The extent and nature of children's real-time exposure to alcohol marketing using wearable cameras and GPS devices

By

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Abstract

Alcohol places substantial financial, physical, social and psychological burdens on society. There is mounting evidence that childhood exposure to alcohol marketing increases the likelihood children will begin drinking, and current drinkers will increase consumption. However, children's exposure to alcohol marketing is typically measured using self-report data, television viewing data or street marketing audits, which are subject to bias and often do not provide quantifiable rates of daily exposure. This study uses an innovative methodology to quantify the extent and nature of children's real-time exposure to alcohol marketing using wearable cameras and GPS devices.

Children aged 11-13 years (n=167) were randomly selected from 16 schools in Wellington, New Zealand. The children wore wearable cameras that automatically captured images approximately every seven seconds and GPS devices that captured latitude and longitude coordinates every five seconds for a four-day period between June 2014 and July 2015. Content analysis of images (n = 700,000) was manually undertaken to assess children's exposure to alcohol marketing. Image data were linked to GPS data to examine the spatial patterning of children's exposure to alcohol marketing.

On average, children were exposed to alcohol marketing 12.4 (95% CI 9.1, 17.1) times per 10 hours, excluding within supermarkets. Children were exposed at home (73%), on-licence alcohol outlets (9%), off-licence shop fronts (5%) and sporting venues (5%). Children were exposed via product packaging (62%), sports sponsorship (11%) and shop front signage (11%). There were stark differences in exposure by sociodemographic characteristics with exposure rates for Māori 5.4 times higher than New Zealand European children and boys 2.0 times higher than girls. In addition, children were exposed to alcohol marketing within supermarkets 3.3 times per week. Children were exposed to alcohol marketing on 85% of their visits to supermarkets for an average of 46 seconds per exposure.

In New Zealand, the findings provide strong evidence to support the Law Commission and Ministerial Forum on Alcohol Advertising and Sponsorship recommendations for legislative restrictions on alcohol marketing, in particular, a ban on alcohol sponsorship of sport. These findings highlight the urgent need for strict legislative restrictions on all

forms of alcohol marketing as called for in the World Health Organization's Global Alcohol Strategy. Given the global nature of alcohol marketing, these findings may be applicable in other jurisdictions.

Acknowledgements

This thesis is the result of a collective effort of supervisors, colleagues, funders, study participants, friends and family. It has been one of the greatest challenges of my professional career. One that has simultaneously provided a source of frustration, validation and enjoyment.

To my supervisors Professor Louise Signal, Dr Moira Smith and Assistant Professor Amber Pearson I extend a huge thank you! Throughout my PhD, you have provided valuable advice and challenged me to fulfil my potential. Your support has extended far beyond this thesis, including support for my other academic pursuits, scholarship applications and sporting goals. In addition, I would like to thank Professor Ichiro Kawachi and Assistant Professor Amber Pearson for hosting me for one year as part of this thesis at Harvard University and Michigan State University. My Fulbright experience at Harvard and Michigan State was a once in a lifetime experience and something that has assisted my transition into a career in academia.

This thesis would simply not be possible without the vision and dedication of the Kids'Cam team, specifically Professor Louise Signal, Professor Cliona Ni Mhurchu, Dr Moira Smith, Dr James Stanley and soon to be Dr Michelle Barr. The ever-expanding research team, projects and overall interest in all Kids'Cam research has rewarded your foresight and belief in the potential of the Kids'Cam method.

I also thank all the funders that supported Kids'Cam and my PhD project. Thank you to the Health Research Council of New Zealand for funding Kids'Cam. Also to the University of Otago for funding my PhD programme through the Special Health Research Scholarship and Fulbright New Zealand for funding my tenure at Harvard University and Michigan State University as a Visiting Scientist. I would also like to thank the Division of Health Sciences and the University of Otago, Wellington for proving funding for my attendance at conferences in Brazil and France.

I would like to thank all the staff and students at the University of Otago, Wellington for your support over the past three years; in particular, the staff and students within the Department of Public Health.

The Kids'Cam team and I extend our gratitude to the parents, children and schools that let us into their lives to find ways we can improve the health of our children.

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Statement of participation

This thesis was conducted as part of Kids'Cam, a study funded by a Health Research Council of New Zealand (programme grant #13/724). Kids'Cam was funded to quantify the nature and extent of children's exposure to food and non-alcoholic beverage marketing using wearable cameras. Kids'Cam included 168 randomly selected Year 8 children from 16 randomly selected schools across the Wellington region. Kids'Cam was one of five studies that formed the Dietary Interventions: Evidence and Translation (DIET) programme, a five-year programme of research focused on informing national and international policies on the most effective and cost-efficient ways to improve population diets and health. DIET was a collaborative research programme led by Professor Cliona Ni Mhurchu (CNM) at the National Institute for Health Innovation (NIHI) at the University of Auckland with collaborators at the University of Otago, Wellington, and The George Institute for Global Health and Oxford University. Further information about DIET can be found at https://diet.auckland.ac.nz/.

The Kids'Cam research team

Kids'Cam was led by Professor Louise Signal (LS), at the University of Otago, Wellington. The Kids'Cam research team consisted of Dr Moira Smith (MS), Dr James Stanley (JS), Dr Gabrielle Jenkin (GJ), Miss Tolotea Lanumata (TL), Miss Michelle Barr (MB), Mr Tim Chambers (TC), Miss Christina McKerchar (CM). Assistant Professor Amber Pearson (AP), Professor Janet Hoek (JH), Dr Cathal Gurrin (CG), Professor Alan Smeaton (AS), Dr Zhengwei Qiu (ZQ), Dr Jiang Zhou (JZ), Aaron Duane (AD). Māori oversight for Kids'Cam was provided by Toi Tangata, as part of the DIET Advisory Group and by Christina McKerchar (Ngāti Kahungunu, Tūhoe and Ngāti Porou descent).

In addition to the collaboration with NIHI, Kids'Cam was also a collaboration with researchers at the Insight Centre for Data Analytics at Dublin City University (DCU). The team from DCU included AS, CG, ZQ, JZ and AD. These researchers developed software to review the wearable camera images and upload the images to the Kids'Cam server. The team at DCU also developed coding software that enabled us to attach codes directly to the images. Further, they worked with JS (Kids'Cam biostatistician) to develop the back end of the software to translate the image codes into numerical data for statistical analysis

This thesis was also assisted by two researchers from Michigan State University; Chris Lowrie (CL) and Zachery Rzotkiewicz (ZR). (CL) wrote the Python script for the automated imputation method, and (ZR) integrated the ST-DBSCAN algorithm into the software application used for the destination analysis.

My role in Kids'Cam

Data collection

Between February 2015 and June 2015, I was involved in 15 of the 25 data collection cycles at 11 different schools. I led data collection in 13 of 15 of the data collection cycles and assisted MB on the other two. In total, I collected data for 86 participants (51% of all Kids'Cam participants).

Image coding

I assisted MB in the development of the Kids'Cam coding framework and had a substantial role in testing and refining it. I contributed to the development of the coding rules and coding protocol document. Along with MB, I was a gold standard image coder for Kids'Cam, responsible for training other coders.

My role in Kids'Cam Alcohol

Kids'Cam Alcohol is the name for the study that was conducted as part of this thesis and is used to differentiate between the main Kids'Cam project outlined above.

Image data

I developed the coding schedule for Kids'Cam Alcohol, using concepts from Kids'Cam, which I also helped develop. I coded all images, outside school time, for 167 of the participants with valid image data (approximately 700,000 images).

GPS data

As mentioned above, in total, I collected data for 86 participants (51% of all Kids'Cam participants), including their GPS data. I converted all 150 participants' GPS data (150 of the 168 had valid GPS data) from GPX files into Shapefiles using ArcGIS (ESRI, Redlands, CA). I led the development of the GPS data cleaning protocol and conducted the data cleaning for all participants' GPS data. I led the development of an imputation method for missing GPS data (working with CL) and then conducted the automated and manual imputation for all 150 participants with GPS data. Finally, I led the development of a software application for destination analyses of GPS data (working with ZR) and conducted the destination analyses of children's GPS data. These methods are outlined in detail in Chapter Five.

Data analysis

I conducted all the Kids'Cam Alcohol analyses. I used the sampling weights developed and used in Kids'Cam by JS, the Kids'Cam biostatistician. Statistical advice was provided by JS, in particular for Chapter Seven of this thesis. AP also provided statistical and spatial advice on the spatial analyses conducted in Chapters Six and Eight.

Supervision and advisory team

Professor Louise Signal, Lead Supervisor: Professor Signal is the Director of the Health Promotion and Policy Research Unit at the University of Otago, Wellington. Professor Signal provided supervision on all aspects of this thesis and is the lead investigator on Kids'Cam.

Dr Moira Smith, Supervisor: Dr Smith is a Senior Research Fellow in the Health Promotion and Policy Research Unit at the University of Otago, Wellington. Dr Smith provided supervision on all aspects of this thesis and is also a named investigator on Kids'Cam.

Assistant Professor Amber Pearson, Supervisor: Assistant Professor Pearson is a Health Geographer based at the Department of Geography, Environmental and Spatial Sciences at Michigan State University. Assistant Professor Pearson provided supervision on all aspects of the spatial data cleaning and analyses conducted in this thesis and other

Kids'Cam studies. Assistant Professor Pearson hosted me at Michigan State University formally between February-March 2016 and informally multiple times between March 2016 and February 2017 while I was at Harvard University on a Fulbright Scholarship.

Dr James Stanley, Advisor: Dr Stanley is a Senior Research Fellow and biostatistician at the University of Otago, Wellington. Dr Stanley developed the statistical analysis plan for Kids'Cam as the named biostatistician for the project. Dr Stanley extracted the coded image data from the DCU software, provided sampling weights to account for the complex sampling strategy and advised on all statistical analyses conducted in this thesis.

Professor Ichiro Kawachi, Advisor: Professor Kawachi is the Chair of the Department of Social and Behavioral Sciences at T.H.Chan School of Public Health at Harvard University. Professor Kawachi hosted me at Harvard University from March 2016-February 2017 as a Visiting Scientist as part of my Fulbright scholarship. Professor Kawachi provided overall advice on this thesis and specifically the neighbourhood analyses.

Publications arising from this thesis

Peer-reviewed journal articles

Chambers T, Stanley J, Smith M, Pearson A, Barr M, Ni Mhurchu C, Signal L. Quantifying the nature and extent of children's real-time exposure to alcohol marketing in their everyday lives using wearable cameras: children's exposure via a range of media in a range of key places. Alcohol and Alcoholism. (2018); agy053. https://doi.org/10.1093/alcalc/agy053

Chambers T, Pearson AL, Kawachi I, Rzotkiewicz Z, Stanley J, Barr M, Smith M, Ni Mhurchu C, Signal L. Kids in space: measuring children's residential neighborhoods and other destinations using activity space GPS and wearable camera data. Social Science and Medicine. 2017;193:41-50. https://doi.org/10.1016/j.socscimed.2017.09.046

Chambers T, Pearson AL, Stanley J, Smith M, Barr M, Ni Mhurchu C, Signal L. Children's exposure to alcohol marketing within supermarkets: an objective analysis using GPS technology and wearable cameras. Health & Place. 2017;46:274-80. https://doi.org/10.1016/j.healthplace.2017.06.003

Conference presentations

Chambers T, Signal L, Kawachi I, Pearson AL, Smith M, Stanley J. [Oral Presentation] "Quantifying the extent of children's exposure to alcohol marketing using wearable cameras" (Global Alcohol Policy Conference, October 4, 2017, Melbourne, Australia).

Chambers T, Pearson AL, Rzotkiewicz Z, Signal L, Smith M, Stanley J, Ni Mhurchu C. [Oral Presentation] "Kids in space: measuring children's neighbourhoods and mobility patterns using wearable cameras and GPS technology" (17^{th} International Medical Geography Symposium, July 2, 2017, Angers, France).

Chambers T, Pearson AL, Signal L, Smith M, Stanley J, Ni Mhurchu C. [Oral Presentation] "The spatial distribution of children's exposure to alcohol marketing: a novel method using wearable cameras and GPS technology" (17^{th} International Medical Geography Symposium, July 2, 2017, Angers, France).

Chambers T, Signal L, Smith M, Stanley J, Pearson AL. [Oral Presentation] "Bombarded with booze: children's exposure to on-site marketing at alcohol outlets" (22nd International Union of Health Promotion and Education World Conference, May 23, 2016, Curitiba, Brazil).

Selected media highlights

"Should alcohol advertising be banned from sport" Interview with John-Michael Swannix, *Newshub Nation*, April 24, 2018, http://www.newshub.co.nz/home/shows/2018/04/shoudl-alcohol-advertising-be-banned-from-sport.html

"Children becoming less active and independent, New Zealand study finds" by Eleanor Ainge Roy, *The Guardian (World)*, November 13, 2017, https://www.theguardian.com/world/2017/nov/13/children-less-active-independent-health-new-zealand-study-finds

"Wearable cameras have found our children are not venturing far" Interview with Jim Mora, *The Panel*, *Radio New Zealand*, November 13, 2017, http://www.radionz.co.nz/national/programmes/thepanel/audio/2018621463/wearable-cameras-have-found-our-children-are-not-venturing-far

"Researchers use body cameras on children as part of alcohol exposure study" Interview with Kate Nicol-Williams, *One News*, October 11, 2017, https://www.tvnz.co.nz/one-news/new-zealand/researchers-use-body-cameras-children-part-alcohol-exposure-study

"Alcohol in supermarkets targets kids" Interview with Jesse Mulligan, *Radio New Zealand*, October 11, 2017, http://www.radionz.co.nz/national/programmes/ afternoons/audio /2018617456/alcohol-in-supermarkets-targets-kids

"Kids in space study: where do our children go?" Interview with Jack Tame, *Breakfast*, *One News*, November 10, 2017.

"Call to ban alcohol in supermarkets after cameras reveal over-exposure to children" by Madison Reidy, *Stuff (Business)*, October 11, 2017, https://www.stuff.co.nz/business/industries/97763336/call-to-ban-alcohol-in-supermarkets-after-cameras-reveal-overexposure-to-children

Prizes

Special Health Research PhD Scholarship, University of Otago
Description: Intended to provide personal support for outstanding graduate students who are contemplating a career in health research.

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Description: Fulbright New Zealand General Graduate Awards are for promising New Zealand graduate students to undertake postgraduate study or research at US institutions in any field. I had a joint appointment at Harvard University under the supervision of Professor Ichiro Kawachi and Michigan State University under the supervision of Assistant Professor Amber Pearson.

PhD Research Prize (Social Science), University of Otago, Wellington
Description: Criteria includes work resulting in peer-reviewed publications and has the potential to make an important difference to the health status of individuals or populations.

Timeframe for thesis

Kids'Cam data was collected from July 2014 to June 2015. I started data collection in February 2015, halfway through the data collection for Kids'Cam. Between February 2016 and March 2017 I lived in Boston, US, while I was hosted at Harvard University as part of a Fulbright scholarship. During this time, I also made multiple short trips to Michigan State University to work with Assistant Professor Amber Pearson on the spatial elements of my thesis. I took one deferral of two months during this thesis timeline to coach the New Zealand Junior Women's Water Polo Team in Volos, Greece in 2017. In addition to my thesis, I was involved in a number of different Kids'Cam projects including research on children's exposure to bluespace, sun-safety and food marketing. Further, I researched alcohol and sport and wrote a paper from my undergraduate dissertation. Papers from this additional work are presented below.

Other related publications produced during this thesis

Gage R, Leung W, Stanley J, Reeder T, Mackay C, **Chambers T**, Smith M, Barr M, Signal L. Studying third-parties and environments: a New Zealand sun-safety case study. Health Promotion International. 2017; Dec 15. https://doi.org/10.1093/heapro/dax094

Gage R, Leung W, Stanley J, Reeder A, Barr M, **Chambers T**, Smith M, Signal L. Sun protection among New Zealand primary school children. Health Education and Behavior. 2017; Dec 1. https://doi.org/10.1177%2F1090198117741943

Signal L, Stanley J, Smith M, Barr M, **Chambers T**, Zhou J, Dunae A, Gurrin C, Smeaton AF, McKerchar C, Pearson AL, Hoek J, Jenkin GLS, Ni Mhurchu C. Children's everyday exposure to food marketing: an objective analysis using wearable cameras. International Society of Behavioural Nutrition and Physical Activity. 2017;14:137. https://doi.org/10.1186/s12966-017-0570-3

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Pearson AL, Bottomley R, **Chambers T**, Thornton L, Stanley J, Smith M, Barr M, Signal L. Measuring blue space visibility and 'blue recreation' in the everyday lives of children in a capital city. International Journal of Environmental Research and Public Health. 2017;14(6):563. http://dx.doi.org/10.3390/ijerph14060563

Signal L, Smith M, Barr M, Stanley J, **Chambers T**, Zhou J, Duane A, Jenkin G, Pearson AL, Gurrin A, Smeaton A, Hoek J, Ni Murchu C. Kids'Cam: a new methodology to objectively study children's exposure to food marketing and other aspects of their lives. American Journal of Preventive Medicine. 2017;53(6):e89-e95. http://dx.doi.org/10.1016/j.amepre.2017.02.016

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Chambers T, Shaw S. Female water polo players' experiences of male coaches' approaches to pain and injury. Graduate Journal of Sport and Exercise & Physical Education Research. 2016; 4:29-42. http://www.worcester.ac.uk/gjseper/

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List of abbreviations and acronyms

ASA	Advertising Standards Authority
ARLA	Alcohol Regulatory and Licensing Authority
BSA	Broadcasting Standards Authority
CPTPA	Comprehensive and Progressive Trans-Pacific Agreement
CST	Consumer Socialization Theory
DALYs	Disability-Adjusted Life Years
DCU	Dublin City University
DLC	District Licensing Committee
FASD	Fetal Alcohol Spectrum Disorder
FCAC	Framework Convention on Alcohol Control
FCTC	Framework Convention on Tobacco Control
FSANZ	Food Standards Australia and New Zealand
GDP	Gross Domestic Product
GIS	Global Information System
GPS	Global Positioning System
GPSAS_Destinations	Global Positioning System Activity Space Destinations
HRC	Health Research Council of New Zealand
IQR	Interquartile Range
LAP	Local Alcohol Policy
NZ	New Zealand
NZE	New Zealand European
NZDep	New Zealand Index of Deprivation (an area-based measure of deprivation)
NZiDep	New Zealand Index of Deprivation for Individuals (a household-level measure of deprivation)
MAUP	Modifiable Areal Unit Problem
MFAAS	Ministerial Forum on Alcohol Advertising and Sponsorship
MoE	Ministry of Education
MoJ	Ministry of Justice
MV	Multivariable
PSNB	Population-Specific Neighbourhood Buffers
RR	Rate Ratio
SNS	Social Networking Sites
SSAA	Sale and Supply of Alcohol Act

ST-DBSCAN	Spatial-Temporal Density-Based Spatial Clustering of Applications with Noise
TA	Territorial Authority
UN	United Nations
UoO	University of Otago
UV	Univariate
WHO	World Health Organization
WTO	World Trade Organization
95% CI	95% Confidence Interval

CHAPTER ONE: INTRODUCTION

1.1 Introduction

Alcohol is a toxic substance that has a wide range of adverse direct and indirect effects on human health (1). Globally, there are 3.3 million alcohol-attributed deaths each year, accounting for 5.9% of all deaths (2). Children and young people are particularly susceptible to alcohol-related harm due to their developing brains and inexperience with the risks of alcohol consumption (3). Early onset drinking is linked with various adverse psychological, physical and social outcomes, such as alcohol dependence (4), involvement in motor vehicle crashes (5), decreased neurological functioning (6), and risky or unwanted sexual interactions (7). In New Zealand (NZ), over half (57%) of children aged 15-17 consume alcohol, with 7.8% drinking hazardously (8).

There is mounting evidence, including multiple systematic reviews, that demonstrates childhood exposure to alcohol marketing is associated with early onset drinking, frequent and hazardous alcohol consumption (9-11). Most countries have self-regulatory codes for alcohol marketing, which involves industry developing and enforcing its own codes of marketing practice. Self-regulation primarily focuses on traditional promotion types, and as such is inadequately equipped to address new forms of promotion in the alcohol industry's expanding marketing strategy (12). Digital marketing, sponsorship and in-store promotions are outside the scope of most self-regulatory systems and have overtaken traditional forms of alcohol marketing (13). A recent systematic review of the effectiveness of self-regulation of alcohol marketing concluded that "self-regulatory systems that govern alcohol marketing practices are not meeting their intended goal of protecting vulnerable populations" (12, p.45). Self-regulatory codes are often weak compared to legislated restrictions, and in countries with self-regulatory systems, the industry has failed to adequately adhere to the codes it has implemented (12).

Alcohol marketing exposure studies typically rely on self-report measures, Likert scale responses or proxies for children's exposure to alcohol marketing that are subject to measurement error (9, 10). Further, these methods do not provide a quantifiable measure of children's daily exposure to alcohol marketing in all places and via all promotion types. As such, we know very little about the extent of children's exposure to alcohol marketing (how often are they being exposed) and the nature of their exposure (where children are being exposed and via what promotion type). The use of wearable cameras and Global Positioning System (GPS) devices may overcome the limitations of previous research, and provide answers about the extent and nature of children’s real-time exposure to alcohol marketing.

This thesis aims to provide a real-time measure of the extent and nature of children’s exposure to alcohol marketing by using wearable cameras, which automatically capture an image every seven seconds, and GPS devices that record latitude and longitude coordinates every five seconds. Using this novel methodology, this thesis aims to provide a quantifiable measure of children’s exposure to alcohol marketing highlighting the extent of the problem. Further, the results may identify places or promotion types for intervention, contributing to the reduction of children’s exposure to alcohol marketing. Policymakers and advocates could use quantifiable measures of children’s real-time exposure to alcohol marketing to inform policy decisions and create healthier environments for children.

The research conducted in this thesis was part of a larger study called Kids’Cam conducted in the Wellington region of New Zealand. Kids’Cam aimed to understand the world in which children live and how it impacts their health. Kids’Cam was initially funded by the Health Research Council of New Zealand (HRC) to investigate children’s exposure to food marketing. This current research investigates children’s exposure to alcohol marketing using the Kids’Cam dataset.

Specifically, this thesis aims to answer the following central research question:

- What is the extent and nature of children’s real-time exposure to alcohol marketing?

and the following sub-questions:

- How does children’s exposure to alcohol marketing differ by sociodemographic characteristics?

- What is the frequency, duration and nature of children’s exposure to alcohol marketing within off-licence alcohol outlets?

- What factors predict children's exposure to alcohol marketing in their residential and school neighbourhoods?
- Can wearable cameras and GPS devices be used to accurately and reliably measure children's exposure to alcohol marketing?
- Can an effective imputation method be developed for missing GPS data?
- What is the extent of children's neighbourhoods?
- What destinations do children visit that may be important for their health?

1.2 Thesis structure

This chapter introduces this thesis and outlines its purpose. Chapter Two provides an outline of the extent and nature of alcohol-related harm globally and in NZ. It also examines the prevalence of children's early onset drinking and hazardous alcohol consumption. The chapter concludes by discussing the effectiveness of policy interventions for reducing alcohol-related harm using the World Health Organization's (WHO) Global Alcohol Strategy (14).

Chapter Three focuses on alcohol marketing restrictions as a demand-side population policy intervention to reduce alcohol-related harm. Restricting alcohol marketing is one of the three 'best buys' for reducing alcohol-related harm outlined by WHO (14). The three 'best buys' include restricting marketing, restricting availability and increasing taxation (14). The chapter examines the relationship between children's exposure to alcohol marketing and alcohol-related harm. Finally, using international examples, possible policy interventions for restricting alcohol marketing are examined.

Chapter Four discusses alcohol availability as a demand-side rather than supply-side policy intervention. Specifically, this thesis examines alcohol availability as a risk factor for children's overall exposure to alcohol marketing. Thus, this thesis argues alcohol availability contributes to children's exposure to alcohol marketing and the normalisation of alcohol. The evidence of the relationship between alcohol availability and childhood drinking is discussed to highlight how alcohol outlets and their associated marketing may influence children's alcohol-related outcomes. To highlight the possible methodological advantages of using wearable cameras and GPS devices, limitations in the current measures of alcohol availability research are examined. Finally, policy interventions to restrict alcohol availability that could reduce children's exposure to alcohol marketing are examined.

Chapter Five outlines the methods used in this thesis, notably the tandem use of wearable cameras and GPS devices. In addition, this chapter outlines a number of other novel methodological tools developed during this research.

The results of this thesis are presented in three chapters. Chapter Six presents methodological results, which include: assessing the effectiveness of a GPS data imputation method, the results of a neighbourhood extent analysis using population-specific neighbourhood buffers (PSNB) and validation of a destination detection application. Chapter Seven presents the results from the content analysis of image data to determine the extent and nature of children's real-time exposure to alcohol marketing, which answers the central research question in this thesis. Chapter Eight presents the spatial results of children's neighbourhood exposure to alcohol marketing and exposure to alcohol marketing within alcohol outlets using micro-spatial analysis.

Chapter Nine concludes this thesis with a discussion of the findings. It begins by contextualising the findings in relation to the current literature on children's exposure to alcohol marketing. Next, this chapter summarises the methodological contributions of this thesis. The strengths and limitations of the current research are then outlined. Finally, the chapter concludes with a discussion of the policy implications and recommendations from this thesis at local, national and international levels in order to reduce children's exposure to alcohol marketing and associated alcohol-related harm.

CHAPTER TWO: ALCOHOL "NO ORDINARY COMMODITY"

> *Globally, harmful use of alcohol causes approximately 3.3 million deaths every year (or 5.9% of all deaths), and 5.1% of the global burden of disease is attributable to alcohol consumption. We now have an extended knowledge of the causal relationship between alcohol consumption and more than 200 health conditions, including the new data on causal relationships between the harmful use of alcohol and the incidence and clinical outcomes of infectious diseases such as tuberculosis, HIV/AIDS and pneumonia. Considering that beyond health consequences, the harmful use of alcohol inflicts significant social and economic losses on individuals and society at large* (2, p.vii).

2.1 Introduction

This chapter presents the central public health issue of this thesis, alcohol-related harm, and the mechanisms for its reduction. The chapter commences with an overview of the burden of alcohol-related harm, including alcohol's contribution to mortality, disability-adjusted life years (DALYs), fetal alcohol spectrum disorder (FASD), social problems and financial costs. Next, the prevalence of frequent and hazardous childhood drinking is outlined, with a focus on alcohol-related problems associated with early onset drinking. Public health approaches to reducing alcohol-related harm are discussed, with a specific focus on alcohol marketing and availability restrictions, including in NZ.

2.2 Global burden of alcohol-related harm

The global burden of alcohol-related harm includes a raft of physical, social and financial costs. Before providing an overview of these harms, this section briefly defines some common terms used in the thesis, including low-risk, harmful and hazardous drinking.

2.2.1 Defining low-risk, harmful and hazardous drinking

Low-risk alcohol consumption is defined differently from country to country, with no internationally agreed definition. In the United Kingdom (UK) and the United States of America (US), low-risk alcohol consumption is considered less than 14 standard drinks per week for men and seven standard drinks for women, distributed evenly over multiple drinking occasions (15, 16). In NZ, low-risk alcohol consumption is defined as two standard drinks a day for women, with no more than 10 per week; and three standard drinks a day for men, with no more than 15 per week (17).

Harmful alcohol use causes adverse health, social and financial consequences. WHO defines the harmful use of alcohol as "drinking that causes detrimental health and social consequences for the drinker, the people around the drinker and society at large, as well as the patterns of drinking that are associated with increased risk of adverse health outcomes" (2, p.2).

Hazardous drinking is a pattern of alcohol consumption that exceeds the upper limits of low-risk definitions (18). For example, the UK National Institute on Alcohol Abuse and Alcoholism and US Centers for Disease Control and Prevention defines hazardous drinking as consuming more than four drinks for women or five drinks for men, per day (16, 19).

With no internationally agreed definition and inconsistencies between countries (18), there are no universal definitions of low-risk, harmful and hazardous drinking. However, the distinction between these measures of drinking is less relevant to this current thesis as no low-risk level of alcohol consumption exists for children, therefore for children, any drinking is likely to be harmful and is therefore referred to as such.

2.2.2 Mortality rates, cancer and infectious diseases

Worldwide, harmful alcohol use is a top five risk factor for death and disease (20). Globally, alcohol contributes to an estimated 3.3 million deaths each year (5.9% of all deaths) (2). There are over 200 alcohol-associated disease and injury conditions that contribute to alcohol-attributed deaths (21). For example, alcohol consumption causes alcohol dependence and liver cirrhosis (20). There is also sufficient evidence to demonstrate that alcohol consumption is carcinogenic to humans, the International Agency for Research on Cancer classified alcohol as a Group 1 carcinogen (22). A meta-analysis of 572 studies examining the relationship between alcohol consumption and cancer (including 486,538 cancer cases), concluded that alcohol contributes to a range of cancers, including cancers of the oral cavity, larynx, pharynx, oesophagus, colon, liver and female breast (23). Further, the meta-analysis revealed a clear dose-response relationship between higher levels of alcohol consumption and an individual's likelihood of having cancer (23). In addition, a growing body of research suggests alcohol use increases the incidence of infectious diseases, such as tuberculosis (24), pneumonia (25) and HIV/AIDS (26). While alcohol causes a substantial number of deaths, cancers and infectious diseases, further damage is caused by alcohol consumption.

2.2.3 Disability-adjusted life years (DALYs)

Alcohol contributes to an estimated 4.6% of global DALYs (27), exceeding those attributed to tobacco (4.1%) (27). Health researchers use DALYs to measure the overall health burden of a particular health-related exposure by also accounting for years of life lost due to disability (1). DALYs enable the quantification of alcohol-related harm, including non-fatal alcohol-related conditions (eg, depression). The top four health consequences contributing to alcohol-attributed DALYs are neuropsychiatric diseases (36.4%), injuries (35.9%), liver cirrhosis (9.5%) and cardiovascular disease (9.5%) (1). Babor, Caetano et al. (1) suggest alcohol-related DALYs underestimate actual levels of disease burden as calculations use conservative criteria and exclude infectious diseases, despite the growing body of evidence of the latter's association with alcohol (24-26).

2.2.4 Fetal Alcohol Spectrum Disorder (FASD)

FASD is the spectrum of disorders caused by maternal alcohol consumption during pregnancy (28). FASD causes adverse outcomes, including poor academic performance, inadequate social relationships and inability to live independently (29). A systematic review of the global prevalence of FASD estimates it to be 23 cases per 1,000 births (28). However, rates vary substantially between countries, with South Africa experiencing 113 cases per 1,000 births, whereas, in Australia, the rate is one case per 1,000 births. In a systematic review of the financial burden of FASD, estimates from Canadian studies ranged between CAN$130 million and CAN$5.4 billion per year, while estimates in US studies suggest the cost is up to US$5.5 billion per year, within their respective countries (29). Currently, there appears to be no estimated global economic burden of FASD, however, it is likely to be a significant contributor to the overall global economic burden of alcohol-related harm.

2.2.5 Social consequences

The social consequences of harmful alcohol use can impact upon individuals' work, social and family life (1). Rehm and Rossow (30) demonstrate alcohol causes a number of work-related problems including, but not limited to, absenteeism, staff turnover, disciplinary problems and poor co-worker relations. Research links harmful alcohol use with a range of violent behaviours, including violence against intimate partners (31) and children (32). Alcohol is a known risk factor for sexual assault, with approximately half of all sexual assaults involving alcohol use by the perpetrator, victim or both (33).

Harmful alcohol use increases the likelihood of adverse sexual outcomes. For example, a meta-analysis investigating the association between alcohol consumption and HIV found overall alcohol consumption, alcohol consumption before or at the time of intercourse and hazardous drinking increased the risk of contracting HIV (26). Likewise, a systematic review looking at the association between alcohol consumption and sexually transmitted diseases concluded alcohol consumption increases the likelihood of contracting a sexually transmitted disease (34). A meta-analysis investigating the link between alcohol consumption and intentions to have unprotected sex used the pooled results of 12 studies to show that for every 0.1% mg increase in blood alcohol concentration, the likelihood of having unprotected sex increased by 2.9% (35). The link between alcohol use and unprotected sex supports the observed associations between alcohol use, HIV, and sexually transmitted diseases outlined above. This review is by no means an exhaustive list of the social consequences of harmful alcohol use, however, it indicates the multi-faceted nature of alcohol-related harm.

2.2.6 Financial costs

The financial costs of harmful alcohol use provide added weight to arguments for more restrictive alcohol control policies, particularly in countries where externalities are high (1). A systematic review of 20 studies from 12 countries estimated the economic burden of alcohol on countries' gross domestic product (GDP) ranges from 0.5 to 5.4% (36). Similarly, another systematic review calculated alcohol-related harm costs in high- and middle-income countries at between 1.3 and 3.3% of their GDP (27). These findings are consistent with Baumberg (37) who concluded that the global cost of alcohol-related harm was between US$210 and US$655 billion per year. Of the countries examined, the financial cost of alcohol-related harm was between 0.3 and 5.5% of their GDP (37). Although costs were calculated differently across the studies, the costs included the direct costs of health care, law enforcement, and property damage, and the indirect costs associated with premature mortality, reduced productivity and lost employment (36). Typically, lost productivity is the largest economic cost of alcohol contributing, on average, 72% of the total costs, followed by health care (13%) and criminal justice (4%) (27). A recent US study found that, in 2010, alcohol-related harm cost the US economy $US249 billion, an average of $2.05 for every alcoholic drink sold, and a per capita cost of $807 per year (38). Moreover, the study found that federal, state and local governments directly absorbed around $US100 billion (40%) of the total cost of alcohol-related harm (38), a result that demonstrates a substantial waste of public funds. This finding provides further evidence for the implementation of effective alcohol control policies.

2.3 The burden of alcohol-related harm in New Zealand

NZ mirrors global trends of alcohol-related harm and in most categories tends to exceed them. In NZ, harmful alcohol use remains one of the highest preventable causes of death and hospitalisation (39). The most recent NZ evidence estimates 5.4% of all deaths are attributable to alcohol use, resulting in over 13,000 years of life lost annually (40). Alcohol-attributed deaths include injuries sustained while drunk (43%), cancer (30%) and other diseases (27%). In addition to premature death, alcohol contributes 6.5% (global average = 4.6%) of all DALYs, which equates to approximately 28,400 years of healthy life lost per year (40).

Harmful alcohol use places a substantial burden on the NZ criminal justice system. In 2009, the NZ Police reported alcohol was a contributing factor in 31% of all offences (41). Additionally, in 2013, 41% of detainees in NZ Police stations were drinking immediately before their arrests (42). Each year, persons under the influence of alcohol commit approximately 60,000 physical assaults and 10,000 sexual assaults (43). In 2007, the NZ Crime and Safety Survey found offenders were drinking in 44% of physical assaults in a public place and 34% of physical assaults in private places (44). Consequently, it is likely alcohol contributes to NZ’s high domestic violence rates. For example, in 2016, the NZ Police investigated over 118,000 incidents of family violence, or one every five minutes (45). Further, it is estimated only one in four incidences of family violence is reported (45). It is likely alcohol control policies could substantially reduce these statistics.

The financial costs of alcohol-related harm place a major burden on NZ's economy. The latest estimated tangible cost of alcohol-related harm in NZ is NZ$5.3 billion (46). Alcohol-related harm is estimated to cost between 1.4% and 4.7% of NZ's GDP (37) with the most recent estimate of 2.5% in 2005/2006 (46). In 2008, 3.2% of New Zealanders reported alcohol impacted their work, study or employment opportunities (47). An estimated 147,000 people aged 15+ take one or more days off work or school per year due to alcohol use, contributing to an estimated 392,000 days of lost productivity (48). In addition to absenteeism, almost 10% of NZ adults go to work under the influence of alcohol one or more times per year (48). In 2007, around 68,900 people (3% of people aged 18+) reported operating heavy machinery while under the influence of alcohol (48).

Rates of hazardous drinking in NZ have increased every year since 2007 (8, 49), reflected in the levels of alcohol-related harm. These hazardous drinking rates have persisted despite the changing demographic composition of NZ that should have mitigated some of this upward trend. For example, Asian adults are less likely to be past-year drinkers or to drink hazardously than New Zealand European (NZE) adults (8). In 2007, only 5% of the NZ population was Asian compared to 12% in 2017 (50).

In NZ, alcohol-related harms disproportionately affect particular sociodemographic groups. For example, Māori are 2.5 times more likely to die from alcohol-attributable causes than other New Zealanders (40). In addition, Māori are more likely than other New Zealanders to be arrested by the Police for an offence involving alcohol and experience ill-effects of alcohol-related injuries, unemployment and financial loss (48). Similar, people living in areas of highest deprivation experience the highest levels of hazardous drinking and its associated harms (48).

2.4 Children's drinking

The prevalence of frequent and hazardous drinking by children reflects trends in adult populations, albeit at a reduced level due to policies restricting children's access to alcohol. In this thesis, child is defined using The United Nations (UN) Convention on the Rights of the Child definition "every human below the age of eighteen years" (51, Article 1). This section provides an overview of the prevalence of children's frequent drinking and hazardous alcohol consumption. However, most surveys focus on children aged 15-17, as methodological and ethical constraints mean it is difficult to obtain reliable numbers for younger children. The section concludes by outlining the immediate and long-term adverse effects of children's early onset drinking.

2.4.1 The prevalence of frequent drinking in children

Globally, the prevalence of lifetime drinking among children aged 15-19 is 46.1% (2). In countries where alcohol consumption is more common, such as Australia, the UK and NZ, the prevalence of youth drinking is higher (2, 52). The 2011 European School Survey Project on Alcohol and Other Drugs found that in all countries surveyed (except Iceland), over 70% of all children aged 15-16 had consumed alcohol (52), with over half consuming alcohol in the previous 30 days (52).

In NZ, the Ministry of Health found over 50% of children (aged 15-17) had consumed alcohol, which has remained unchanged since 2011 (8, 53) and exceeds the global average (46.1%) (2). In 2013, another Ministry of Health study found two in five children reported drinking before age 15 (54).

2.4.2 The prevalence of hazardous drinking in children

Globally, child drinking patterns involve drinking more per drinking occasion or drinking more hazardously than adults (55). The average monthly occurrence of hazardous drinking among children is 11.7%; in the adult population, it is 7.5% (2). The prevalence of hazardous drinking is higher in the Western Pacific Region, with 12.5% of children drinking hazardously (2). In NZ, 13% of children aged 15-17 report drinking hazardously, which has remained relatively unchanged since 2012 (11%) (8, 54). These findings suggest that some children regularly drink hazardously.

2.4.3 Early onset drinking and harm

Research has established an association between children's early onset drinking and a range of detrimental psychological, physical and social outcomes in later life. Different definitions of early onset drinking are used in the literature, incorporating a range of ages, including 12 and younger (56), 13 and younger (57), 14 and younger (4), and 15 and younger (58). Consequently, a limitation in synthesising the literature is the ability to compare studies with differing definitions and methodologies.

Alcohol dependence and hazardous drinking

There is a strong body of international evidence demonstrating a link between childhood alcohol consumption and alcohol dependence in later life. Alcohol dependence can affect an individual's performance in social life, at work, and within important relationships (1). In a study of 5,856 adults, 15.9% of participants who began drinking before age 12 met the criteria for alcohol dependence and 13.5% for hazardous drinking (56). Another longitudinal study of 27,616 adults found there was a 400% increase in the risk of developing alcohol dependence for those drinking before age 14 compared to those delaying drinking until age 20 (59). Likewise, Hingson, Heeren et al. (4) found 47% of participants drinking before age 14 developed alcohol dependence in later life, compared to 9% for those delaying drinking until after age 21 (4). Furthermore, the results follow a biological gradient whereby the older the age of drinking onset, the lower the rate of alcohol dependence (4). Similarly, in another longitudinal study, 9.0% and 13.7% of adults drinking before age 14 developed alcohol dependence and hazardous drinking patterns, respectively (56). In contrast, only 1.0% and 2.0% of adults delaying the onset of drinking until age 19 or older developed alcohol dependence and hazardous drinking patterns (56). In NZ, in a 30-year longitudinal nationally-representative study, Odgers, Caspi, et al. (60) concluded that early onset drinking increased the risks of later alcohol dependence, and risks related to sexual activity, violence, and crime.

Neurological functioning

Alcohol is a toxin that has damaging effects on the brain and neurological functioning (1). Children's brains are particularly susceptible to the effects of alcohol given the brain undergoes continual development well beyond the age of 20 (61). Neurological differences in brain matter lead to a range of neurological deficiencies in children who drink alcohol, such as decreased attention span (62, 63), memory (63, 64) and psychomotor speed (62). For example, De Bellis, Clark, et al. (65) used MRI imaging in a case-control study comparing brain structures of children with and without alcohol use disorders (diagnosed by a clinical psychiatrist). Children with an alcohol use disorder had significantly less hippocampal volume (a cerebral feature critical to learning new information and forming memories) than healthy controls matched to cases on age and sex (65). More recently, McQueeny, Schweinsburg, et al. (66) found childhood hazardous drinking reduced the quality of brain white matter, which is responsible for the connection and communication between the brain stem, motor areas and cortex. Similarly, Lisdahl, Thayer, et al. (67) found reductions in brain white and grey matter volumes in the cerebellum of teenagers aged 16-19 years were associated with the number of drinks they consumed per drinking session.

Motor vehicle crashes

Children's early onset drinking increases their chances of being involved in an alcohol-related vehicle crash, as either a passenger or driver. Babor, Caetano et al. (1) suggest children are particularly vulnerable to alcohol-related vehicle crashes due to their inexperience in driving and tendency to experiment with alcohol. In a US study, Hingson and Zha (5) found that adults who started drinking before age 14 were three times more likely to drive drunk than adults delaying drinking until after age 21. In another US study, adults who started drinking before age 15 or drank to intoxication before age 16 were 1.6 and 2.2 times more likely to drink and drive than participants who delayed drinking, respectively (68). NZ evidence suggests for any given blood alcohol concentration, children are at higher risk of being involved in an alcohol-related crash than adults (69). Collectively, these findings suggest that delaying the onset of drinking may reduce alcohol-related crashes both in childhood and as an adult.

Risky and unwanted sexual activity

Children's alcohol use increases their likelihood of engaging in risky and unwanted sexual activity, with significant adverse consequences. Dermen, Cooper, et al. (70) suggest the link between alcohol consumption and risky or unwanted sexual behaviour is due to the sexual enhancement expectancies and pharmacological effects of alcohol that reduce inhibitions and interfere with decision-making processes. Children's hazardous alcohol use increases risky sexual behaviour and contraction of sexually transmitted diseases (7, 71). Further, children's alcohol use is positively associated with the number of sexual partners (61, 72), earlier engagement in sexual activity (61), unwanted or early pregnancy (71, 73, 74) and regretting sexual activity (75). Girls are three times more likely than boys to become a victim of unwanted sexual activity when they drink hazardously (61). Muram, Hostetler, et al. (76) found that just under half of the female victims of sexual assault consumed alcohol before their assault.

Crime

Research shows children's alcohol use increases delinquent behaviour and criminal activity (77). One explanation for the relationship between alcohol and crime is that alcohol affects the major neurotransmitters in the brain that increase risk-taking and aggressive behaviours among drinkers (78). In a sample of over 800 US participants aged 10-24, Mason, Hitch, et al. (79) demonstrated that early onset drinking and hazardous drinking resulted in a higher likelihood of late childhood and early adulthood criminal behaviour. In a longitudinal study of NZ children, Fergusson, Lynskey, et al. (80) demonstrated harmful alcohol use increased violent offences and property crime. Given the relationship between early onset drinking in children and crime (77, 79, 80), delaying alcohol consumption and reducing the levels of consumption by current child drinkers could reduce childhood criminal behaviour and disrupt children's pathway towards a life of crime as an adult.

2.4.4 Summary

The global prevalence of childhood drinking is high. Childhood alcohol consumption produces a vast and complex range of physical, social and financial harms that not only affect the individual but also substantially affect those around them. Early onset drinking is associated with a range of adverse health outcomes including alcohol dependence, reduced neurological functioning, increased motor vehicle crashes, risky sexual activity and crime. These are major public health issues. Reducing frequent and hazardous alcohol consumption needs to be a priority for improving children's health outcomes and reducing the burden of alcohol-related harm. Central to this is public policy focusing on reducing alcohol-related harm to children.

2.5 Socio-ecological model of health

A socio-ecological model of health is the theoretical framework used in this thesis to understand how alcohol marketing influences children's alcohol-related outcomes and how to intervene. A socio-ecological model of health posits that behaviour is influenced at multiple levels, and thus focuses on the environmental influences on health (81). Sallis, Owen et al. (81) argue four key principles typically underpin socio-ecological models of health: 1) there are multiple influences on behaviours; 2) these influences interact on various levels; 3) socio-ecological models should be behaviour-specific, and 4) multi-levelled policy interventions are the most effective in changing behaviour (81). To maximise the health benefits of behaviour change, the environments, policies and social norms that surround individuals must support healthy choices.

Figure 1 presents a stylised socio-ecological model demonstrating the different levels of influence on health. Within this model, child behaviours are influenced on an individual level by knowledge, attitudes and skills (82). On an interpersonal level, children's behaviours are influenced by social interactions with significant persons such as friends and family. The organisational and community practices, including those observed in the home and neighbourhood, influence children's behaviours at a broader level. Importantly, within this model, public policy has an overarching influence on all other levels.

Socio-ecological models conceptualise health behaviour change from a broad perspective, facilitating a comprehensive picture of the psychological, social and environmental aspects influencing behaviour. They are increasingly used in public health in a range of areas (83-85). Thus, socio-ecological models provide a more comprehensive understanding of the influences on an individual's health behaviours than behavioural models or theories that focus on intrapersonal characteristics. For example, alcohol research adopting a socio-ecological model focuses on the role of drinking contexts and environments on alcohol use and related problems (85). This is not to say behavioural models do not help inform behaviour change; rather socio-ecological models are better equipped to explain the multi-levelled complexities of health behaviours and how to modify them.

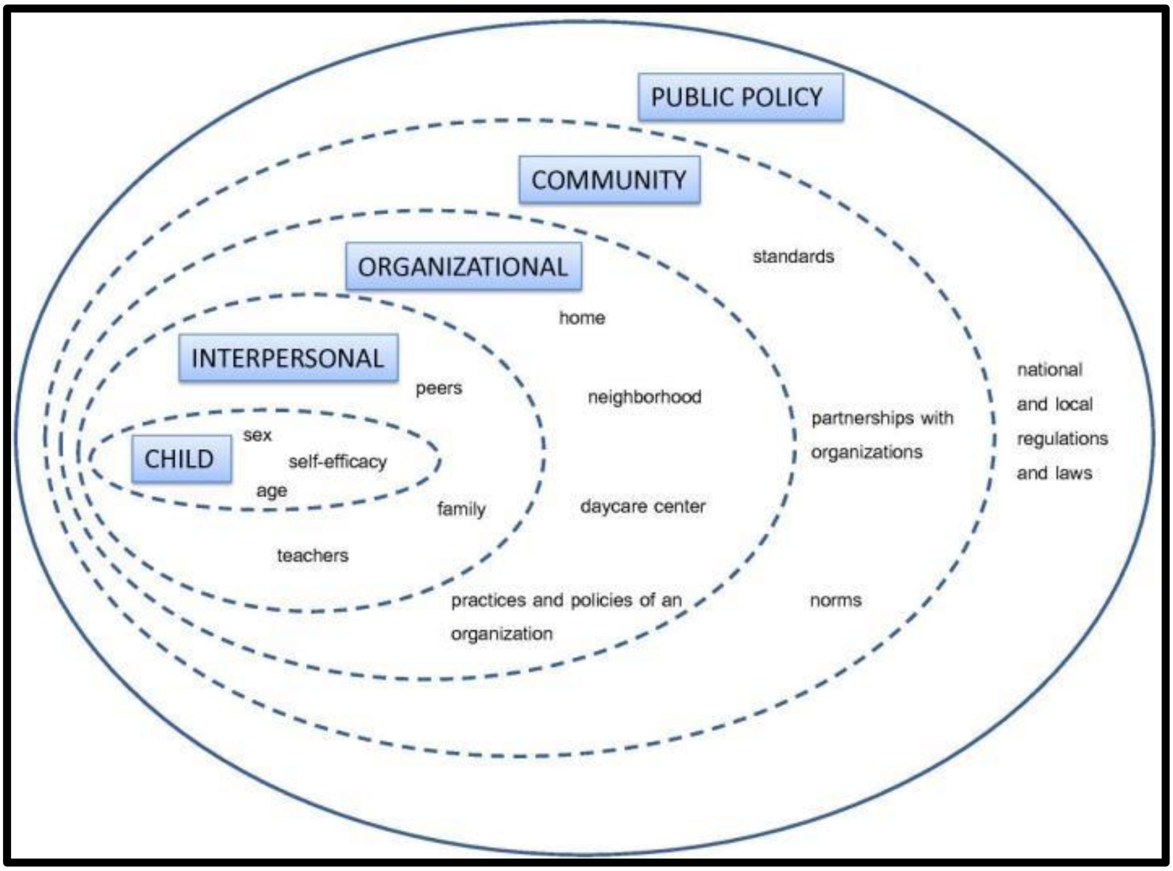


Figure 1: A socio-ecological model of health. Source: Mehtälä, Sääkslahti et al. (82)

In alcohol research, many studies conceptualise alcohol-related harm from a socio-ecological perspective. For example, there is extensive research on the community drivers of alcohol-related harm that focus on built environment features, alcohol marketing and alcohol availability (86, 87). A shift in focus from individual-level characteristics to environmental features that predict alcohol use is a promising avenue for understanding the broader influences of individual's alcohol-related behaviours (85).

2.5.1 Neighbourhoods

A key component within a socio-ecological model of health is the neighbourhood (82), and it is the one emphasised in this thesis. There is now mounting evidence that neighbourhoods influence health (88-91). These neighbourhood effects fall into two conceptual categories, either health-promoting or health-damaging (92). Health-promoting effects may include greater access to medical care, fresh food and job opportunities, whereas health-damaging effects may include physical disorder, high density of alcohol outlets and incidences of violent crime.

Research on neighbourhoods has tended to focus on adult populations (88), but this is changing as research has focused on children (93-99). The interest in children in neighbourhood research is likely a good thing for children's health outcomes as children's neighbourhoods may influence their health more than adults given their limited mobility and reliance on the local environment (93). Studies link neighbourhood factors to adverse health outcomes in children including obesity (94, 95), mental health (96), behavioural problems (97) and decreased physical activity (98). Neighbourhoods are also associated with positive future outcomes for children, such as university degree attainment, higher salaries and reductions in single-parent homes (100).

Neighbourhoods research examining the effects of built environment features on children's alcohol consumption focus on features such as alcohol marketing and alcohol availability (101-106), discussed in further detail in Chapters Three and Four.

2.5.2 Public policy

Within a socio-ecological model, public policy has the ability to affect all other levels of influence on an individual's health (82), this is an important factor in improving children's environments and health. The epidemiologist Geoffrey Rose outlines two broad strategies for prevention in public policy; high-risk and population-based (107). High-risk strategies target individuals at the greatest risk and typically have little effect on people with a lower risk of developing the health outcome (108). While sometimes cost-effective, high-risk strategies have limited capacity to change population health as they primarily deal with people who have already developed the outcome of interest. In contrast, population-based strategies target the underlying causes of adverse health outcomes to produce health benefits for the entire population (108). These strategies reduce the risk of developing the health outcome for the entire population, and with it, considerable benefits for the population including those at the most risk. (108). Consequently, population-based strategies primarily focus on preventing an adverse health outcome by influencing all people. Rose (107) argues research should focus on discovering and controlling the causes of incidence, which immediately produces a preference for population-based approaches over high-risk approaches.

The majority of people experience some form of alcohol-related harm, be it first- or second-hand (2, 48). As a result, population-based strategies are best positioned to simultaneously reduce alcohol-related harm in high-risk populations while improving the health of the entire population. Further, people at high-risk of alcohol-related harm are likely to be more sensitive to interventions, highlighting how population-level approaches may promote health equity (1).

2.6 Population-based approaches to reducing alcohol-related harm: the 5+ solution

Also in line with a socio-ecological model of health, WHO is focusing upon the context within which people live with their 5+ solution to reducing alcohol-related harm. WHO promotes population-based approaches to alcohol-related harm as the most effective policy interventions (1). The 5+ solution is an evidence-based framework that outlines a diverse range of alcohol harm reduction policies based on the WHO-sponsored publication *Alcohol: No Ordinary Commodity* (1) and confirmed in a *Lancet* alcohol series (109). The five solutions are: restricting alcohol marketing, restricting alcohol availability, raising alcohol prices, raising the minimum purchasing age and increasing drink-driving counter-measures; the '+' refers to increasing treatment opportunities for heavy drinkers. WHO classifies the marketing, availability, and taxation policy interventions as 'best buys' (14), that is, the most cost-effective method of reducing alcohol-related harm. As mentioned previously, only two of the 5+ solutions are directly relevant to this thesis: restricting alcohol marketing and restricting alcohol availability so this chapter focuses particularly on them.

2.6.1 Demand-side vs supply-side population-based interventions

Population-based approaches to reducing alcohol-related harm are further conceptualised into demand-side and supply-side interventions. To explain how different population-based interventions target alcohol-related harm, Kypri (110) developed a taxonomy of demand-side and supply-side population-based interventions (Table 1). Demand-side strategies aim to reduce a person's desire to drink. In this taxonomy, demand broadens from its traditional economic definition – "a want backed up by an ability to pay" (111, p.40). Instead, in this conceptual framework, demand refers to the psychological and cultural drivers of the desire to drink (110). The psychological drivers include neural effects, which translate into finding drinking pleasurable, and chronic effects, which lead to addition. The cultural drivers relate to the extent alcohol holds a valued position in our collective culture. Common demand-side population interventions include restrictions on alcohol marketing, increasing public health messaging, and increasing drink-driving restrictions and enforcement (1). In contrast, supply-side strategies focus on restricting alcohol availability by increasing the economic or opportunity costs of attaining alcohol. Common supply-side strategies include increasing the minimum purchase age, reducing the number of alcohol outlets and increasing taxes on alcohol. Two population interventions are investigated in this thesis: restricting alcohol marketing and restricting alcohol availability.

Table 1: Taxonomy of population-based alcohol policy interventions. Source: Kypri (110)

Policy paradigm		**Population-based interventions** **Policies and interventions applied to whole populations without regard to individual risk**
Demand-side	*Regulated*	**Alcohol marketing** Drink-driving laws and enforcement
	Voluntary	Public health messaging School-based education
Supply-side	*Physical*	**Alcohol availability (outlet density/proximity)** Minimum purchase/drinking age >18 Alcohol service laws
	*Economic***	Taxes on alcohol Minimum unit pricing

* **Bolded** policies are investigated in this thesis

2.6.2 Restricting alcohol marketing

Restricting alcohol marketing is one of the most cost-effective population-based policy interventions for reducing alcohol-related harm. The WHO-sponsored grading system for policies and interventions rates all alcohol-related policy interventions based on the evidence of three categories, 1) their effectiveness to reduce alcohol-related harm, 2) the breadth of research and 3) cross-national testing (1). To indicate the strength of the policy, each category has a rating from zero to '+++'. Some categories rated as '?' indicate there is not enough evidence to provide a rating. Restricting alcohol marketing received a '+/++' rating for effectiveness, '+++' for the breadth of evidence and '++' for cross-national testing (Table 2). Therefore, alcohol marketing restrictions are highly effective, with a large evidence base, tested in a number of countries. To regulate the volume and content of direct and indirect marketing, sponsorships and promotions, WHO recommends the establishment of a legislation-based regulatory framework. In contrast to legislative restrictions, WHO rated self-regulatory codes for alcohol marketing with a zero for effectiveness, with a wide range of evidence of their ineffectiveness, including research from multiple jurisdictions (1). Since this rating, a systematic review of studies investigating the effectiveness of industry self-regulation concluded such systems are inadequate at protecting children from alcohol marketing (12). Furthermore, since the publication of these ratings, two further systematic reviews of longitudinal studies concluded children's exposure to alcohol marketing is associated with increased alcohol consumption and hazardous drinking (10, 112), which is discussed further in Chapter Three.

Table 2: WHO ratings for alcohol marketing restrictions, scale 0 to +++. Source: Babor, Caetano et al. (1, p.246)

Intervention	Effectiveness	Breath of research	Cross-national testing	Comments
Legal restrictions on exposure to alcohol marketing	+/++	+++	++	Strong evidence of the dose-response effect of exposure on young people's drinking, but evidence of small or insignificant effects on per-capita consumption from partial advertising bans; advertising bans or restrictions may shift marketing activities into less-regulated media (eg internet).
Alcohol industry's voluntary self-regulation codes	0	++	++	Industry voluntary self-regulation codes of practice are ineffective in limiting exposure of young persons to alcohol marketing, nor do they prevent objectionable content from being aired.

2.6.3 Restricting alcohol availability

Alcohol availability refers to all avenues that make alcohol more accessible, including the number of outlets, the distance to outlets, willingness of licenced premises to sell to minors and trading hours, days and volumes of alcohol sales (1). Typically, restrictions on alcohol availability posit that increasing the economic and opportunity costs of obtaining alcohol reduces alcohol consumption (113). However, as noted in Chapter One, this thesis argues that alcohol availability is a risk factor for children's overall exposure to alcohol marketing, which is discussed further in Chapter Four. The WHO-sponsored policy strategies and interventions grading system rates restricting alcohol availability with a '++' rating for effectiveness and '+++' for the breadth of evidence (1) (Table 3).

Table 3: WHO rating for alcohol availability restrictions, scale 0 to +++. Source: Babor, Caetano et al. (1, p.244)

Intervention	Effective-ness	Breath of research	Cross-national testing	Comments
Restrictions on outlet density	++	+++	++	Evidence for both consumption and problems. Changes to outlet numbers affect availability most in areas with low prior availability, but bunching of outlets into high-density entertainment districts may cause problems with public order and violence.

2.7 Alcohol control policies in New Zealand

A brief overview of alcohol policy in NZ is required to fully understand the current levels of alcohol-related harm and the regulatory environment. In NZ, since 1967 there has been a major liberalisation of alcohol policy. This liberalisation most directly relates to the increased availability of alcohol but also includes limited regulation of alcohol marketing and taxation. However, NZ did not always have liberal alcohol control policies and a brief overview of the legislative changes over time demonstrates the ideological shift in alcohol policy that has occurred.

As early as the 1830s alcohol-related harm has been a problem in NZ, with the Bay of Islands gaining an international reputation for drunkenness and lawlessness (114). In response, to curb alcohol-related harm, early NZ alcohol control policies were restrictive. For example, in 1842, the Legislative Council's (NZ's upper house at the time) prohibited the distillation of spirits as one of its first legislative acts (115). As a wartime measure, in 1917, the next major legislative action introduced six o'clock closing times, which continued until 1967. The six o'clock closing time was colloquially known as the 'six o'clock swill', where patrons would attempt to consume as much alcohol as possible before closing time (116). McEwan, Campbell et al. (116) argue that the 'six o'clock swill' served as a precursor for the hazardous drinking culture in contemporary NZ.

The liberalisation of NZ's alcohol laws started in 1967 with the extension of the national alcohol licensing hours from 6.00pm to 10.00pm. The intention of the extended hours was to remove the incentive to drink as much alcohol, as fast as possible, in the hour from the end of work (typically 5.00pm) until closing time. However, it had the unintended consequence of increasing the number of licenced venues, with sports clubs and nightclubs also able to supply alcohol (117). Further, as drinking patterns had been established by the 'six o'clock swill' era, extending trading hours simply provided more hours for New Zealanders to drink hazardously.

Before 1980, the Broadcasting Standards Authority (BSA) NZ's statutory body, regulated alcohol marketing on television and radio (118). During the 1980s, the Advertising Standards Authority (ASA), an industry-funded body entered a system of co-regulation with the BSA. During this period, alcohol marketing shifted from focusing on products and services to drinking contexts and brand promotion. That is, the misleading cultural aspects of drinking, such as sporting and sexual success, began to dominate marketing content. In 1993, an amendment to the 1989 Broadcasting Act shifted responsibility for alcohol marketing from the BSA to the industry-regulated ASA (118). Currently, the ASA regulates the codes and practices of alcohol marketing in NZ. The ASA is discussed extensively later in this chapter and in Chapter Three.

The 1989 Sale of Liquor Act exemplifies the trend of alcohol liberalisation by successive NZ Governments. The 1989 Sale of Liquor Act increased the types of alcohol outlets that could obtain a licence to sell beer and wine, most notably giving supermarkets permission to sell wine (119). The subsequent increase in alcohol availability from 1989 to 1993 was associated with a 17% increase in wine sales (120). During this time, there was no significant change in sales of beer or spirits suggesting an increase in total consumption in response to increased availability (120). The liberalisation of NZ's alcohol laws continued in 1999 with an amendment to the Sale of Liquor Act, which permitted supermarkets to sell beer, decreased the legal purchase age from 20 years to 18 years and relinquished restrictions on 24-hour trading for on-licence premises (121). Consequently, the number of alcohol licences granted between 1999 and 2010 increased substantially, with the number of on-licences tripling and off-licences doubling (122). Subsequently, supermarkets now dominate the off-licence alcohol market, accounting for 30% of all beer and 60% of all wine sales in NZ, despite only making up 3% of outlets (116).

NZ's liberalisation of alcohol policy is marked by consistent and substantial levels of alcohol-related harm as outlined earlier in this chapter. The high burden of alcohol-related harm led the Law Commission to produce an issues paper in 2009 (123), and subsequently in 2010, a review of NZ’s alcohol laws (48). The Law Commission (124) is an independent Crown entity responsible for reviewing NZ’s laws and providing solutions to fix their shortcomings. Both works produced compelling evidence of NZ’s alcohol-related harm and legislative shortcomings in the area. The 2010 review attracted almost 3,000 written submissions from individuals, non-government organisations and industry. The Law Commission produced 153 recommendations in numerous areas including, increasing alcohol tax, increasing the legal purchase age, restricting the availability of alcohol, restricting alcohol marketing and increasing drink-driving counter-measures.

However, the Government has made no changes to the current system of industry self-regulation for alcohol marketing. In contrast, the Government drafted and ratified into law the 2012 Sale and Supply of Alcohol Act (SSAA) to address alcohol availability. To provide an overview of the current regulatory environment in NZ for alcohol marketing and availability, the following sections discuss the ASA codes for alcohol marketing, the SSAA for alcohol availability and Te Tiriti o Waitangi as a possible mechanism for alcohol control.

2.7.1 Alcohol marketing in NZ

The ASA is the industry-funded organisation responsible for the development, monitoring and enforcement of marketing practice in NZ (125). The ASA is comprised of 14 member organisations from the marketing industry, making the ASA a self-regulatory system. The ASA Code for Advertising and Promotion of Alcohol regulates alcohol marketing (126). The main regulations for alcohol marketing include time restrictions, density restrictions on television advertisements, age-gated verification for digital marketing, and restrictions on content and sponsorship guidelines. The time restrictions prohibit any alcohol marketing on television between 6.00am and 8.30pm. The density restrictions prohibit more than six minutes of alcohol marketing on television per hour and permit no more than two advertisements within a single commercial break. Age-gated verification technology is required for all digital marketing using competitions and games. Restrictions on content require drinkers be over 25 years, prohibit using identifiable heroes or heroines of the young and prohibit content that has strong appeal to minors. Finally, guidelines for alcohol sponsorship are somewhat ambiguous, but state that alcohol marketing via sponsorship is permitted any time except during programmes particularly intended for minors (aged <18).

Globally, self-regulatory systems for alcohol marketing are common. However, a systematic review of 76 studies assessing the effectiveness of self-regulatory systems for alcohol marketing found that such systems were inadequate at preventing childhood exposure to alcohol marketing and that violations of the codes were common (12). The Law Commission concluded NZ's self-regulatory system was unable to prevent children's exposure to alcohol marketing or adequately regulate the content of alcohol marketing (48). Casswell and Maxwell (127) argue that the decision process often takes longer than the duration of the alcohol marketing campaign, thus, making the complaints redundant. Gee, Sam, et al. (128) argue the codes that regulate sports sponsorship are ambiguous and undermine the effectiveness of NZ's self-regulatory system. For example, two frequency analyses of alcohol marketing in televised sport in NZ found viewers (including children) were exposed to alcohol marketing between 1.2 and 3.8 times per minute, and in some cases for over 50% of the total broadcast (128, 129), circumventing the self-regulatory codes.

To address the weaknesses of self-regulation in NZ, Members of Parliament have proposed legislative changes. For example, in 2005, the Sale of Liquor (Youth Alcohol Harm Reduction) Amendment Bill, a Private Member's Bill, proposed Government regulation of alcohol marketing (130). The Bill proposed to legislate the current ASA codes and move the jurisdiction from the ASA to the Government-run BSA; however, the Bill did not make it past its second reading. Likewise, in 2006, another Private Member's Bill, the Liquor Advertising (Television and Radio) Bill, proposed a ban on alcohol marketing on television and radio from NZ broadcasters. The Bill was debated in 2009 but did not progress past the first reading (131). In 2010, the Sale and Supply of Liquor and Liquor Enforcement Bill proposed Government regulation of alcohol marketing with similar policy implications as the Sale of Liquor (Youth Alcohol Harm Reduction) Amendment Bill (132). In addition to a legislated code on alcohol marketing, the Bill recommended the establishment of a Liquor Advertising Advisory Board responsible for the development of marketing codes, introducing a complaints system and referring serious offences to the Director-General of Health. However, the Bill did not make it to the third reading. As such, no substantive changes to the regulation of alcohol marketing have occurred since the introduction of the ASA codes, despite repeated attempts at change.

In addition to the proposed legislative changes, successive Governments have commissioned several reviews on alcohol marketing regulation. For example, in 2006, the Government-initiated Review of the Regulation of Alcohol Advertising Steering Group reviewed alcohol marketing regulations (133). In 2007, the steering group recommended implementing a legislative framework that contained public policy goals and regulated all forms of alcohol marketing, with the Government permitted to investigate and punish breaches. The 2010 Law Commission report concluded that the legislative improvements suggested by previous Bills and the steering group were insufficient considering the health risks posed by exposure to alcohol marketing (48). The Law Commission recommendations related to alcohol marketing included:

1) A ban on alcohol sports sponsorship;

2) Extending the television watershed from 8.30pm to 10.00pm;

3) Removing all drinking context (eg, people drinking) from alcohol marketing;

4) Removing alcohol marketing on public transport and cinemas (except R18 movies);

5) The formation of an interdepartmental committee to review and implement alcohol marketing policy (48).

In addition, in 2014, the NZ Government commissioned the Ministerial Forum on Alcohol Advertising and Sponsorship (134) (MFAAS), a joint initiative between the ministries of Health and Justice, with a mandate to review and recommend improvements to alcohol marketing regulation in NZ. The MFAAS recommended the complete removal of alcohol sponsorship from sports broadcast, teams and stadia, and further restrictions on alcohol sponsorship of other cultural events and activities. In addition, further restrictions on outdoor marketing and television were recommended. However, to date, no Government response to any of the recommendations for alcohol marketing provided in these Government-initiated inquires has resulted. Furthermore, there has been no changes to the ASA Code for Advertising and Promotion of Alcohol.

2.7.2 Alcohol availability in NZ

In 2012, there was a legislative change to alcohol availability in NZ. The Law Commission recommended introducing a new licensing system for the supply of alcohol that attempted to provide greater community involvement in alcohol licensing decisions (48). In response to the Law Commission recommendations, the National-led Government of John Key introduced the SSAA aimed to ensure, "The sale, supply, and consumption of alcohol should be undertaken safely and responsibly" (135, Article 4.1a), apparently reversing the trend of liberalisation.

Within the SSAA, District Licensing Committees (DLC) consist of locally elected representatives that are responsible for licensing decisions for new and renewing alcohol licences (135). The Alcohol Regulatory and Licensing Authority (ARLA) is a judicial body that rules on legal challenges to DLC licensing decisions. ARLA decisions are also subject to legal challenge in NZ courts. The SSAA also gave Territorial Authorities (TAs), local jurisdictions in NZ, partial control over alcohol availability by permitting them to implement Local Alcohol Policies (LAPs). LAPs permit TAs to regulate outlet density, location, and days and hours of sale.

The second objective of the SSAA is that "The harm caused by the excessive or inappropriate consumption of alcohol should be minimised" (135, Article 4.1b). Thus, the SSAA has a legitimate public health objective: to reduce alcohol-related harm by curbing hazardous drinking. While a legitimate public health goal, the SSAA focuses on only one aspect of alcohol-related harm, the availability of alcohol. Importantly for this thesis, other than clauses that seek to ban the irresponsible promotion of alcohol and tighter restrictions on alcohol promotion within supermarkets, the SSAA largely overlooks alcohol marketing (135).

The restrictions that do exist for alcohol marketing within the SSAA require supermarkets to have a single, designated alcohol sales area that is not on the most direct path from the entrance to the checkout. All alcohol marketing must be within these designated areas. The use of end-of-aisle displays that surround the single designated area and exposure shoppers not in alcohol areas to alcohol marketing is not directly regulated by legislation. Thus, the legality of end-of-aisle displays is a matter of interpretation under section 14.1d (iii) of the SSAA. Consequently, the law is applied differently throughout NZ as different DLCs have both permitted and prohibited end-of-aisle displays. For example, in one case, end-of-aisle displays were initially permitted by one DLC and supported by an ARLA decision. However, the ARLA decision was overruled in a 2015 High Court ruling stating the decision had "misfired" and was "entirely flawed" (136). At least one supermarket has won a three-year-long legal case in the Court of Appeal to keep its end-of-aisle display (137), despite the 2015 High Court ruling. End-of-aisle displays are present in some supermarkets around the country and are currently being appealed by Medical Officers of Health (138-140). The SSAA provisions provided supermarket owners a grace period of 3-18 months to bring their stores into compliance with the different sections of the SSAA. There appears to be no evidence evaluating this change.

The Law Commission report and SSAA provided NZ with an opportunity to create a multi-targeted approach with a central focus on reducing alcohol-related harm. Instead, the legislation primarily focuses on slowing the proliferation of alcohol outlets and defers responsibility for alcohol regulation from central government to TAs through LAPs (135). The process of developing a LAP involves TAs implementing policies that are deemed necessary for their constituents, a draft LAP is provided for interest group feedback, and then a provisional LAP is developed that is subject to judicial appeal for 30 days. Developing a LAP is a complicated and time-consuming process for TAs, which is further complicated by legal proceedings (141). For example, the average duration for the notification of a provisional LAP to its adoption is 616 days (142). Furthermore, of the 31 provisional LAPs proposed thus far, 30 have been appealed in Court, over half by the alcohol industry (142). Consequently, there have been 165 changes to provisional LAPs after judicial review. According to Alcohol Healthwatch, a non-government alcohol health promotion organisation, 71% of those changes were towards less restrictive provisions (142). Currently, only 12 LAPs representing 19 TAs (28% of all TAs) have been adopted, meaning that only one in seven New Zealanders lives in a TA with a LAP (142).

There are numerous criticisms from health professionals and advocates of the new legislation. These include placing a greater burden on health professionals, containing confusing language hindering its applicability and accessibility, and not using the full range of measures available to address alcohol-related harm (143-145). Further, it does not address two of three 'best buys' outlined by WHO, taxation and alcohol marketing.

2.7.3 Te Tiriti o Waitangi

Te Tiriti o Waitangi is a possible legal mechanism for implementing effective alcohol control policies. Te Tiriti o Waitangi is NZ's founding document signed in 1840 between Māori and the Crown of England (146). However, the meaning of Te Tiriti o Waitangi and its position in domestic legislation is contested due to discrepancies between the Māori and English versions (146). Came, McCreanor, et al. (147) argue there are three main discourses 1) Te Tiriti o Waitangi, the Māori language text; 2) the Treaty of Waitangi, the English language text 3); and the Treaty Principles, aspects of the Treaty recognised by the Crown. The legal doctrine of *contra proferentem* sides against the party that drafts an ambiguous text, which positions the Māori version as the authoritative text. However, domestically, the Crown-defined Treaty Principles of partnership, participation, protection are the most common references to the Treaty in legislation, a position that ignores the constitutional rights of Māori under Te Tiriti o Waitangi. In 1975, the Treaty of Waitangi Act established the Waitangi Tribunal, a court with judicial and statutory authority to interpret and rule on cases brought against the Crown in relation to Te Tiriti o Waitangi.

Te Tiriti o Waitangi contains three articles that define the agreement between Māori and the Crown. Article 1 requires the Government to engage in honourable governance but does not cede Māori sovereignty to the Crown, as implicated by the English version. In 2014, the Waitangi Tribunal ruled Article 1 did not constitute a cessation of Māori sovereignty (148). Article 2 ensured the protection of taonga (treasures), which extends to cultural (language), social (health), material (possessions) and natural resources (water). Under Article 2 Māori have a constitutional right to good health, however, this interpretation is acknowledged but not accepted by the Government (146). Article 3 guarantees Māori the same rights and privileges as British subjects, implying equity between Māori and non-Māori. Further, if such inequities exist, the Crown would intervene through royal protection to prevent such inequity.

The SSAA does not contain any Treaty provisions, a feature of some other NZ legislation. For example, Section 8 of the Resource Management Act requires the principles of the

Treaty (partnership, participation and protection) to be taken into account in any decisions (149). However, the SSAA does not contain any such provisions, despite the disproportionate levels of alcohol-related harm experienced by Māori compared to non-Māori outlined earlier in this chapter. The disproportionate levels of alcohol-related harm experienced by Māori can be considered a breach of the Treaty under Article 3. Currently, the Waitangi Tribunal is considering a claim against the Crown for failing to implement the Law Commission recommendations on the grounds that Māori are disproportionately affected by alcohol-related harm, and alcohol control policies would benefit Māori (150). While evidence exists that increasing alcohol taxation and restricting alcohol availability would promote health equity for Māori (48, 151), evidence that alcohol marketing restrictions promote health equity is required to support the Waitangi Tribunal claim. The Waitangi Tribunal is an alternative avenue to achieve national legislation on alcohol marketing as their decisions are legally binding on the state.

2.8 Summary

Globally, the burden of alcohol-related harm is multi-faceted, adversely affecting individuals, communities and countries. Children are most vulnerable to the adverse effects of alcohol due to numerous psychological, neurological, physical and social reasons. Despite the overwhelming evidence of the damaging effects of alcohol-related harm, there has been limited implementation of the most effective strategies expertly summarised and evaluated by WHO (1).

In NZ, the historic liberalisation of alcohol laws has been accompanied by substantial levels of alcohol-related harm. Health professionals routinely criticise national legislation for not doing enough to address the growing and multi-faceted problem of alcohol-related harm (141, 142, 152). Further, a case before the Waitangi Tribunal argues the government has breached its responsibility to Māori by not sufficiently implementing the Law Commission recommendations.

While NZ legislation adopted some of the Law Commission's recommendations in the SSAA, it excluded many effective policies for reducing alcohol-related harm, such as marketing. There have been numerous government-initiated reports that recommend legislative restrictions on alcohol marketing, yet no such action has occurred. Two of the three most cost-effective policies in reducing alcohol-related harm – comprehensive alcohol marketing restrictions and restricting alcohol availability (14) – are discussed in Chapters Three and Four.

CHAPTER THREE: ALCOHOL MARKETING

> *Marketing plays a critical role in the globalization of patterns of alcohol use among young people, and reflects the revolution that is occurring in marketing in general* (153, p.10).

This thesis is focused on the extent and nature of children's exposure to alcohol marketing. This chapter presents a review of the literature on alcohol marketing and its impact on children's alcohol-related outcomes. First, the chapter begins by defining marketing as a form of commercial communication. Second, Consumer Socialization Theory (CST), as the guiding theory of marketing in this thesis, is used to explain the how alcohol marketing may influence children's alcohol-related outcomes. Third, the literature on the impact of alcohol marketing on children's alcohol-related outcomes is synthesised. Finally, policy interventions used to restrict alcohol marketing are outlined, including international and NZ policies.

3.1 Defining alcohol marketing

Alcohol marketing is defined by the European Alcohol Policy Alliance as:

> *A mix of sophisticated, integrated strategies, grouped around four main elements: the product, its price, its place (distribution) and its promotion. All four elements have ways of doing marketing, such as product design and brand name (product), pricing strategy and wholesale (pricing), distribution channels and placing within retail establishments (place) and promotional strategy, advertising, sales promotion and public relations (promotion)* (154, p.6).

This thesis adopts this definition of alcohol marketing because it has been used to study alcohol marketing (154) and incorporates the four Ps of marketing discussed in marketing literature; product, price, place and promotion (155). However, of the four Ps, price is not examined in this thesis as it is unlikely to influence children aged 11-13, the age of the participants in this study, as it is illegal to sell alcohol to minors.

3.2 Marketing

Marketing has been described as a form of communication that aims to persuade, incite and remind potential customers about certain brands or products (156). As such, for companies, effective marketing campaigns are central to building and managing public perceptions of the brands and products they sell (156). The deregulation of television, the proliferation of digital marketing and the growing global economy has contributed to an unprecedented escalation of marketing (157).

Establishing how marketing influences consumer preferences and behaviour is a point of contention in marketing literature. Zajonc (158) proposes that mere exposure to marketing influences an individual's perception and attitudes towards a brand or product. Mere exposure works through creating and reinforcing a memory of a brand or product that can be used when developing an attitude or faced with making a decision (159). Consequently, children's repeated exposure to alcohol marketing may increase positive attitudes towards alcohol, even if they cannot consciously recall the marketing (160).

Children who lack an understanding of, and have not developed defence mechanisms against, marketing often accept the information conveyed in them as truthful and accurate (161). To combat the bias and persuasive messages in marketing, children must acquire skills that guide them as consumers in the marketplace (162). One such skill is to differentiate commercial from non-commercial content. Another is to understand how marketing intends to influence consumer preferences. For children, these consumer skills develop over time, mainly as a function of their cognitive and social development.

3.3 Consumer Socialization Theory (CST)

CST is a socialisation theory that posits children acquire skills, attitudes and knowledge that guide their consumer preferences (163). There is a range of theories that could have been used to conceptualise how marketing influences children's attitudes and knowledge. In this thesis, CST is used because it focuses on the social and cognitive development of children at different ages and how marketing influences children at each developmental stage. Figure 2 demonstrates how a learning outcome (consumer preference) is a product of a socialisation process that involves sociodemographic characteristics (social class & gender), children's age and socialising agents (mass media and peers). CST is concerned with highlighting how socialising agents, such as mass media, act to influence children's consumer preferences at distinct developmental stages (164).

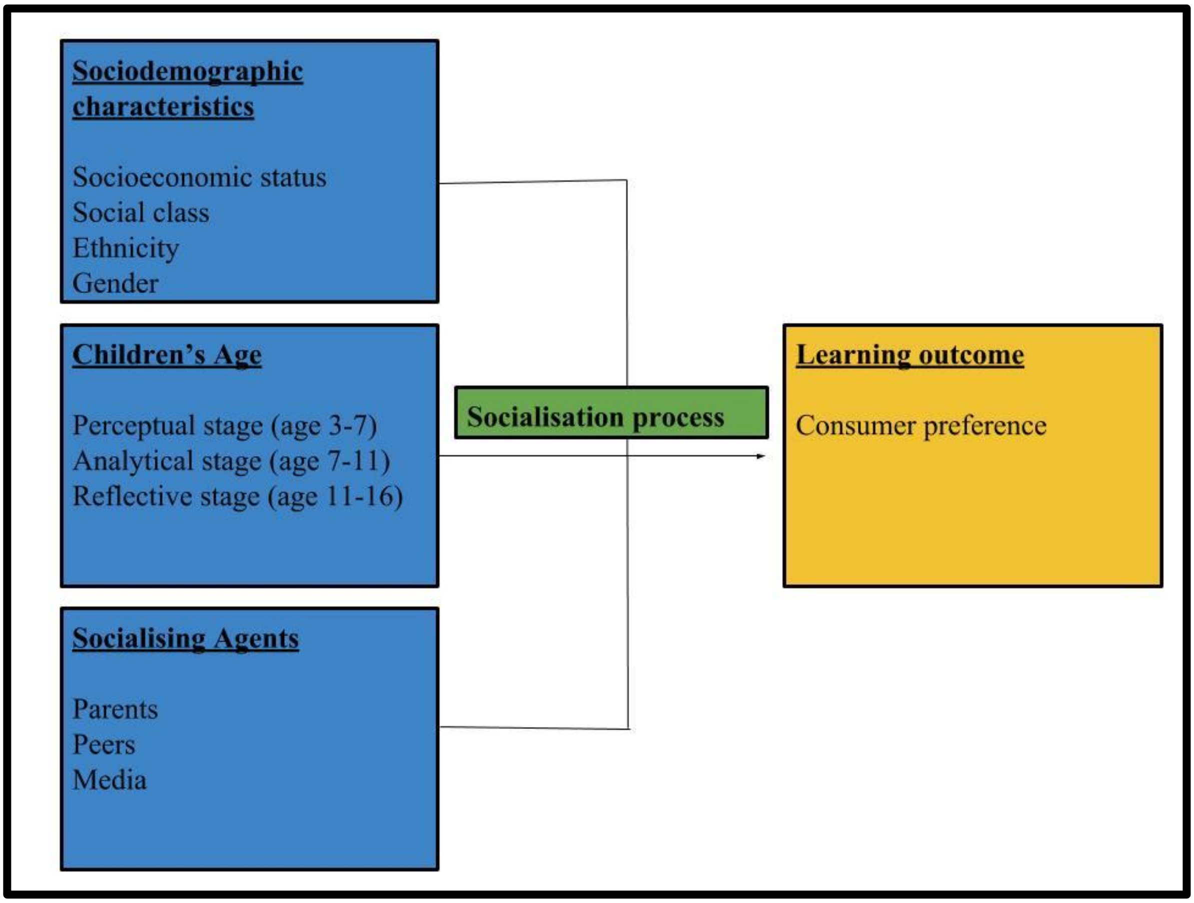


Figure 2: Consumer Socialization Theory logic model. Source: John (165)

CST suggests children's social and cognitive capabilities as a consumer include three developmental stages based on their age: perceptual stage (ages three to seven), analytical stage (ages seven to 11) and reflective stage (ages 11-16) (165). The perceptual stage is characterised by children understanding perceptual features of marketing, for example, the colours, pictures and words used in marketing. As such, children develop familiarity with marketing concepts (eg, brands) but rarely understand them beyond a surface level. During the analytical stage, children undergo substantial social and cognitive development, in which, they begin to understand the underlying concepts of marketing (to sell products) and develop a more sophisticated understanding of marketing concepts. However, during the analytical stage, children are not likely to have developed effective defence mechanisms against marketing messages, thus, are still vulnerable.

John (165) argues that, during the reflective stage, children focus on the social meaning of brands and products. As such, children typically value other people's perspectives and want to shape their identity by conforming to group expectations. For example, children aged 11-12 start to make inferences about people based on the brands they use (166). More importantly, children aged 12-13 start to develop connections between the brands they use and self-identity (167). Consequently, children focus on the social meaning of brands, which influences their consumer preferences. While children in the reflective stage are beginning to develop defence mechanisms against some of the misleading aspects of marketing, such defences are inadequate at the beginning of the reflective stage (165). Even children who understand the purpose of marketing often overlook these biases as they also struggle to weigh up the long-term health consequences of their decisions against short-term rewards (168).

In addition to children's cognitive development, CST outlines three primary socialising agents that influence children's consumer knowledge; parents, peers, and mass media. Each socialising agent affects children's consumer preferences differently, depending on the developmental stage of the child (165). For example, Michael and Eva (169) argue parents play a more influential role in the perceptual and analytical stages, whereas peers become a more important socialising agent in the reflective stage. Mass media appears to have a consistent impact throughout child development (169). However, mass media is an increasingly influential socialising agent with demographic changes in the family unit and advances in the type and quality of marketing. Franco, Miguel, et al. (170) argue increases in single-parent families and in families where both parents work reduces children's interaction with their parents, hindering parents' capacity to shape their children's consumer preferences. The types and extent of media available to children, particularly via social media, is rapidly increasing (157). Thus, CST posits that marketing plays a significant role in constructing children's consumer preferences, attitudes and knowledge as well as informing their perceptions of others and themselves.

3.3.1 CST and children's exposure to alcohol marketing

CST has been used to understand how children entering or progressing through the early reflective stage (ages 11 to 13) are particularly vulnerable to alcohol marketing. For example, a NZ study of 500 children aged 10-17 found that those aged 10 to 13 accepted as realistic the representations of alcohol in alcohol marketing (171). A longitudinal study of 552 Scottish children found that consumer socialisation to alcohol brands at age 13 was positively associated with hazardous drinking at age 15 (172). The authors used three measures as a proxy for consumer socialisation; brand salience (the ability to recall alcohol brands), unaided brand recognition (being able to name masked alcohol brands) and aided brand recognition (whether children had seen a particular brand after being prompted by alcohol brand imagery and name) (172). The findings suggest a link between consumer socialisation to alcohol brands in the reflective stage and subsequent alcohol use.

Previous research links children's exposure to alcohol marketing with developing positive attitudes towards alcohol (171, 173). Further, these findings provide a theoretical premise for other longitudinal research that consistently demonstrates associations between exposure to alcohol marketing and childhood drinking (9-11).

3.4 Alcohol marketing and childhood drinking

According to WHO "marketing plays a critical role in the globalization of patterns of alcohol use among young people, and reflects the revolution that is occurring in marketing in general" (153, p.10). Marketing is a crucial aspect driving demand for alcohol, with billions of dollars spent by the alcohol industry every year. For example, Diageo, the largest global alcohol company, spent UK£1.8 billion on its global marketing strategy in the 2016/2017 financial year (50% of its operating profit) (174).

Alcohol companies utilise an expanding mix of tactics to increase the effectiveness of their marketing strategy (175). The expansion of alcohol marketing into less traditional and less regulated forms of marketing, such as sponsorship, digital marketing and point of sale promotions increase the potential avenues of children's exposure to alcohol marketing. The different promotion types used in alcohol marketing strategies are not intended to function as independent levers but work together as an integrated marketing mix (176, 177). However, limitations of research methodology often result in researchers investigating the impact of specific promotion types on children's drinking, particularly television. While some promotion types show smaller effects than others, the effectiveness of the alcohol industry's marketing strategy is reliant upon the cumulative effects of multiple promotions (177). The following section reviews the evidence demonstrating the impact of alcohol marketing, first by overall exposure to all forms of alcohol marketing, and then by individual promotion types.

3.4.1 Overall exposure to alcohol marketing

Three systematic reviews have investigated the impact of childhood exposure to alcohol marketing on childhood drinking (9-11). In total, the reviews included 25 longitudinal studies that followed up over 73,000 participants from multiple countries. Each review concluded that longitudinal studies consistently demonstrate a positive association between exposure to alcohol marketing and children's earlier onset drinking and the likelihood of engaging in hazardous drinking. In 2010, before the publication of the third systematic review, Babor, Caetano et al. (1) concluded "the extent and breadth of research available is considerable, utilises a range of methodologies, and is consistent in showing effects on young people (1, p.196)". The most recent systematic review, including 12 studies published between 2010 and 2016, found positive associations in all 12 longitudinal studies (10). Thus, evidence of the association between alcohol marketing and childhood drinking continues to mount. However, as mentioned earlier, some of the studies included in these systematic reviews focus on a single promotion type. As such, the following sections examine the association between children's exposure to alcohol marketing and subsequent drinking, by promotion types.

3.4.2 Television marketing

Historically, television has been the predominant promotion type investigated in alcohol marketing research. For example, 18 of the 25 longitudinal studies included in the three systematic reviews cited above focused on television alcohol marketing, with a further three studies focusing on exposure at cinemas and in movies. In one of these longitudinal studies, US children aged 12-13 years (n = 2,998) at one-year follow-up showed that for every standard deviation increase in exposure to televised alcohol marketing, beer drinking increased by 44%, wine/spirits drinking by 34% and hazardous drinking by 26% (178). In Germany, a longitudinal study of 2,130 children (aged 11-17 years) found that exposure to alcohol marketing on television was positively associated with the earlier onset of drinking (179). In NZ, a longitudinal study with children (n = 667, aged 13 and 15 at baseline) found that televised alcohol marketing recalled at age 15 for boys was positively associated with hazardous drinking at age 18 (180). Similarly, televised alcohol marketing exposure at age 13 for girls was positively associated with drinking frequency at age 18 (180). Overall, the longitudinal evidence suggests exposure to television marketing may increase early initiation of alcohol use and hazardous drinking.

3.4.3 Digital marketing

Everyday communications and entertainment are increasingly accessed through digital media, prompting alcohol marketers to take advantage of the opportunities the internet provides. Forms of digital marketing commonly used by alcohol marketers include brand websites, brand pages on social networking sites (SNS) such as Facebook, downloadable content (video games) and smartphone applications (181). Digital marketing differs from traditional forms of inherently passive marketing, such as television marketing, in that it facilitates greater consumer engagement with interactive marketing on different platforms, particularly SNS (182). The informal, and often user-generated, brand promotion facilitated by digital media contributes to the construction of an individual's social identity and group social norms (183). For example, Griffiths and Casswell (184) argue engagement with digital alcohol marketing on SNS leads to the construction of intoxigenic social identities, in which alcohol consumption and hazardous drinking are normalised. Alcohol marketing exposure studies show children frequently see alcohol marketing via digital marketing (185-187).

There is now a growing evidence base demonstrating the association between exposure to digital alcohol marketing and children's alcohol-related outcomes. In a systematic review of 15 studies investigating the impact of digital alcohol marketing on children's alcohol consumption, exposure to alcohol marketing was positively associated with childhood drinking, children's positive expectancies towards alcohol consumption and their intentions to use alcohol (188). However, this systematic review included studies with participants aged up to 24 (n = 11) and cross-sectional studies (n = 14). Only four studies included participants exclusively under 18, of which, only one was a longitudinal study (189). In the longitudinal study, with 1,563 15-year-old US children, the authors found that children's exposure to alcohol-related content on their friends' SNS was associated with alcohol use (189). Interestingly, alcohol-related content on SNS was more influential on children without drinking friends compared to those with drinking friends. Thus, conformity to social identities created on SNS may be an important aspect of children’s drinking. This finding aligns with CST – that posits children in the reflective stage attempt to conform to group expectations.

A longitudinal study published since the systematic review, that included 6,651 children (aged 14) from Germany, Italy, the Netherlands and Poland, found that children’s exposure to digital alcohol marketing increased the odds of childhood drinking at one year follow-up (190). Another longitudinal study with 1,596 young people (aged 15 to 20) from the US showed that engagement with digital alcohol marketing at baseline predicted future hazardous drinking at one year follow-up, after controlling for internet use, sociodemographic and personality characteristics, and peer and parent drinking (182). Given the sample included persons aged 18 to 20 the findings may overestimate children’s drinking, as older participants may be more likely to both drink alcohol and engage with alcohol marketing.

In addition to the building longitudinal evidence base, there is cross-sectional evidence that supports the associations between digital alcohol marketing and consumption. In a narrative review of 47 studies investigating digital alcohol marketing, the authors concluded that exposure to such marketing was associated with childhood drinking (181). However, only two of the studies included children under 18 and specifically investigated the impact of digital marketing exposure and children’s drinking (177, 191). One study, a cross-sectional study of 1,113 Australian children aged 12-17, found that exposure to digital alcohol marketing increased the odds of recent drinking (within the past four weeks) (191). The association between digital alcohol marketing and recent drinking was strongest in boys aged 12-15. Another cross-sectional study of over 9,000 children from Germany, Italy, the Netherlands and Poland showed that exposure to digital alcohol marketing increased the odds of early onset drinking and hazardous drinking (192). Similarly, in NZ, a cross-sectional study with 2,538 children showed that children who engaged in digital alcohol marketing were 98% more likely to consume alcohol than children who had not engaged in alcohol marketing (193). Further, the authors found a stronger association between active engagement in digital alcohol marketing and drinking outcomes than passive exposure.

Overall, the emerging longitudinal evidence base, supported by the established cross-sectional evidence, suggests that there are consistent associations between exposure to digital alcohol marketing and children's attitudes of alcohol, intentions to drink and overall drinking.

3.4.4 Product packaging

Product packaging is a key marketing tool used to promote products and brands. All aspects of product packaging contribute to creating a desirable image of a product, including the colours, images and fonts (183). Brand design, including its packaging, influences consumer preferences in children as young as 12 years old (194). Product packaging is an important marketing strategy for the alcohol industry as alcohol is a product often consumed from its packaging, and is often done so in group and peer contexts (173). In children's environments, alcohol consumption is a powerful marketing tool when viewed with its associated product packaging. For example, Figure 3 displays photographs of the All Blacks' (NZ rugby team) captain Richie McCaw and then NZ Prime Minister John Key sharing a beer (*Steinlager*, All Blacks' sponsor) after All Blacks' victories. The alcohol brand appears on the bottle and is a powerful marketing tool linking NZ's most successful sports team and NZ leaders (Richie McCaw and then PM John Key) with alcohol, in this instance, the *Steinlager* brand. Research on the impact of product packaging and children's drinking is limited but is a growing area of interest.

The evidence of product packaging's influence on children's drinking or perceptions of alcohol is limited to experimental studies. A study of 210 Australian children aged between 12-17 years found that product packaging was appealing to children and was associated with higher palatability ratings of the product (195). A further study using the same participants found product packaging increased children's acceptability of alcohol in the drinks, tasted during a blinded test (196). Another Australian study conducted focus groups with children aged 12-14 and found their perceptions of alcohol products came primarily from the products' packaging, rather than the children's experience of drinking it (197). Children's reliance on product packaging to inform their consumer knowledge shows how product packaging may be even more influential for children, who are beginning to experiment with alcohol, than adults. However, the studies discussed above had relatively small samples (<250), were experimental study designs and did not measure the impact of exposure to alcohol product packaging on drinking behaviours. While evidence specifically investigating the impacts of product packaging on children's drinking is sparse, product packaging is a known and important aspect of alcohol marketing strategies (14, 154, 198). The limited evidence base is likely due, at least in part, to the difficulty in acquiring a reliable exposure measurement for product packaging as it is hard to capture or recall such exposures.

Figure 3: Richie McCaw (All Blacks' captain) and then Prime Minister of NZ John Key drinking a beer (*Steinlager*) after All Blacks' victories

3.4.5 In-store marketing

Research suggests a positive association between exposure to in-store alcohol marketing and increased alcohol consumption in children. In-store marketing uses a range of sales tactics that aim to stimulate demand for products, including product displays, contests associated with major events and giveaways. Further, in-store marketing includes other promotion types including product packaging, signs and digital media, which occur within an alcohol outlet. A potential mechanism of in-store marketing's influence is the conflation of alcohol with everyday consumer products (102). Children's consumer knowledge of alcohol is further confused by the alcohol industry adopting promotional tactics, such as sales promotions and in-store displays, used for everyday products that act to portray alcohol as an ordinary commodity (199).

A US longitudinal study of 3,111 children aged 12 to 14 years demonstrated that non-drinkers at baseline exposed to in-store marketing within alcohol outlets were 42% more likely to use alcohol than children not exposed to in-store marketing (102). Interestingly, in this study, children with weak connections to other socialising agents (eg peers or parents) had stronger associations between in-store marketing exposure and drinking than children with stronger connections to other socialising agents. Similarly, a cross-sectional study in the US found children (n = 2,125 aged 11 to 15 years) exposed to in-store alcohol marketing were 50% more likely to use alcohol than children with no exposure (105). A cross-sectional analysis of 1,193 Australian children demonstrated that exposure to in-store marketing at on-licence alcohol outlets was positively associated with early onset drinking and overall alcohol consumption (191). Exposure to in-store marketing at off-licence outlets was also positively associated with early onset drinking (191). A cross-sectional study of 2,538 NZ children aged 13 to 14 years found that over half of current drinkers could recall alcohol marketing exposure within alcohol outlets, including supermarkets (193). The authors estimated that this exposure increased the likelihood of being a drinker by 8%. Collectively, the research reviewed suggests a relationship between exposure to in-store alcohol marketing and alcohol use in children.

3.4.6 Sports sponsorship

Sports sponsorship is an important and effective alcohol marketing strategy (200). Sponsorship is defined as "a company's investment in cash or kind, for creating a business-to-business relationship with a sports team, in order to gain publicity and awareness in a specific target group, via the support of an activity, not directly associated to their business" (201, p.33). Sport is emotionally captivating, is highly popular with a diverse and broad audience, and generates media attention (202). For example, the Fédération Internationale de Football Association (FIFA), the governing body of international football, reported over 265 million people participate in football worldwide (203). Furthermore, over 3.2 billion people watched the 2014 FIFA World Cup; with over one billion people watching the final alone (an event sponsored by the alcohol brand

ABInBev) (204). Children make up a large portion of sports spectatorship, for example, around 90% of children watch televised sport in the US and NZ (205, 206).

Alcohol sports sponsorship enables alcohol marketers to reach and influence non-drinkers and drinkers while also exposing children to the same marketing. Sports sponsorship often allows alcohol marketing at times and in places not permitted under most self-regulatory codes on alcohol marketing (128). Consequently, alcohol companies report, in internal memos, that sports sponsorship has increased their profits (207). Unsurprisingly, the alcohol industry continues to increase its sponsorship of many major sports events, teams and players globally (208). In NZ, brand protection legislation (the Major Events Management Act 2007), enacted before NZ hosted the 2011 Rugby World Cup, ensures a tightly prescribed relationship between sports organisations and sponsors by protecting sponsors' rights to promote their products (128). This arrangement protects, in legislation, alcohol companies' agreements with sports organisations, strengthening their position and in turn increasing the appeal of sports sponsorship as a promotion type over traditional forms of marketing.

There is now a growing body of evidence linking exposure to alcohol marketing via sports sponsorship and alcohol-related outcomes (112). For example, a systematic review investigating the impact of alcohol sponsorship on drinking outcomes concluded that alcohol sponsorship increased drinking outcomes in both children exposed to alcohol marketing via sponsorship and the athletes themselves (112). The two studies that focused on children's drinking behaviours found positive associations between exposure to alcohol sponsorship and alcohol consumption. One longitudinal study that included 6,651 children (14 years at baseline) found that greater exposure to alcohol marketing through sports sponsorship increased both drinking intentions and actual drinking at one year follow up (190). The other study included in the review was a cross-sectional study conducted in Wales with 294 children aged 14 to 15, which found that awareness of alcohol sponsorship was associated with children's likelihood to drink and likelihood to drink hazardously (209). Another longitudinal study of 552 Scottish children aged 12 to 13 years at baseline showed 61 percent recalled alcohol sponsorship of televised sport, with a further 66% recalling the logos on sports clothing (210). The same study found that awareness of alcohol brands at age 12 increased the odds of children drinking alcohol at two years follow up by 35%. However, the effects of sponsorship were not analysed separately from other promotion types so the effect of sports sponsorship cannot be isolated (210).

The association between sports sponsorship alcohol marketing exposure and childhood drinking is exacerbated when considering the extent of exposure. For example, multiple frequency analyses of televised sports sponsorship found viewers are exposed to alcohol marketing between 0.7 and 3.8 times per minute, across a range of sports, in a number of countries (128, 129, 200, 202, 211). However, as these studies exclusively investigated exposure via televised sport, they do not account for the full range of sports sponsorship material used to promote alcohol, such as promotional posters, replica jerseys and sporting equipment. Collectively, the findings of the literature suggest a link between exposure to alcohol sports sponsorship and children's alcohol-related outcomes (112, 190, 210).

3.4.7 Outdoor marketing

Outdoor marketing includes promotion types such as billboards, outdoor signs and shop front signage. A systematic review of 26 studies of neighbourhood predictors of alcohol use concluded that the evidence suggests neighbourhood alcohol marketing influences alcohol use (86). However, studies finding positive relationships between outdoor marketing exposure and alcohol consumption have methodological shortcomings, such as basing exposure on neighbourhood audits of alcohol marketing, reflecting the difficulty of measuring exposure to alcohol marketing in the outdoor environment. As such, the review described the studies demonstrating the association as weak (86). Furthermore, only one study included in the review observed children's exposure to alcohol marketing (212). In this longitudinal study of 2,586 children in the US city of Chicago, the authors found that exposure at ages 11 to 12 to outdoor marketing around the children's school predicted intentions to use alcohol at ages 14 to 15 (212). Two longitudinal studies, conducted since the systematic review discussed above was published, that included outdoor marketing in their exposure measures found positive associations between alcohol marketing exposure and childhood alcohol use (210, 213). However, neither study examined the impact of promotion types independently. Thus, it is not possible to conclude the observed associations were between outdoor marketing and alcohol use; instead, they reflected the cumulative effect of numerous promotion types.

The challenges of measuring people's exposure to outdoor alcohol marketing may also explain the dearth of studies investigating outdoor marketing relative to other promotion types, such as the digital or television marketing, despite outdoor marketing contributing similar rates of exposure as other promotion types (214). Despite the limitations of previous research, this body of evidence suggests outdoor marketing likely influences children's attitudes towards alcohol and alcohol consumption.

3.4.8 Summary

Children's exposure to alcohol marketing is associated with positive attitudes towards alcohol, increased alcohol consumption and hazardous drinking (9-11). These effects are consistent across the different promotion types including via television (178-180), digital marketing (189, 190), product packaging (195-197), in-store marketing (102, 105), sports sponsorship (112, 190, 210) and outdoor marketing (210, 212, 213). This body of research has laid the foundation for this thesis by drawing the association between children's exposure to alcohol marketing and subsequent alcohol-related outcomes. As such, this thesis builds on this established evidence base, while highlighting possible avenues for new research. For example, few exposure studies have attempted to quantify the extent of children's exposure to alcohol marketing. Those that have mostly rely on self-report exposure measurements or proxies calculated from television viewing times, which are prone to recall bias and measurement error (10). Self-report measures often use Likert scales to gauge exposure status, which are not able to provide information on the context or quantity of exposure (213, 215, 216). Quantifying the extent and nature of children's exposure to alcohol marketing highlights the degree of the problem, and where to intervene, to protect children from alcohol-related harm.

There appears to be only one study attempting to quantify children's real-time exposure to alcohol marketing using another method (214). In this study, children used handheld electronic computers to record their exposures to alcohol marketing. The authors instructed children what qualified as alcohol marketing and children were required to record any exposure to such marketing during their normal daily activities. However, even this study may have underestimated the extent of children's exposure to alcohol marketing. First, product packaging is not included in this estimate. Second, their method required children to recognise and record exposures, which increases reliance on the user and it is possible many exposures were unreported due to children's unfamiliarity with alcohol brands and the sublimity of marketing (217). Third, their research ignored repeat exposures to alcohol marketing, which ignores how marketing functions through mere exposure (158-160). Recommendations for further research call for methods that provide a more objective account of exposure and that account for the full range of promotion types used by the alcohol industry (199).

3.5 Policy approaches to restricting alcohol marketing

The mounting evidence of the association between exposure to alcohol marketing and childhood drinking has increased calls for action on alcohol marketing. Peak medical and public health bodies are prominent in these calls internationally (eg, Australia, Ireland, the UK, the US, South Africa) and in NZ (55, 218-221). As discussed in Chapter Two, alcohol marketing restrictions are one of the most cost-effective approaches to reducing alcohol-related harm (109). The establishment of a regulatory framework with a legislative basis to regulate the volume and content of direct and indirect marketing is one of WHO's priority recommendations for the reduction of alcohol-related harm (2).

Despite the growing case for tighter restrictions on alcohol marketing, in 2008, an assessment of marketing restrictions in 64 countries using data from the 2002 and 2008 WHO Global Survey on Alcohol and Health showed that over a third (36%) of participating countries still had no restrictions on alcohol marketing in 2008 (222). The assessment included countries from developed and developing countries, and countries from each of the six WHO regions. The authors also found there were no substantial changes in the restrictiveness of alcohol marketing between 2002 and 2008 in those countries with marketing restrictions at baseline (222). NZ ranked in the least restrictive category, alongside the US, Niger, the Republic of Congo and Zambia. The sections below outline global examples of alcohol marketing policies.

3.5.1 Complete bans

Some Scandinavian countries, such as Denmark and Finland, had complete bans on alcohol marketing, which have been weakened to partial bans in order to comply with European Union regulations (1). In 2017, Lithuania implemented a complete ban on alcohol marketing including via television, radio, print, sponsorship and merchandise (223). However, Lithuania's ban is likely to face legal opposition in the European Union Court based on similar legal challenges to alcohol marketing regulations in Denmark and

Finland. Consequently, countries with the most restrictive alcohol marketing policies often implement partial bans. For example, the French legislation, the *Loi Evin*, is often regarded as one of the most comprehensive laws restricting alcohol marketing (1). A key feature of the *Loi Evin* is the legislation prohibits all alcohol marketing unless the law provides an exemption (1). Consequently, the law enables the regulation of new and emerging media, and clearly outlines what are permitted forms of alcohol marketing. Notably, the *Loi Evin* imposes a complete ban on alcohol sports sponsorship and televised alcohol marketing. As there is limited evidence of complete bans on alcohol marketing, possible alcohol marketing restrictions are discussed by promotion type in the following sections.

3.5.2 Television marketing

Policies to reduce exposure to alcohol marketing on television include complete bans and restrictions on time and content. Countries such as Denmark, Finland, Norway, Sri Lanka, Turkey and France have implemented complete bans on televised alcohol marketing (224, 225). However, the European Union Court overturned bans in Denmark and Finland due to their incompatibility with European Union regulations (12). The European Union Court decision contradicts an earlier decision, on the French *Loi Evin*, that declared restrictions on alcohol marketing were proportional to the benefits to public health (226). Likewise, in France, under pressure from alcohol industry lobbying, a 2016 amendment to the *Loi Evin* allowed alcohol marketing on television for the first time since 1991 (225). Sweden has also implemented a complete ban on televised alcohol marketing. However, channels broadcasting under UK licences (five such channels broadcast in Sweden) circumvent the ban, as the UK licences imply they are subject to UK law (227). These examples demonstrate that complete bans on televised alcohol marketing are possible to implement but are subject to industry lobbying, potential legal action and are vulnerable to the global nature of television broadcasts (12, 225).

In the Ukraine, Belarus and the Netherlands, time restrictions are mandated by law, with alcohol marketing not permitted between the hours of 6.00am to 11.00pm, 7.00am to 10.00pm and 6.00am to 9.00pm, respectively (2, 12, 228). However, even legislated time restrictions do not guarantee children's protection from alcohol marketing. For example, in the Netherlands, the alcohol industry's response to the introduction of legislated time restrictions on televised alcohol marketing between 6.00am to 9.00pm was to increase the number of advertisements broadcast after 9.00pm from 7,500 to 23,000. As a result, exposure to alcohol marketing at all ages increased from the pre-legislative levels, with more children aged 12-17 years exposed to alcohol marketing than adults (228).

Some countries have implemented content restrictions on alcohol marketing, which vary widely between countries (12). The most restrictive regulations on the content of televised alcohol marketing require health messages and permit only information on the product, such as where it is produced and its alcohol content (225). France has strict statutory regulation on the content of alcohol marketing messages, prohibiting marketing that associates alcohol with pleasure, glamour, success, sport, sex or opinion leaders (225). However, there is less evidence of the effectiveness of restrictions on alcohol marketing content (3). Further, a systematic review found that alcohol marketing frequently used young, attractive or famous models, and youth-oriented content such as cartoon characters that breached codes on content (12).

In NZ, the self-regulatory ASA codes prohibit any alcohol marketing on television between the hours of 6.00am and 8.30pm (126). Children frequently watch television outside these times and are therefore likely exposed to alcohol marketing on television. For example, in a study of 1,200 NZ children aged 5-17, the authors installed peoplemeters in participants' home televisions that record what participants were watching, including the advertisements to which they were exposed (229). The authors found that 90% of children were exposed to alcohol marketing on television at least once per week, with exposure to an estimated average of 500 televised alcohol advertisements each year. Similarly, in 2014, 75% of children aged 15-17 reported being exposed to alcohol marketing on television (230).

Collectively, the evidence suggests that restrictions on the time and content of televised alcohol marketing are ineffective, even when mandated by law. Self-regulatory systems are particularly poor at complying with their codes of marketing leading to children being frequently exposed to alcohol marketing under such systems (12). Thus, complete bans are the most effective approaches to televised alcohol marketing.

3.5.3 Digital marketing

Digital marketing is an emerging and rapidly growing promotion type for alcohol. Problematically, governments have been slow to adapt and have struggled to implement effective restrictions on digital marketing. For example, a narrative review of 47 studies, in a range of countries, concluded digital alcohol marketing undermines the current restrictions on alcohol marketing (181). For example, in the UK, the Code of Non-Broadcast Advertising, Sales Promotion and Direct Marketing (the CAP code) is used to regulate digital alcohol marketing (185). However, multiple alcohol brands' websites contain content that has a high appeal for children, such as games and other downloadable content, features that contradict the CAP code (231). Likewise, recent studies show children can easily access alcohol-branded content online and that the current age-gating technology, that requires users to input their date of birth to verify they are of legal age to purchase alcohol, is ineffective (12).

In Norway, there is a total ban on digital alcohol marketing on websites that are open to the public (232). That is, alcohol marketers can only promote their products on restricted websites that require unique passwords. Such websites are typically accessed by members of the alcohol industry. Norway's policy is one of the more restrictive and has the potential to limit children's exposure to alcohol marketing. In France, the *Loi Evin* regulates digital alcohol marketing. Before 2009, the law prohibited digital marketing of alcohol products above 1.25% alcohol content. However, in 2009, an amendment to the *Loi Evin* permitted digital alcohol marketing (233), but prohibits marketing on websites directed at young people or websites run by sports organisations. Recently, Finland introduced statutory regulations on digital alcohol marketing. Specifically, it prohibits any alcohol marketing on SNS that encourages consumer engagement, such as contests, 'liking' and 'sharing' and user-generated content such as Facebook posts (234).

In NZ, restrictions on digital alcohol marketing are guided by the industry self-regulated ASA codes. A study of 2,538 NZ children, that showed children frequently see digital alcohol marketing, highlights the vulnerabilities in the current ASA codes (193).

3.5.4 Product packaging

Product packaging is another promotion type used by the alcohol industry to market alcohol (183), but it is also an opportunity for health promotion. For example, in South Africa, every alcoholic beverage must contain one of seven different health warnings such as "alcohol abuse is dangerous to your health" (235). The interest in health warning labels for alcohol is, in part, due to the effectiveness of tobacco health warning labels, which reduce positive attitudes towards tobacco and increase the likelihood of smoking cessation (198). Evidence suggests health warnings on alcohol labels are effective in reducing intentions to drink in adult populations (236, 237).

Despite the effectiveness of health warning labels, WHO reported that only 41 of 167 reporting countries had mandatory health warning labels for alcohol (2). Countries such as Israel, Kenya, Russia, the US and France have statutory regulation enforcing health warnings on alcohol products that are more effective both in increasing industry compliance and consumer awareness than self-regulatory systems (2, 238). While these countries mandate health warnings through legislation, the size and content of the warnings differ substantially between countries. For example, in Kenya, legislation requires alcohol packaging to include two of five health warnings, which must comprise no less than 30% of the total surface area of the package (235). Health warnings also differ in content, from South Korea “alcohol is a carcinogen, so excessive drinking causes liver cancer and gastric adenocarcinoma” to Argentina “drink in moderation” (235).

In addition to text-based health warnings, evidence suggests that health warning labels for alcohol using graphic imagery, such as those used on tobacco packaging, are effective at decreasing intentions to drink, reducing positive perceptions of alcohol and increasing intention to quit drinking alcohol (237). Currently, Thailand is the only country attempting to introduce graphic health warnings on alcohol, as seen in Figure 4 (235). However, Thailand’s policy is currently being challenged by the World Trade Organization (WTO) Technical Barriers to Trade Agreement (239). Ironically, both the Australian and NZ Governments alerted WTO that Thailand’s graphic warning labels on alcohol may breach WTO agreements by impeding free trade. At the same time, Australia has also recently fought similar WTO arguments while introducing similar warnings on tobacco packaging and NZ has implemented similar warnings on tobacco packaging. The legal challenge to Thailand highlights potential barriers to modifying alcohol product packaging.

Figure 4: Graphic health warning label for alcohol packaging proposed in Thailand, translation "Alcohol can cause disabilities and deaths". Source: Charuvastra (240)

Plain packaging is another strategy to modify alcohol product packaging but has received little attention (198, 241). The strategy is primarily based on the success in tobacco control. Plain packaging involves reducing the style and design of product packaging to a standardised version, stripping away all elements of the brand imagery (242). Plain packaging of tobacco products has been shown to decrease children’s positive attitudes towards cigarettes (243). Moreover, it increases awareness of associated health warnings on labels by emphasising the health warnings (198). Therefore, it is likely similar effects could result from plain packaging on alcohol products.

In contrast to mandated labelling, evidence shows the alcohol industry's voluntary health warnings are ineffective at gaining the attention of consumers, are slow to be implemented and often have low compliance (238, 244). In countries with industry-regulated health warnings, such as the UK, Australia and NZ, health warnings tend to be less prominent, vague and text-based (241, 244). In 2008, the UK established a voluntary agreement with the alcohol industry for health warning labels on alcohol packaging. However, by 2009, most (85%) alcohol packaging failed to comply with the agreement (238). Despite the lack of compliance, the voluntary agreement was extended and is currently under independent review.

In Australia and NZ, Food Standards Australia and NZ (FSANZ) regulates food and alcohol labelling. The FSANZ board includes 12 members from diverse backgrounds, including the food and alcohol industry (245). In 2011, the Australia and New Zealand Ministerial Forum on Food Regulation, a forum made up of ministers from the NZ and Australian Governments, recommended FSANZ introduced voluntary health warning labels about the dangers of drinking while pregnant (244). By 2014, only 32% of beer and 76% of ready-to-drink products had pregnancy warnings (244). In 2014, FSANZ granted the alcohol industry another two years of voluntary regulation; it is now up for review.

3.5.5 In-store marketing

As outlined earlier in this chapter, in-store marketing includes all alcohol promotions that occur within on- and off-licence alcohol outlets, including but not limited to; product packaging, sale promotions, signs and product displays. Even under one of the more restrictive alcohol marketing laws, the French *Loi Evin*, in-store marketing is permitted. A survey of a nationally representative sample of French children aged 13-17, found that over 70% of the sample reported seeing in-store alcohol marketing within supermarkets at least once a month, the most of any promotion type (225). However, some Australian (191) and US states (246-248) have statutory regulation banning alcohol sales and associated marketing from supermarkets. Nevertheless, some Australian supermarket chains exploit the regulations by owning off-licence alcohol outlets built into or nearby the supermarket.

In NZ, there are few restrictions on in-store marketing. In-store marketing is permitted to target all legal-aged consumers, that is, those aged 18 and over. This contradicts the self-regulated restrictions on alcohol marketing, which do not apply to in-store marketing, that do not allow alcohol to be marketed to youth or depict anyone under the age of 25 in marketing. As discussed in Chapter Two, the SSAA has provisions to prevent undue exposure of shoppers in supermarkets to displays and promotions of alcohol (135). One of these provisions includes restricting alcohol marketing to a single-designated area within supermarkets, which is not on the most direct path through the supermarket. Research investigating the effectiveness of single-designated alcohol areas in preventing shopper's exposure to alcohol marketing has yet to emerge. However, in 2014, 55% of NZ children aged 15-17 reported being exposed to alcohol marketing within supermarkets, despite the implementation of the SSAA (230).

3.5.6 Sports sponsorship

Sports sponsorship is an increasingly attractive promotion type for the alcohol industry because it 1) enables marketing at times and places often not permitted under self-regulatory codes, 2) utilises sportspeople and teams that possess high social capital and 3) associates alcohol with the healthy pursuits of athletes and sport in general (1). In response, some countries have attempted to restrict sports sponsorship by alcohol companies. For example, in 1991 in France, the French *Loi Evin* removed all alcohol sports sponsorship, including sponsorship of teams, stadia and athletes (225). However, restrictions have since loosened in a number of areas (225), for example, alcohol marketers can now promote their products at some sports grounds. A recent study with a nationally representative sample of 6,642 French children aged 13-17 found 36.4% were exposed to alcohol marketing at sporting events (225). Like France, Norway has a complete ban on alcohol sports sponsorship (232), which has remained unchanged since its implementation. The only challenge to the Norwegian law is when television broadcast international sporting fixtures, which is hard to avoid in a global marketplace. Currently, Australia (220), Scotland (249) and NZ (134) are considering bans on sports sponsorship.

Removing alcohol sports sponsorship does not necessarily mean depriving sporting organisations of financial resources. There are viable models of sponsorship replacement, internationally and in NZ, which typically involve governments imposing new (sometimes hypothecated) taxes or increasing existing taxes on products. For example, in Victoria, Australia, a hypothecated tax on tobacco products went to the Victorian Health Promotion Fund, which was then used to replace tobacco sports sponsorship (250). In NZ, in 1990, the Smoke-free Environments Act banned tobacco sports sponsorship (48), and replaced the sponsorship with government funds administered by the Health Sponsorship Council. These results suggest that alcohol sponsorship replacement programmes are feasible and can be successful with little to no impact on sport itself.

Given few countries have implemented bans on alcohol sponsorship, similar examples of sponsorship replacement programmes for alcohol are limited. Most recently, *Healthway* in Western Australia, implemented a sponsorship replacement programme for sports willing to end alcohol, unhealthy food and gambling sponsorship, and promote healthy messages (251). In 2013, *Healthway* funded 464 applications for sponsorship for a total value of AU$4.5 million (252). Further, in 2013, it is estimated *Healthway* sponsorship led to over 2 million potential exposures to health promotion messages (252). In Australia, at a national level, twelve national sporting organisations signed up to a deal valued at AU$25 million to relinquish ties with alcohol companies in sponsorship replacement programmes funded by the central Government (253). The programmes implemented above were not in response to any bans or restrictions on alcohol marketing.

Even in the absence of sponsorship replacement programmes, it is possible that removing alcohol sponsorship could have little impact on sports revenue given there are other, health-neutral, companies that may be interested in sponsorship. For example, in the year after Australia banned tobacco sponsorship, sponsorship revenue increased by 45% (254), being sourced from other companies. Likewise, the 1998 Football World Cup in France found another sponsor after the *Loi Evin* removed the American Brewer *Anheuser Bush* as its major sponsor (225). The 2015 Cricket World Cup, hosted in Australia and NZ, did not have a major alcohol sponsor. While the reasons for this are unknown, presumably, alcohol companies were either outbid by non-alcohol sponsors or the

International Cricket Council, the governing body of international cricket, decided to exclude alcohol company sponsorship from the event. The most recent contract for sponsorship of the Australian-based National Rugby League was from a telecommunications company, valued at AU$6.5 million, more than four times higher than the largest bid from an alcohol company (*Carlton United Company*, AU$1.5 million) (255). In 2016, the CEO of NZ Rugby, Steve Tew, stated that if alcohol sponsorship of the sport was banned, NZ Rugby would be able to replace the income with brands from other categories (256). These results suggest health-neutral or health-promoting companies are likely willing to take over sports sponsorships previously held by alcohol companies.

3.5.7 Outdoor marketing

Outdoor marketing includes signs, shop front signage and billboards that appear in outdoor settings. The best examples of alcohol policy for controlling outdoor alcohol marketing come from countries that have completely banned alcohol marketing on billboards, bus stops, public transport and commercial vehicles and public areas in shopping malls (257). In Finland, violations of bans on outdoor alcohol marketing are monitored at a national level by the National Product Control Agency for Welfare and Health and by local governing bodies at a regional level (238). In Finland, children's exposure to outdoor marketing has decreased since the implementation of the ban (224). In Israel, there is also a law banning alcohol marketing on billboards, with a violation being a criminal offence, punishable by a fine (257). Similarly, in Latvia, all alcohol marketing is prohibited on the shop fronts of alcohol outlets (257). While there is limited evidence assessing the effectiveness of these interventions, the results from Finland suggest that complete bans are likely to lead to decreased exposure to outdoor alcohol marketing.

In many US cities, restrictions on outdoor marketing function at a local level. For example, in 1994, Baltimore enacted zoning regulation on tobacco and alcohol marketing, which cut the number of billboards from 1,400 to 70 (258). The zoning regulation removed all marketing from around schools and areas frequently visited by children. Importantly, Baltimore's policy was successfully implemented despite a legal challenge from the alcohol industry, with the US Supreme Court declaring the restrictions reasonable to defend the health and safety of Baltimore's citizens (258). Likewise, in

New York City, the Metropolitan Transportation Authority banned alcohol marketing on buses, subway cars and stations (259). By contrast, self-regulatory zoning agreements by tobacco and alcohol advertisers in New York, Chicago and Milwaukee failed to restrict marketing near schools and playgrounds, as there were no enforcement mechanisms (258). In NZ, outdoor marketing is subject to the same industry-regulated codes on content as television or radio marketing (126). There are no restrictions on the placement of alcohol marketing billboards or signs close to sites that children visit, such as schools.

Schools are an important consideration in outdoor marketing as they are a setting where children spend more of their waking hours than any other outside of the home (260). One approach to reducing exposure to alcohol marketing around schools is to introduce clean zones, that is, distances around schools where certain products cannot be sold or promoted. The evidence for clean alcohol zones around schools is limited. However, there is evidence of similar, viable models in the food and tobacco literature. In the US, Detroit zoning regulations prohibit fast food restaurants within 500 feet of schools (261), and Kentucky and Texas were the first US states to enact restrictions on tobacco marketing around schools (258). Likewise in South Korea, junk food sales are not permitted within 200m of schools (262). In NZ, policies in a few local jurisdictions prohibit alcohol outlets and their associated marketing between 40-300m of schools (142).

3.6 Assessing the effectiveness of alcohol marketing restrictions

There is emerging evidence on the effectiveness of alcohol marketing restrictions. A time-series analysis of alcohol marketing restrictions using data from 20 countries over a 26 year period concluded that with each incremental restriction on alcohol marketing there was a 5-8% reduction in population-level alcohol consumption (263). Another modelling study, using advertising expenditure data to estimate children's exposure to alcohol marketing, estimated that a 28% reduction in children's exposure to alcohol marketing would likely result in a 1-3% reduction in children's monthly hazardous drinking (264). The same study estimated the 28% reduction in exposure would also reduce past month drinking by 21-25% and hazardous drinking by 8-12% in the adult population (264). More recent US evidence using data from a cohort of four million people concluded a complete ban on alcohol marketing would reduce alcohol-related deaths by over 7,500 and reduce alcohol-related years of life lost by over 16% (265). Modelling in the UK estimated that prohibiting television alcohol marketing would reduce children's alcohol consumption by 9% (266). Further, the population benefits would include a potential 30,000 fewer criminal offences, amounting to around GB£28 million in justice savings. The authors of the modelling presented above (263-266), concluded governments should consider banning alcohol marketing as it is a cost-effective approach to reducing alcohol-related harm. WHO agrees, stating that restrictions on alcohol marketing are one of the 'best buys' for governments seeking to reduce the burden of alcohol-related harm (2).

3.7 The failure of self-regulation

As discussed, many countries rely on industry self-regulatory codes to govern the extent and nature of alcohol marketing (12). Self-regulation typically relies on industry developing, monitoring and enforcing their codes of marketing practice (222). As such, self-regulatory codes are more susceptible to alcohol industry influence than legislated regulation because industry sets the rules. Public health advocates argue these self-regulatory measures serve the purpose of reducing political pressure for and pre-empt regulations with a legislative base (267). Self-regulation tends to focus on aspects of traditional broadcast media and is inadequately equipped to address new forms of promotion used in the alcohol industry's expanding marketing strategy (12). Digital marketing, sponsorship and in-store marketing are outside the scope of most self-regulatory systems, despite increasing investment from alcohol companies (13).

Alcohol self-regulation is inadequate at achieving the stated objectives (1, 12). For example, a systematic review of 76 studies assessing the effectiveness of self-regulatory systems for alcohol marketing found that violations of the codes were common (12). In this systematic review, 45 of the 57 (79%) exposure studies included in the review concluded that youth (under 25) regularly saw alcohol marketing as a consequence of violations of the self-regulatory codes (12). In one of these studies, Patil, Winpenny, et al. (268) found UK children aged 10-15 were exposed to more alcohol marketing per viewing hour than adults aged over 24. Further, they found children and young adults (aged 13-19) in the Netherlands were exposed to more alcohol marketing than adults aged over 20. In Australia, not only were children exposed to the same amount of alcohol marketing as young adults, but the content of the marketing regularly broke the country's voluntary codes (12). In Australia, another example of the inadequacies of self-regulation is a loophole around time restrictions that allows alcohol marketing during live sports broadcast during restricted times, which was recently extended to include all sports programming, despite over 70% of the public supporting increased restrictions (269).

In NZ, critics of the self-regulatory codes cite the time delay between lodging a complaint and the removal of an advertisement (48, 127). Alcohol companies often run short, but intense, campaigns (48). Consequently, by the time the complaints process takes effect, the advertising campaign has concluded. For example, in 2018, the ASA ruled that an advertising campaign using a sports hero breached the codes; however, it took six weeks from the time of the complaint until the removal of the advertisement, at which point, the campaign had already concluded (270). This demonstrates how the industry undermines the intent of the codes by adjusting the nature of its marketing strategy to generate the maximum effect (127).

In summary, evidence of common violations and high alcohol marketing exposure in children demonstrates self-regulatory systems are inadequate at protecting children from alcohol marketing. Further, it reinforces criticisms that self-regulation is a tactic used by industry to deflect legislative action on alcohol marketing (13).

3.8 Challenges to implementing alcohol marketing policy

There are several challenges to implementing effective policy on alcohol marketing. The increasing number of sophisticated and multi-country trade deals poses one such challenge. The biggest obstacle to effective alcohol policy in these trade deals are provisions that protect corporate investment (271). As discussed above, WTO prevents the implementation of national alcohol marketing policies in multiple countries via the Technical Barriers to Trade Agreement. Most notably, Thailand's attempt to introduce graphic health warnings on alcohol packaging. Likewise, the European Union Court ruled against Denmark and Finland's attempts to restrict television alcohol marketing due to their incompatibility with European Union regulations.

In NZ, the Government recently signed the Comprehensive and Progressive Trans-Pacific Agreement (CPTPA) (formally known as the Trans-Pacific Partnership or TPP), which has investment provisions stronger than those contained in WTO agreements (271). For example, Beard (272) suggests that these investment provisions could allow transnational corporations to sue governments for revenue lost by the actions of any individual country. Thus, if NZ legislated alcohol marketing restrictions, which then led to a loss in profits for transnational alcohol companies, under the CPTPA, the NZ Government could be liable for these losses. The CPTPA also contains less transparent dispute settlement mechanisms than WTO agreements, limiting the ability to create precedent. Labonté, Schram, et al. (273) suggest the high costs associated with a dispute and the difficulty in knowing how the tribunal will rule, contribute to the regulatory chill of governments, which leave them reluctant to implement effective policy. Another provision of the CPTPA permits participation in regulatory settings by governments, interested persons and enterprise, essentially permitting transnational alcohol companies to be included in the formulation of national regulation in CPTPA countries (271).

The challenges posed by international trade deals provide evidence for an international approach to reducing alcohol-related harm. For example, the Framework Convention on Tobacco Control (FCTC) provides a template for how international agreements can overcome WTO challenges and promote effective policy. A Framework Convention on Alcohol Control (FCAC) is promoted by health researchers and advocates (13, 274, 275). However, there is resistance, as some health researchers argue that aiming for an FCAC is unlikely to succeed due to lack of political will and the power of the alcohol industry. They suggest that to pursue the development and implementation of a FCAC could delay the implementation of other harm-reducing policy alternatives, albeit less legally robust and effective ones (276-278).

Second, the alcohol industry poses a threat to effective alcohol marketing policy. The alcohol industry refers to the commercial industry involved in manufacturing, distributing and selling alcohol (1). A few large corporations dominate the international alcohol market due to the consolidation and globalisation of the alcohol industry (279). These transnational corporations possess enormous financial resources and use sophisticated marketing and public relations techniques to sell their products (279). As such, the alcohol industry is positioned to influence international and national alcohol policy and thus is a major obstacle to effective alcohol control policies.

A much-researched tactic used by the alcohol industry is direct lobbying via public submissions for new marketing restrictions (267). For example, Martino, Miller, et al. (280) found during the Australia National Preventative Health Agency's review of alcohol marketing regulations that the alcohol industry submissions consistently argued more evidence was needed and made claims to the Government that were contradictory to the evidence base. Unsurprisingly, submissions to the New South Wales Parliament over their Alcoholic Beverages Advertising Prohibition Bill in 2015 contained similar industry arguments (281). For example, a large Australian alcohol company, *Brown Forman*, claimed they supported an evidence-based approach to policy making but saw no evidence to support a change in approach to alcohol marketing in Australia (281).

Third, industries outside, but related to the alcohol industry, also provide substantial resistance to effective regulation of alcohol marketing. In response to the 2015 Alcoholic Beverages Advertising Prohibition Bill currently being read in the New South Wales Parliament (Australia), broadcasters opposed the Bill because it would significantly impact on advertising revenue, posing a threat to the financial security of some broadcasters (281). Likewise, popular sporting codes made similar arguments that banning alcohol marketing revenue would undermine the economics of professional sport in Australia (281). However, as discussed earlier in this chapter, the broadcasting and sporting industries produced similar arguments during the removal of tobacco sponsorship, yet when tobacco sponsorship was eventually removed, no such revenue decreases occurred (254). Finally, the marketing industry is typically an opponent to any restrictions on alcohol marketing as alcohol companies regularly contract marketing firms to produce large and expensive campaigns. For example, in Australia, media stories after the National Preventative Health Taskforce recommended ending industry self-regulation showed that marketing industry actors were almost always opposed to any changes to the current system (282). Further, the majority of marketing industry comments were based on two arguments that such changes were 1) unnecessary for a responsible industry and 2) an attack on legitimate commercial activity (282).

A fourth challenge to the implementation of alcohol marketing restrictions is gaining public support for such interventions. The challenge lies in overcoming industry-led arguments that such interventions are paternalistic, lack evidence for effectiveness and unfairly impact moderate drinkers (267). However, in NZ, there is considerable public support to restrict alcohol marketing seen and heard by children, with 79% supporting such restrictions and another 13% neither favouring nor opposing them (230). Likewise, 65% of New Zealanders support banning alcohol sponsorship of the sports young people attend, with a further 20% neither favouring nor opposing such an intervention. Therefore, the vast majority of New Zealanders would not oppose further restrictions on alcohol marketing or a ban on alcohol sports sponsorship.

3.9 Summary

This chapter began by defining marketing, how marketing functions through repeated exposure and outlining CST that highlights a potential mechanism through which alcohol marketing may influence children's alcohol-related outcomes. Specifically, CST posits children are vulnerable to alcohol marketing because they lack the cognitive or social skills to fully understand the biases in marketing.

There is mounting evidence that exposure to alcohol marketing, via a range of promotion types, is associated with early onset drinking, increased drinking frequency and hazardous drinking (9-11). While these studies highlight alcohol marketing is a problem for children's health, few studies examine the extent and nature of the problem. Also the few studies done have often relied on self-report exposure measurements or proxies that are prone to recall bias and measurement error (213, 215, 216). Consequently, we still know little about the extent and nature of children's real-time exposure to alcohol marketing.

There are now examples of a broad range of policies aimed at restricting alcohol marketing. There is extensive research demonstrating the inadequacies of self-regulatory models of alcohol marketing (12). In contrast, comprehensive restrictions grounded in legislation produce the greatest health and financial benefits for governments attempting to reduce the burden of alcohol-related harm and protect children (1, 222). Despite the strengthening case for legislative action on alcohol marketing, there are considerable challenges posed by international trade agreements, the alcohol industry and other interest groups, which suggest that change may be difficult.

CHAPTER FOUR: ALCOHOL AVAILABILITY

> *An increased density of alcohol outlets is associated with increased amounts of alcohol consumption in young people, numbers of assault, and with other harms such as homicide, child abuse and neglect and self-inflicted injury* (109, p.2238).

4.1 Introduction

This chapter outlines how alcohol availability may influence children's alcohol-related outcomes. Specifically, this chapter builds a case that alcohol availability may be a risk factor for children's overall exposure to alcohol marketing. First, this chapter commences with an examination of the different theoretical approaches used to understand how alcohol availability influences alcohol consumption. Second, the association between alcohol availability and children's alcohol consumption is discussed. Potential limitations of alcohol availability research are discussed and possible explanations for conflicting findings examined. The chapter also explores the social inequalities in alcohol availability by sociodemographic characteristics. Third, the chapter concludes by providing possible policy interventions to reduce alcohol availability, specifically, introducing government-owned monopolies, zoning policy and outlet density and proximity restrictions.

4.2 Defining alcohol availability

Alcohol availability relates to the ease of obtaining alcohol. Babor, Caetano et al. (1) outline a number of elements related to alcohol availability, including the number of outlets, the distance to outlets, minimum purchase age, willingness of outlets to sell to minors, outlet trading hours and days, and volumes of alcohol sales (1). Three systematic reviews investigating the association between alcohol availability and alcohol consumption include studies exploring these elements of alcohol availability (86, 283, 284). However, given this thesis focuses on young children (aged 11-13), the only measures of alcohol availability of interest are outlet density and proximity.

Campbell, Hahn, et al. (285) define outlet density as the "number of physical locations in which alcoholic beverages are available for purchase either per area or population" (285, p.556). Outlet proximity is the distance to the nearest alcohol outlet from a point of interest, typically measured as the crow flies or via road networks (286). The point of interest is typically a residential location (home, postcode or census tract) but may also include schools, churches or other alcohol outlets. Typically, these locations are selected because they are important community settings, likely influence health and retrieving accurate information on these settings is relatively easy.

Internationally, alcohol outlets are typically divided into two categories, on-licence and off-licence, defined according to where the purchased alcohol is consumed (122). On-licence outlets sell alcohol that must be consumed on-site; typical on-licence outlets include bars, sports clubs, and restaurants. In contrast, the alcohol purchased in off-licence outlets must be taken off-site for consumption; typical off-licence outlets include supermarkets and liquor stores. In NZ, in addition to on-licence and off-licence alcohol outlets, two other licence types exist, club licences and special licences (122). Club licences are intended for sports and cultural clubs but essentially function as on-licence outlets. In this thesis, club licences are collapsed into the on-licence category. Special licences permit alcohol sales at particular events or series of events. Given special licences expire at the conclusion of the event, they are not considered in this thesis.

4.3 Theories of alcohol availability

Several theories help explain how alcohol availability could influence alcohol consumption (122, 285, 287). Availability Theory posits increasing the distance to outlets or difficulty in obtaining alcohol increases the financial and opportunity costs, increasing alcohol's true cost more than the purchase price (122). Since the amount of alcohol a drinker consumes is sensitive to price (288), Availability Theory makes a rational assumption that an indirect increase in the cost of alcohol may decrease total consumption. This approach to alcohol availability is entrenched in the supply-side paradigm discussed in Chapter Two. Given it is illegal to sell alcohol to children, and that children tend to acquire their alcohol from other sources, such as through parents or friends (289), a supply-side explanation for the relationship between alcohol availability and children's drinking is insufficient. Instead, Heather and Stockwell (287) argue that alcohol availability research needs to encompass the socio-cultural effects of alcohol availability.

Amenity Theory starts to address the socio-cultural aspects of the environment by suggesting alcohol outlets alter the character of the surrounding area and create environments where adverse social outcomes are more likely (290). In line with Amenity Theory, Gruenewald and Remer (291) argue the high density of on-licence alcohol outlets in entertainment districts increases violence by creating niche establishments that can attract violent patrons. The increased flow of patrons between outlets also increases the interactions between patrons, which in turn, increases the chances of violent behaviour (1). In a narrative review of alcohol availability, Gruenewald (292) found that areas with high outlet density tend to attract problem drinkers and anti-social behaviour. In NZ, a clause in the SSAA requires alcohol licensing decisions to account for potential effects on the local amenity (135). However, like Availability Theory, Amenity Theory is entrenched in a supply-side paradigm of alcohol rather than demand.

Another, less utilised, theoretical approach posits that alcohol availability increases the demand for alcohol through the promotion and normalisation of alcohol (285). McGuinness (293) suggests that alcohol outlets are one aspect of the alcohol industry's marketing strategy, influencing drinking by stimulating demand for alcohol. More recently, Campbell, Hahn et al. (285) suggest that reducing alcohol availability could reduce alcohol-related harm by preventing exposure to on-site alcohol marketing. The presence of alcohol outlets near or within places frequently visited by children conflates alcohol with everyday consumer goods (102). Further, the promotional tactics utilised at alcohol outlets are similar to the promotional tactics used to market general products. Again, this normalises alcohol as an ordinary commodity (199).

Figure 5 presents an analytical framework proposed by Campbell, Hahn et al. (285) that highlights how alcohol availability increases alcohol marketing and the normalisation of alcohol. They argue a higher number of alcohol outlets contributes to increased exposure to alcohol marketing but also has a normalising effect on alcohol in people's social and physical environments, contributing to excessive alcohol consumption, early onset drinking, and related harms. This analytical framework is consistent with a socio-ecological model of health (81), as it focuses on environmental influences on health. Thus, reducing alcohol availability has the potential to decrease children's exposure to alcohol marketing and the normalisation of alcohol, which in turn, reduces two drivers of demand.

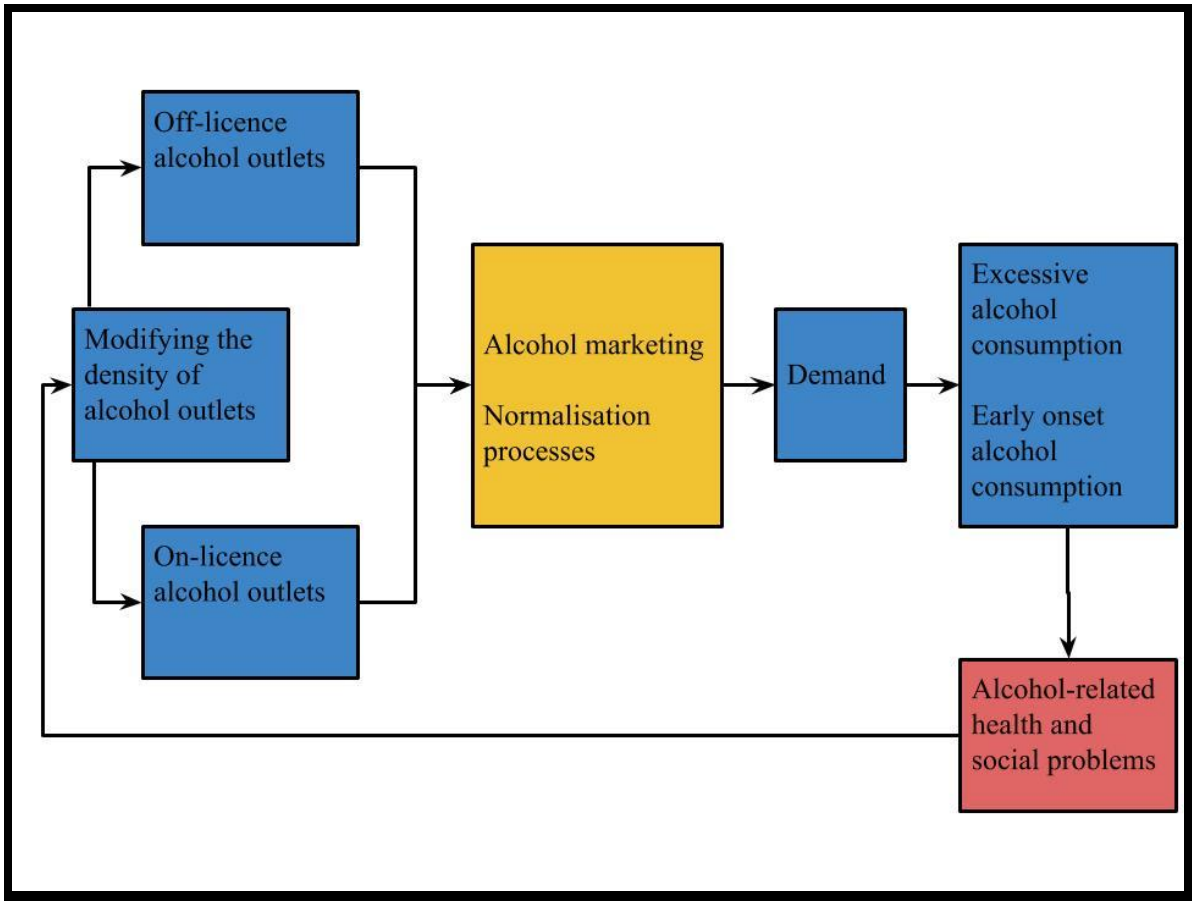


Figure 5: Analytical framework showing the hypothesised association between alcohol availability and alcohol-related outcomes. Source: Campbell, Hahn et al. (285)

This thesis builds on the well-established supply-side theories underpinning alcohol availability by arguing alcohol availability stimulates demand for alcohol via marketing and normalising processes as outlined by Campbell, Hahn et al. (285). In this way, increased restrictions on alcohol availability may reduce children's exposure to alcohol marketing and create healthier environments for children. Keeping this analytical framework in mind, the association between alcohol availability and children's alcohol consumption is discussed in the following section.

4.4 Alcohol availability and childhood drinking

Three systematic reviews investigating the association between alcohol availability and alcohol consumption conclude the evidence suggests that alcohol availability influences drinking outcomes and alcohol-related harm in adults and children (86, 283, 284). These reviews included 135 studies examining many different aspects of alcohol availability (eg, hours and days of sale and density), outlet types (eg, on-licence and off-licence), samples (eg, adults and children) and methodologies (eg, cross-sectional and longitudinal). However, only seven studies examined children. Of these seven studies, only two were longitudinal and one focused exclusively on ethnic minorities in Chicago. The findings of these seven studies and four more published since the systematic reviews are explored below.

4.4.1 Neighbourhood alcohol availability and children's hazardous drinking

Emerging evidence suggests a link between alcohol availability and increased childhood hazardous drinking. The most robust evidence comes from a longitudinal study of 1,091 children (aged 14-16 at baseline) in California that found off-licence alcohol outlet density was associated with childhood hazardous drinking (294). However, another US longitudinal study of 5,655 primarily African-American and Hispanic children aged 11-14 did not find an association between alcohol availability and childhood hazardous drinking (295). However, the latter longitudinal study focuses on only a subset of the population. The study also had methodological limitations, including measuring alcohol availability by the number of outlets per 1,000 people within a community area. Community areas in Chicago are large geographic units, for example, Ashburn has a land area of 3,100 acres with a population of 42,000 people, which is problematic as other research has found that outlets farther than 800m from home have no impact on children's alcohol consumption (101).

While longitudinal evidence is limited, there is more cross-sectional evidence of an association between alcohol availability and children's hazardous drinking (101, 103, 296-300). An analysis of 3,660 US children aged 12-17 found a positive relationship between neighbourhood alcohol availability and hazardous drinking (101). The authors estimated that every additional alcohol outlet within 800m of the home could increase the observed association by 0.1 percentage point. Furthermore, they estimated that reducing the number of outlets from 9.5 per 800m to 5.5 per 800m could decrease the prevalence of childhood hazardous drinking by 12.5%. In another US cross-sectional study, children (n=2,724, aged 10-16) living in areas with high levels of alcohol availability had increased odds of hazardous drinking (298). Likewise, an Australian study of 67,000 children aged 12-17 found off-licence outlet density was associated with hazardous drinking in urban, but not rural environments (297). Another Australian study of 999 children aged 14 found that having an off-licence outlet within 800m of the home was associated with a 79% increase in the odds of hazardous drinking (296).

In NZ, the evidence investigating the association between alcohol availability and children's hazardous drinking is limited to cross-sectional studies (103, 299). Huckle, Huakau et al. (103) conducted a cross-sectional study of 1,179 children aged 12-17 and showed every additional alcohol outlet in the neighbourhood was associated with a 0.5% increase in the odds of childhood hazardous drinking (103). More recently, another NZ study found a positive association between neighbourhood alcohol availability and children's (aged 12-15) hazardous drinking (299). However, alcohol availability was not associated with drinking patterns in older children (aged 16-17), which is consistent with research showing greater associations between alcohol availability and younger children's alcohol consumption (289). Collectively, the study findings presented in this section suggest there is a link between higher alcohol availability and increased children's hazardous drinking.

4.4.2 Neighbourhood alcohol availability and childhood drinking

There is increasing evidence demonstrating a positive association between alcohol availability and childhood drinking. There appear to be only four longitudinal studies investigating the association between alcohol availability and children's drinking (294-296, 301). Two of these were discussed in the section above (294, 295); one found a positive relationship (294), and the other found no association (295). The third is an Australian study of 2,835 children aged 11-17 years that found that alcohol availability increased the likelihood of childhood drinking (301). The authors estimated that a 10% increase in outlet density at baseline increased the odds of alcohol consumption by 17% at one year follow up (301). The fourth, an Australian longitudinal study of 648 children aged 14 at baseline, found that children living within 800m of an off-licence alcohol outlet at age 14 had 2.3 times higher odds of drinking at age 17, than children without an off-licence alcohol outlet within 800m of home (296).

The majority of evidence on the relationship between alcohol availability and childhood drinking is limited to cross-sectional studies (286, 289, 297, 298, 300, 302). An Australian cross-sectional study of 10,143 children aged 12-17 found outlet density was associated with increased risk of children (aged 12-14) consuming alcohol. However, there was no association for older children aged 15-17 (289). Another cross-sectional study of 979 Scottish 15-year-old children found off-licence outlet density was associated with increased odds of weekly drinking (286). The results showed a dose-response gradient, with the odds of weekly drinking among children increasing with increasing numbers of off-licences in their neighbourhoods. Children living in areas of the highest outlet density were 1.48 times more likely to engage in weekly drinking than those with the fewest off-licence outlets. The authors also found children living within 200m of an off-licence were 1.97 times more likely to drink frequently than children living 800m from an off-licence outlet (286).

NZ evidence of a relationship between alcohol availability and childhood drinking is sparse. A NZ study of children aged 12-17 found no association between outlet density and childhood drinking (103). However, outlet density was measured as the number of outlets reached within an administrative unit, a measure that may not represent children's actual neighbourhoods. Thus, the null result may reflect a poor neighbourhood measurement of outlet density for children.

In summary, international evidence suggests there is a positive relationship between alcohol availability and the frequency of childhood drinking and hazardous drinking (86), although, the mechanisms by which this occurs are contested. That is, often supply-side arguments are used when interpreting the associations between alcohol availability and children's alcohol-related outcomes. However, the strongest associations between alcohol availability and drinking are found in younger children (aged 12-14), who are unlikely to attempt to purchase, let alone acquire alcohol from alcohol outlets. A finding that reinforces the idea that environmental exposure to on-site alcohol marketing and normalisation of alcohol are important factors in this relationship, as suggested by Campbell, Hahn et al. (285).

4.4.3 Alcohol availability around schools and childhood drinking

Given the potential relationship between alcohol availability and childhood drinking, the proliferation of alcohol outlets near places frequently visited by children, such as schools, is a concern. As discussed in Chapter Three, school is an important setting for children and is part of their everyday life. However, there is limited research investigating alcohol availability around schools and childhood drinking. There appear to be only three such studies. An Australian study of 999 children aged 14 found in a cross-sectional analysis that children with an off-licence alcohol outlet within 800m of school were 2.3 times more likely to use alcohol than children without an alcohol outlet within 800m of school (296). However, the observed statistically significant association at age 14 did not persist in the longitudinal analyses of children at age 17.

One cross-sectional study included 52,214 middle and high school students aged 11-19 in Taiwan. The authors found children with schools in areas of high alcohol outlet density (1,000m concentric buffer) were 8% more likely to drink alcohol than those in areas of low alcohol outlet density (302). However, these findings are likely an underestimate, as areas with approximately two alcohol outlets were characterised as low alcohol outlet density. Furthermore, only chain convenience stores were included; other sources of alcohol such as supermarkets, liquor stores and restaurants were not included in the analysis (302). Therefore, the results may be subject to residual confounding from the misclassification of alcohol availability.

Another cross-sectional study included 1,194 ninth graders (aged 15) and their school principals in Switzerland. The authors found a positive relationship between outlet density around schools and increased alcohol consumption and drunkenness in children (303). However, public drinking and drunkenness mediated the association between alcohol availability and alcohol consumption. Thus, children’s drinking norms are influenced by the presence of alcohol, whether being consumed or sold in public. A major limitation of this research is its measure of outlet density, which relied on school principals’ estimation of outlets based on the question “to what extent do you agree with the statement ‘we have a lot of small alcohol shops and kiosks here’” (303). Despite this, the observed association suggests an increased presence of alcohol in the school neighbourhood may shape drinking norms in children.

In summary, while the evidence is limited, early cross-sectional analyses suggest schools are important settings for children and that exposure to alcohol outlets and their associated marketing in such settings may impact children’s alcohol-related outcomes, particularly at younger ages.

4.4.4 Inconsistencies in alcohol availability research

The majority of studies investigating the link between alcohol availability and children’s drinking have reported positive associations; however, some studies have reported null associations. Gmel, Holmes et al. (284) suggest that limitations in the evidence base include methodological inconsistencies between studies, such as the use of aggregated data in ecological studies, and the differing sociodemographic characteristics of participants and measures of alcohol availability.

Methodological differences may explain some of the variations in findings; one difference is outlet type. For example, many studies found positive associations between alcohol availability and increased childhood drinking when using off-licence alcohol outlets as the availability measure (101, 286, 294). In contrast, research including on-licence outlets found non-significant or weaker associations than those observed for off-licence outlets (286, 289). Consequently, off-licence alcohol outlets may influence children’s drinking more than on-licences, which has led to some researchers excluding on-licence outlets from analyses (294, 302, 304, 305). However, by excluding on-licence outlets, these studies may overlook a potentially important aspect of alcohol availability. Equally problematic are those studies that sum on- and off-licences into a single measure of alcohol availability. This measure of alcohol availability ignores the possibility that on-licence and off-licence outlets may impact children differently, which may potentially confound associations. Alternatively, one previous study included three measures of alcohol availability; off-licence, on-licence and all licence measures (101). This approach may be a solution to improving methodological consistency between studies and draw out associations by outlet type.

Inconsistent results may also be attributed to differences in settings. For example, in an Australian study discussed above, associations between alcohol availability and childhood drinking were observed for children living in urban but not rural settings (297). The authors suggest that in Australia, different drinking cultures exist in urban and rural settings. As such, the interplay between alcohol availability and drinking outcomes is likely to differ. Furthermore, rural settings may have more outlets per capita but far fewer per km^2 than in urban settings, so the alcohol availability metric may not be equally meaningful in both settings. Similarly, the authors of a US study suggested that the suburban setting contributed to the observed null association between alcohol availability and childhood drinking as such settings are characterised by small numbers of alcohol outlets (305).

Exposure measurements of alcohol availability also differ between studies. Common strategies to measure alcohol availability involve counting the number of outlets within an administrative unit (103, 286), or in a buffer around a participant's school (302) or home (298), or road network (300). Administrative units make larger national level studies feasible, as they are readily accessible and recognised among jurisdictions, however, they have a number of limitations. First, administrative units make assumptions about participants' daily lives and the places they travel. For example, Basta, Richmond, et al. (306) demonstrated that people's daily movements did not correspond accurately with the administrative unit they lived in. Second, research using administrative units assumes they are an accurate proxy for children's neighbourhoods (306). However, estimates for children's neighbourhood extent vary widely between studies (99, 307-310). Third, large administrative units also do not account for the potential effects of clustering of alcohol outlets in particular areas.

An alternative to using administrative units in alcohol availability research is to use buffers. Buffers are pre-defined zones that create geographic boundaries around certain locations (eg, home, school) that are used to approximate neighbourhoods (311). In contrast to administrative units, buffers enable observation of user-defined areas, which can provide a more accurate measure of individual levels of alcohol availability. The size and type of buffers depend on the population and phenomena of interest. Children-centred alcohol availability studies have used buffers including 160m (298), 400m (298), 500m (302), 800m (101, 298), 1,000m (302), 1,200m (286) and 3,200m (298, 305) around settings of interest. However, studies using greater than 1,200m buffers have produced non-significant associations (298, 305), suggesting larger measures may not adequately reflect children's neighbourhoods. To conclude, research using buffers tends to suffer from the same methodological problems as larger geographic areas, albeit to a lesser extent (306), which is discussed in detail in Chapter Five.

4.5 Social inequalities in alcohol availability

Internationally, people living in areas of the highest deprivation tend to experience the highest levels of alcohol availability (101, 312, 313). At a household level, Truong and Sturm (101) found in a US study that families in the lowest quartile of income had the highest levels of alcohol availability. In an Australian study, Morrison, Gruenewald et al. (313) mapped alcohol availability and the alcohol retail market using outlet and sales data. The authors concluded that while the largest market potential was in areas with older, male and higher income populations, alcohol outlets tended to be concentrated in adjacent areas of high deprivation, likely due to the lower operating costs in deprived neighbourhoods. Another explanation the authors suggest was that areas of higher deprivation often have less social and political capital to resist new licences or licence renewals (313). Hence, licences are more likely to be approved in areas of higher deprivation. Consequently, outlets tend to cluster in neighbourhoods with the highest deprivation, thus, impacting the residents in those neighbourhoods, further exacerbating health inequalities.

NZ mirrors the international trend of alcohol outlets proliferating in areas of high deprivation. In two nationally representative studies of alcohol availability in NZ, the authors used similar methods and found that people living in the most deprived areas had the highest levels of alcohol availability (314, 315). In addition to having a higher number of outlets, Hay, Whigham, et al. (316) found people living in high deprivation had to travel, on average, 50% less to reach an alcohol outlet than people living in the least deprivation. As a result, the concentration of alcohol outlets in areas of high deprivation exacerbates the unequal distribution of alcohol-related harm in NZ.

International evidence suggests that alcohol outlets appear to concentrate in those areas with greater proportions of minority or indigenous people (101, 312, 317). For example, Sturm (317) found in a US study that the number of minority students positively predicted the number of alcohol outlets within 400m of schools. Truong and Sturm (101) used data from 14,595 households participating in the California Health Interview Survey and found alcohol availability was significantly higher for minority families (African American, Hispanics, Asian and Pacific) than Caucasian families. Similarly, Romley, Cohen et al. (312), using a dataset of 9,361 zip codes in the US, found that non-Caucasian children live in areas of higher outlet density than their Caucasian counterparts. Given national level data showed lower consumption by minorities compared to Caucasians (312), the authors concluded that the higher availability of alcohol in minority neighbourhoods was unlikely the result of higher demand.

In NZ, evidence examining the differences in alcohol availability by ethnicity mirror the international trends outlined above. For example, Ayuka, Barnett, et al. (318) found outlet density was highest in neighbourhoods with high numbers of younger Māori and Pacific peoples. The patterns of the disparity between supply and demand seen in US-based studies (101, 312, 317) mirror Māori and Pacific peoples in the NZ context, as the prevalence of drinking among New Zealand European (NZE) (85%) is higher than Māori (80%) and Pacific peoples (56%) (54). Speaking in the US context, Berke, Tanski, et al. (319) suggest that alcohol companies deliberately target ethnic minority and indigenous neighbourhoods to maximise profits, due to the high number of heavy drinkers and never drinkers (growth market). Therefore, as Romley, Cohen et al. (312, p.48) concluded

> *Mismatches between alcohol demand and the supply of liquor stores constitute an environmental injustice for minorities and lower-income persons, with potential adverse consequences for drinking behaviour and other social ills.*

4.6 Alcohol availability and exposure to alcohol marketing

As discussed in Chapter Three, alcohol outlets are places of intense alcohol marketing, both in-store and on their shop fronts. There is evidence showing children are frequently exposed to alcohol marketing outside (214) and within alcohol outlets (191, 225). Moreover, that exposure to alcohol marketing at alcohol outlets is associated with increased alcohol consumption (102, 105, 191) and earlier onset of drinking (191). Despite this, there appear to be no studies investigating the direct association between alcohol availability and exposure to alcohol marketing.

The dearth of evidence of the relationship between alcohol availability and marketing is likely attributable to most availability studies using a supply-side paradigm and thus not accounting for the impact of alcohol marketing in their analyses. On the other hand, exposure studies for alcohol marketing use a demand-side paradigm and often ignore exposure associated with alcohol outlets. Marketing exposure studies that include on-site marketing (102, 105, 191) do not examine the impact of alcohol availability on exposure to alcohol marketing. Another explanation for the lack of evidence may be due to the difficulty in obtaining a reliable exposure measurement for alcohol marketing, particularly one capable of being analysed spatially in conjunction with alcohol availability measures.

4.7 Policy interventions for alcohol availability

There is a range of policy interventions used to control the availability of alcohol, including implementing government-owned alcohol outlet monopolies and restrictions on the density and location of alcohol outlets. WHO (14) recommends implementing government-owned alcohol outlet monopolies to control the sale and supply of alcohol, which have exclusive rights to sell and promote alcohol. Advocates of government-owned monopolies argue public interests rather than commercial interests are at the centre of any licensing decision (1). The New Zealand Law Commission (48) argued that Government-owned outlets may operate more responsibly as their brief extends beyond the profit maximisation of commercial operators. Moreover, government profits generated through alcohol sales can be used to support community and government initiatives. Such arrangements exist in many European countries (Sweden, Iceland and Norway) US states, Canadian provinces and a few

NZ TAs (1, 48). However, gradually most government-owned monopolies have either folded or been weakened under commercial pressure and via international trade agreements. For example, Sweden attempted to stop individuals importing alcohol online as it bypassed the government-owned monopoly; however, the European Union Court ruled the law restricted the free movement of goods within the EU and thus, violated EU trade agreements (320).

Changes in the retail environment from government-owned monopolies to privatised models provide a number of natural experiments. In Finland, in 1969, the Government permitted private stores to sell beer alongside the government-owned stores. In response, in one year, off-licence outlets increased from 130 to around 17,600, on-licence outlets increased from 940 to over 4,000 and overall alcohol consumption increased by 48% (1). The health consequences documented during the five years following the privatisation of alcohol sales included a 110% increase in hospital admissions for alcohol psychosis, a 50% increase in liver cirrhosis and an 80% increase in arrests for drunkenness (321). Similarly, in Sweden, the year following the privatisation of alcohol sales total alcohol consumption increased by 15%. Sweden later retracted the law and reintroduced a government-owned monopoly, and in the following year saw a 15% decrease in total alcohol consumption (1). Similarly, privatisation of wine sales in the US resulted in a 42% to 150% increase in wine sales across four states, without a decrease in beer or spirit sales, suggesting an overall increase rather than a substitution effect (322). In NZ, the 1989 Sale of Liquor Act, that permitted supermarket sales of wine, resulted in a 17% increase in wine sales with no substitution effect (120). These examples demonstrate the effectiveness of government-owned monopolies to control alcohol sales and decrease overall alcohol consumption.

Mechanisms for reducing or capping the number of outlets include local zoning and land-use regulations that can limit the number of outlets by geographic unit or population. This can be achieved by introducing location-based restrictions, establishing a cap on alcohol outlets or implementing temporary freezes on new alcohol licences (323). Limiting the location of alcohol outlets to commercial land under zoning regulations prevents alcohol outlets from being located in residential neighbourhoods. In 2017, the US city of Baltimore implemented new zoning policies which prohibited off-licence alcohol outlets in residential zones, which is likely to affect 110 outlets (324). In NZ, the Central Hawkes Bay's District

Plan restricts alcohol outlets within residential zones (142). Further, LAPs permit additional zoning restrictions. Building on district plans, three TAs have implemented further restrictions on zoning (142). Such restrictions include prohibiting new licences in areas of high deprivation (Rotorua) and no new licences in priority areas (Auckland).

US state laws commonly restrict outlet density through caps on outlets by county or city population. Effectively, caps prohibit new licences until the concentration falls under a specified number. For example, in California, a licence may be rejected if the ratio of licences to population is greater than one per 2,500 people or is in an area with 20% higher crime than the county average (325).

In NZ, ten of the 67 TAs introduced caps on the number of off-licence outlets in specific areas in their draft LAPs. Provisions that set caps in TA's LAPs (number of outlets per area), such as those observed in the US, were removed during the judicial process of LAP development (142). Only one LAP has managed to implement a density restriction. In 2017, Auckland's LAP introduced a temporary freeze on any new off-licence outlets for 24 months in specific areas with high levels of alcohol-related harm as identified from submissions by the Auckland City Council, the Police and Regional Public Health (326).

Another strategy recommended by WHO is the regulation of alcohol sales in certain places. Location-based restrictions typically aim to prevent licences near sensitive sites, such as educational or religious centres, or to prevent clustering of outlets. For example, Pennsylvania prohibits alcohol outlets within 100m of a church or school (327). Similarly, Californian state Law prohibits alcohol outlets within 200m of schools, public playgrounds, not-for-profit facilities, churches and hospitals (325).

In NZ, the SSAA provides no specific provisions for sensitive sites. However, LAPs do permit such restrictions. Five of 67 TAs implemented specific proximity requirements ranging from 40m to 300m (142). Another Five TAs have proximity requirements in their draft or provisional policies. However, in many cases, as LAPs are subject to judicial appeal, many proximity requirements are weakened. For example, Tauranga City's LAP had a proximity requirement of 500m from sensitive sites in its draft LAP, which was removed following a judicial appeal. Likewise, other draft proximity requirements have either been reduced (300 to 150m in Gisborne), exempted supermarkets (Hauraki) or permitted outlets when no significant adverse effects can be demonstrated (Eastern Bay of Plenty). As a result, proximity restrictions that have survived judicial appeal are often accompanied by clauses, like those outlined above, that severely weaken their applicability.

4.8 Summary

In summary, there is an emerging evidence base demonstrating a link between alcohol availability and children's alcohol-related outcomes. The strongest association between alcohol availability and children's alcohol consumption is in analyses using off-licence outlets as the measure of alcohol availability. Further, the strongest associations are found in those studies of younger children (aged 12-14). These results suggest that a more nuanced approach to alcohol availability is required to understand the impact of alcohol availability on children's alcohol-related outcomes, one that includes aspects of demand as outlined by Campbell, Hahn et al. (285). However, it appears no studies have directly analysed the association between neighbourhood alcohol availability and children's exposure to alcohol marketing, a primary driver of demand. Such data could provide useful information to inform the theoretical premise underpinning the observed associations between alcohol availability and young children's alcohol-related outcomes.

The mismatch between supply and demand of alcohol in neighbourhoods of high deprivation and of high populations of minority or indigenous people is a social injustice, which may account for and/or exacerbate existing health inequalities. Consequently, people with the least resources to combat the proliferation of alcohol outlets and who experience a disproportionate amount of alcohol-related harm, have the highest levels of alcohol availability.

Multiple policy interventions exist to reduce alcohol availability that includes government-owned monopolies, restrictions on density and restrictions on outlets near sensitive sites. The next chapter outlines the methodology used in this thesis to explore the extent and nature of children's exposure to alcohol marketing.

CHAPTER FIVE: METHODOLOGY

> *Children perceive and act upon the world differently from adults; therefore, research aimed at uncovering phenomenological meaning of children's experiences should consist of participatory methods that engage children* (328, p.292).

5.1 Introduction

This thesis investigates the extent and nature of children's real-time exposure to alcohol marketing using wearable cameras and GPS devices. Children in the Wellington region of NZ wore both devices for four consecutive days to provide a real-time account of the world in which they live. The image data from the wearable cameras were coded using content analysis, facilitated by custom-built coding software. GPS data were cleaned, linked to image data and spatially analysed using the spatial software program ArcGIS (Redlands, ESRI, CA).

This chapter presents the methodology used in this thesis. As discussed previously, research analysing children's exposure to alcohol marketing suffers from methodological limitations. To address such limitations, this chapter discusses the strengths and limitations of adopting a novel methodological approach, using wearable cameras and GPS devices, to investigate children's real-time exposure to alcohol marketing. Additionally, this chapter discusses the potential of these devices to improve on existing methods used in neighbourhood analyses of health-related exposures.

The current study, Kids'Cam Alcohol, is an ancillary study of a larger project, Kids'Cam. Before presenting the data cleaning and analysis procedures for this study, Kids'Cam Alcohol, relevant aspects of the overarching Kids'Cam study are outlined. Next, my contribution to Kids'Cam is summarised. The methods for Kids'Cam Alcohol are then explained, notably, the cleaning of a large GPS dataset, accounting for missing GPS data using a mixed imputation method, developing a destination detection application, developing a content analysis protocol for alcohol marketing and developing a micro-spatial analysis method using tandem image and GPS data in a Global Information System (GIS).

5.2 Methodological considerations

This section outlines some methodological considerations of this thesis. These relate to the use of wearable cameras, GPS and GIS in health research and conducting neighbourhood, destination and micro-spatial analyses.

5.2.1 The use of wearable cameras in health research

Wearable cameras may be one method to overcome the limitations of previous alcohol exposure studies. As discussed in Chapters Three and Four, alcohol exposure studies rely on self-report data, aggregated marketing data or neighbourhood audits that are prone to recall bias and measurement error (10). In recent years, health researchers have used wearable cameras to observe several health-related behaviours and exposures including blue space (329), diet (330), physical activity (331), food marketing (332) and housing (333). Typically, participants fix the wearable cameras on their bodies and images are passively captured at a pre-defined capture rate. Wearable cameras are consistent with a socio-ecological model of health as they enable the analysis of environmental influences on children's health (82).

Wearable cameras provide advantages over traditional observational research methods. They are less invasive and time intensive as the researcher's presence is not required during the data collection period (334). Data can be collected from several participants simultaneously allowing for the collection of a large amount of data while reducing the onus on the researcher (334). Additionally, the collected data highlights the wearers' exposure to environmental drivers of health by focusing on their lived experiences, improving the ecological validity of the results (335).

While wearable cameras are a promising and novel observational tool, researchers have noted some limitations of using these devices, including poor image quality in low light, limited battery life and the burden of analysing large image datasets (336-338). However, technological improvements in wearable cameras and analysis techniques, such as automated image recognition software, may reduce the impact of these limitations (339). There are also some ethical and legal concerns such as the privacy and anonymity of the participant and captured third-parties. Kelly, Marshall, et al. (340) outline an ethical framework for using wearable cameras that attempts to mitigate these problems.

5.2.2 The use of GPS and GIS in health research

Health geographers and, increasingly, public health researchers often use GPS devices or instruments that use satellites to pinpoint a fixed location on the earth's surface to a latitude and longitude coordinate, to determine a person's location at a point in time (311). This facilitates the observation of movement patterns and exposures without issues of participant burden associated with other methods such as travel logs (341). Further, research demonstrates GPS data are more accurate than self-report travel surveys or activity diaries (342, 343). Thus, GPS data enables researchers to objectively analyse participants' real-time movement in real-world conditions.

Like any technology, there are challenges and limitations of using GPS devices. Technological limitations of GPS devices include signal loss, signal noise, slow location detection, the spatial precision of the device, battery power and study participants forgetting to switch on or off or charging the device (311). A recent systematic review investigating the extent and nature of GPS data loss revealed that many studies using GPS had significant problems with data loss due to signal drop-outs, loss of battery power, and participant compliance (344). These limitations contributed to data loss of between 2.5% and 92% (344). Data collection and cleaning protocols can reduce the severity of such issues (345-348).

GPS data are seldom used in isolation; rather GPS data is often used in conjunction with other spatial data in a GIS. A GIS is a software used to capture, store, process, analyse and visualise spatial information, such as GPS data (349). GIS enables the display and analysis of spatial information gathered from many sources to generate meaningful results (349). For example, GIS can link geo-referenced data to tabular environmental and census data using a spatial join tool. Linking spatial data enables greater understanding of the influence of the physical and social environment on health, as the spatial interaction between different environmental features can be directly assessed (349). Another useful feature of GIS is presenting spatial results in a visually meaningful way, often through maps (349).

Given the advantages of GPS and GIS technologies, their coupled use provides a key opportunity for health researchers to objectively measure the environmental context of individual-level, health-related behaviours and exposures (350). For, example, health researchers have used combined GPS and other spatial data in a GIS to investigate the impact of food environments on eating patterns (351), physical activity (344), exposure to pollutants (352) and youth mobility (353, 354). However, coupled GPS and other spatial data analysed in a GIS is a rarely utilised method in alcohol research. An example is a US study that used GPS-enabled cell phones to study children's exposure to alcohol outlets (355). In this study, GPS data were imported and linked with geocoded alcohol outlet data in a GIS to enable real-time analysis of children's mobility patterns and subsequent exposure to alcohol outlets. This study highlights how GPS data integrated into a GIS provides an insight into alcohol availability in children's environments based on their real-time experiences.

A key issue in health research using spatial data, particularly information that could reveal sensitive information about participants, is geoprivacy (356-358). Geoprivacy is a person's right to protect their identifying location information from disclosure (356). There are many geospatial techniques for protecting participants' anonymity, broadly referred to as geomasking data. Geomasking degrades the quality of spatial data by introducing inaccuracy, increasing imprecision or maintaining vagueness of descriptive terms (358). For example, displaying participants' residential addresses aggregated to the administrative unit level maintains the spatial pattern over a study area but obscures the data enough to protect their precise home location.

5.2.3 Defining children's neighbourhood extent

As discussed in Chapter Two, neighbourhoods are a key point of interaction for children with potential health-promotion and health-damaging exposures. Within a socio-ecological model of health (82), neighbourhoods are a level at which environmental exposures, such as alcohol marketing, are likely to influence children's behaviours and health. However, methodological issues associated with neighbourhood research exist. A major issue relates to using an appropriate definition for the extent of participants' neighbourhoods and is a point of contention in health research (341, 359, 360). The phrase 'neighbourhood extent', used throughout this thesis, refers to the spatial boundaries of children's neighbourhoods. As Guo and Bhat (361, p.31) note:

> *Any study about neighborhoods is a spatial investigation. Yet, the spatial definition of neighborhood has received very little attention in the literature. Theoretical studies of neighborhood effects often use the term neighborhood rather loosely… On the other hand, empirical studies of neighborhood effects across many disciplines typically use census tracts, zip code areas, or transport analysis zones as operational surrogates for neighborhoods.*

Scale

Contention surrounding the definition of neighbourhood is primarily an issue of selecting the appreciate scale of analysis. The scale is the level at which an analysis is conducted (349), that has become an essential prerequisite for research analysing neighbourhood influences on health (311). The most appropriate scale for capturing the impact of neighbourhood features could be influenced by a number of factors including the sociodemographic characteristics of the study population (eg, children vs elderly), the extent to which that population relies on vehicular versus pedestrian transportation, the rurality of the setting and the extent of urban sprawl (311, 360, 362). For example, an individual's capacity and motivation to travel long distances are likely affected by personal mobility (age), local land use and activity space (311).

Previous studies found utilising different scales of analysis in neighbourhood research significantly altered the study results (341, 363, 364). Differences in study results due to changes in the scale of analysis are primarily attributed to a spatial phenomenon called the modifiable areal unit problem (MAUP). The MAUP posits that observed study findings may change unpredictably as the scale of analysis changes (365). For example, the strength or direction of an association may change based on definitions of the neighbourhood extent, the scale of neighbourhood analysis. Therefore, the underlying assumption that causes issues related to the MAUP is that any aggregated data is uniform within, but distinct among, the defined spatial units (366). Health researchers should consider the spatial aspects of the health-related behaviour, participant characteristics and the built environment when determining the appropriate scale of analysis to limit the impact of the MAUP (360).

Health researchers have used multiple methodological approaches to define neighbourhoods. Such approaches include using an administrative unit (eg, a census tract), a pre-defined buffer around a central point of interest (eg, a 500m buffer around home) and most recently, PSNB (defined using participants' GPS data). The advantages and limitations of these methodological approaches are outlined below.

Administrative units

Administrative units are commonplace in neighbourhood studies primarily because they are easily accessible and recognised across jurisdictions (103, 286). The basic assumption of using administrative units as a proxy for an individual's neighbourhood is that people are spatially constrained to these government-defined areas, used primarily for resource allocation (367). Improvements in research utilising administrative units have included using computer algorithms to generate new boundaries based on administrative level data (368). For example, Haynes, Daras et al. (368) showed a computer algorithm, using variables such as major railways/roads, housing type, deprivation and geographic shape, was relatively effective in generating meaningful neighbourhood boundaries in the city of Bristol, England.

While administrative units are a relatively easy and convenient measure of an individual's neighbourhood, particularly when exact point locations of participants' homes are unavailable, they have limitations. Individuals determine the size of their neighbourhood every time they move through their surroundings, creating unique activity spaces that do not necessarily map onto arbitrary boundaries (369). For example, Basta, Richmond et al. (306) demonstrated that people's daily movements did not correspond accurately with the administrative unit they lived in, and may not be meaningful representations of participants' neighbourhoods.

Buffers

Another common method for defining neighbourhoods is using pre-defined buffer sizes, typically between 200 and 1,600m, from a central point of interest (eg, home or school) (311). Studies analysing children's neighbourhoods tend to reflect buffer sizes between 100 and 1,600m (99, 307, 310), partly due to children's reliance on walking for independent transport (311, 370). However, buffers have come under increasing scrutiny due to methodological considerations about their size (341, 359, 360). Differences in buffer size can significantly change study results (341, 363, 364). The same criticisms of administrative units are also relevant for buffers due to potential error from the MAUP as buffers may not reflect participants' actual neighbourhoods (367). Consequently, health researchers call for neighbourhood research to incorporate time, space and scale into definitions of the neighbourhood (99, 360, 371).

Population-specific neighbourhood buffers (PSNB)

PSNB are a methodological improvement on using buffers at arbitrary distances (99). Using PSNB is a process that uses participants' GPS data, where participants spend their time, to determine a suitable scale of analysis. The process involves producing buffers at various scales, then using participants' GPS data to determine the appropriate scale of analysis or definition of the neighbourhood (99). For example, researchers analysing children's active transport initially decided on an 800m neighbourhood buffer, but after visually observing participants' GPS data, the researchers agreed that 1,000m was a more appropriate representation (99). However, the authors did not specify the reasons for this decision. It is important that researchers document the reasons behind decisions on the scale of analysis as they can influence study results.

5.2.4 Destination detection and identification beyond the neighbourhood

Within a socio-ecological model of health, neighbourhoods are important places for children's health, but ignoring destinations outside their neighbourhood may overlook key sites in children's lives and thus, potential environmental influences on health. Information on destinations frequently visited by children outside their neighbourhood may provide insight into the broader influences on their health.

In health research, detecting and identifying destinations visited by participants using real-time data has received limited attention. The studies focusing on destinations often do a better job of detecting the number of destinations visited by participants than identifying the destinations being visited (372, 373). For example, a study attempting to identify the destinations of children's physical activity used GPS data to detect destinations but relied on geocoded amenities data to identify destinations (372). Amenities data is subject to misclassification bias due to its reliance on systematic recording of frequently changing or outdated amenity information (374).

Another study of destinations visited by adults used a data-mining algorithm to detect destinations, called Spatial-Temporal Density-Based Spatial Clustering of Applications with Noise (ST-DBSCAN) (373). ST-DBSCAN requires users to define three cluster (destination) parameters 1) a minimum number of points 2) a maximum distance between points and 3) minimum time between points (375). The authors used ST-DBSCAN to group GPS data that met density, space and time parameters, which were used to detect the number of destinations visited by adults wearing GPS devices. However, GPS data alone could not identify the destinations visited; instead, the study focused on quantifying the total number of destinations visited. Thus, neither study discussed above provided a robust method for detecting and identifying destinations visited by study participants.

5.2.5 Micro-spatial analysis

Determining the precise spatial location of the exposure within indoor settings, such as supermarkets, provides a set of challenges for exposure studies. GPS data used in isolation is prone to measurement error when participants are indoors and are therefore unreliable. Consequently, spatial analyses largely treat geographical features such as buildings as indivisible entities without internal partitions or subunits (376). In response, there is increasing interest in developing a research methodology for analysing smaller geographical units, particularly indoor spaces (377). Micro-spatial analysis enables a greater understanding of people's movements and behaviour within indoor structures (376). Recently, micro-spatial analyses have examined building population distributions (378), route analysis in university buildings (377) and emergency management and response in buildings (379). Therefore, micro-spatial analyses offer a promising methodology for investigating the relationship between smaller spatial units and health-related behaviours or exposures.

5.2.6 *Summary*

This chapter has outlined important methodological considerations that helped guide the methods used in this thesis. First, this chapter outlined how wearable cameras may overcome limitations in previous alcohol research that rely on self-report measures and provide a potential alternative for measuring alcohol marketing exposure. Second, the use of GPS devices may uncover spatial patterns in children's exposure to alcohol marketing that other studies have been unable to capture. Third, given this thesis' use of a socio-ecological model of health, neighbourhoods are important settings for children's health, thus using a neighbourhood definition that best reflects participants' lived experiences is a key methodological consideration. Fourth, analyses focusing on destinations children visit outside their neighbourhood are a key aspect of research interested in uncovering the broader environmental influences on children's health. Fifth, micro-spatial analysis is a promising method to understand the spatial patterns in exposure within smaller geographic units such as a supermarket.

5.3 Kids'Cam methods

This section outlines the study design, sampling strategy, data collection and data management processes of Kids'Cam. Kids'Cam is a HRC funded project that aimed to explore the world in which children live and how it impacts their health. The study was initially funded to study the nature and extent of children's exposure to food marketing (380). Kids'Cam involved 168 children (aged 11-13) wearing wearable cameras and GPS devices that captured images approximately every seven seconds and latitude and longitude coordinates every five seconds. Content analysis, guided by a coding framework, enabled analysis of the resulting image data. Multivariable analyses compared exposure to food marketing between Māori, Pacific and NZE children, and between children from schools with low, medium and high decile ratings, a socio-economic measure used by the Ministry of Education (MoE) for funding purposes, that indicates the socio-economic background of children that attend that school (381). Schools in decile one have the largest proportion of children from low socio-economic backgrounds, while schools in decile 10 have the largest proportion of children from high socio-economic backgrounds. In Kids'Cam, school decile strata were divided into low decile schools (decile ranking of 1-3), medium decile schools (decile rankings of 4-7) and high decile schools (decile ranking of 8-10).

5.3.1 Study design: cross-sectional

Kids'Cam uses a cross-sectional study design, which is widely used in health science research to describe the prevalence of an attribute or disease and its associated trends and distribution at a population level (382). The use of a cross-sectional study design allows for the simultaneous collection of information about the exposure of interest and the outcome, making it time efficient and cost-effective (383). However, cross-sectional studies are not designed to determine causation between the exposure and outcome of interest. As such, Kids'Cam does not seek to establish causation, but rather to investigate the extent and nature of exposure and any possible differences by sociodemographic characteristics.

5.3.2 Sampling strategy

Sampling frame

The Kids'Cam sampling frame included schools from the four TAs in the Wellington region: Wellington City, Lower Hutt City, Upper Hutt City and Porirua City (Figure 6). To be eligible for inclusion, schools were required to have a MoE assigned decile ranking; this excluded one very small school. Both private and state schools were eligible for inclusion. The sampling frame included 93 schools.

Sample population

The sample population in Kids'Cam was NZE, Māori and Pacific Year 8 children (aged 11-13) from across the Wellington region. Given Māori and Pacific children in NZ are disproportionately impacted by obesity and its associated complications (8), and Kids'Cam focused on food marketing and childhood obesity, the sample was restricted to New Zealand's three major ethnic groups: NZE, Māori and Pacific. Children aged 11-13 years were selected as they were deemed the youngest age group capable of complying with the demands and responsibilities of participating in Kids'Cam and still particularly vulnerable to the inherent biases of marketing, in line with CST.

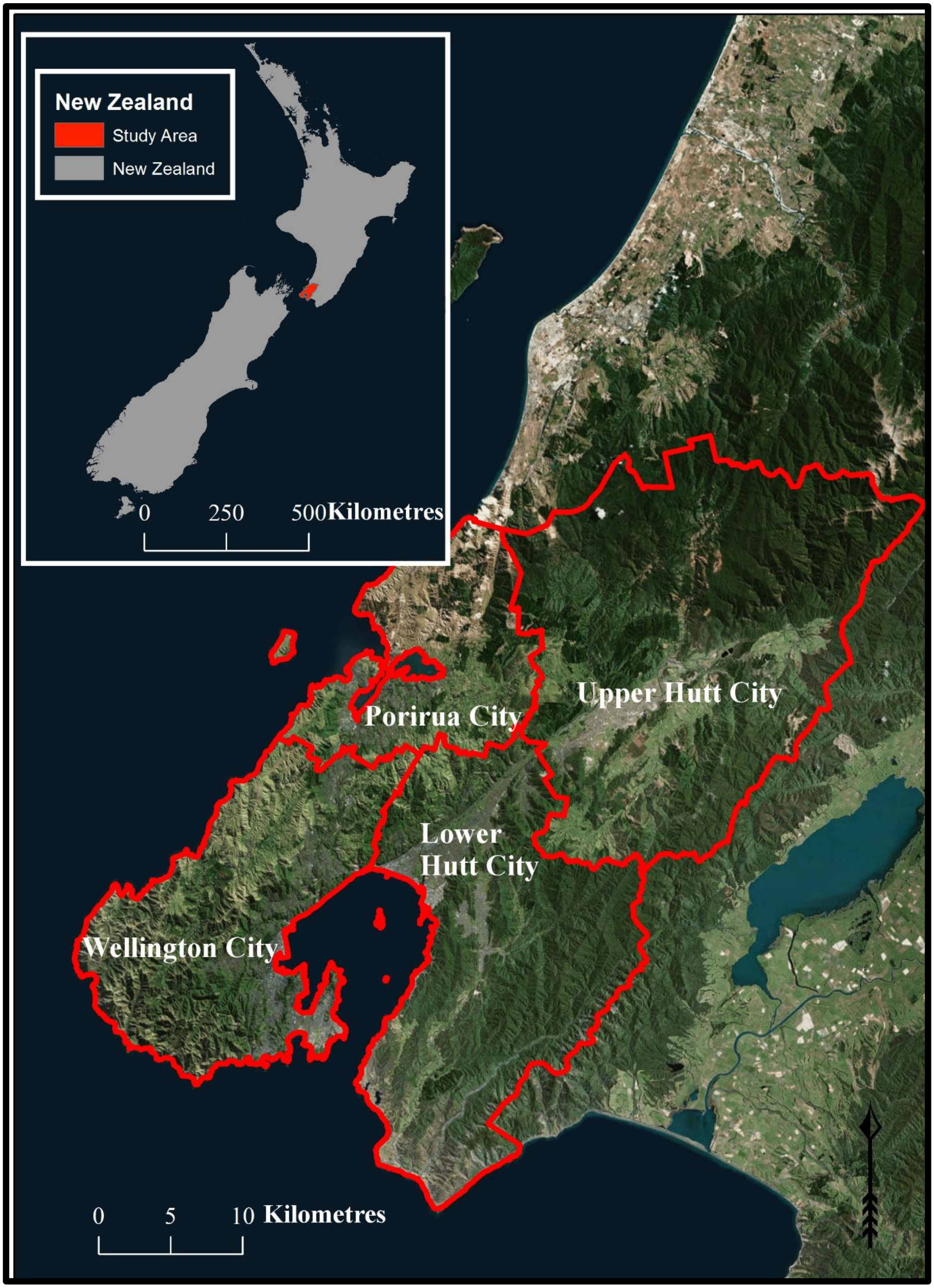


Figure 6: Map of the Wellington region, highlighting the four Territorial Authorities (Wellington City, Lower Hutt City, Upper Hutt City and Porirua City)

Sampling methods

Kids'Cam used a two-stage sampling method, conducted by the Kids'Cam biostatistician, Dr James Stanley. First, schools were stratified into three decile strata (low, medium and high), then probability-proportional-to-size sampling was used to select schools. Probability-proportional-to-size sampling methods gave larger schools higher probabilities of being selected, within a given stratum. Next, children were selected using simple random sampling.

Researchers obtained a list from the MoE of all schools in the Wellington region whose role included Year 8 students (381). This list included total numbers of Year 8 students per school and the number of Year 8 students by ethnicity. The first-stage sampling of schools was performed separately for each ethnic grouping (NZE, Māori, Pacific) and each of the three school decile groups (low, medium, high). Sampling was performed using the SAS 9.4 (Cary, SAS Institute Inc, NC) procedure PROC SURVEYSELECT, using the probability-proportional-to-size method for school selection.

Kids'Cam participants were randomly sampled using a list of Year 8 students from the sampled ethnicity retrieved from the participating school. For each study cycle, between four and six participants were required. Any less or more would result in under/oversampling according to the sampling strategy. Children were selected using a simple random sampling method facilitated by the R statistical computing software (R Institute, Vienna).

Sample size estimation

Kids'Cam sample size calculations were based on children's estimated daily exposure to food marketing. The lack of evidence on expected exposure levels for food marketing limited the certainty of the estimated sample size. Calculations were based on children seeing a mean of 60 marketing exposures per day (SD 20), 95% confidence interval (95% CI) 20 to 100 exposures per day. A sample size of 28 children per study group (ethnicity and decile group: 168 children in total; allowing for 25% dropout = 224 children) would produce a margin of error of 7.5 marketing exposures. Under these assumptions, it would also allow 80% power to detect differences in means between these groups of 15 marketing exposures per day. Therefore, the sample size estimates suggested 168 participants were required; with allowance for dropout and incomplete data of 25%, giving a total sample size of 224 children to recruit.

Given that food marketing is likely more common than alcohol marketing in children's environments, it is likely the Kids'Cam sample size limits the power to detect differences in exposure to alcohol marketing by sociodemographic characteristics in Kids'Cam Alcohol.

Definition of sociodemographic characteristics

In Kids'Cam, data on sex, ethnicity and deprivation were the three key sociodemographic characteristics collected and used in analyses. Sex and ethnicity were defined using the information provided by schools from the MoE database, which is self-identified by the child's caregiver upon enrolment. Kids'Cam and Kids'Cam Alcohol use the MoE definition of sex and ethnicity.

Individual-level deprivation was determined using the New Zealand Index of Deprivation for Individuals (NZiDep2006), a non-occupational measure of individual-level deprivation (384), however, in this study it was used as a proxy for household deprivation. An individual's NZiDep score is derived from a series of eight questions that relate to eight deprivation characteristics (384). NZiDep is a five-point index, with index scores ranging from one (no deprivation characteristics reported) to five (five or more deprivation symptoms reported). In Kids'Cam and Kids'Cam Alcohol, NZiDep quintiles were grouped into low (score 1), moderate (scores 2-3) and high (scores 4-5) deprivation categories.

5.3.3 The Kids'Cam camera: the Autographer

The Autographer is a wearable camera that automatically captures an image at regular user-defined intervals. The Autographer can be worn around the neck on a lanyard and clipped onto clothing to secure it in place (Figure 7). The Autographer has a 5-megapixel camera with a 136° wide-angle lens. The Autographer contains five sensors to detect changes in light and motion to improve the quality of images. The Autographer has 8 GB of internal memory storage allowing for the capture of multiple days of data. The Autographer is equipped with a privacy dial. When engaged, it covers the camera lens and allows the wearer up to five minutes of privacy before the camera automatically shuts down. Since the conclusion of Kids'Cam, the manufacturer of the Autographer has ceased production of the camera.

Figure 7: Child wearing the Autographer (above) and close up of Autographer (below)

5.3.4 The Kids'Cam GPS device: QStarz (model BTQ1300ST)

The GPS device used in Kids'Cam was the Qstarz (model: BTQ1300ST). A recent study of GPS devices used in health research compared seven different brands of GPS devices on a range of performance variables such as battery life and spatial accuracy (385). In this comparison, an earlier model of the Qstarz GPS (model BT-Q1000XT) performed well in battery life, accuracy and price. The review stated the QStarz GPS device had excellent inter-unit reliability and had an average dynamic positional error of 2.9m (385). Various research projects have successfully utilised the Qstarz GPS (model BT-Q1000XT) (347, 372, 386, 387), including those with child participants (347, 372, 387). Based on the successful implementation of these devices in previous studies, the ease of use, relatively good spatial accuracy, low price and small size the most recent Qstarz GPS sports recorder (model BT-Q1300ST) was utilised in Kids'Cam. As with the Autographer, the GPS was attached to a lanyard and worn by children around their necks (Figure 8). Unlike the Autographer, the GPS had no clip to attach to clothing as it did not need to be held still for accuracy.

Figure 8: Child wearing the GPS device QStarz model BT-Q13000ST (above) and close up (below)

5.3.5 *Recruitment*

School recruitment

The principal investigator for Kids'Cam, Professor Louise Signal, approached principals at the randomly selected schools to invite them to participate. Principals were first contacted by phone, then via an email with further details of the project and the information sheet and consent forms for participating schools (Appendix 1). The Kids'Cam principal investigator and lead researcher met with the school principals to discuss the project. On request, the staff at two of the participating schools were briefed by the research team about the project and the requirements for participation. The staff briefing session provided an opportunity to answer questions or raise concerns about the project. After obtaining staff consent, the principal investigator emailed the school principal a brief outline of the research to include in the school newsletter to inform the school community about the study. Schools included the information in the newsletter at least one week before the invitation session. If there was any objection from the school community, the study did not proceed in that school; this happened in one school. Following this process, written consent was given by the school principal on behalf of the school community. Then, the Kids'Cam team discussed with them the ideal time to conduct the study in their school.

Participant recruitment

To ensure we recruited the correct number of children per cycle, we invited 20 children for every six participants required. The list of randomly selected participants was emailed to the school principal or corresponding teacher. The principal and staff reviewed the list alongside the study inclusion and exclusion criteria, outlined below, to identify children who met the criteria.

Inclusion criteria

The inclusion criteria included: child's expression of interest in participating in the study, provision of written consent and a commitment to attend multiple sessions at school, either during class time, during lunchtimes and or before or after school; and provision of written parental consent to participate and to record images in the home environment.

Exclusion criteria

Children were excluded from Kids'Cam if no participant or parental consent was provided or there was no desire to participate. Children who were unable to collect data or deal with the demands of the study due to disability or circumstance were also excluded.

Response rates

Figure 9 is a flow diagram of the sampling and recruitment for Kids'Cam by ethnicity and school decile, with response rates. In total, 57% of schools agreed to participate (16 of 28 invited), with relatively equal spread across school decile groups. Reasons for declining to participate included: school community feedback (n=1), school flooded during a storm (n=1), too busy to commit to the requirements of the study (n=10). In total, 43% of the invited children consented to participate in the study with higher response rates from NZE (53%) than Māori (35%) and Pacific (42%) children. There were higher response rates from children attending high and medium decile schools (47%) than low decile schools (38%). However, to prevent oversampling during certain cycles, only the first six on the random list were allowed to participate. Most children consenting but not participating were NZE children (n=19) and children from middle (n=15) and high decile schools (n=7). Consequently, the sampling rates for the final Kids'Cam sample (n=168) were relatively equal between ethnicity and school decile groups.

5.3.6 Data collection

The Kids'Cam data collection process required team members travelling to schools to invite participants into the study, conducting briefing sessions, and providing children with an opportunity to review their images. It also required downloading all image data and uploading the data to the University of Otago (UoO) secured server. The following sections explain the data collection procedure in more detail.

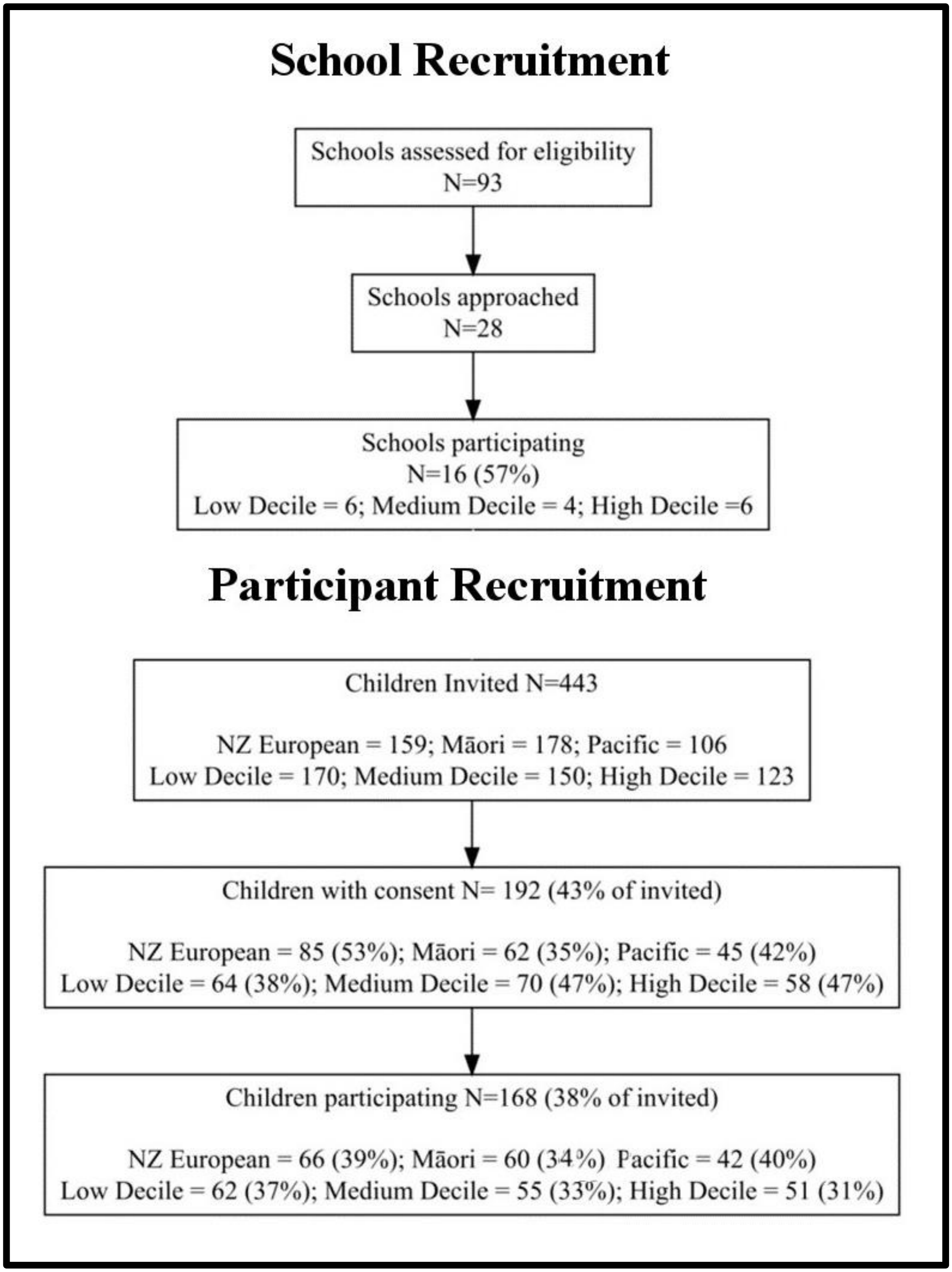


Figure 9: Kids'Cam sampling and recruitment flow diagram for schools and children, by ethnicity and school decile stratum. Source: Signal, Stanley et al. (332)

Invitation to children for participation

After obtaining a list of eligible participants, researchers travelled to the school to conduct an introductory session with the children to invite them to participate in the study. The introductory meeting involved a short presentation about the objectives and requirements of the study, including how the equipment worked. Children were shown the Autographer and GPS device, and they had the opportunity to briefly use and hold the devices. The session provided children with an opportunity to ask any questions or raise concerns about the study. Children consented to a study aimed to investigate the world in which they live and how it impacts their health. Thus, the children were blinded to any particular research focus. At the conclusion, children received a parental information form, parental consent form, participant information form, participant consent form and demographic information sheet (Appendix 1). Participants' agreed to pass ownership of the images over to the UoO when signing the consent forms. The demographic information sheet included data on children's age, deprivation (NZiDep) and residential address (Appendix 1). Children had until the end of the week of the invitation session to return their signed consent forms to the school principal or designated staff member.

Briefing for consenting children

Before the briefing session, researchers prepared equipment boxes, charged all equipment, checked each box contained an instruction manual and a plugboard with the chargers for the equipment. The week following the invitation session, on either Tuesday or Wednesday, researchers travelled to the school to conduct a briefing session with consenting participants. At that session, signed participant and parental consent forms were collected. The ethical, legal and practical issues associated with using the study equipment were discussed, and participants were instructed how to use the equipment and what they were required to do following data collection. In addition to the wearable camera and GPS device, each participant received a user manual, which detailed everything discussed in the briefing session (Appendix 1). Children were instructed to wear the cameras and GPS device for every waking hour for four consecutive days. Children were told to remove the equipment in situations where privacy should be expected, the camera could be damaged or if requested by another person.

Study period

The data collection period began the Thursday immediately following the briefing session. Participants were instructed to turn on and wear the equipment as soon as they woke up on Thursday morning. Participants (and their parents) were sent a text message on their mobile phone each morning to remind them to wear their devices and another message each evening to remind them to charge their devices. The study concluded on the Sunday night when the participant went to bed. Due to school constraints, one school (four participants) collected data from Friday until Monday. In this case, Monday was used as a proxy for Thursday in data analysis.

Collection and review

On the Monday or Tuesday immediately after the data collection period, researchers travelled to the school to collect the study equipment. The data from the cameras were downloaded onto a laptop computer using purpose-designed software developed by Dublin City University (DCU). At a time convenient to the school, researchers returned with the laptop to allow participants to review their images and remove any sensitive/personal images before researchers viewed them. The review session also provided children with an opportunity to give feedback about their experiences and report any problems they encountered during the study period. Most children reported having no problems during the collection period. The most reported problem was the GPS chargers breaking down. For Kids'Cam, children's height and weight were recorded to calculate their BMI.

5.3.7 Data management

The data management procedures involved downloading, backing up and uploading data onto the UoO secure server.

Image data

Before children reviewed their images, the original image data was downloaded onto a password protected hard drive as a back-up. After the image review session with children, the post-review data was downloaded onto a separate hard drive for back-up. Finally, the reviewed image data was uploaded to the UoO secure server using project-specific processing and analysis software developed by DCU. The image data was stored on the UoO server for the duration of the study using cloud technology. Both hard drives storing the pre- and post-review data were stored in a locked cabinet at the UoO, Wellington. All image data remains the property of UoO.

GPS data

After the retrieval of the GPS devices, researchers used the *QSports* version 3.75 software program (Qstarz International Company Ltd, Taipei, Taiwan) to extract the GPS data as a GPX (GPS Exchange Format) file onto a password-protected computer. The GPX files were backed up on a password-protected hard drive.

Data analysis

Image data were coded for place, promotion type and food product type using a custom-built coding interface developed by DCU. Kids'Cam codes were used during the mixed imputation process for GPS data and the destination analysis conducted in Kids'Cam Alcohol, is discussed later in this chapter.

5.3.8 Ethical approval and Māori consultation

For Kids'Cam, ethical approval was obtained from the UoO Human Ethics Committee (Health) (13/220) to study any aspect of the world children live in and their interaction with it.

As part of the ethics application for Kids'Cam and in response to comments from the Ethics Committee, the Kids'Cam team took steps to address any ethical or legal concerns. First, the Kids'Cam team consulted with the NZ Police who advised that taking photos in public places is legal and did not require third-party consent. However, it is not permitted to take photographs in places where there is an expectation of privacy (such as public toilets and changing areas) (388). To address this, children were instructed about situations where the camera needed to be turned off. Second, wearable cameras can potentially capture images of illegal activity that the wearer is either participating in or witnessing. An earlier pilot study of Kids'Cam sought legal advice from staff within the Faculty of Law at UoO (Associate Professor Margaret Briggs) and advised that the capture of illegal activity was extremely unlikely (338). However, if any sequence of images adequately recorded abuse or violence in which the wearer of the device was either the victim or aggressor, the research team would be obligated to pass it on to the Police. No such activity was observed in any of the images recorded. Third, participants had the opportunity to review and delete personal or sensitive images following data collection. Fourth, all images used in the disseminated material containing information that could identify the participants, third-parties and the participating schools are blurred.

Māori consultation was conducted with the Ngai Tahu Research Consultation Committee, required by the Memorandum of Understanding between Te Runanga o Ngai Tahu and the UoO. The Committee recommended recording ethnicity where possible, and research findings be disseminated to Māori health organisations.

5.3.9 My contribution to Kids'Cam

As stated at the beginning of this thesis, between February 2015 and June 2015, I was involved in 15 of the 25 data collection cycles at 11 different schools. I led data collection in 13 of 15 data collection cycles and assisted on the other two. In total, I collected data for 86 participants (51% of all Kids'Cam participants). Additionally, I assisted in the development of the Kids'Cam coding framework for food marketing and had a substantial role in testing and refining it.

My most significant contribution to Kids'Cam came in relation to the GPS data. While I collected 86 of the 168 children's GPS data, I was responsible for the conversion and cleaning of every participant's GPS data. The final GPS dataset was prepared to conduct spatial analyses for Kids'Cam Alcohol. As such, the GPS data cleaning, management and analyses are discussed as part of Kids'Cam Alcohol. In addition to Kids'Cam Alcohol, other Kids'Cam studies have used, and continue to use, the final GPS dataset I cleaned and prepared for future analyses (329). All aspects of the spatial data cleaning and analyses were overseen by Assistant Professor Amber Pearson at Michigan State University. In addition, two other students at Michigan State University assisted in elements of cleaning and analysing the GPS data. Chris Lowrie wrote the Python script for the automated imputation method, and Zachery Rzotkiewicz integrated the ST-DBSCAN algorithm into the software application used for destination analyses.

5.4 Kids'Cam Alcohol methods

The following section outlines the methods unique to Kids'Cam Alcohol. Specifically, these include the development of a coding framework used to guide content analysis, the spatial analysis methods, ethical approval and statistical analyses. Kids'Cam Alcohol excluded all school time data due to the unlikelihood of exposure to alcohol marketing occurring during school hours. As such, children's non-school waking time is referred to as their leisure time in subsequent analyses. The following sections are ordered for consistency with the three following results chapters: 1) methodological analyses (Chapter Six), 2) content analyses (Chapter Seven) and 3) spatial analyses (Chapter Eight).

5.4.1 Methodological analyses (Chapter Six)

Briefly, this section outlines the methods used to overcome issues found with GPS data, prior to analyses to answer the research questions. These methods include the cleaning of the Kids'Cam GPS dataset, developing and implementing a mixed imputation method for missing GPS data, creating PSNB for analyses and the development of a destination detection application for GPS data.

GPS data cleaning protocol

A GPS data cleaning protocol was developed which employed a combination of R and ArcGIS software. The protocol involved three stages. First, using R software, each GPS timestamp was rounded to the nearest 5-second interval and converted from Coordinated Universal Time (the recording time) to NZ time. Second, all data points between 10.00pm and 6.00am or outside of each participant's research cycle (generally the days either side, Wednesday or Monday) were removed, as these were not considered part of the Kids'Cam study period. Third, GPS signal noise from indoor environments (Figure 10, A, B & C) and cold starts (Figure 10, D) were identified in ArcGIS and removed. Kerr, Duncan et al. (348) recommend researchers decide what constitutes implausible movement for their environment and population. For example, small (30m) or repeated back-and-forth movements are typical of indoor GPS noise where the building interferes with the GPS signal and creates multiple points within a short distance that do not represent normal human movement (348). Cold starts arise when the signal between the satellite and device is interrupted or there are delays in the GPS device gaining a satellite signal immediately after powering on (348). These points were identified visually in ArcGIS. Only data with over 100 GPS points or greater than 100m of spatial inaccuracy were eligible for cleaning, smaller spatial inaccuracies were not cleaned. This process involved identifying and removing invalid points. Next, removed points were given the correct coordinates based on closest accurate GPS recording. Manual cleaning of GPS data took approximately one month of full-time work.

Mixed automated and manual imputation: accounting for missing GPS data

The initial cleaning process did not compensate for missing GPS data typical of GPS device malfunction, flat battery or participants' decisions not to wear or power on the device. As such, a mixed imputation method for missing GPS data was developed. The imputation method is defined as mixed as it contained both an automated element that used a Python script to impute points (available in Appendix 2) and a manual element that required imputation based on image data on a gap-by-gap basis.

Imputation is a method for addressing missing GPS data that can limit the potential bias attributed to data missingness (389-392). Imputation methods vary but typically involve the use of known parameters to estimate missing parameters (389). In the case of GPS data imputation, 'bookends' are recorded GPS coordinates on either side of a gap of missing data (389).

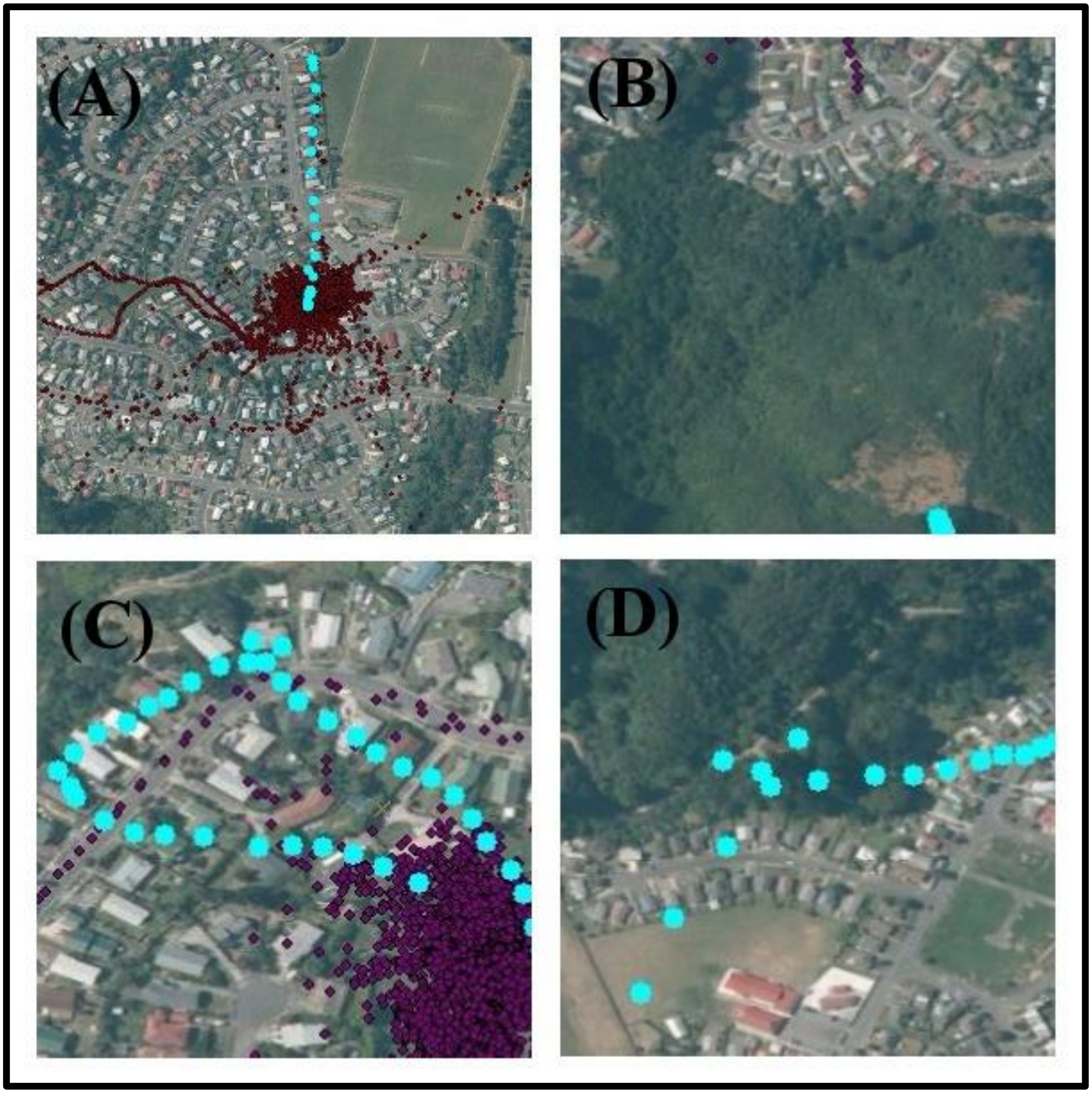


Figure 10: Examples of GPS signal interference from indoor jittering (A, B & C) and cold starts (D) in ArcGIS. Highlighted blue dots = inaccurate GPS points

In this thesis, an automated imputation process using a Python script (Appendix 2) and ArcGIS accounted for small gaps in GPS data, which was subsequently validated using image data (see Figure 11 for process and rules). Next, the automated imputation points were verified using image data from a subset of participants. For ten children from one school, image data confirmed the spatial accuracy for the 470 imputed points. The validation test involved purposely selecting four types of data gaps: 1) a static setting (eg, school or home); 2) a dynamic setting (eg, on public transport, along a street or sidewalk); 3) gaps < 1 min; and 4) gaps > 3 mins. For each category, the imputed locations were verified using images taken at the same time (Figure 12). Last, a manual imputation method utilised the image data to inform the imputation of GPS points for larger data gaps. Given the manual imputation relied totally on image data, only 5-second intervals with associated image data were eligible for imputation. Before manual imputation could begin, coded image data was tabulated and linked to both GPS data and the identified missing 5-second intervals using Stata 14 statistical software (Stata Corp, College Station, TX). All missing 5-second intervals without image data were removed and considered non-imputable. Next, all 5-second intervals with images coded as having 'dynamic settings' were removed as their location could not be guaranteed, for example, settings such as the street, private transport and public transport. Then, rules were applied and images were used to manually impute missing GPS data (Figure 13).

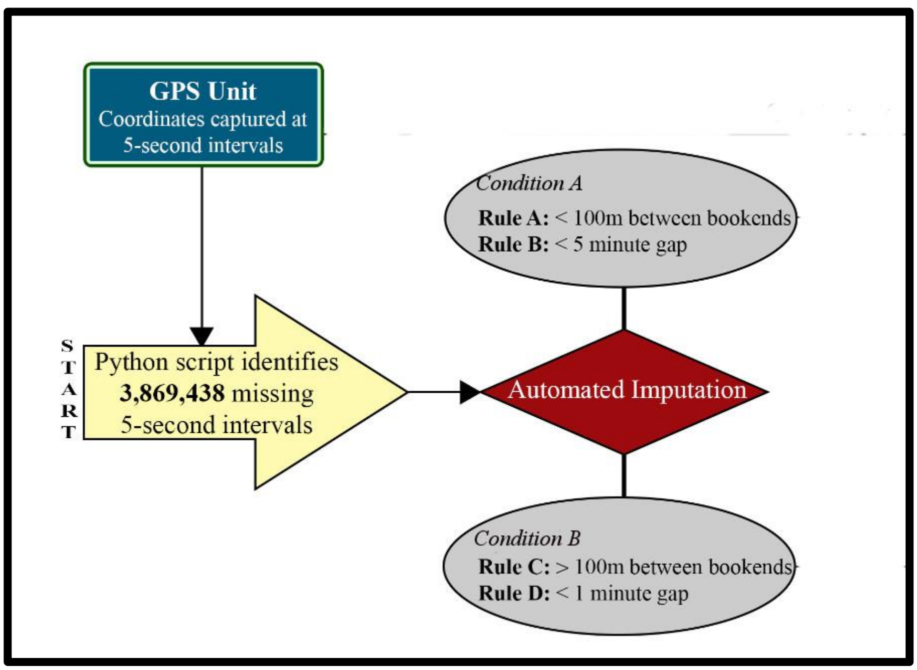


Figure 11: Spatial and temporal rules for automated imputation

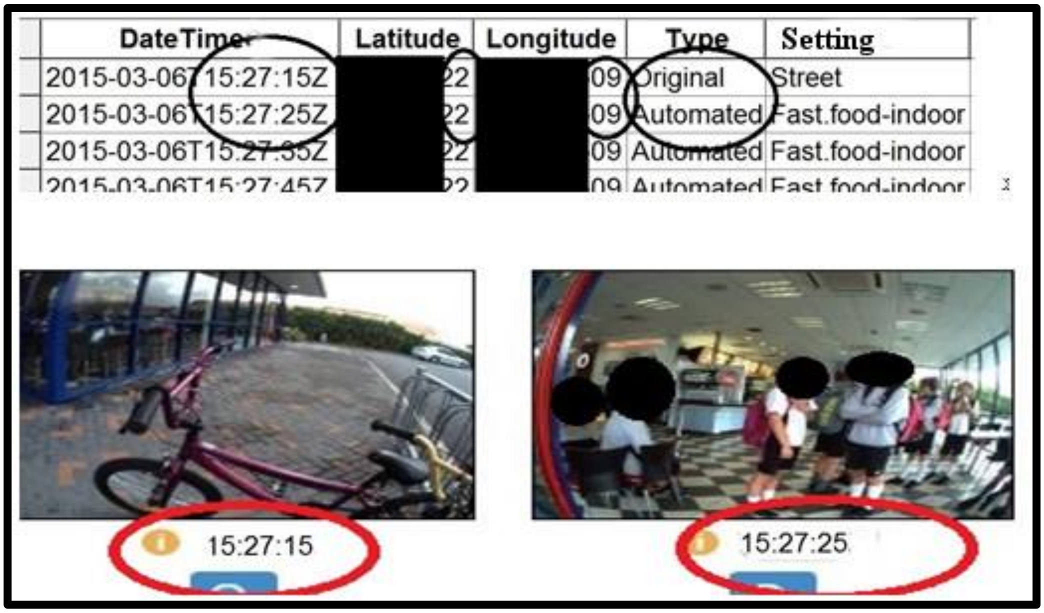


Figure 12: Example of validation test for the automated imputation method

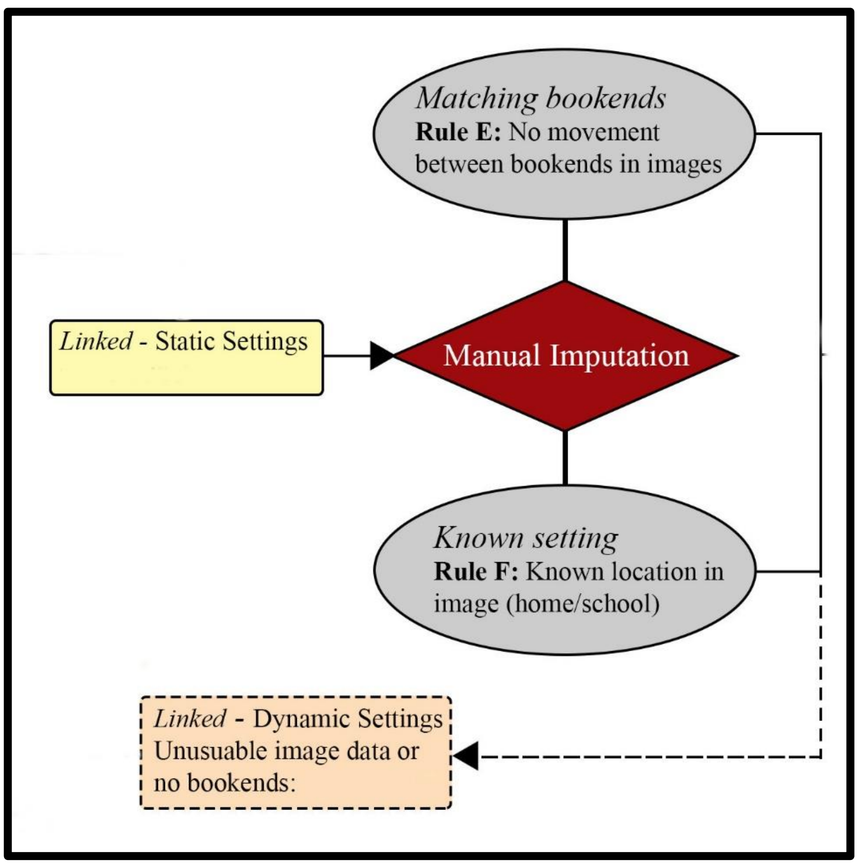


Figure 13: Manual imputation flow chart with imputation rules

Creating population-specific neighbourhood buffers (PSNB)

As discussed earlier in this chapter, PSNB are a unique methodological approach that may better reflect participants' neighbourhoods. Creating PSNB involved geocoding every participant's residential address, creating multiple concentric and network buffers around their residential address, and to determine where the child spent most of their time, spatially joining their GPS data to the buffers at incremental distances.

Geocoding participants' addresses

Geocoding is the process of matching raw address information with a digital spatial dataset mapped to latitude and longitude coordinates (311). Participants' raw residential address information was retrieved from the demographic information sheets as part of Kids'Cam. In total, 161 of the 168 addresses were geocoded successfully. Three of the remaining seven participants had their residential addresses identified using linked image and GPS data. The most GPS points concentrated around a 'home' image code from Kids'Cam was used as the primary residential address. In total, addresses for 164 of the 168 participants were successfully geocoded.

Determining the extent of children's neighbourhoods

In ArcGIS, multiple concentric and network buffers at incremental distances were created around each participant's residential address. Based on frequent citations in the literature, the distances chosen were 200m (308), 500m (309), 750m (307) 1,000m (99), 1,250m (307) and 1,600m (307). In Figure 14, the amount of GPS data (and thus, time spent) that occurred within the residential concentric (A) and network (B) buffers for non-school time or leisure time was examined. To ensure we were using data representative of children's leisure time, the analysis included only participants with over eight hours of GPS data (n=114). The results of the neighbourhood extent analysis are presented in Chapter Six.

Figure 14: Multiple concentric (A, yellow polygons) and network buffers (B, blue polygons) around a participant's residential address at 200, 500, 750, 1000, 1250 and 1600m with GPS data (green point data)

Determining the extent of children's school neighbourhoods

In addition to the residential neighbourhood, school neighbourhoods were also a point of interest for this thesis. Alcohol control policies specifically refer to schools as sensitive sites that can influence alcohol licensing decisions. School addresses were geocoded using *Google maps*. School neighbourhood analyses used a 500m concentric buffer, based on existing alcohol control policies concerning sensitive sites (142).

Destination detection application "GPSAS_Destinations"

As discussed earlier, neighbourhoods are important settings for children's health but may overlook the influence of other key destinations visited by children beyond the neighbourhood. To determine the places children visited outside their neighbourhood, we developed a bespoke destination detection application using a modified ST-DBSCAN Python script, called Global Positioning System Activity Space Destinations (GPSAS_Destinations). The application uses three parameters based on the spatial, temporal and density relationships between GPS points. Data clusters that meet user-specified parameters are created to show the duration of time spent within each data cluster. Identified clusters (destinations) were linked with image data to identify the destination.

Statistical analyses overview

All statistical analyses for this thesis were conducted in Stata 14 (Stata-Corp, College Station, TX, USA). All analyses accounted for the complex sampling design used in Kids'Cam (which had a stratified sample, with clustering of children within sampled schools) using sampling weights determined by Dr James Stanley, the Kids'Cam biostatistician and using Stata's svy prefix commands. Analyses used a combination of negative binomial regression and Poisson regression models as Kids'Cam outcome data were count data (393). Negative binomial regression models are an extension of Poisson regression models that account for the overdispersion of data (393). For each analysis, a goodness of fit test determined the appropriate regression model based on the dispersion of outcome data (Stata command 'nbvargr'). For all analyses, each GPS point was treated as representing five seconds of observation time, based on the GPS device data capture rate. Likewise, each image was treated as representing seven seconds of observation time as this was the average image capture rate. All inferential statistics used participant observation time as the offset term, which acts as the denominator for the rate calculations. All rates and rate ratios are presented with 95% CI and statistical hypothesis tests use an alpha of 0.05 to judge significance.

Statistical analyses for methodological results

First, the imputation results used Pearson chi-squared tests to examine sociodemographic differences between included and excluded children based on their collection of GPS data. Confidence intervals for the calculation of the mean proportion of missing GPS points per child accounted for the complex sampling strategy. Second, the neighbourhood extent results used Poisson regression models, using the total duration of available data per child as the offset term to calculate the mean time spent within residential concentric and network buffers. Time spent at, and the number of visits to, destinations outside the defined neighbourhood buffers were calculated using negative binomial regression models, the total duration of available data per child was used as the offset term. Time spent at destinations is reported as rates per hour of GPS data, while the number of visits to destinations is reported as rates per 10 hours of GPS data.

5.4.2 Image content analyses (Chapter Seven)

This section outlines the methods used to conduct the content analyses for children's exposure to alcohol marketing. This includes the coding framework used to code image data, the coding rules used in the content analysis and the statistical analyses conducted on tabulated image data.

Defining marketing

As discussed in Chapter Three, the definition of marketing in this thesis is the European Alcohol Policy Alliance definition: “a mix of sophisticated, integrated strategies, grouped around four main elements: the product, its price, its place (distribution) and its promotion. For example, product design and brand name (product), pricing strategy and wholesale (price), distribution channels and placing within retail establishments (place) and promotional strategy, advertising, sales promotion and public relations (promotion)” (154, p.6). The coding framework developed for the content analyses incorporate the place, promotion and product elements of this definition, price is not included as discussed in Chapter Three.

Coding framework development

The bespoke computer software used in Kids’Cam was used to undertake content analysis in Kids’Cam Alcohol. My role in the development of the computer software was limited to providing feedback during Kids’Cam team meetings with DCU colleagues, identifying software ‘bugs’ and providing suggestions for coding features to assist content analysis. The software utilised a three-tiered framework that enabled the user to tag image data with codes, shown on the left side of Figure 15. The first tier was the *place* (Figure 15 A, blue level), the second tier was the *promotion type* (Figure 15 B, orange) and the last tier was the *exposure variable* (Figure 15 C, white=not selected and green=selected). The software interface displays many images at one time, seen in the background of Figure 15. In this example, the green box (Figure 15, D) indicates that the image is coded for *place* (Home), *promotion type* (Merchandise) and *exposure variables* (Exposure 1, Supervised).

The content analysis in this thesis focused on two separate exposures. The first was *marketing exposures,* which included any exposure to alcohol marketing except within an off-licence alcohol outlet. Marketing exposures were defined as “*Exposure to a single or numerous types of alcohol marketing except within alcohol off-licence outlets.”* The second type of exposures were *marketing encounters,* which included only alcohol marketing within off-licence alcohol outlets. Marketing encounters were defined as "*Exposure to a single or numerous types of alcohol marketing within an off-licence alcohol outlet. The encounter begins from the first exposure to alcohol marketing within an off-licence alcohol outlet and includes every image where alcohol marketing is present*". The distinction between the two exposure types was necessary as children could be exposed to 100+ marketing exposures within off-license alcohol outlets, which are fundamentally and conceptually different to those marketing exposures that occur outside of off-licence outlets. The decision to analyse these exposures separately was made following consultation with multiple alcohol and marketing researchers and discussion with supervisors.

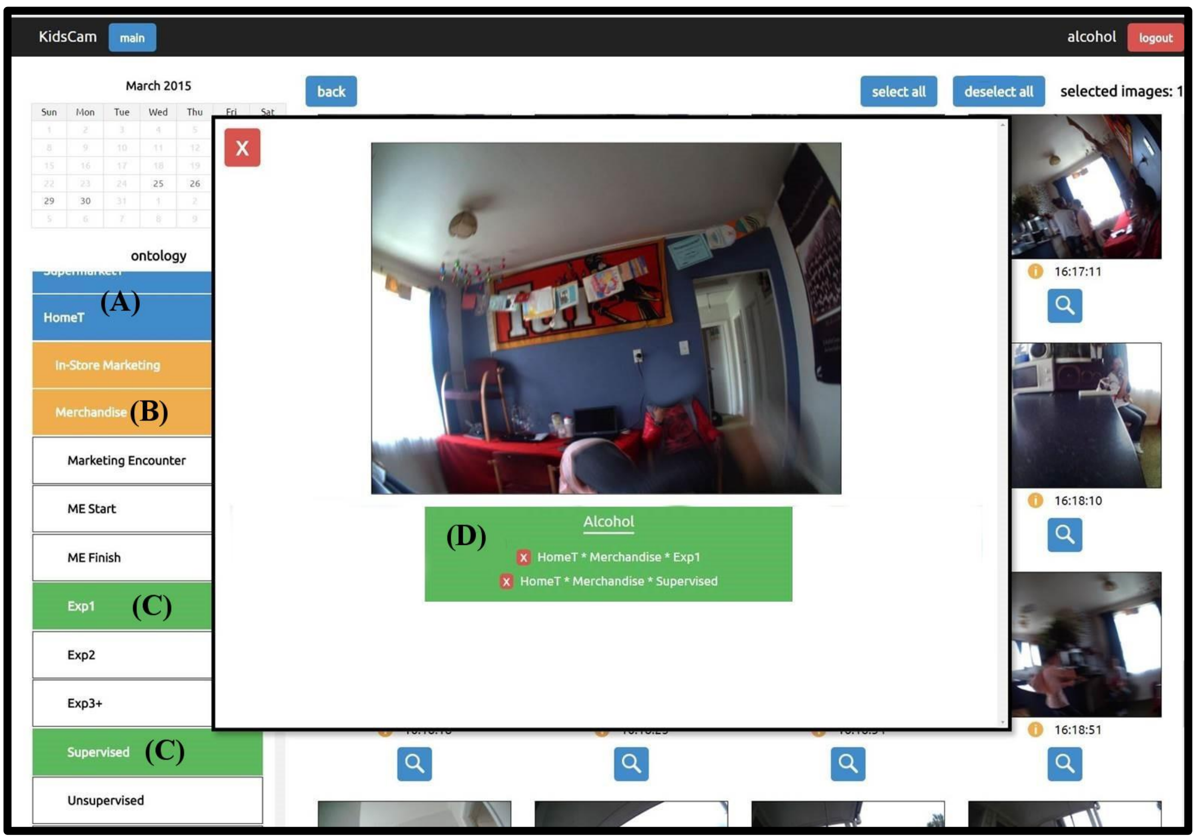


Figure 15: Coding software interface developed by Dublin City University to facilitate content analysis of image data (A= place, B= promotion type, C=exposure variables, D= coded image)

For the first aspect of the content analysis, eg, coding marketing exposures, the first tier was used to define the place where the exposure occurred, seen in column 1 of Table 4. The second tier signified the promotion type used to market the alcohol product (Table 4, column

2). The third tier measured the number of marketing exposures up to a maximum of three per image and the children's supervision status. The maximum number of exposures was three in any given frame due to limitations in the coding software. The consequences of this decision are discussed in Chapter Nine. For each exposure, images were coded for supervision status if children were accompanied by an adult or not.

Table 4: Coding framework for the extent and nature of children's real-time exposure to alcohol marketing, excluding within off-licence alcohol outlets, *marketing exposures*

Place	Promotion type	Exposure variable
Home*	In-store marketing	Exposure 1
Liquor store	Merchandise	Exposure 2
On-licence	Print media	Exposure 3+
Public spaces	Product packaging	Supervised
Street	Screen	Unsupervised
Structured sport	Shop front signage	
Supermarket	Sign	
	Sports sponsorship	

*Home refers to any residential location - not necessarily the child's primary residential address

For the second aspect of the content analysis, marketing encounters, the first tier of the framework focused on the type of alcohol outlet (column 1 in Table 5). Liquor stores are off-licence alcohol outlets, the primary purpose of which is to sell alcohol for consumption at another location. In NZ, supermarkets are off-licence alcohol outlets, the primary purpose of which is to sell everyday goods but also sell alcohol. The second tier of the coding framework (promotion type) was classified as in-store marketing for all marketing encounters as a number of different promotional activities occurred simultaneously. The third tier of the coding framework recorded every frame where alcohol marketing was present during a marketing encounter, the child's supervision status 'supervised or unsupervised', and when the marketing encounter began 'marketing encounter start' and finished 'marketing encounter finish.' For example, the first image that contains alcohol marketing within an off-licence outlet is coded as marketing encounter start. Every subsequent image that contains alcohol marketing is coded as a marketing encounter to gauge the duration of the marketing encounter. The final image with alcohol marketing within an off-licence alcohol outlet is coded as marketing encounter finish to signal the end of an encounter. If an adult accompanied the child, then the marketing encounter was coded as ‘supervised’. If no adult was present during the marketing encounter, then it was coded as unsupervised.

Table 5: Coding framework for children’s real-time exposure to alcohol marketing within off-licence alcohol outlets, *marketing encounters*

Place	Promotion type	Exposure variable
Liquor store Supermarket	In-store marketing	Marketing encounter start Marketing encounter finish Marketing encounter Supervised Unsupervised

Coding rules

The coding rules used in this content analysis are based on rules from Kids’Cam (332), which were partly based on previous frequency analyses of televised marketing exposure (128, 129). There were two key coding rules used in Kids’Cam Alcohol including the 50% rule for coding alcohol marketing and the 30-second rule for coding repeat exposures.

The 50% rule required 50% or more of a logo or brand name to be visible in order to code a marketing exposure. While it is possible marketing is recognisable when less than 50% of the brand is visible, the 50% criterion increased the likelihood an exposure had occurred and is likely a conservative coding criterion.

The 30-second rule prevented coding a marketing exposure multiple times in a sequence of images unless the marketing disappeared from the image entirely for a period of greater than 30 seconds (128, 129). For example, in Figure 16, only the first alcohol marketing exposure (Figure 16, A) in this sequence was coded (the ‘Tui’ beer sign). The subsequent images (Figure 16, B, C & D) are not coded until a gap in exposure of over 30 seconds occurred. The 30-second rule captures the notion that marketing functions through repeated exposures. It was included as it increased the likelihood that the alcohol marketing had actually left the child’s field of vision than shorter temporal parameters (eg, seven seconds). These rules were successfully implemented in Kids’Cam (332) and Kids’Cam Alcohol. For the full coding schedule for Kids’Cam Alcohol see Appendix 3.

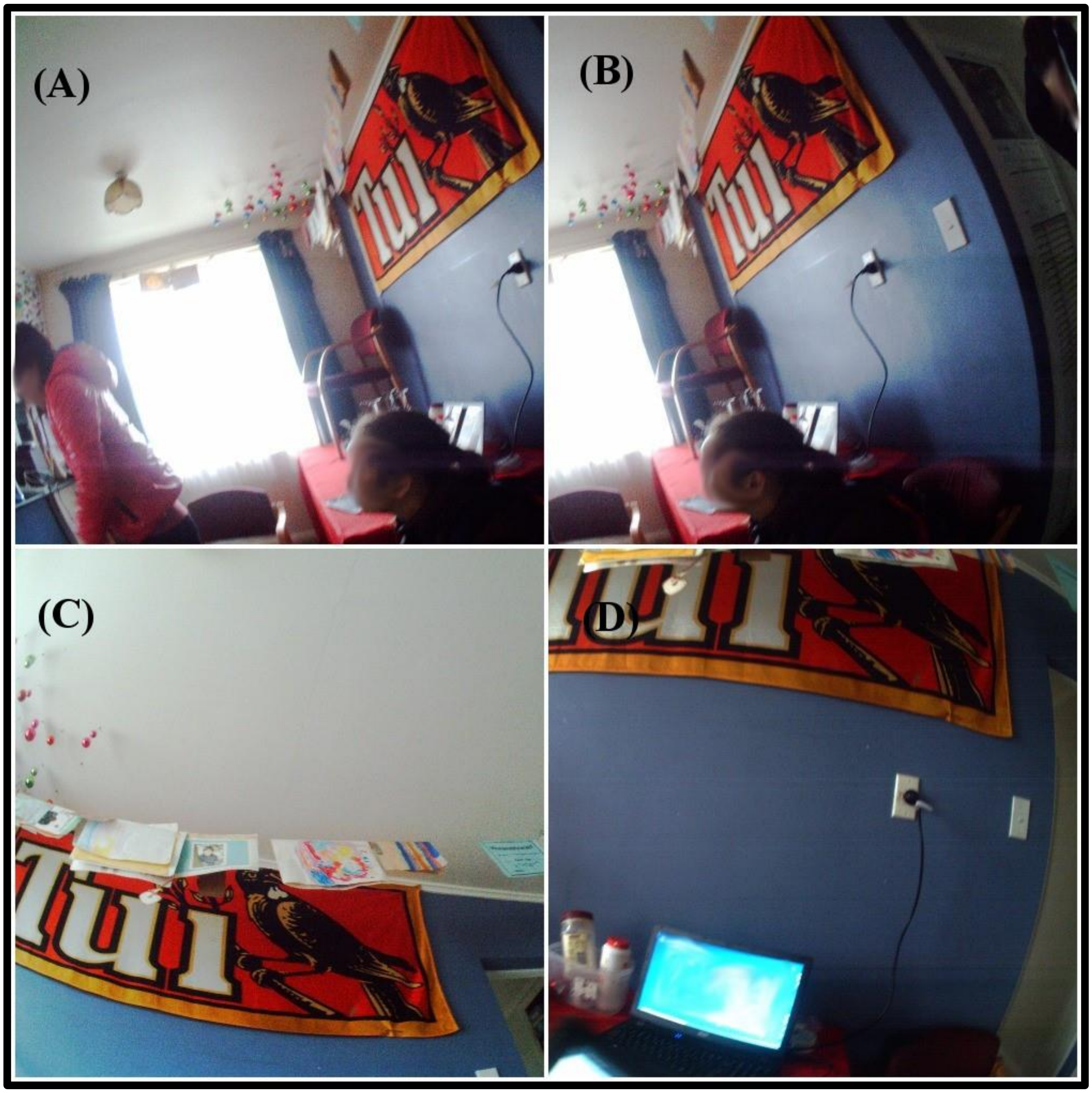


Figure 16: Example of an image sequence (A =1st, B = 2nd, C= 3rd, D = 4th images in sequence) coded as a single marketing exposure

Analytic sample

The analytic sample included data from every participant, on all four days of data collection, except during school time. Using the MoE definition, school time on Thursday and Friday included all time in between 9.00am and 3.00pm (394). Excluding school time was based on initial analysis that suggested alcohol marketing was unlikely to occur on school grounds; and that including school time would substantially increase the coding time for predictably little results. Of all participants, only one child had no image data outside school and was excluded from the analysis. In total, the analytic sample included 700,000 images eligible for content analysis from 167 children.

Statistical analyses for image content results

Image data from the content analysis were tabulated as a Microsoft Excel file, then exported into Stata 14 for statistical analysis. Statistical analyses of image data included producing descriptive rates, mean rates accounting for the complex sampling strategy and participant observation time and mean rates adjusted for sociodemographic characteristics.

First, descriptive statistics provided an overview of the variation in children's exposure, stratified by sociodemographic characteristics. The median rate, with interquartile range (IQR), of marketing exposure was calculated accounting for the complex sampling design. For marketing exposures, both mean rates of exposure and rate ratios (RR) were calculated using negative binomial regression models where the offset term was the total duration of available data per child. Univariate (UV) models calculated the unadjusted mean rate of exposure within sociodemographic groups, while rate ratios compared the mean rates of exposure between groups. Sociodemographic characteristics included sex, ethnicity and neighbourhood deprivation. Multivariable (MV) models calculated the rate ratios within sociodemographic groups, while mutually adjusting for sex, ethnicity and neighbourhood deprivation.

For marketing encounters, mean rates of exposure to alcohol marketing within off-licence alcohol outlets were calculated using Poisson regression, with the offset term the total duration of available data per child. Similar to alcohol exposures, univariate models calculated the unadjusted mean exposure rate within sociodemographic groups, while rate ratios compared the mean exposure rates to detect statistically significant differences between groups. The multivariable model calculated the ratio ratios within groups, while mutually adjusting for sex, ethnicity and neighbourhood deprivation. The mean duration exposed to alcohol marketing within off-licence alcohol outlets was calculated by dividing the total amount of time exposed by the number of marketing encounters while accounting for the complex sampling strategy. Differences in mean duration of exposure by sociodemographic groups were tested using Kruskal-Wallis equality-of-population rank tests.

5.4.3 Spatial analyses (Chapter Eight)

This section outlines the methods used to conduct the spatial analyses in this thesis. The section begins with a description of additional GPS data imputation for alcohol marketing exposures to facilitate alcohol marketing neighbourhood analyses. Second, it describes how the spatial co-variates used in neighbourhood analyses were created. Third, the methods used in the macro- and micro-spatial analyses of children's exposure to alcohol marketing within supermarkets is outlined. Finally, the statistical analyses used for the spatial analyses in Chapter Eight are described.

Additional imputation of missing GPS data for alcohol marketing exposures

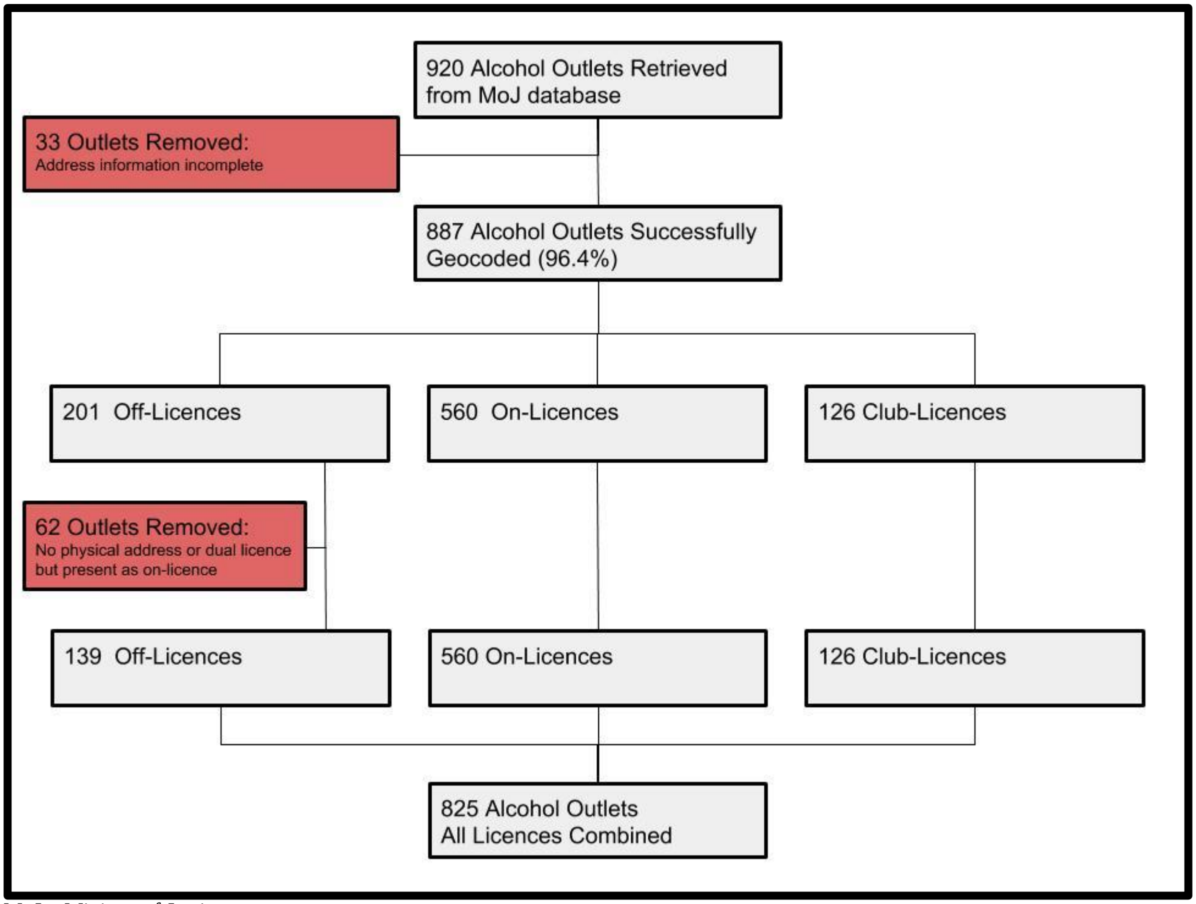
After applying the automated and manual imputation methods outlined earlier, 389 images with alcohol marketing exposures and 21 images with marketing encounters (eg within off-license alcohol outlets) still had missing GPS data. Missing GPS data for marketing exposures were manually retrieved (even for those participants with no GPS data) using image data to identify their spatial location. In total, GPS points for 325 of the missing 389 alcohol marketing exposures (84%) and 21 marketing encounters (100%) were recovered this way.

Generating spatial co-variates for neighbourhood analyses

In addition to the sex, ethnicity and deprivation characteristics used in Kids'Cam, there were additional spatial co-variates generated for the spatial analyses of neighbourhood exposure to alcohol marketing in Kids'Cam Alcohol. The spatial co-variates included an area-level measure of deprivation, neighbourhood alcohol outlet density and individual-level alcohol outlet proximity to home or school. The New Zealand Deprivation Index (NZDep2013) is a non-occupational, small area-based measure of socioeconomic deprivation using data from the 2013 NZ census (395). Higher NZDep2013 scores indicate higher levels of neighbourhood deprivation. Neighbourhood deprivation was defined using the Meshblock (an administrative unit between 300 and 500 people) NZDep scores. To generate alcohol availability measures (density and proximity), the alcohol outlets in the Wellington region were geocoded, using the current alcohol outlets (February 2015) obtained from the Ministry of Justice (MoJ) national registry. Of the 920 outlets, 33 (3.6%) alcohol outlets were excluded because they were missing address information that could not be retrieved (Figure 17). Of these 33 excluded alcohol outlets, 17 were shared sports clubs, 14 were 'conveyances' (boats or trains), and two were duplicates in the database.

There were 201 off-licence alcohol outlets in the four TAs (Wellington City, Lower Hutt City, Porirua City, Upper Hutt City). Some outlet categories were excluded as they were not physical locations (eg, mail order) or had dual licences but presented more like an on-licence (eg, tavern), including auctioneer endorsed (1), chartered club (4), caterer endorsed (21), hotel (3), mail order (9), restaurant (7), other (1) brewer (2) and tavern (14) (total excluded off-licences =62). The final sample of off-licence outlets was 139. All 560 on-licence outlets and all 126 club-licences were included for analyses. In total, 825 outlets were included in spatial analyses (139 off-licences, 560 on-licences and 126 club-licences).

The spatial precision of the geocoding process was validated on 30 randomly selected alcohol outlets. The outlets were checked by entering the address into *Google Earth*, and the longitude and latitude coordinates from the geocoding process. The *Google Earth* result was compared with the geocoded result with 24 producing the exact same location on *Google Earth*. The average difference between the remaining six outlets was 3.7m. Therefore, the spatial accuracy of the geocoding process was confirmed. Alcohol outlet density was calculated as the number of alcohol outlets per km^2. Alcohol outlet proximity was calculated as the distance from home or school to the nearest alcohol outlet.



MoJ = Ministry of Justice

Figure 17: Alcohol outlet geocoding flow diagram

Macro-spatial analysis of exposure to alcohol marketing within supermarkets

Content analysis revealed supermarkets were a major source of children's exposure to alcohol marketing within off-licence outlets; all supermarkets visited by children were mapped to conduct a macro-spatial analysis of exposure within supermarkets over the Wellington region. First, alcohol outlets classified by the MoJ national registry as supermarkets in the Wellington region were included (n=86). Second, all image data coded as "Supermarket" were linked with GPS data and spatially joined with supermarkets that sold alcohol. Third, the number of visits made by participants over the study period was determined to provide a denominator for children's rate of exposure to alcohol marketing within supermarkets. Using image data, individual visits to supermarkets were defined by the first image when a participant entered a supermarket to the last image a participant was in the supermarket. The location of each visit was validated manually using the image data and *Google maps* to determine that the trip had been assigned to the correct supermarket.

Fourth, all marketing encounters were spatially joined to supermarkets to calculate the rate of children's exposure to alcohol marketing within each supermarket across the Wellington region.

Micro-spatial analysis of exposure to alcohol marketing within supermarkets

Micro-spatial analysis of the indoor supermarket environment provided unique and rich data on children's exposure that has the potential to highlight reasons for their exposure that extend beyond what content analyses provide alone. The micro-spatial analyses focus on two primary objectives 1) to compare children's exposure in supermarkets with high and low rates of exposure and 2) to use a case study of a supermarket with notable changes enforced by the SSAA.

In this study, two supermarkets, one with no exposures and one with a high rate of exposure were used to investigate the reasons why children were exposed to alcohol marketing within some supermarkets and not others. This included a supermarket with the most visits but with no exposures (four visits, zero exposures) and a supermarket with a similar number of visits with a high number of exposures (six visits, with exposure on 100% of visits). Both supermarkets were from the same supermarket chain and located in the same TA (Wellington City). To investigate the impact of the SSAA, a supermarket with the most visits and noticeable changes to its layout and the promotion of alcohol midway through data collection was selected. Due to the flexible timeline for implementation of the SSAA, this was the only supermarket that had sufficient data to confirm changes to the promotional environment in order to comply with the SSAA and was purposely selected as a case study.

Using image data, the supermarkets' floor plans were recorded using pen and paper. In one case, a supermarket was visited in person because the image data did not reveal enough of the floor plan to map the entire supermarket. Systematic recording involved noting the placement of aisles and the products that were being sold. The raw data was then inputted into *SketchUp* (Trimble Inc, Sunnyvale, CA, https://www.sketchup.com/) (Figure 18, A). The floor plan was exported from *SketchUp* into an image file (.jpeg) and imported into ArcGIS.

Using image data, a child's journey through the supermarket was recorded as line data in ArcGIS over the floorplan, as seen in Figure 18 (B). Once all visits to the supermarket were entered, varying line density was used to show differences in the intensity of time spent in each area within the supermarket (Figure 18, C). The location of alcohol marketing observed by children was added as point data (red squares in Figure 18, C). The location of the child when exposed to alcohol marketing was recorded (blue dots in Figure 18, C). Finally, the number of times individual alcohol marketing was observed and the participant number were tabled.

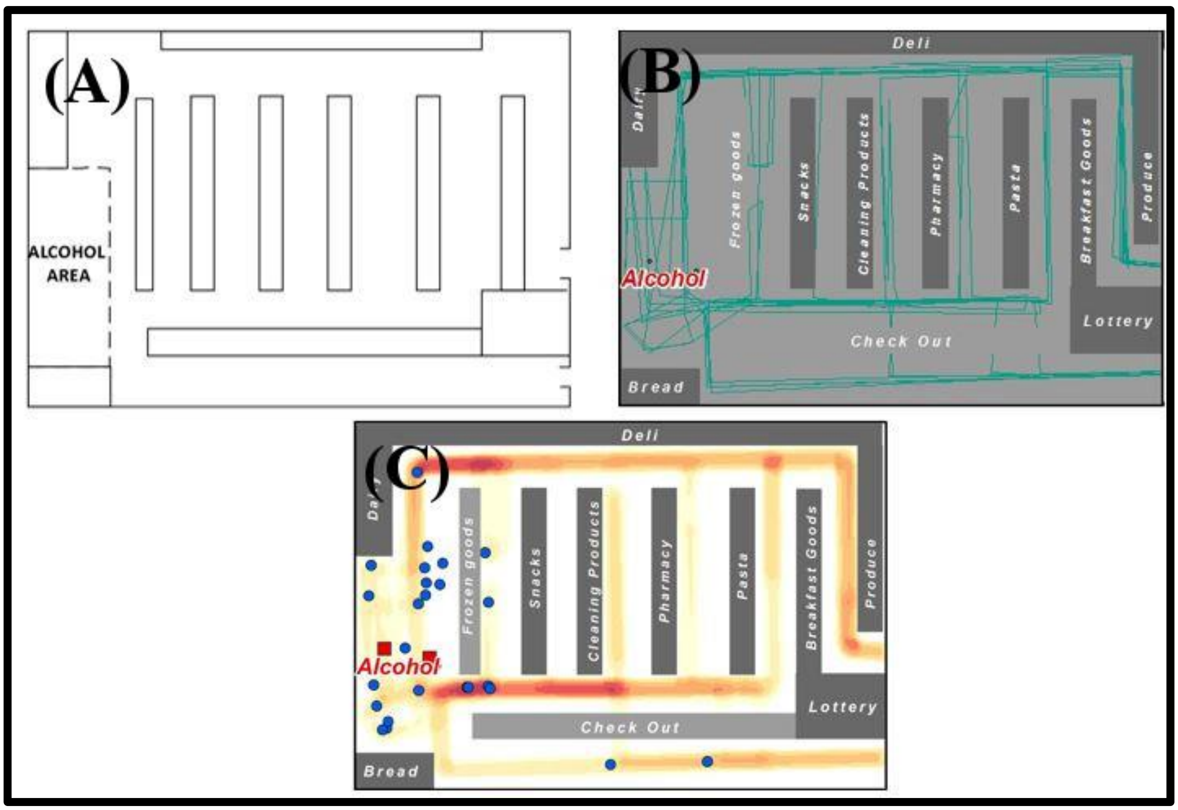


Figure 18: Micro-spatial analysis method: *SketchUp* supermarket floor plan (A), line data of children's visits (B), exposure point of view and line density analysis (C)

Statistical analyses for spatial results

First, for neighbourhood analyses, negative binomial regression models were used in all analyses of both residential and school neighbourhood exposure to alcohol marketing as outcome data were count data over-dispersed towards zero. Univariate models were used to calculate rate ratios that compared differences between sociodemographic groups (sex, ethnicity and neighbourhood deprivation) and alcohol availability measures (outlet density and proximity). Multiple multivariable models examined the differences in neighbourhood exposure to alcohol marketing by sociodemographic characteristics, mutually adjusted for sex, ethnicity, neighbourhood deprivation and alcohol availability.

For the supermarket analysis, exposure rates for supermarkets were calculated by dividing the total number of marketing encounters at a supermarket by the total number of visits to that location. In the SSAA case study, exposure rates for each individual piece of alcohol marketing in the analysis of pre- and post-legislation conditions were calculated using Poisson regression. Individual marketing exposure rates are presented as mean rates per visit (with 95% CI, from Poisson regression). Comparisons between pre- and post-legislation conditions were calculated using Poisson regression and are presented as rate ratios (with 95% CI).

5.4.4 Ethical approval and Māori consultation

For Kids'Cam Alcohol, ethical approval was obtained from the UoO Human Ethics Committee (Health) (13/220) by requesting permission to add my name to the list of Kids'Cam researchers. The original ethics approval permitted the Kids'Cam team to study anything that may affect children's health. All images used in disseminated material had all identifiable material blurred. Any spatial data was aggregated to protect participants' anonymity. Like Kids'Cam, Māori consultation was conducted with the Ngai Tahu Research Consultation Committee, required by the Memorandum of Understanding between Te Runanga o Ngai Tahu and the UoO. The Committee recommended recording ethnicity where possible, and research findings be disseminated to Māori health organisations.

5.5 Conclusion

This chapter outlined the methodology used in this thesis to answer the central question of what is the extent and nature of children's real-time exposure to alcohol marketing. Existing literature on the use of wearable camera and GPS technology in health-related studies was synthesised, including their strengths and weaknesses. Next, this chapter discussed the potential methodological challenges faced when conducting neighbourhood research. This chapter made explicit the differences between the HRC-funded study called Kids'Cam and the research conducted in this thesis called Kids'Cam Alcohol with reference to my contributions to both projects. The specific methods used in Kids'Cam Alcohol to analyse the Kids'Cam dataset were outlined. These methods included data imputation for missing GPS data, analyses for children's neighbourhood extent, development of destination detection application, a coding framework to facilitate content analysis and micro-spatial analysis. All these methods utilised image, GPS or secondary spatial data to provide a method for analysing children's real-time exposure to alcohol marketing, accounting for exposure in both place and space.

CHAPTER SIX: RESULTS - METHODOLOGICAL ANALYSES

6.1 Introduction

As outlined in Chapter Five, this chapter is the first of three results chapters. It presents the methodological results of this thesis. Specifically, this chapter presents the results of a mixed imputation method for missing GPS data, neighbourhood extent analysis and destination analysis outlined in Chapter Five.

There were a number of methodological challenges with the Kids'Cam GPS dataset. First, there was a moderate level of missing GPS data after data collection. Data missingness and strategies to deal with missing data, such as imputation, both have the potential to bias results. A second challenge was defining the spatial extent of children's neighbourhoods for later neighbourhood analyses. As mentioned in Chapter Five, neighbourhood extent is a phrase used to refer to the spatial boundaries of children's neighbourhoods. Third, little is known about the destinations children visit, which may need to be considered in research focusing on children's health, including alcohol health promotion research. The results presented in this chapter aim to address these methodological challenges and answer the following research questions:

- Can an effective imputation method be developed for missing GPS data?
- What is the extent of children's neighbourhoods?
- What destinations do children visit that may be important for their health?

The methodological results presented in this chapter inform the spatial results of this thesis (Chapter Eight) by accounting for missing GPS data and determining children's neighbourhood extent. First, this chapter outlines the results of a novel mixed GPS data imputation method. The imputation method employed a combination of automated and manual methods to impute missing GPS data based on a set of temporal and spatial parameters (outlined in Chapter Five). Second, the results from an analysis of children's neighbourhood extent using concentric and network buffers at incremental distances are presented. Finally, the results from an analysis of destinations that the children visited outside their neighbourhood extent are presented.

6.2 Can an effective imputation method be developed for missing GPS data?

The temporal and spatial parameters of the imputation methods have been outlined previously in Chapter Five. Briefly, GPS points were automatically imputed if data gaps were < 5mins, whereas larger gaps used image data to manually impute missing GPS data. The results from the automated and manual imputation methods are now presented.

6.2.1 Children with and without GPS data in Kids'Cam

Of all recruited children, faulty equipment, non-participation and participant dropout reduced the sample of children with GPS data to 150 from 168. Imputation could not be conducted for participants with nil GPS data (n=18), as the imputation method relied on existing, recorded points. The sociodemographic characteristics of the children with and without GPS data are presented in Table 6. Pearson chi-squared tests detected no significant differences in those participants with and without GPS data, by sociodemographic characteristics. Participants with and without GPS data were relatively equal by sex, ethnicity and deprivation. As mentioned in Chapter Five, household deprivation is classified using New Zealand Individual Deprivation Index (NZiDep2006) (384). In total, six participants had missing NZiDep2006 information. As reported in Chapter Five, neighbourhood deprivation was classified using the New Zealand Deprivation Index (NZDep2013), using Meshblock NZDep scores (395). In total, four participants had missing address information, so their NZDep2013 information was missing.

Table 6: Sociodemographic characteristics of Kids'Cam participants with and without GPS data, by sex, ethnicity, household deprivation and neighbourhood deprivation

Sociodemographic characteristics		Number missing (%)		p value
Total	*Missing*	18	(11%)	
	Not missing	150	(89%)	
Sex*	*Males*	7/78	(9%)	0.462
	Females	11/90	(12%)	
Ethnicity*	*NZE*	7/66	(11%)	0.940
	Māori	7/60	(12%)	
	Pacific	4/42	(10%)	
Household deprivation (NZiDep2006)*	*Low*	6/52	(12%)	0.481
	Moderate	7/58	(12%)	
	High	3/52	(6%)	
	Missing value	2/6	(33%)	
Neighbourhood deprivation (NZDep2013)*	*Low*	5/58	(9%)	0.141
	Moderate	7/49	(5%)	
	High	2/57	(4%)	
	Missing value	4/4	(100%)	

*p values for difference calculated using Pearson chi-squared test

6.2.2 Defining and measuring GPS data missingness

To test the effectiveness of the imputation method, it was essential to define GPS data missingness. The study protocol required participants to turn off and remove their equipment in certain situations, including where the equipment could be damaged (eg, playing sport, activities that may cause water damage), or if requested by another party, typically for privacy (eg, at home, someone else's home, church, medical offices or some stores). Further, children were instructed to take off their devices and charge them overnight. Collectively, these issues made determining the temporal boundaries of children's days and creating a denominator for missingness difficult.

To quantify the potential missing data, every 5-second interval between 7.00am and 9.00pm with missing GPS data was defined as missing data. These time parameters were considered the temporal boundary of children's days, as less than 1.5% of the total data was collected outside these margins. There was a total of 3,869,438 5-second intervals for which GPS data were missing (64.0% of the possible 6,048,000 5-second intervals) for the 150 participants (between 7.00am and 9.00pm over the four-day period)**.**

Table 7 presents the percentage of missing GPS data by sociodemographic characteristics. Before imputation, there were no statistically significant differences detected by sex, ethnicity or neighbourhood deprivation. Children living in households of the highest deprivation had significantly higher proportions of missing GPS data (69.7%) than children in the least deprived households (58.0%) (p = 0.006).

Table 7: Percentage of missing GPS data by sociodemographic characteristics

Sociodemographic characteristics		Mean % of missing data (SD)	p value
Total		64.0 (18.1)	
Sex§	*Male*	61.5 (18.5)	0.232
	Female	65.3 (18.0)	
Ethnicity ƚ	*NZE*	62.6 (18.8)	0.654
	Māori	64.6 (16.2)	
	Pacific	66.3 (19.4)	
Household deprivation ƚ (NZiDep2006)	*Low*	58.0 (19.1)	0.006*
	Moderate	65.0 (16.5)	
	High	69.7 (17.1)	
Neighbourhood deprivation ƚ (NZDep2013)	*Low*	63.0 (16.3)	0.744
	Moderate	62.2 (21.3)	
	High	65.4 (18.4)	

§ p value for difference calculated using a t-test, accounting for the complex sampling strategy
ƚ p value for difference calculated using an ANOVA, accounting for the complex sampling strategy
* Statistically significant difference at the 0.05 level or greater

To facilitate the spatial analysis of alcohol marketing exposure data, the development of the imputation method was primarily focused on recovering GPS data for image data with no spatial reference. As a result, the effectiveness of the imputation method is also examined using a second definition of missingness, which is all image data without associated GPS data. There was a total of 1,216,318 images collected by 150 participants (7.00am to 9.00pm over the four-day period). Prior to imputation, 700,256 images were linked successfully to GPS data (57.6%). Therefore, 515,062 images (42.4% of all images) had missing GPS data. As such, two definitions of missing GPS data exist in this thesis:

1) Every 5-second interval between 7.00am and 9.00pm with missing GPS data over the four-day period (before imputation = 3,869,438 5-second intervals (Figure 19, A) or 64% of the 6,048,000 possible 5-second intervals).

2) All image data without associated GPS data (before imputation = 515,062 images, or 42.4% of all image data).

6.2.3 Mixed imputation method results

As outlined in Chapter Five, the imputation method is considered mixed because it contains automated and manual elements. The mixed imputation process was conducted in two stages. First, the automated process used a Python script to impute missing data. Second, image data was used to confirm and manually impute spatial data.

Automated imputation

Automated imputation recovered 338,108 coordinates of the potential 3,869,438 (8.7% of the missing data) seen in Figure 19 (B), addressing the first definition of missingness. Of the automatically imputed points, only 37,963 matched image data that were missing GPS data, which was 7.4% of the total images missing GPS data (second definition of missingness).

Manual imputation

Manual imputation focused on GPS data gaps that did not fit the automated criteria (eg, gaps > 5mins). As manual imputation relied on image data, all 5-second intervals that did not have image data were ineligible for manual imputation. In total, 3,053,231 5-second intervals did not have linked image data (and were therefore considered non-imputable using manual imputation) (Figure 19, C). A total of 478,099 5-second intervals were considered eligible for manual imputation. Manual imputation resulted in an additional 307,440 imputed coordinates (Figure 19, D). GPS data could not be imputed for 170,659 images (Figure 19, E) because these images were either in a dynamic setting where the location could not be confirmed (on the street), the image data was blocked, or the gap bookends had no valid GPS data on which to base imputation. In total, all imputed data comprised 23% of the total final spatial dataset (n = 2,824,129 GPS points) (Figure 19).

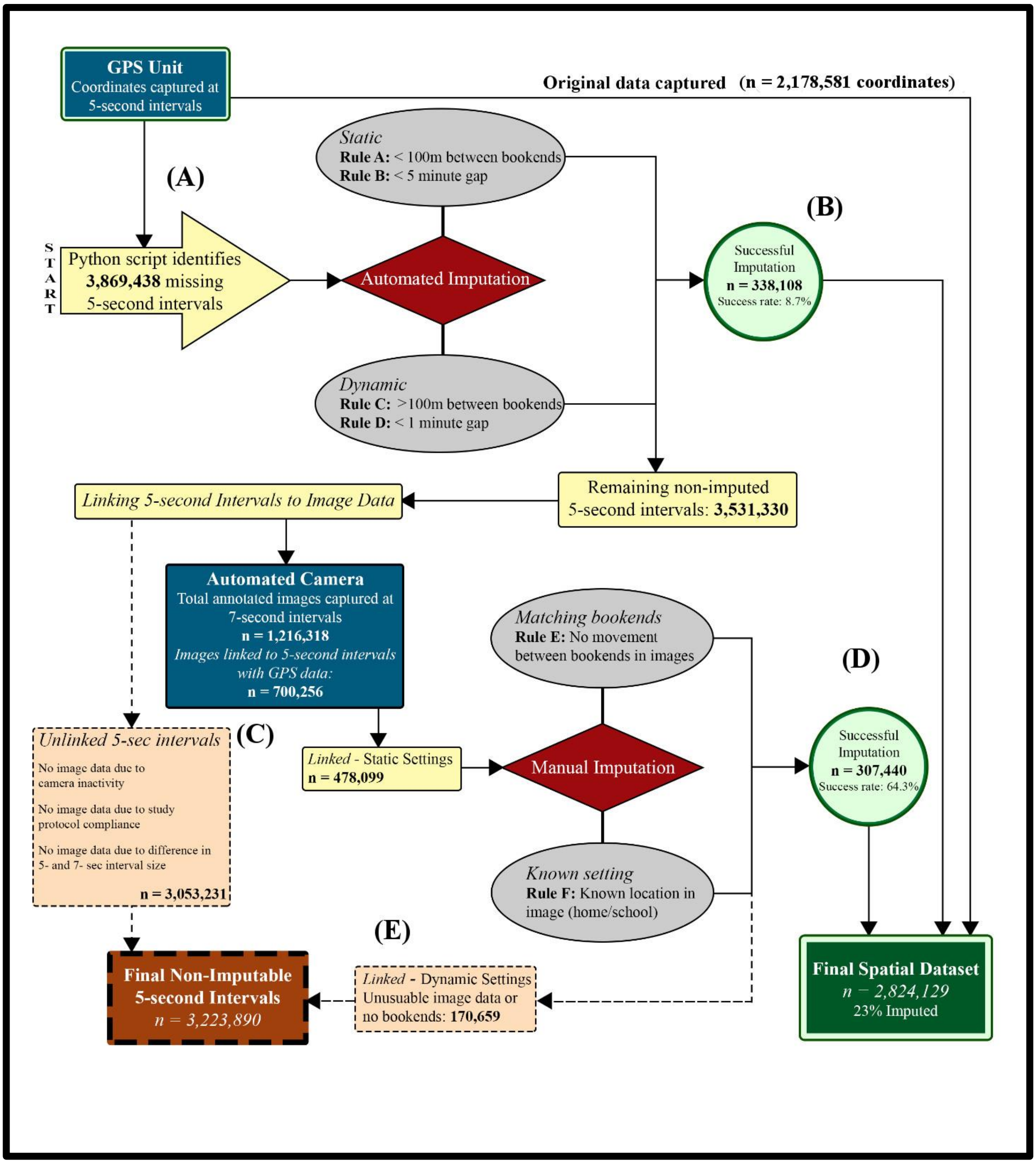


Figure 19: Mixed imputation flowchart and results for each step

Conservative criteria restricted the pool of missing data eligible for imputation. However, the mixed imputation method led to the recovery of 645,548 coordinates (Table 8). Using the first definition of GPS data missingness, the imputation process retrieved 16.6% of all 5-second intervals between 7.00am and 9.00pm that were missing. The automated imputation process retrieved slightly more GPS data (8.7%) than the manual imputation method (7.9%), in substantially less time. Under the second definition of missingness, of the 515,062 images missing GPS data, 345,403 had GPS data successfully imputed (67.1% of all images missing GPS data). In contrast to the automated method, the manual method retrieved substantially more GPS data for images with missing data (59.7% of all images missing GPS data) than the automated method (7.4% of all images missing GPS data).

Table 8: GPS points imputed using automated and manual imputation and the percentage of missing data recovered using two definitions of data missingness

Imputation methods	Imputed points, n	Definition one *n, (% of 3,869,438 5-second intervals missing GPS data)*	Definition two *n, (% of 515,062 images missing GPS data)*
Automated	338,108	338,108 (8.7)	37,963 (7.4)
Manual	307,440	307,440 (7.9)	307,440 (59.7)
Total	645,548	645,548 (16.6)	345,403 (67.1)

Of the remaining non-imputed 5-second intervals (>3 million), a total of 1,340,640 (44%) missing GPS points were comprised of entire days where participants did not turn the device on. Another large portion of non-imputable 5-second intervals can be attributed to participants beginning data collection after 7.00am and finishing before 9.00pm (eg, having a shorter day or sleeping), particularly on weekends. As mentioned earlier, children were sometimes in situations where they were instructed to remove the equipment (eg, playing sport, activities that may cause water damage and if requested by someone for privacy). These situations resulted in approximately 1,000,000 of the non-imputed 5-second intervals. Of the non-imputed 5-second intervals that had matched images (n = 170,659), data could not be imputed due to there being blocked images, or no valid GPS bookends identified.

6.2.4 Sociodemographic bias in imputation method

To determine if the mixed imputation method biased data missingness, the difference in children's mean percentage of missingness before and after data imputation by sociodemographic characteristics was tested (Table 9). As reported earlier, before imputation, only one statistically significant difference was detected among sociodemographic groups; children in the most deprived households had a higher proportion of missing data than children in the least deprived households. This difference was exacerbated in the post-imputation condition, with an absolute difference of 16.2% data missingness between children living in the least household deprivation (42.8%) and children living in the highest household deprivation (59.0%). The strength of the association increased from a p value of 0.006 in pre-imputation to <0.001 in post-imputation.

There were statistically significant differences in missing data by ethnicity only after imputation, whereby more missing data was imputed for NZE children than for Māori and Pacific children. For NZE children, the mean percentage of missing data decreased 15.6% in absolute terms, from 62.6% before imputation to 47.0% after imputation. In contrast, Māori and Pacific children had mean decreases in data missingness of only 8.6% and 10.0%, respectively. Statistically significant differences by ethnicity were not detectable pre-imputation but became statistically significant post-imputation (pre-imputation p = 0.654, post-imputation p = 0.035). There were no significant differences detected by neighbourhood deprivation or sex. These results suggest that imputation increased bias in missing data by ethnicity and household deprivation.

Table 9: Analysis of bias of missing data by sex, ethnicity, household deprivation and neighbourhood deprivation: original data versus imputed data

Sociodemographic characteristics		**Original data** ***mean % of missing data (SD)***	**p value**	**Imputed data** ***mean % of missing data (SD)***	**p value**
Total		64.0 (18.1)		53.3 (21.0)	0.001*
Sex§	*Male*	61.5 (18.5)	0.232	47.2 (21.7)	0.097
	Female	65.3 (18.0)		53.1 (21.1)	
Ethnicity ł	*NZE*	62.6 (18.8)	0.654	47.0 (22.0)	0.035*
	Māori	64.6 (16.2)		56.0 (18.2)	
	Pacific	66.3 (19.4)		56.3 (21.0)	
Household deprivation ł (NZiDep2006)	*Low*	58.0 (19.1)	0.006	42.8 (21.9)	0.001*
	Moderate	65.0 (16.5)		51.5 (19.8)	
	High	69.7 (17.1)		59.0 (19.3)	
Neighbourhood deprivation ł (NZDep2013)	*Low*	63.0 (16.3)	0.744	47.8 (20.2)	0.300
	Moderate	62.2 (21.3)		50.1 (23.7)	
	High	65.4 (18.4)		54.7 (20.3)	

§ p value for difference calculated using a t-test, accounting for the complex sampling strategy
ł p value for difference calculated using an ANOVA, accounting for the complex sampling strategy
*Statistically significant difference at the 0.05 level or greater

6.2.5 *Validation of automated imputation*

A validation test of the automated imputed data was conducted in a sub-sample of 10 children from one school, presented in Table 10. Image data were used to examine the spatial accuracy of 470 imputed 5-second intervals. The validation test involved purposively selecting four types of data gaps, including 1) a static setting; 2) a dynamic setting; 3) gaps < 1 min; and 4) gaps > 3 minutes. For each category, the imputed locations were verified using images captured at the same time. Notes were made regarding participant behaviour and settings that may help explain the missing GPS data. The automated method was found to be spatially accurate within the usual GPS tolerance/noise levels (eg, within 5m) when validated against the simultaneous image data. Most of the missing coordinates appeared to be the result of random interference with the GPS signal. However, observed causes of potential GPS signal interference included interference from electronic devices, cold starts, extended periods indoors, and transitions from indoor to outdoor settings.

Table 10: Validation results for automated imputation from 10 children

Validation test features	n	Spatial accuracy, %
Participants	10	100
Static setting gaps validated	10	100
Dynamic setting gaps validated	6	100
< 1 minute gaps validated	9	100
≥ 3 minute gaps validated	10	100
Total coordinates validated	470	100

6.2.6 *Processing*

Coding image data for the setting was completed as part of Kids'Cam (approximately 1,400 person-hours) (332), in which I did not participate. If the coding framework for Kids'Cam was simplified, the coding time could be significantly reduced (perhaps by as much as 80%). As discussed in Chapter Five, the Kids'Cam coding framework required coders to search each image for instances of food marketing, then assign the place, promotion type and product category into the three-tiered coding interface. The current study only required coding for the top level (place), an aspect more easily coded.

As discussed in Chapter Five, I conducted the data linkage of the image to GPS data. The development of a functional Python script for automated imputation took approximately 40 hours. Once the Python script was functional, the automated imputation process took approximately three person-hours. The manual imputation process was more time-consuming, taking approximately 240 person-hours.

6.3 What is the extent of children's neighbourhood?

This section presents the results of the neighbourhood extent analysis using PSNB. These results present children's GPS observation time, the sociodemographic characteristics of children included in the neighbourhood extent analysis and the overall results of children's neighbourhood extent.

6.3.1 Leisure time defined

As discussed in Chapter Five, Kids'Cam Alcohol examined only children's leisure time, defined as all non-school waking time (all time except weekdays between 9.00am and 3.00pm, as defined by the MoE). Thus, all image and GPS data between 9.00am and 3.00pm on weekdays (school time) were removed from subsequent analyses (1,448 observation hours removed). In addition to school time, all data before 7.00am and after 9.00pm were removed from the analyses, as these were considered the temporal extremities of children's waking days. Therefore, the full GPS data set was reduced from 4,024 observation hours to 2,609 observation hours in the leisure time dataset.

6.3.2 Leisure time GPS dataset

The descriptive results of children's leisure time GPS data are presented in Table 11. Collectively, the children collected 2,609 hours of GPS data, with a mean of 17.4 hours per child. Boys had a higher mean of data collected than girls, albeit not statistically significant. However, overall, more data were collected by girls, a consequence of the sample including 10 more girls than boys. NZE children (mean 20.1 hours) collected more GPS data than either Māori (mean 15.7 hours) or Pacific children (mean 15.5 hours) (p value 0.004). Children living in the least deprived neighbourhoods collected a mean of 19.4 hours per child, higher than the 18.5 hours and 15.1 hours collected by those children living in moderately deprived and highly deprived neighbourhoods, respectively. The only significant difference between groups was by ethnicity, with NZE children collecting more data per child than Māori or Pacific children.

Table 11: Number of children and GPS data collected by sex, ethnicity and neighbourhood deprivation, with total and mean hours of GPS data collected in each stratum

Sociodemographic characteristics		n*	Total (hours per stratum)	Mean (hours per child)	p value**
Sex	*Male*	70	1,297	18.5	0.230
	Female	80	1,312	16.4	
Ethnicity	*NZE*	59	1,187	20.1	0.004
	Māori	54	848	15.7	
	Pacific	37	574	15.5	
Neighbourhood deprivation (NZDep2013)	*Low*	55	1,066	19.4	0.069
	Moderate	41	759	18.5	
	High	52	783	15.1	
	Missing	2	0.2	0.1	
Total		150	2,609	17.4	

*Note: 18 participants did not collect GPS data during the leisure time period
**p value for difference calculated using Kruskal-Wallis equality-of-populations rank test

6.3.3 Sociodemographic characteristics

This section presents the participant characteristics for the neighbourhood extent analysis. To ensure the GPS data represented a valid snapshot of children's leisure time, a further 35 children were excluded due to insufficient GPS data, that is <8 hours over four days. The eight-hour cut-off was based on previous analyses investigating children's leisure time that used similar cut-off points (396). One more child was excluded because their residential address information was missing. The final sample for the neighbourhood extent analysis included 114 children, with a combined 2,448 observation hours (Table 12). The analytic sample had approximately equal numbers of boys and girls (49% male), and distribution by household deprivation. There were more NZE children (43%) than Māori (36%) or Pacific children (21%). More children lived in highly deprived neighbourhoods (41%) than in moderately (29%) or least deprived (30%) neighbourhoods. The included and excluded (for no GPS data and insufficient GPS data) groups were tested for differences by sociodemographic characteristics using Pearson chi-squared tests; no statistically significant differences were detected.

Table 12: Sociodemographic characteristics of Kids'Cam children – both included and excluded in neighbourhood extent analysis.

Sociodemographic characteristics		Included (n=114), n (%)	Excluded (n=54)*, n (%)	p value¥
Sex	*Male*	56 (49)	24 (44)	0.428
	Female	58 (51)	30 (56)	
Age, range (mean)		11-14.5 (12.5)	11.6-13.3 (12.6)	0.105
Ethnicity	*NZE*	49 (43)	17 (31)	0.178
	Māori	41 (36)	20 (37)	
	Pacific	24 (21)	17 (32)	
Household deprivation (NZiDep2006)	*Low*	34 (30)	19 (35)	0.722
	Moderate	39 (34)	19 (35)	
	High	37 (32)	13 (24)	
	Missing	4 (4)	3 (6)	
Neighbourhood deprivation (NZDep2013)	*Low*	34 (30)	20 (37)	0.255
	Moderate	33 (29)	16 (30)	
	High	47 (41)	12 (22)	
	Missing	0 (0)	6 (11)	

¥ p value for difference between included and excluded groups calculated using Pearson chi-squared tests.
* Excluded category included those children with insufficient GPS data (n=35), no GPS data collected (n=18) and missing address information (n=1).

6.3.4 Neighbourhood extent analysis

This section presents the neighbourhood extent results, shown in Figure 20, which used concentric and network buffers at incremental distances. Figure 20 (A) shows the average time spent within each buffer size, calculated using Poisson regression models accounting for the complex sampling strategy and participant observation time. The threshold dotted line signifies 50% of children's leisure time data, the first criteria for deciding on children's neighbourhood extent. Children spent more than 50% of their leisure time within 500m of their homes using both concentric (59.2% of total leisure time, 95% CI 52.9, 66.3, blue line) and network (51.4% of total leisure time, 95% CI 43.0, 61.3, red line) buffers. Figure 20 (B) displays the absolute percentage increase in leisure time spent from one buffer to the next. The largest difference in the percentage of spent leisure time occurred between the 200m and 500m buffers for both concentric (4.1% absolute increase) and network (9.1% absolute increase) buffers. Based on these criteria, 500m was used to define children's neighbourhood extent for the neighbourhood analyses in Chapter Eight.

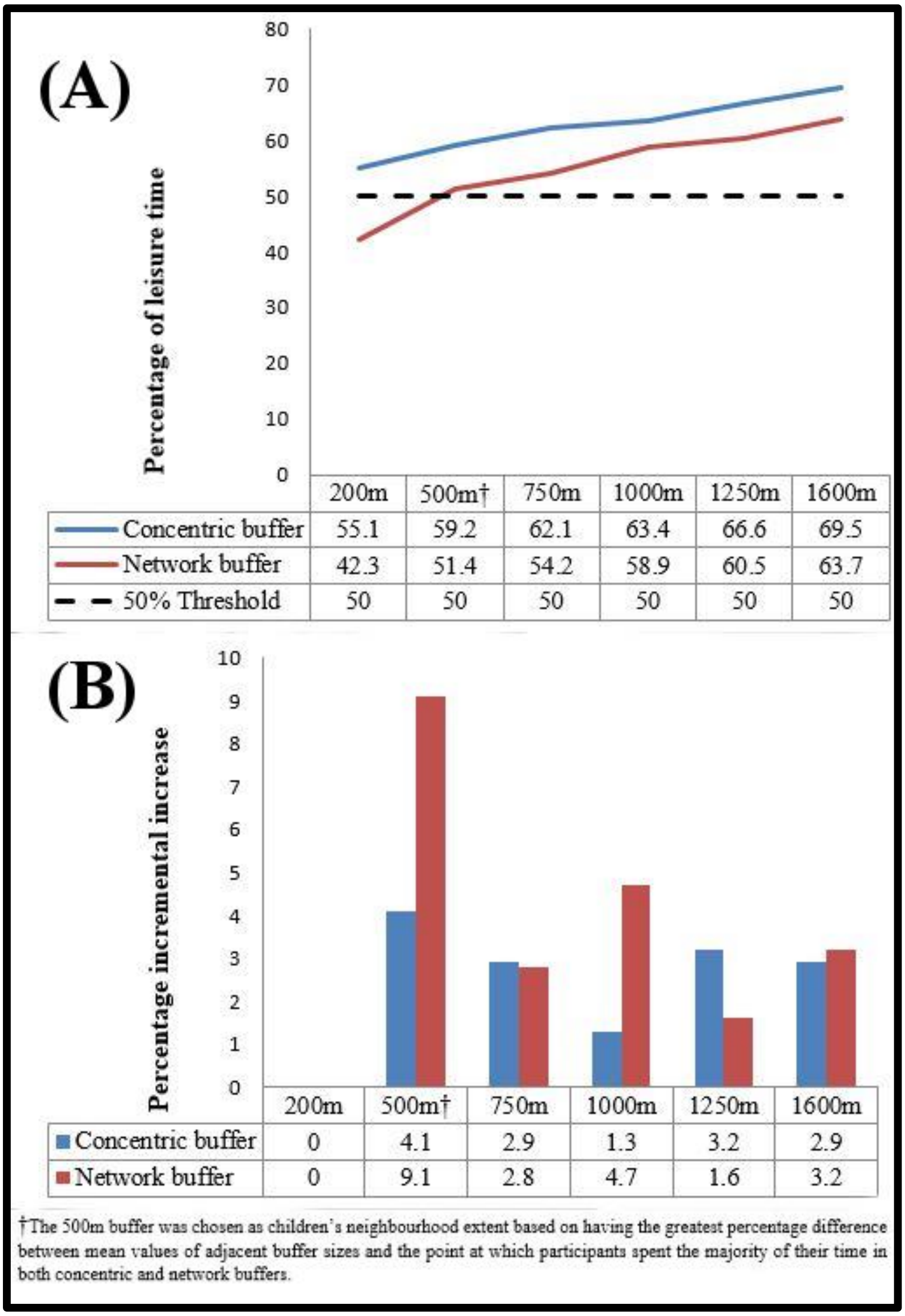


Figure 20: The average percentage of leisure time spent within concentric and network buffers at incremental distances around participants' homes (mean, 95% CI, from Poisson regression), accounting for complex sampling strategy and participant observation time. Source: Chambers, Pearson, et al. (397)

Table 13 presents the mean percentage time spent within a 500m concentric residential buffer by sociodemographic characteristics. There were no statistically significant differences detected by sociodemographic characteristics. Boys spent slightly more time in their residential neighbourhood than girls (RR 1.05, 95% CI 0.82, 1.35). Māori children (57.1%) spent slightly less time in their residential neighbourhood than NZE (59.5%) or Pacific (60.7%) children. Children living in the least deprived households (62.6%) and least deprived neighbourhoods (64.4%) spent more time in their residential neighbourhood than children living in moderate (household 56.4%, neighbourhood 48.2%) and high deprivation (household 56.1%, neighbourhood 59.4%).

Table 13: Mean percentage of time spent within 500m concentric residential buffer, by sociodemographic characteristics

Sociodemographic characteristics		Mean percentage (95% CI) ±	Rate ratio (95% CI)	p value¥
Sex	*Female*	57.7 (47.4, 70.1)	1 (reference)	
	Male	60.7 (52.7, 70.0)	1.05 (0.82, 1.35)	0.666
Ethnicity	*NZE*	59.5 (51.7, 68.5)	1 (reference)	
	Māori	57.1 (44.5, 73.4)	0.96 (0.72, 1.28)	0.770
	Pacific	60.7 (47.2, 78.0)	1.02 (0.76, 1.36)	0.885
Household	*Low*	62.6 (56.8, 69.1)	1 (reference)	
deprivation	*Moderate*	56.4 (46.0, 69.0)	0.90 (0.70, 1.16)	0.383
(NZiDep2006)	*High*	56.1 (38.6, 81.6)	0.90 (0.61, 1.32)	0.556
Neighbourhood	*Low*	64.4 (58.9, 70.3)	1 (reference)	
deprivation	*Moderate*	48.2 (32.3, 72.0)	0.75 (0.48, 1.16)	0.183
(NZDep2013)	*High*	59.4 (44.5, 79.4)	0.92 (0.69, 1.24)	0.576

± Means calculated using Poisson regression, accounting for complex sampling strategy and participant observation time

¥ p value for difference calculated using Poisson regression, accounting for complex sampling strategy and participant observation time

6.4 What destinations do children visit that may be important for their health?

As outlined in Chapter Five, I led the development of a destination detection application that used spatial, temporal and density parameters to detect groupings of GPS data that were then used to detect children's visits to destinations. The destination detection application was developed to provide insights into where children spend their time and the destinations that they visit. These data may help identify important places in children's environments, which may serve as possible sites of intervention on matters of public health interest, such as the alcohol marketing discussed in this thesis. This section outlines the sensitivity analysis and validation test for this methodological tool. The results of children’s visits to destinations outside of their neighbourhood are then presented.

6.4.1 Sensitivity analysis

To confirm the correct parameters were selected to run the destination detection application, a sensitivity analysis was conducted by adjusting the destination parameters. Initially, the parameters used to define a destination included: no more than 100m between data point (spatial constraint), at least 20 points (density parameter), and no less than five minutes (temporal parameter). Under these parameters, the destination detection application identified 1,763 unique destinations with 99% of GPS points included in destinations. This suggests that the cluster parameters were too broad. Consequently, many smaller destinations were not representative of an actual visit to a destination in this context; instead, they were noise representative of participants’ slow movement or GPS device interference. Visual confirmation using ArcGIS reinforced this conclusion.

Increasing the temporal parameter to define a destination as at least 10 minutes and the density parameter to a minimum of 60 points reduced the number of destinations from 1,763 to 1,109 with 91.1% of GPS points being included in destinations. Consequently, around 9% of GPS points were either in transit or represented shorter visits at destinations (<10mins). These new parameters removed the majority of the aforementioned noise and increased the likelihood that the destinations represented actual visits.

6.4.2 Validation test

Destinations were validated through visual inspection in ArcGIS, image data and *Google Street View,* as outlined in Chapter Five. The validation sub-set included 20 visits to destinations with at least three visits to each destination category: home, school, community venue, food retail, sport and outdoor recreation settings. The average time spent at the 20 destinations validated was 86.5 mins per visit, ranging between 10.4 and 268.7 mins. There was 100% concordance between the image codes from the wearable cameras and the type of location observed in *Google Street View*.

6.4.3 *Destinations visited by children*

In total, children visited 1,109 total destinations, which included 91.1% of all leisure time spent more than 500m away from home. Figure 21 demonstrates four examples of destinations captured by the cameras (clockwise from top left image): outdoor recreation, structured sport, food retail and other residential.

The rates of both children's leisure time visits to destinations per 10 hours and time spent at destinations per hour are presented in Figure 22. Children left their neighbourhood most frequently to visit: school (mean 2.4, 95% CI 1.9, 3.0, visits per 10 hours of leisure time), other residential location (other than their primary home address) (mean 1.9, 95% CI 1.4, 2.7, visits per 10 hours) and food retail outlets (mean 1.9, 95% CI 1.3, 2.8, visits per 10 hours). School in this context is a leisure time destination and is not necessarily the school the child attends. Further, it should be noted that not all children in New Zealand have equal access to school grounds as some schools close their gates outside of school hours, although this was not observed in the current data. School, other residential locations and food retail outlets had more visits collectively (mean 6.2 visits per 10 hours) than all other identifiable destinations combined (mean 3.2 visits per 10 hours). Children made more visits to food retail outlets (mean 1.9 visits per 10 hours) than structured sport and outdoor recreation locations collectively (mean 1.5 visits per 10 hours). There were no statistically significant differences in the destinations visited by season, except children were 1.8 times more likely to visit a food retail outlet in the winter terms than in the summer terms.

Children spent the most time at the following destinations: other residential locations (mean 14.4, 95% CI 10.1, 20.7, mins/hour), school (mean 10.3, 95% CI 7.8, 13.6, mins/hour), and food retail outlets (mean 8.5, 95% CI 6.1, 11.5, mins/hour). Nearly a quarter (mean, 14.4 mins/hour) of the leisure time spent outside of the neighbourhood occurred at another residential location. Similar to the number of visits, the collective time spent at other residential locations, school (for leisure) and community venues was greater (mean, 33.3 mins/hour) than all other places combined (mean, 16.6 mins/hour).

Figure 21: Examples of places coded in destination analysis (clockwise from the top left panel); outdoor recreation, structured sport, food retail, other residential. Source: Chambers, Pearson et al. (397)

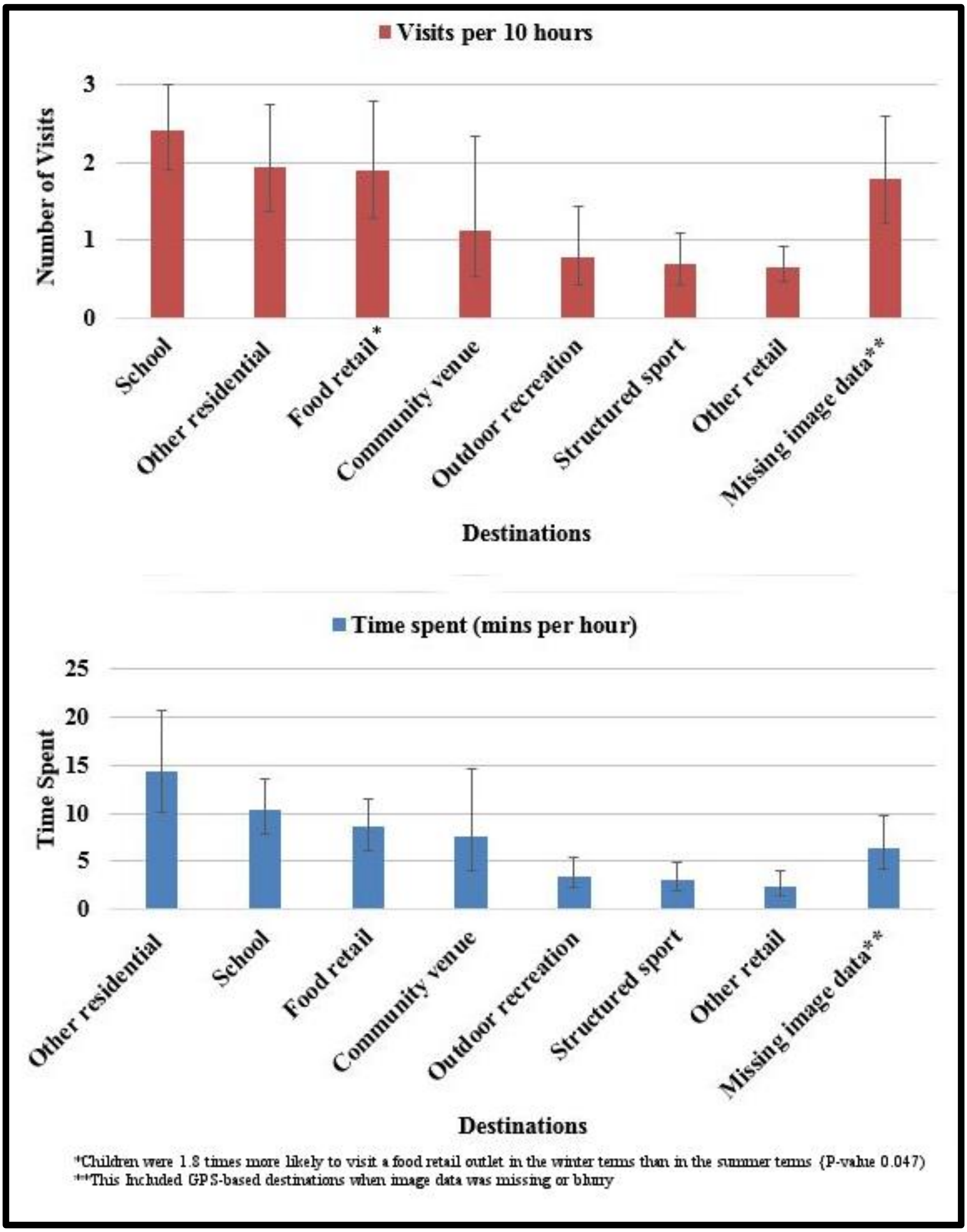


Figure 22: Mean rate of visits to destinations (per 10 hours) and mean time spent at destinations (minutes per hour) (with 95% CI, from negative binomial regression), accounting for complex sampling strategy and participant observation time. Source: Chambers, Pearson et al. (397)

6.5 Summary

There were a number of methodological challenges posed by the Kids'Cam GPS dataset. In attempting to solve these methodological challenges and answer the subsequent research questions, I led the creation of novel methodological approaches. This chapter has presented the results of a mixed imputation method, a method to determine the spatial extent of children's neighbourhoods and a destination detection analysis using a custom-built application.

The imputation method recovered a substantial amount of missing GPS data, particularly for image data that was missing spatial information. Automated imputation was more time efficient than manual imputation while recovering a similar amount of missing GPS data. However, automated imputation only recovered a small portion of GPS data for images missing spatial data (<9%). Manual imputation was required to recover data from larger data gaps and for those images still without spatial data. In contrast to automated imputation, manual imputation was highly effective at retrieving spatial information for image data but was time intensive. Fortunately, this process enabled the recovery of most GPS data for image data (>90%) missing spatial data, facilitating the spatial analyses conducted in Chapter Eight. Therefore, the imputation method partially addressed the methodological challenge posed by data missingness in the Kids'Cam GPS dataset.

Another challenge of the Kids'Cam GPS dataset, other studies using GPS data, and neighbourhood and health research more broadly, is determining the appropriate neighbourhood extent to use in neighbourhood analyses. The neighbourhood extent analysis utilised children's GPS data to derive an appropriate neighbourhood extent measure and is more robust than previous methods (99, 307-309). The criteria used in this study resulted in a neighbourhood extent of 500m, a distance that is used in Chapter Eight.

The development and implementation of a destination detection application demonstrated that school, other residential locations and food retailers are important destinations for children outside of the neighbourhood. These destinations highlight potential sites of health invention to improve children's environments, including for alcohol health promotion, which is discussed in Chapter Nine.

CHAPTER SEVEN: RESULTS - CONTENT ANALYSES

7.1 Introduction

This chapter presents the results of the content analysis of the image data to answer the central research question of this thesis:

- What is the extent and nature of children's real-time exposure to alcohol marketing?

and the following sub-questions:

- How does children's exposure to alcohol marketing differ by sociodemographic characteristics?
- What is the frequency, duration and nature of children's exposure to alcohol marketing within off-licence alcohol outlets?

First, this chapter outlines the children's sociodemographic characteristics and observation time. Second, children's exposure to alcohol marketing, excluding exposures within off-licence alcohol outlets, is presented. Third, children's exposure to alcohol marketing within off-licence alcohol outlets, defined as marketing encounters, is presented. For both marketing exposures and marketing encounters, descriptive and inferential statistics are presented.

7.2 Sociodemographic characteristics

In Kids'Cam, the children collected a total of approximately 1.3 million images. As discussed in Chapter Five, of the total Kids'Cam images, only those captured outside school time (9.00am to 3.00pm on weekdays) were coded for alcohol marketing (n=700,000). Thus, in Kids'Cam Alcohol, all observation time is children's leisure time. One child had no data outside school hours and was subsequently excluded from the analysis, reducing the analytic sample for Kids'Cam Alcohol to 167 children.

Table 14 presents the sociodemographic characteristics of the 167 participants included in analyses for Kids'Cam Alcohol. There were similar numbers of boys (47%) and girls (53%) in the sample, with a mean age (±SD) of 12.6 ± 0.5 years. The sample included more NZE (40%) than Māori (36%) and Pacific (24%) children. Children were spread evenly across household deprivation strata, measured using NZiDep2006, with 31% in high, 34% in moderate and 31% in low deprivation. Neighbourhood deprivation, measured using NZDep2013, varied slightly, with more children living in neighbourhoods of high (35%) and low (34%) than moderate (29%) deprivation. These results primarily reflect the intentional sampling design, which was stratified by ethnicity and school decile.

Table 14: Sociodemographic characteristics of Kids'Cam Alcohol children with leisure time image data

Sociodemographic characteristics		n	%
Total		167	100
Sex	*Male*	78	47
	Female	89	53
Age	*11*	13	7
	12	122	73
	13	25	15
	14	1	1
Mean (SD)	*12.6 (±0.5)*		
Total		161*	96
Ethnicity	*NZE*	66	40
	Māori	60	36
	Pacific	41	24
	Total	167	100
Household deprivation (NZiDep2006)	*Low*	52	31
	Moderate	57	34
	High	52	31
	Total	161*	96
Neighbourhood deprivation (NZDep2013)	*Low*	57	34
	Moderate	48	29
	High	58	35
	Total	163**	98

*Six participants had missing demographic information on age and household deprivation
**Four participants had missing address information

7.3 Leisure time: image data set

The number of children and leisure time image data collected, represented as hours of image data, are presented in Table 15. The average capture rate of the cameras over the study period was seven seconds, thus each image captured by the participants was treated as seven seconds of person-time for all analyses. From here on, observed leisure time hours are simply referred to as hours. In total, children collected a total of 1,351 hours of image data, with a mean (±SD) of 9.8 ± 6.1 hours of image data collected over the study period. A Shapiro Wilk test ($p < 0.001$) and visual observation of histogram showed the distribution was skewed to the right of the distribution curve. Thus, most children had a relatively moderate amount of data, while some had a very substantial amount. Boys collected an average of 10.3 hours of data whereas girls collected a mean of 9.4 hours; the difference was not statistically significant. NZE children collected significantly ($p < 0.001$) more data (mean 11.6 hours) than Māori (mean 6.5 hours) and Pacific (mean 6.7 hours) children. NZE collected half of all data (686 hours), whereas Māori and Pacific children collected 30% and 20%, respectively. Children living in the least deprived neighbourhoods (mean 11.6 hours) collected significantly ($p < 0.001$) more data than children living in moderate (mean 9.4 hours) and the most deprived neighbourhoods (mean 6.9 hours). Consequently, almost half (46%) of all the data comes from children living in the least deprived neighbourhoods, despite these children only making up 31% of the total sample.

Table 15: Number of children, with total and mean observation hours by sociodemographic characteristics

Sociodemographic characteristics		n	Total hours for stratum (% total)	Mean hours per child (SD)	p value*
Total		167	1,351 (100)	9.8 (6.1)	
Sex	*Male*	78	668 (49)	10.3 (5.9)	
	Female	89	683 (51)	9.4 (6.3)	0.501
Ethnicity	*NZE*	66	686 (50)	11.6 (5.6)	
	Māori	60	401 (30)	6.5 (5.6)	
	Pacific	41	264 (20)	6.7 (6.0)	<0.001
Neighbourhood	*Low*	57	623(46)	11.6 (5.5)	
deprivation	*Moderate*	48	390 (29)	9.4 (6.0)	
(NZDep2013)	*High*	58	336 (25)	6.9 (6.2)	<0.001
	Missing	4	2 (<1)	0.7 (1.0)	

* p value for difference calculated using Kruskal-Wallis equality-of-populations rank test

7.4 Marketing exposures

This section presents the results of the content analysis investigating children's exposure to alcohol marketing, excluding within off-licence alcohol outlets. The descriptive rates of children's exposure to alcohol marketing by overall exposure, place, promotion type and sociodemographic characteristics are presented. The results provide an overview of the distribution and variability in exposure among children and highlight the nature of the data used in subsequent analyses. The mean rates of exposure are also presented. Negative binomial regression models were used to generate inferential statistics, accounting for the complex sampling strategy and participant observation time. The multivariable negative binomial regression models describe differences in rates by several factors, mutually adjusted for sex, ethnicity and neighbourhood deprivation, accounting for the potential confounding of model variables.

7.4.1 Median rates of exposure to alcohol marketing: descriptive results

Overall exposure rate

Figure 23 presents a box plot displaying the overall median rate of exposure to alcohol marketing per hour, with IQR. The median rate of exposure was 0.5 (IQR 0.0 to 1.8) per hour, showing that half of the children had fewer than 0.5 exposures per hour. The minimum and maximum rates among the upper quartile were 1.8 and 3.9 exposures per hour, respectively. In contrast, the minimum and maximum rates of the lower quartile were 0.0 to 0.0, respectively. The lower quartile shows that over 25% of the children were not exposed to alcohol marketing during the study period. In contrast, the upper quartile shows over 25% of the children were exposed at a rate three times higher than the median, demonstrating that the children exposed to alcohol marketing were exposed at a high rate. There were a few outliers with very high rates of exposure, with the maximum rate for one child being 10.2 exposures per hour.

A Shapiro Wilk test for normality ($p < 0.001$) and visual observation of the histogram showed the distribution was not normal but skewed to the right. Thus, most children had relatively modest rates of exposure to alcohol marketing, while a few children had high rates of exposure. The descriptive rates presented here do not account for participants' observation time as those children with small amounts of observation time were more likely to have zero exposures. Problems caused by differences in observation time are better handled with Poisson-like regression models, such as negative binomial regression, as person-time contribution effectively scales a given participant's contribution to the overall outcome (393). Analyses to calculate the mean rates of exposure using regression models to account for differences in observation time are presented later in this chapter.

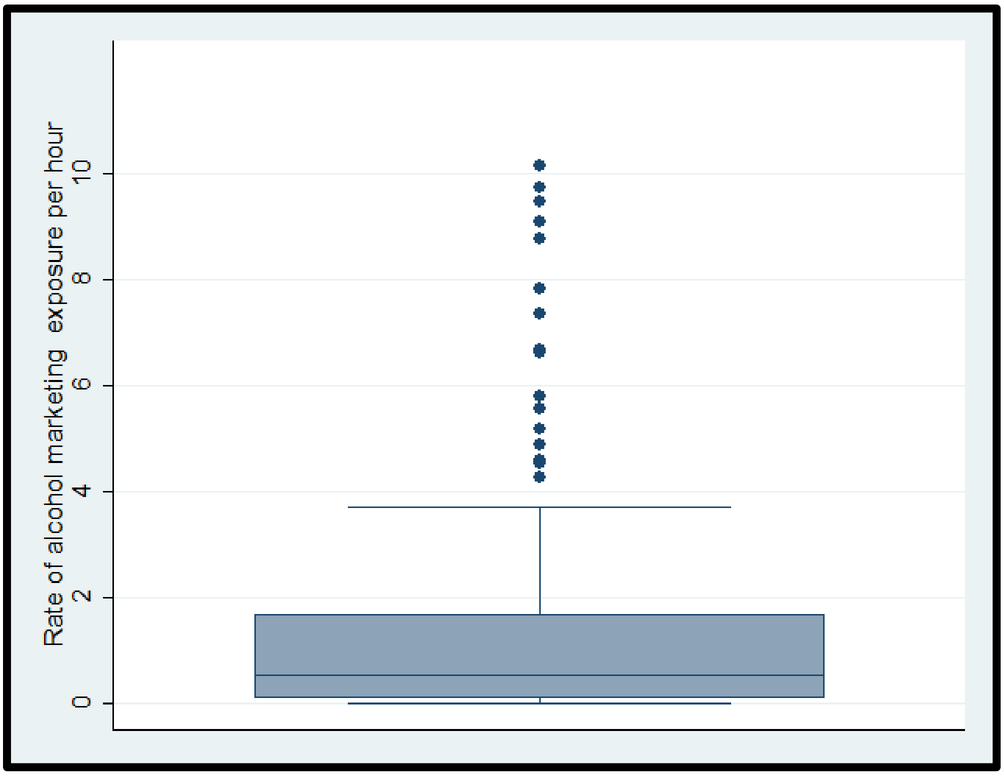


Figure 23: Median rates, with IQR (shaded area), of exposure to alcohol marketing per hour

Median rates of exposure to alcohol marketing by place

To calculate median rates of exposure for place, total observation time was used as the denominator and was not stratified by time spent within each place. The median rates and IQR of children's exposure to alcohol marketing per hour by place are presented in Figure 24. The highest rate of exposure to alcohol marketing occurred within the home, at a median rate of 0.2 (IQR 0.0 to 0.9) exposures per hour (Figure 24). The interquartile range shows that 25% of children were exposed over 0.9 (5.7 maximum) times at home per hour, while another 25% did not have a single exposure at home. The remaining places had median rates of 0.0 exposures per hour, highlighting the uneven distribution of exposures among places.

Obtaining the denominator for time spent in each place was considered too burdensome for the nature of this analysis as it would have required coding every single image for place (n = 700,000) rather than just the images with alcohol marketing exposures (n = 1,361). Thus, the low rates of exposure in some places may also reflect children's propensity to spend more time at some places than others. For example, in Figure 24, while fewer exposures occurred at sports venues during the study period than at home, it is likely children spent more time at home and therefore had more opportunities for exposure than at sports venues.

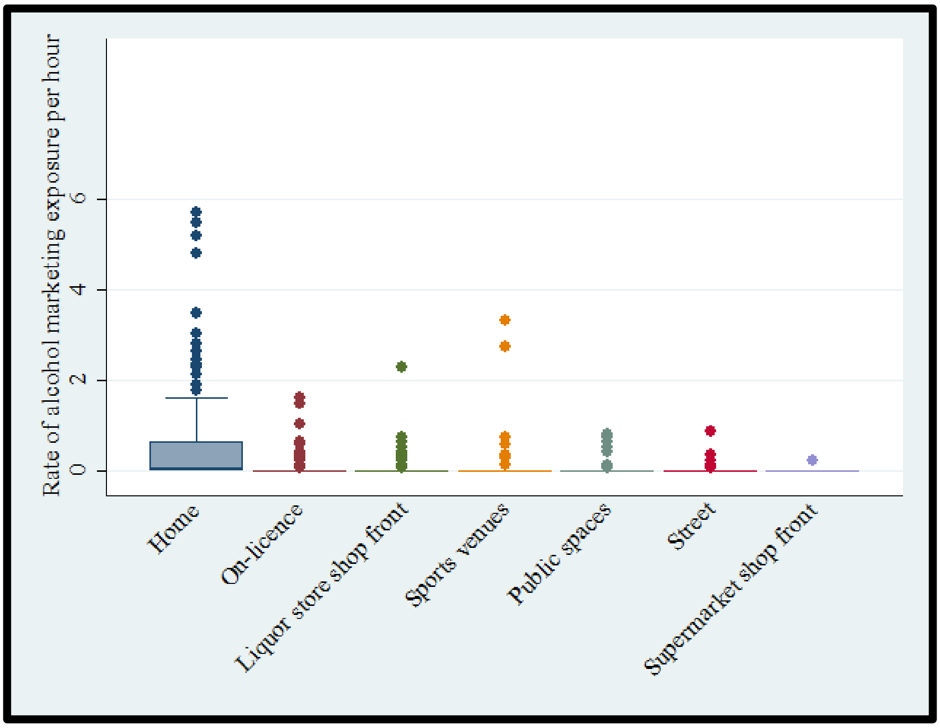


Figure 24: Median rates, with IQR (shaded area), of children's exposure to alcohol marketing per hour by place

Figure 25 displays examples of images captured by participants of the different place categories used to code alcohol marketing exposures including home (A), on-licence (B), liquor store shop front (C), sports venues (D), public spaces (E) and street (F). In the content analysis, 'home' included all residential addresses the child visited. Thus, exposure coded as home may not be occurring within a participant's primary residential address.

Figure 25: Examples of children's exposure to alcohol marketing by place home (A), on-licence (B), liquor store shop front (C), sports venues (D), public spaces (E) and street (F)

Median rates of exposure to alcohol marketing by promotion type

As shown in Figure 26, the highest median rate of exposure to alcohol marketing occurred via product packaging, at 0.2 times per hour (IQR 0 to 0.7). The next most prevalent promotion type was shop front signage, with a median rate of 0.0 (IQR 0 to 0.1) exposures per hour. Shop front signage was the only promotion type, other than product packaging, that over 25% of children were exposed to over the study period. Less than 25% of the study population were exposed to the remaining promotion types, as represented by zero values for the upper quartiles.

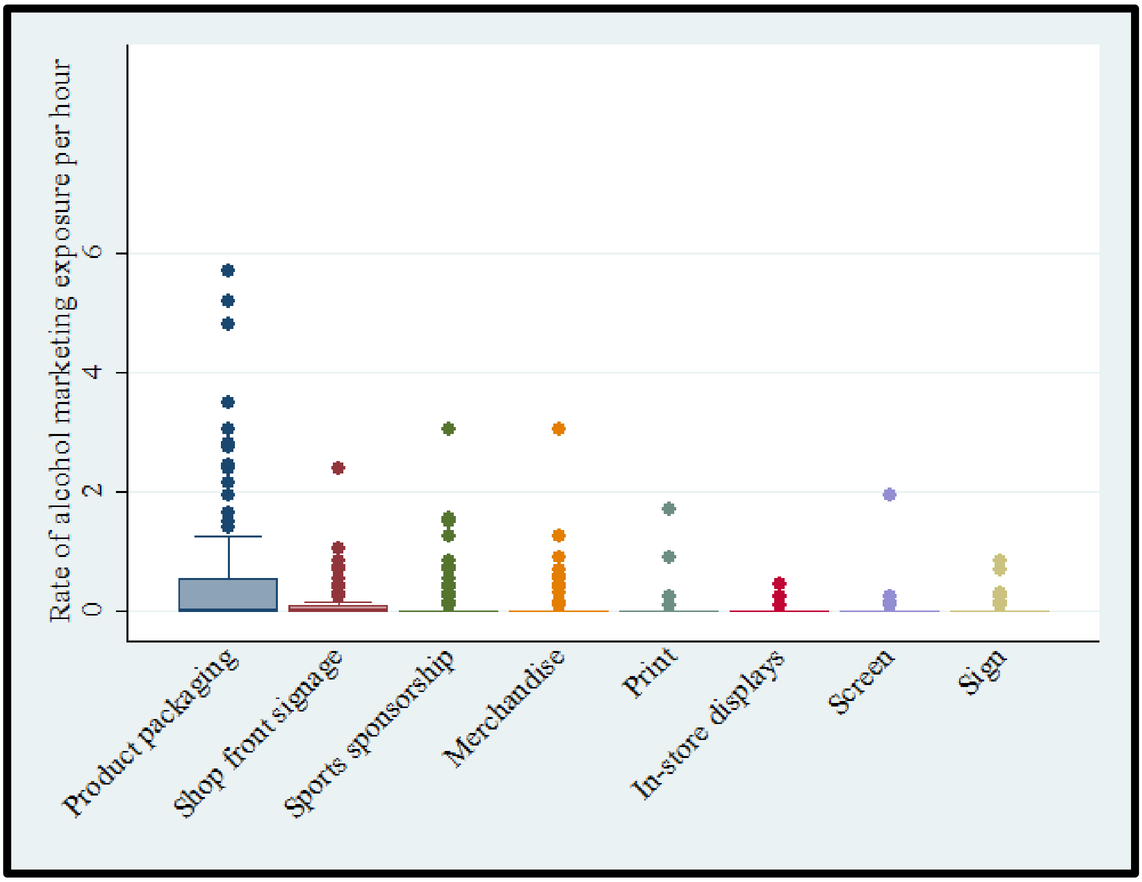


Figure 26: Median rates, with IQR (shaded area), of children's exposure to alcohol marketing per hour by promotion type

Figure 27 demonstrates examples of children's exposure to alcohol marketing by promotion type captured by participants. Codes included product packaging (A), shop front signage (B), sports sponsorship (C), merchandise (D), print (E), in-store displays (F), screen (G) and sign (H).

Figure 27: Examples of children's exposure to alcohol marketing by promotion type product packaging (A), shop front signage (B), sports sponsorship (C), merchandise (D), print (E), in-store displays (F), screen (G) and sign (H)

Median rates of exposure by sex, ethnicity and neighbourhood deprivation

The median rates of exposure to alcohol marketing are presented by sex, ethnicity and neighbourhood deprivation in Table 16. Boys had slightly higher median rates of exposure per hour than girls (boys = 0.6, girls = 0.5). Pacific children had the lowest median rate of 0.3 (IQR 0.0 to 1.8) exposures per hour, while Māori children had the highest, with 0.6 (IQR 0.0 to 1.7) exposures per hour. Children living in the least deprived neighbourhoods had the lowest median rate of exposure (median rate 0.2 exposures per hour). Children living in neighbourhoods of moderate deprivation had the next highest median rate of exposure (0.3 per hour) and those children living in neighbourhoods of the highest deprivation had the highest median rate of exposure (0.5 per hour). Therefore, median rates and interquartile ranges are relatively consistent across sex, ethnicity and neighbourhood deprivation strata.

Table 16: Median rates, with IQR, of children's exposure to alcohol marketing per hour, by sex, ethnicity and neighbourhood deprivation

Sociodemographic characteristic		The median rate of alcohol marketing exposures per hour (IQR)
Total		0.5 (0.1, 1.7)
Sex	*Male*	0.6 (0.3, 2.1)
	Female	0.5 (0.0, 1.5)
Ethnicity	*NZE*	0.5 (0.3, 1.6)
	Māori	0.6 (0.0, 1.7)
	Pacific	0.3 (0.0, 1.8)
Neighbourhood deprivation (NZDep2013)	*Low*	0.2 (0.0, 1.0)
	Moderate	0.3 (0.1, 1.0)
	High	0.5 (0.2, 1.2)

Rates of exposure to alcohol marketing by day and time

Figure 28 demonstrates the rates of exposure by day of the week and time of day. Friday was the day with the highest rate of exposure (1.68/hour), followed by Saturday (1.30/hour), then Sunday (1.29/hour) and Thursday (1.14/hour). The highest rates of exposure occurred during Friday evening (1.95/hour), Saturday evening (1.80/hour) and Friday morning (1.76/hour).

Supervision status

As outlined in Chapter Five and further in Appendix 2, during every alcohol marketing exposure, images were also coded for the presence of a supervising adult. In total, there were 1,796 alcohol marketing exposures over the study period. Of these exposures, an adult was present during 1,136 (63%) of them. Thus, children were unsupervised on 37% of all alcohol marketing exposures.

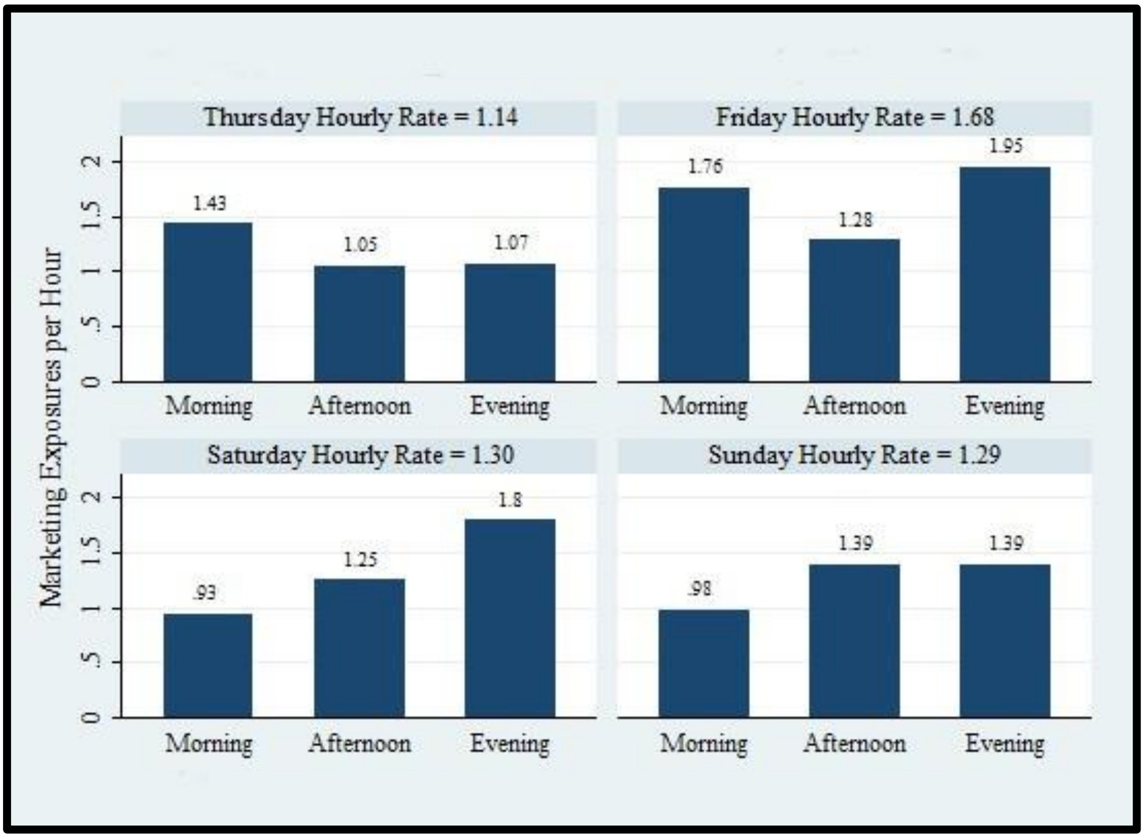


Figure 28: Exposure to alcohol marketing by day of the week and time of day

7.4.2 Mean rates of exposure to alcohol marketing: inferential statistics

In this section, the results of negative binomial regression models that account for the complex sampling strategy and the variations in children's observation time are presented. Negative binomial regression models were selected as the exposure data were over-dispersed count data. Further, the variance of count values was higher than expected under a Poisson distribution. Negative binomial regression is one way to deal with this overdispersion. Model fit tests run in Stata (graph variable, Poisson & negative binomial probabilities, "nbvargr") demonstrated negative binomial regression models had the best fit. The first set of results presented are the mean rates of exposure with their rate ratios demonstrating differences between sociodemographic groups, including multivariable models mutually adjusted for sex, ethnicity and neighbourhood deprivation. Next, the mean rates of exposure by place are presented, including results stratified by, and adjusted for, sociodemographic characteristics. Finally, the mean rates of exposure by promotion type are presented, with results stratified by, and adjusted for, sociodemographic characteristics.

Mean rates of exposure to alcohol marketing

Overall, children in this study were exposed to a mean of 12.4 (95% CI 9.1, 17.1) alcohol marketing exposures per 10 hours (Table 17). There were no statistically significant differences found in children's exposure by sociodemographic characteristics. While the rate ratio for Māori children compared to NZE children was 1.76, the confidence interval was broad (95% CI 0.96, 3.23) and hence the difference is not statistically significant. Likewise, children living in the least deprived households had a rate ratio of 1.50, but with wide confidence intervals (95% CI 0.91, 2.48). Similar trends were observed by neighbourhood deprivation. Children living in the most deprived neighbourhoods were exposed to alcohol marketing 19.4 (95% CI 12.4, 30.6) times per 10 hours, which was 74% (RR 1.74, 95% CI 0.99, 3.07) higher than children living in the least deprived neighbourhoods, albiet, not statistically significant e due to the confidence interval crossing the null. In both measures of deprivation, those in the highest stratum of deprivation experienced the highest rates of exposure, suggesting a considerable degree of collinearity between the variables. However, upon inspection using Stata's correlation function, the correlation between deprivation measures was 35%, well under the threshold for serious multi-collinearity problems (393).

Table 17: Univariate models showing the mean rate (per 10 hours, 95% CI, from negative binomial regression) of exposure to alcohol marketing and the differences (RR) by sociodemographic characteristics

Sociodemographic characteristics		Mean rate per 10 hours (95%CI)	Rate ratio (95%CI)	p value*
Total		12.4 (9.1, 17.1)		
Sex	*Female*	11.6 (7.0, 19.2)	1 (reference)	
	Male	13.4 (10.3, 17.4)	1.15 (0.71, 1.86)	0.541
Ethnicity	*NZE*	10.8 (6.2, 18.7)	1 (reference)	
	Māori	19.0 (13.0, 27.8)	1.76 (0.96, 3.23)	0.066
	Pacific	12.7 (7.1, 22.9)	1.18 (0.56, 2.49)	0.647
Household deprivation (NZiDep2006)	*Low*	12.3 (8.1, 18.6)	1 (reference)	
	Moderate	7.9 (5.9, 10.5)	0.64 (0.40, 1.01)	0.056
	High	18.5 (12.2, 27.9)	1.50 (0.91, 2.48)	0.116
Neighbourhood deprivation (NZDep2013)	*Low*	11.1 (7.4, 16.8)	1 (reference)	
	Moderate	10.2 (6.9, 14.9)	0.91 (0.61, 1.36)	0.639
	High	19.4 (12.4, 30.6)	1.74 (0.99, 3.07)	0.053

*p value for difference calculated using negative binomial regression, accounting for complex sampling strategy and participant observation time

Table 18 presents children's exposure to alcohol marketing by sociodemographic characteristics, mutually adjusting for sex, ethnicity and neighbourhood deprivation. Only the neighbourhood deprivation measure was included due to the data being more complete than household deprivation measures, and the established links between neighbourhood deprivation and alcohol-related outcomes (103, 299, 300). All estimates in the adjusted models are not statistically significant; however, results may be indicative of social patterning of exposure. Similar to the univariate model, Māori children had higher rates of exposure than NZE children, represented by a rate ratio of 1.54, but with broad confidence intervals (95% CI 0.81, 2.96). Children living in the most deprived neighbourhoods had rates of exposure 59% (RR 1.59, 95% CI 0.95, 2.66) higher than children in the least deprived neighbourhoods.

Table 18: Multivariable model (95% CI, from negative binomial regression) showing the differences (RR) in children's exposure to alcohol marketing by sociodemographic characteristics, mutually adjusted for sex, ethnicity and neighbourhood deprivation

Sociodemographic characteristics		Rate ratio (95% CI)	p value*
Sex	*Female*	1 (reference)	
	Male	1.20 (0.72, 2.01)	0.467
Ethnicity	*NZE*	1 (reference)	
	Māori	1.54 (0.81, 2.96)	0.174
	Pacific	1.03 (0.47, 2.28)	0.934
Neighbourhood	*Low*	1 (reference)	
deprivation	*Moderate*	0.87 (0.55, 1.37)	0.529
(NZDep2013)	*High*	1.59 (0.95, 2.66)	0.080

*p value for difference calculated using negative binomial regression, accounting for complex sampling strategy and participant observation time

Mean rates of exposure to alcohol marketing by place

Table 19 presents the results of children's exposure to alcohol marketing by place. The place with the highest rates of exposure was home, with a mean of 9.1 (95% CI 6.0, 13.8) exposures per 10 hours of total observation time. Over two-thirds of all exposures occurred within the home. The next highest place of exposure was at on-licence outlets, with a mean of 1.2 (95% CI 0.7, 1.9) exposures per 10 hours. The third most prevalent place of exposure to alcohol marketing was outside liquor store shop fronts, with a mean of 0.6 (95% CI 0.3 to 1.6) exposures per 10 hours. Sports venues produced a similar rate of exposure as liquor store shop fronts, with an average of 0.6 (95% CI 0.3 to 1.4) exposures per 10 hours. There were relatively few exposures to alcohol marketing at public spaces, in the street and at supermarket shop fronts. Consequently, public spaces and street were not included in further analyses investigating the sociodemographic differences in exposure by place. Supermarket shop front exposures were added to liquor store shop front exposures because they are similar exposures and are hereafter defined as off-licence shop front exposures [but not in Table 19].

Table 19: The mean rate of alcohol marketing exposures (per 10 hours, with 95% CI, from negative binomial regression) for total exposures and by place (with the total percentage share of all exposures)

Total/place	Rate per 10 hours (95% CI)	% of total
Total (any place)	12.4 (9.1, 17.0)	100
Place		
Home	9.1 (6.0, 13.8)	73.6
On-licence	1.2 (0.7, 1.9)	9.3
Liquor store shop front	0.6 (0.3, 1.6)	5.3
Sports venues	0.6 (0.3, 1.4)	4.9
Public spaces	0.5 (0.2, 1.6)	4.3
Street	0.2 (0.1, 0.4)	1.9
Supermarket shop front	0.1 (0.0, 0.6)	0.7

Table 20 presents the univariate rate ratios (with 95% CI, from negative binomial regression) of exposure by places, stratified by sex, ethnicity and neighbourhood deprivation. Māori children had 13.73 (95% CI 4.12, 45.83) times higher rates of exposure from off-licence shop fronts than NZE children. On average, Māori children were exposed to alcohol marketing at off-licence shop fronts nearly three times per 10 hours, whereas the exposure rate for NZE children was 0.2 times per 10 hours. Children living in higher neighbourhood deprivation (RR 5.73, 95%CI 1.58, 20.73) had higher rates of exposure from off-licence shop fronts than children living in the lowest stratum neighbourhood deprivation. Māori children were exposed 12.2 times (95% CI 1.10, 139.4) more to alcohol marketing at sports venues than NZE children. However, while the rate ratio is high, the confidence intervals are wide indicating statistical imprecision. No statistically significant differences in exposure to alcohol marketing from home or on-licence alcohol outlets were detected among sociodemographic groups. These univariate rates do not adjust for the potential confounding of other sociodemographic characteristics. In order to disentangle the trends occurring by sociodemographic characteristics, an adjusted multivariable model is required to account for potential confounding.

Table 21 presents the rate ratios from the univariate models displayed against the multivariable rate ratios (MV) (from negative binomial regression), mutually adjusted for sex, ethnicity and neighbourhood deprivation. Māori children still had significantly higher rates of exposure from off-licence shop fronts than NZE children (RR 13.56, 95% CI 3.84, 47.95), even when adjusting for the potential confounding by sex and neighbourhood deprivation. In contrast, exposure estimates from off-licence shop fronts by neighbourhood deprivation were substantially reduced when adjusting for sex and ethnicity (eg UV RR 5.73 to 2.29 MV RR), while confidence intervals broadened to the point that the results were no longer statistically significant. The shift in rate ratios observed in boys (UV RR 1.72 to MV RR 0.03) and Māori (UV RR 12.22 to MV RR 1379) children at sports venues suggest that, in this sample, girls and Māori children may visit sports venues more often, thus contributing to their higher rates of exposure at such places. However, the estimates for sports venues are very large with wide confidence intervals, suggesting the estimates are too imprecise to get a reliable measure.

Table 20: Univariate models showing the mean rate (per 10 hours, 95% CI, from negative binomial regression) of exposure to alcohol marketing by place and the differences (RR) by sociodemographic characteristics

Sociodemographic characteristics		Home		On-licence		Off-licence shop front		Sports venues	
		Mean rate	**Rate ratio**	**Mean rate**	**Rate ratio**	**Mean rate**	**Rate ratio**	**Mean rate**	**Rate ratio**
Sex ≠	*Female*	8.8 (4.6, 17.0)	1 (reference)	1.2 (0.7, 2.3)	1 (reference)	0.7 (0.3, 2.0)	1 (reference)	0.5 (0.1, 1.8)	1 (reference)
	Male	9.6 (7.0, 13.1)	1.09 (0.61, 1.96)	1.1 (0.6, 2.2)	0.90 (0.37, 2.20)	0.7 (0.2, 2.6)	1.02 (0.26, 3.96)	0.8 (0.8, 2.7)	1.72 (0.23, 13.05)
Ethnicity≠	*NZE*	8.6 (4.8, 15.6)	1 (reference)	1.1 (0.6, 1.9)	1 (reference)	0.2 (0.1, 0.4)	1 (reference)	0.2 (0.2, 1.6)	1 (reference)
	Māori	10.9 (6.5, 18.4)	1.26 (0.57, 2.78)	1.7 (0.6, 4.5)	1.62 (0.52, 5.04)	2.9 (1.2, 7.3)	13.73 *** (4.12, 45.83)	2.3 (0.7, 8.0)	12.22* (1.07, 139.4)
	Pacific	9.7 (4.3, 21.9)	1.13 (0.41, 3.07)	1.0 (0.3, 3.2)	0.90 (0.23, 3.50)	1.0 (0.1, 7.9)	4.85 (0.53, 44.36)	0.3 (0.04, 2.3)	1.63 (0.09, 29.63)
Neighbourhood	*Low*	8.4 (5.0, 13.8)	1 (reference)	1.2 (0.6, 2.5)	1 (reference)	0.3 (0.2, 0.7)	1 (reference)	0.6 (0.1, 2.7)	1 (reference)
deprivation≠	*Moderate*	7.1 (3.7, 13.8)	0.86 (0.44, 1.65)	0.8 (0.3, 2.2)	0.65 (0.17, 2.55)	0.7 (0.1, 5.3)	2.21 (0.46, 10.53)	0.6 (0.1, 3.8)	0.97 (0.82, 11.58)
(NZDep2013)	*High*	14.4 (8.4, 24.8)	1.73 (0.86, 3.48)	1.5 (0.7, 3.5)	1.24 (0.42, 3.68)	1.9 (0.6, 5.8)	5.73* (1.58, 20.73)	0.7 (0.2, 2.2)	1.17 (0.14, 9.73)

*p < 0.05, **p < 0.01, *** p < 0.001

≠ p value for difference calculated using negative binomial regression, accounting for complex sampling strategy and participant observation time

Table 21: Multivariable models (MV, 95% CI, from negative binomial regression) showing the differences (RR) in children's exposure to alcohol marketing by sociodemographic characteristics, mutually adjusted for sex, ethnicity and neighbourhood deprivation (displayed against the UV RR), stratified by place

Sociodemographic characteristics		Home		On-licence		Off-licence shop front		Sports venues	
		UV RR	MV RR	UV RR	MV RR	UV RR	MV RR	UV RR	MV RR
Sex≠	*Female*	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Male	1.09 (0.61, 1.96)	1.10 (0.63, 1.91)	0.90 (0.37, 2.20)	1.05 (0.47, 2.32)	1.02 (0.26, 3.96)	1.11 (0.64, 1.93)	1.72 (0.23-13.05)	0.03** (0.003,0.23)
Ethnicity≠	*NZE*	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Māori	1.26 (0.57, 2.78)	1.03 (0.47, 2.29)	1.62 (0.52, 5.04)	2.28 (0.65, 8.01)	13.73 *** (4.12, 45.8)	13.56*** (3.84, 48.0)	12.22* (1.07, 139.4)	1379.00 *** (33.47, 56816)
	Pacific	1.13 (0.41, 3.07)	0.91 (0.33, 2.52)	0.90 (0.23, 3.50)	1.48 (0.30, 7.32)	4.85 (0.53, 44.4)	3.12 (0.51, 19.1)	1.63 (0.09, 29.63)	7.45 (0.47, 118.93)
Neighbourhood	*Low*	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
deprivation≠	*Moderate*	0.86 (0.44, 1.65)	0.87 (0.46, 1.68)	0.65 (0.17, 2.55)	0.46 (0.08, 2.73)	2.21 (0.46, 10.5)	0.70 (0.21, 2.29)	0.97 (0.82, 11.58)	0.08** (0.02, 0.37)
(NZDep2013)	*High*	1.73 (0.86, 3.48)	1.77 (0.92, 3.42)	1.24 (0.42, 3.68)	0.73 (0.16, 3.28)	5.73* (1.58, 20.7)	2.29 (0.83, 6.32)	1.17 (0.14, 9.73)	0.14 (0.01, 2.02)

*p < 0.05, **p < 0.01, *** p < 0.001
≠ p value for difference calculated using negative binomial regression, accounting for complex sampling strategy and participant observation time

Mean rates of exposure to alcohol marketing by promotion type

The rate of exposure to alcohol marketing per 10 hours by promotion type is presented in Table 22. Product packaging was the most prevalent promotion type, with a mean of 7.7 (95% CI 4.5, 12.6) exposures per 10 hours, accounting for over 60% of all exposures. The second highest rate of exposure was through sports sponsorship, which contributed to 1.4 (95% CI 0.8, 2.6) exposures per 10 hours, over 10% of all exposures. Similarly, shop front signage (RR 1.4, 95% CI 0.8, 2.3) and merchandise (RR 1.1, 95% CI 0.5, 2.4) each contributed over one exposure per 10 hours, accounting for just under 20% of all exposures collectively. Collectively, the remaining four promotion types, that is, signs, print, screens and in-store displays, contributed to less than 7% of all exposures. Given the small number of exposures, these categories were not included in subsequent analyses of sociodemographic differences in alcohol marketing exposure by promotion type.

Table 22: The mean rate of alcohol marketing exposures (per 10 hours, with 95% CI, from negative binomial regression) for total exposures by promotion type (with the total percentage share of all exposures)

Total/promotion	Rate per 10 hours (95% CI)	% of total
Total (any promotion)	12.4 (9.1, 17.0)	100
Promotion type		
Product packaging	7.7 (4.5, 12.6)	61.9
Sports sponsorship	1.4 (0.8, 2.6)	11.4
Shop front signage	1.4 (0.8, 2.3)	11.4
Merchandise	1.1 (0.5, 2.4)	8.9
Signs	0.4 (0.1, 1.1)	3.0
Print	0.2 (0.04, 0.8)	1.5
Screens	0.2 (0.04, 0.5)	1.2
In-store displays	<0.1 (0.02, 0.3)	0.7

Table 23 displays the univariate negative binomial regression models demonstrating the association between sociodemographic characteristics and exposure to alcohol marketing by promotion type. No significant differences were detected for product packaging, however, there were much higher mean rates observed by NZE (mean rate 8.2 per 10 hours) than Pacific children (mean rate 5.2 per 10 hours), albeit too imprecise to be conclusive. Māori

(RR 4.13, 95% CI 1.12, 15.16) and Pacific children (RR 5.22, 95%CI 1.27, 21.41) had significantly higher rates of exposure via sports sponsorship than NZE children. In fact, Māori and Pacific children were exposed to alcohol marketing via sports sponsorship around three times per 10 hours, whereas there was less than one exposure for NZE children. Children living in the most deprived neighbourhoods had rates of exposure via sports sponsorship 3.58 times (95% CI 1.12, 11.47) higher than children from the least deprived neighbourhoods.

Māori children had 3.90 times (95% CI 1.51, 10.1) the rates of exposure via shop front signage than NZE children. This result is consistent with Māori children having higher rates of exposure outside off-licence shop fronts, for which shop front signage is the predominant promotion type. Māori children were exposed 6.03 times (95% CI 1.53, 23.83) more via merchandise than NZE children. Those living in the most deprived neighbourhoods were exposed via merchandise 6.46 (RR 6.46, 95% CI 1.30, 32.16) times more than children living in the least deprived neighbourhoods. In these univariate models, exposure appeared to be patterned by ethnicity and neighbourhood deprivation for a number of promotion types. Product packaging was the only promotion type for which no statistically significant differences were detected.

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Table 23: Univariate models showing the mean rate (per 10 hours, 95% CI, from negative binomial regression) of exposure to alcohol marketing by promotion type and the differences (RR) by sociodemographic characteristics

Sociodemographic characteristics		Product packaging		Sports sponsorship		Shop front signage		Merchandise	
		Mean rate	**Rate ratio**	**Mean rate**	**Rate ratio**	**Mean rate**	**Rate ratio**	**Mean rate**	**Rate ratio**
Sex≠	*Female*	8.0 (3.9, 16.3)	1 (reference)	0.8 (0.2, 3.1)	1 (reference)	1.4 (0.8, 2.4)	1 (reference)	0.6 (0.2, 1.8)	1 (reference)
	Male	7.5 (4.8, 11.8)	0.94 (0.47, 1.85)	2.0 (0.5, 1.9)	2.49 (0.54, 11.4)	1.4 (0.6, 3.3)	1.02 (0.38, 2.77)	1.6 (0.6, 4.5)	2.59 (0.59, 11.3)
Ethnicity≠	*NZE*	8.2 (4.3, 15.8)	1 (reference)	0.7 (0.4, 1.2)	1 (reference)	0.9 (0.5, 1.7)	1 (reference)	0.6 (0.2, 1.6)	1 (reference)
	Māori	7.9 (4.8, 13.1)	0.97 (0.43, 2.21)	2.8 (0.9, 8.8)	4.13* (1.12, 15.2)	3.5 (1.7, 7.4)	3.90* (1.51, 10.1)	3.6 (1.3, 10.1)	6.03* (1.53, 23.8)
	Pacific	5.2 (1.7, 15.5)	0.63 (0.18, 2.26)	3.5 (1.0, 12.6)	5.22* (1.27, 21.4)	1.3 (0.3, 6.6)	1.42 (0.25, 8.12)	0.6 (0.3, 1.6)	1.05 (0.29, 3.80)
Neighbourhood deprivation≠ (NZDep2013)	*Low*	7.6 (4.4, 13.2)	1 (reference)	1.0 (0.5, 2.1)	1 (reference)	1.1 (0.6, 2.3)	1 (reference)	0.6 (0.2, 1.6)	1 (reference)
	Moderate	7.2 (3.8, 13.5)	0.94 (0.54, 1.64)	0.8 (0.2, 3.2)	0.83 (0.17, 3.97)	0.9 (0.2, 3.8)	0.79 (0.16, 3.87)	0.4 (0.2, 0.7)	0.68 (0.19, 2.39)
	High	8.9 (4.6, 17.1)	1.16 (0.56, 2.42)	3.5 (1.4, 8.8)	3.58* (1.12, 11.5)	2.7 (1.2, 6.1)	2.36 (0.85, 6.58)	3.7 (1.2, 11.8)	6.46* (1.30, 32.2)

*p < 0.05

≠ p value for difference calculated using negative binomial regression, accounting for complex sampling strategy and participant observation time

Table 24 presents results from a multivariable negative binomial regression model showing children's exposure to alcohol marketing by promotion type, adjusting for sex, ethnicity and neighbourhood deprivation. Similar to the univariate model, there are no statistically significant differences in exposure via product packaging, and the estimates remain relatively unchanged. In contrast, the rate ratios for boys' compared to girls' exposure to alcohol marketing via sports sponsorship increased from 2.49 (95% CI 0.54, 11.4) to 5.07 (95% CI 1.82, 14.1) times higher after adjusting for ethnicity and neighbourhood deprivation. The higher rate ratios observed in Māori and Pacific children than NZE children via sports sponsorship in the univariate models (RR 4.13 and RR 5.22, $p < 0.05$) persist even when accounting for sex and neighbourhood deprivation (RR 3.44 and RR 5.49, $p < 0.05$). These results suggest that boys had higher rates of exposure via sports sponsorship than girls, even when adjusting for potential confounders. Likewise, Māori and Pacific children had higher rates of exposure via sports sponsorship than NZE children when adjusting for sex and neighbourhood deprivation.

Māori children had higher rates of exposure via shop front signage (RR 4.10, 95% CI 1.44, 11.7) and merchandise (RR 7.20, 95% CI 2.04, 25.40), when adjusting for sex and neighbourhood deprivation. Exposure estimates via sports sponsorship and merchandise by neighbourhood deprivation were substantially reduced in the multivariable models compared to the univariate models, with increasing amounts of imprecision represented by the widening confidence intervals. Therefore, sex and ethnicity appear to be confounding the associations detected by neighbourhood deprivation observed in the univariate models. In summary, exposure to alcohol marketing via all promotion types, except product packaging, appeared to be patterned by sociodemographic characteristics to some extent, with ethnicity being a particularly strong predictor of exposure via sports sponsorship, shop front signage and merchandise when accounting for sex and neighbourhood deprivation.

Table 24: Multivariable models (MV, 95% CI, from negative binomial regression) showing the differences (RR) in children's exposure to alcohol marketing by sociodemographic characteristics, mutually adjusted for sex, ethnicity and neighbourhood deprivation (displayed against the UV RR), stratified by promotion type

Sociodemographic characteristics		Product packaging		Sports sponsorship		Shop front signage		Merchandise	
		UV RR	MV RR	UV RR	MV RR	UV RR	MV RR	UV RR	MV RR
Sex≠	*Female*	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Male	0.94 (0.47, 1.85)	0.93 (0.48, 1.79)	2.49 (0.54, 11.4)	5.07** (1.82, 14.1)	1.02 (0.38, 2.77)	1.13 (0.41, 3.18)	2.59 (0.59, 11.3)	1.36 (0.21, 8.78)
Ethnicity≠	*NZE*	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Māori	0.97 (0.43, 2.21)	0.89 (0.38, 2.1)	4.13* (1.12, 15.2)	3.44* (1.03, 11.4)	3.90* (1.51, 10.1)	4.10* (1.44, 11.7)	6.03* (1.53, 23.8)	7.20** (2.04, 25.4)
	Pacific	0.63 (0.18, 2.26)	0.55 (0.14, 2.12)	5.22* (1.27, 21.4)	5.49* (1.29, 23.3)	1.42 (0.25, 8.12)	1.18 (0.27, 5.05)	1.05 (0.29, 3.80)	2.65 (0.35, 19.8)
Neighbourhood	*Low*	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
deprivation≠	*Moderate*	0.94 (0.54, 1.64)	1.01 (0.56, 1.84)	0.83 (0.17, 3.97)	0.71 (0.17, 3.03)	0.79 (0.16, 3.87)	0.49 (0.12, 1.99)	0.68 (0.19, 2.39)	0.19 (0.03, 1.04)
(NZDep2013)	*High*	1.16 (0.56, 2.42)	1.37 (0.64, 2.92)	3.58* (1.12, 11.5)	2.70 (0.71, 10.3)	2.36 (0.85, 6.58)	1.40 (0.46, 4.24)	6.46* (1.30, 32.2)	1.73 (0.34, 8.87)

* $p < 0.05$, ** $p < 0.01$

≠ p value for difference calculated using negative binomial regression, accounting for complex sampling strategy and participant observation time

7.4.3 *Mean rates of exposure to alcohol marketing: with product packaging and screen-based exposures excluded*

As presented in the previous section, product packaging contributed the most alcohol marketing exposures, but it is often not included in alcohol marketing exposure studies (191, 214). Furthermore, 90% of all product packaging exposures occurred at home, which might explain the high rates of exposure observed at home. The following section provides the mean rates of exposure to alcohol marketing using negative binomial regression models, excluding product packaging from the analyses. The reason for the additional analyses was twofold: 1) to examine how product packaging was influencing the overall results, particularly in relation to exposure by place, promotion type and sociodemographic characteristics; and 2) to enhance the comparability with previous alcohol marketing exposure studies. In addition to product packaging, screen-based exposures are excluded in the subsequent analyses. The Kids'Cam methodology could not accurately quantify children's exposure via screens due to poor screen resolution, camera positioning and lighting, that are discussed further in Chapter Nine. While screen-based exposures are excluded, a brief qualitative summary of exposures via screens is provided.

Mean rates of exposure to alcohol marketing, excluding product packaging and screen-based exposures

Table 25 presents the results of children's exposure to alcohol marketing from negative binomial regression models, mutually adjusted for sex, ethnicity and neighbourhood deprivation, with product packaging and screen-based exposures removed. Overall, children were exposed to alcohol marketing 4.5 (95% CI 3.3, 6.0) times per 10 hours. Boys had a significantly higher rate of exposure than girls (RR 1.96, 95% CI 1.60, 2.41) when adjusting for ethnicity and neighbourhood deprivation. Higher rates were also observed for Māori (RR 5.45, 95% CI 3.23, 9.20) and Pacific (RR 3.02, 95% CI 1.55, 5.86) children than NZE children. Māori children were exposed to alcohol marketing over 10 times (mean rate 10.5, 95% CI 7.0, 15.8) and Pacific children over six times (mean rate 6.7, 95% CI 3.7, 12.1) per 10 hours, whereas NZE children were exposed to alcohol marketing 2.5 times per 10 hours. The higher rates observed for Māori and Pacific children highlight how the previous inclusion of product packaging, which was predominantly seen by NZE children, was affecting the analyses of sociodemographic differences in overall exposure to alcohol marketing. Children living in moderately deprived neighbourhoods had significantly less (RR 0.38, 95%CI 0.21, 0.70) exposure to alcohol marketing than children living in the least deprived neighbourhoods.

Table 25: Multivariable model showing mean rates (per 10 hours, 95% CI, from negative binomial regression) and showing the differences (RR) in children's exposure to alcohol marketing by sociodemographic characteristics, mutually adjusted for sex, ethnicity and neighbourhood deprivation (excluding product packaging and screen-based exposures)

Sociodemographic characteristics		Mean rate per 10 hours (95%CI)	Rate ratio (95%CI)	p value*
Total		4.5 (3.3, 6.0)		
Sex	*Female*	3.3 (2.0, 5.2)	1 (reference)	
	Male	5.8 (4.0, 8.4)	1.96 (1.60, 2.41)	<0.001
Ethnicity	*NZE*	2.5 (1.8, 3.6)	1 (reference)	
	Māori	10.5 (7.0, 15.8)	5.45 (3.23, 9.20)	<0.001
	Pacific	6.7 (3.7, 12.1)	3.02 (1.55, 5.86)	0.003
Neighbourhood deprivation (NZDep2013)	*Low*	3.4 (2.6, 4.5)	1 (reference)	
	Moderate	2.7 (2.0, 3.7)	0.38 (0.21, 0.70)	0.004
	High	10.5 (5.8, 18.9)	1.37 (0.76, 2.47)	0.280

* p value for difference calculated using negative binomial regression, accounting for complex sampling strategy and participant observation time

Table 26 compares the mean rates and percentage share of exposure by place and promotion type, with product packaging and screen-based exposures both excluded and included. Home is still the predominant place of exposure (mean rate 2.1, 95% CI 1.2, 3.6), albeit with reduced total percentage share with the removal of product packaging (73.6% reduced to 47.4%). The remaining places maintain their positions from the previous results with product packaging included in the analysis, although with a higher proportion of the total percentage share of exposure due to the reductions in home exposures. Similar trends are observed by promotion type, with the order of most common exposures remaining unchanged. Sports sponsorship makes up 31.4% of all exposures, at a mean rate of 1.4 (95% CI 0.8, 2.6) per 10 hours with product packaging and screen-based exposures excluded. Sports sponsorship, shop front signage and merchandise, had relatively equal contributions to total exposure and collectively accounted for 86% of all exposures. The remaining 14% of exposures were by signs, print and in-store displays combined.

Table 26: Mean rate (per 10 hours, 95% CI, from negative binomial regression) and percentages of total exposure by place and promotion type, with a comparison between product packaging excluded and included

Total/place/promotion	Rate per 10 hours (95% CI)	% of total	% of total including product packaging and screens
Total (any place/promotion)	4.5 (3.3, 6.0)	100	36.2
Place			
Home	2.1 (1.2, 3.6)	47.4	73.6
On-licences	0.8 (0.5, 1.4)	18.7	9.3
Off-licence shop fronts	0.7 (0.3, 1.8)	16.0	6.1
Sports venues	0.5 (0.2, 1.4)	12.1	4.9
Public places	0.4 (0.1, 0.6)	5.8	6.1
Promotion			
Sports sponsorship	1.4 (0.8, 2.6)	31.4	11.4
Shop front signage	1.4 (0.8, 2.3)	30.1	11.4
Merchandise	1.0 (0.5, 2.4)	24.5	8.9
Signs	0.4 (0.1, 1.1)	8.2	3.0
Print	0.2 (0.04, 0.8)	4.0	1.5
In-store displays	0.1 (0.02, 0.3)	1.8	0.7
Product packaging	Excluded		61.9
Screens	Excluded		1.2

In Table 27, the results of alcohol marketing exposure by place, stratified by sociodemographic characteristics and mutually adjusted for sex, ethnicity and neighbourhood deprivation are presented. Boys had six times (RR 6.04, 95% CI 3.36, 10.8) more home exposures than girls. The higher rates of home exposures for boys are primarily driven by sports sponsorship (53.7% of all home exposures), as boys had higher rates of exposure via sports sponsorship than girls. Pacific children had 4.56 times (95% CI 1.44, 14.40) higher rates of exposure at home than NZE children. Māori children had a rate of exposure 13.60 (95% CI 3.84, 47.90) times higher from off-licence shop fronts than NZE children. Likewise, Māori children had higher rates of exposure from sports venues (RR 1044.0, 28.0, 39111.0) than NZE children. However, the estimates are so high and confidence intervals so broad that the precise level of this higher rate is very uncertain. Boys experienced significantly lower rates of exposure at sports venues than girls (RR 0.03, 95% CI 0.003, 0.22).

Table 28 displays children's exposure to alcohol marketing by promotion type without product packaging and screen-based exposures, mutually adjusted for sex, ethnicity and neighbourhood deprivation. Boys' exposure to alcohol marketing via sports sponsorship was five times (RR 5.07, 95% CI 1.82, 14.10) higher than for girls. Māori and Pacific children experienced three (RR 3.44, 95% CI 1.04, 11.40) and five (RR 5.49, 95% CI 1.29, 23.30) times higher rates of exposure via sports sponsorship than NZE children, respectively. Māori children experienced significantly higher rates of exposure via shop front signage (RR 4.10, 95%C CI 1.44, 11.66) and merchandise (RR 7.20, 95% CI 2.04, 25.41) than NZE children. Children living in the most deprived neighbourhoods had higher rates of exposure than children in the least deprived neighbourhoods across all promotion types, although results are imprecise with confidence intervals crossing the null.

Table 27: Multivariable models (95% CI, from negative binomial regression) showing the differences (RR) in children's exposure to alcohol marketing (excluding product packaging and screen-based exposures) by sociodemographic characteristics, mutually adjusted for sex, ethnicity and neighbourhood deprivation, stratified by place

Sociodemographic characteristics		**Home** **Rate ratio (95% CI)**	**On-licences** **Rate ratio (95% CI)**	**Off-licence shop fronts** **Rate ratio (95% CI)**	**Sports venues** **Rate ratio (95% CI)**
Sex≠	*Female*	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Male	6.04 (3.36, 10.80)***	0.82 (0.28, 2.44)	1.11 (0.64, 1.93)	0.03 (0.003, 0.22)**
Ethnicity≠	*NZE*	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Māori	2.60 (0.82, 8.23)	1.71 (0.49, 5.96)	13.6 (3.84, 47.90)***	1044.0 (28, 39111)***
	Pacific	4.56 (1.44, 14.40)*	0.43 (0.13, 1.39)	3.12 (0.51, 19.10)	12.63 (0.78, 204.86)
Neighbourhood	*Low*	1 (reference)	1 (reference)	1 (reference)	1 (reference)
deprivation≠	*Moderate*	0.76 (0.15, 3.81)	0.55 (0.08, 3.63)	0.70 (0.21, 2.29)	0.09 (0.19, 0.45)**
(NZDep2013)	*High*	3.63 (0.89, 14.80)	1.25 (0.24, 6.55)	2.29 (0.83, 6.32)	0.08 (0.01, 1.07

* p < 0.05, ** p < 0.01, *** p < 0.001

≠ p value for difference calculated using negative binomial regression, accounting for complex sampling strategy and participant observation time

Table 28: Multivariable models (95% CI, from negative binomial regression) showing the differences (RR) in children's exposure to alcohol marketing (excluding product packaging and screen-based exposures) by sociodemographic characteristics, mutually adjusted for sex, ethnicity and neighbourhood deprivation, stratified by promotion type

Sociodemographic characteristics		**Sports sponsorship RR (95% CI)**	**Shop front signage RR (95% CI)**	**Merchandise RR (95% CI)**
Sex≠	*Female*	1 (reference)	1 (reference)	1 (reference)
	Male	5.07 (1.82, 14.1)**	1.13 (0.41, 3.19)	1.36 (0.21, 8.78)
Ethnicity≠	*NZE*	1 (reference)	1 (reference)	1 (reference)
	Māori	3.44 (1.04, 11.4)*	4.10 (1.44, 11.66)*	7.20 (2.04, 25.41)**
	Pacific	5.49 (1.29, 23.3)*	1.18 (0.27, 5.05)	2.65 (0.35, 19.8)
Neighbourhood deprivation≠ (NZDep2013)	*Low*	1 (reference)	1 (reference)	1 (reference)
	Moderate	0.71 (0.17, 3.03)	0.49 (0.12, 1.99)	0.19 (0.03, 1.04)
	High	2.70 (0.71, 10.30)	1.40 (0.46, 4.24)	1.73 (0.34, 8.87)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

≠ p value for difference calculated using negative binomial regression, accounting for complex sampling strategy and participant observation time

7.4.4 Qualitative analysis of screen-based alcohol marketing exposures

The cameras often missed children's screen-based exposures to alcohol marketing, but the images in which alcohol marketing was observed provided useful information on the nature of screen-based exposures. Based on previous research, screen-based alcohol marketing is likely the most common exposure for children given their high screen use and the weak regulations that surround forms of screen-based alcohol marketing such as televised sports sponsorship, self-regulatory television codes and digital marketing via social media platforms (12, 214). As such, the following section focuses on this important form of promotion. To demonstrate the nature of children's exposure via screens, but not the extent of exposure, some specific examples of screen-based exposures are provided.

Exposure via digital marketing

Digital marketing is an increasingly important form of promotion for the alcohol industry, as tighter regulations are imposed on traditional forms of marketing such as television and outdoor marketing. One of the most common forms of digital alcohol marketing is on SNS such as Facebook, YouTube and Twitter. Figure 29 shows examples of digital alcohol marketing captured by participants via YouTube, a video sharing service that encourages and permits users to watch videos posted by other users and to upload videos. Figure 29, panel (A), is an example of a full-screen advertisement (for *Mr Beer*, a beer brewing kit) that plays before a user-selected video is permitted to play, a form of payment on the 'free' media platform. Figure 29, panel (B), is an example of a passive advertisement (for 1 Litre Vodka, an "UNREAL DEAL") that is visible for the duration of the video clip but can change from one product to another while the user-selected video plays. Figure 29, panel (C), is a banner advertisement (for the *Speights* beer brand's promotion for the ultimate man shed) that generally remains in the field of vision as a user scrolls through potential videos of interest in the search results.

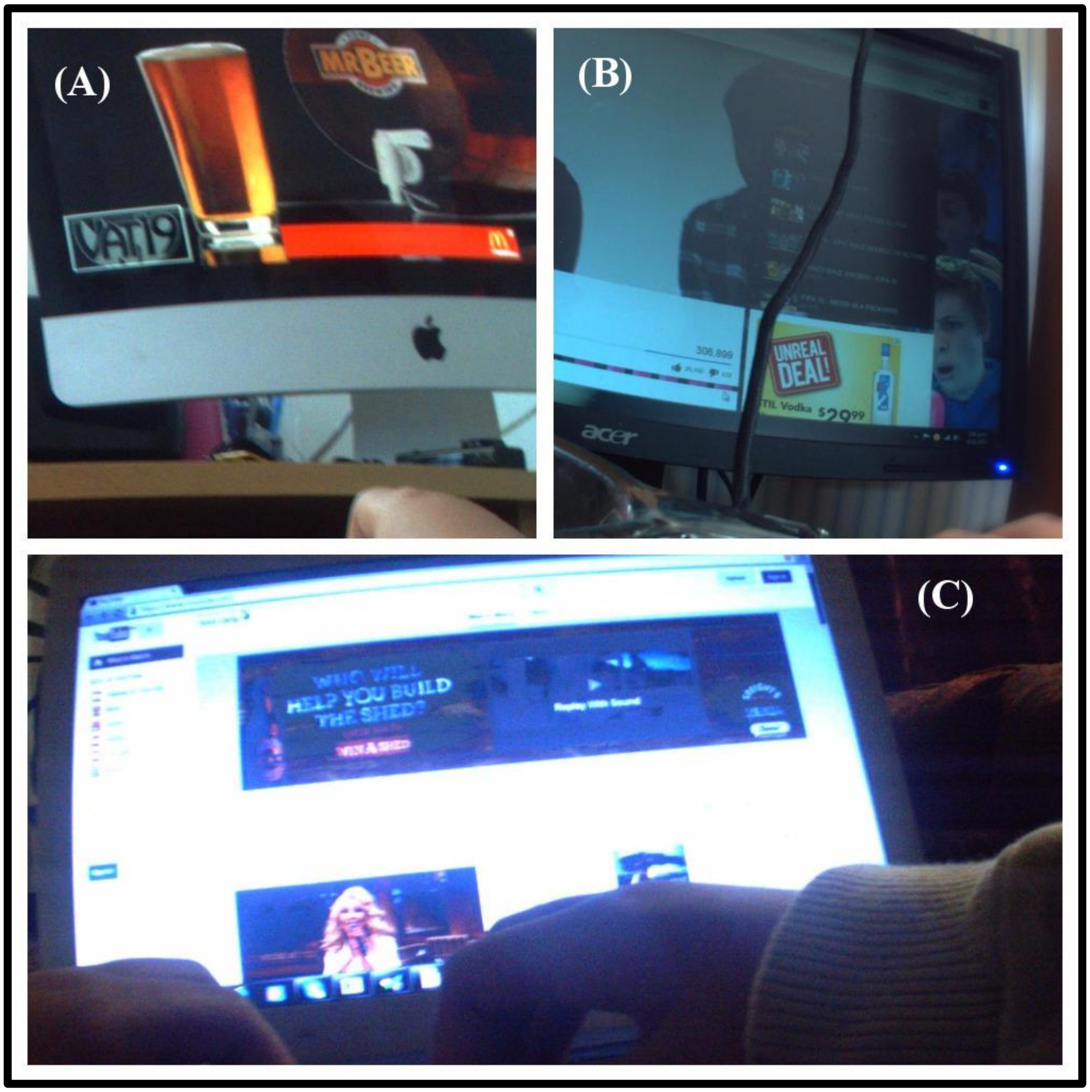


Figure 29: Examples of digital alcohol marketing exposure on a social media platform *YouTube*

Exposure via sports sponsorship of televised sport

Figure 30 presents examples of children's exposures on screens from alcohol companies' sports sponsorship. These exposures occurred at times that alcohol marketing is not permitted on television by the industry's self-regulatory codes. In Figure 30, panels (A) and (B) are examples of alcohol brands occupying the sports arena itself. In panel (A), *Miller Lite* (beer) branding occupies the fighting mat on which athletes from the Ultimate Fighting Championship compete, whereas, in panel (B), *Tui* (beer) occupies the sideline hoardings used to create a boundary of play for rugby matches. Figure 30 panel (C) is an example of an advert break buffer advertisement, quick promotional graphics that play before and after official advertising breaks but are still technically part of the sports broadcast. In this case, *Tui* (beer) is the sponsor of the rugby and has a short graphic played before and after the advertisement break that functions almost entirely as an official advertisement. Figure 30 panel (D) the beer brand, *Castle Lager,* is printed on the shirts of the South African cricket players enabling alcohol marketing in a sports event that had no major alcohol sponsor (2015 Cricket World Cup).

Figure 30: Examples of exposure to alcohol marketing on screens via sports sponsorship (see text for explanations)

Exposure via television advertisements

Figure 31 shows two examples of advertisements seen on television by children. Panel (A), *Tui* (beer), was an advertisement occurring after 8.30pm during a cricket broadcast on a Saturday night. Children frequently watch television after 8.30pm and generally watch large sporting events, which have more advertisements per hour than regular broadcast television (398). Panel (B), shows an advertisement for *Countdown* (supermarket chain), specifically an advertisement for alcohol, that was seen in the morning at a time not permitted by the self-regulatory codes. The image highlights a weakness of watershed times for marketing with the popularity and accessibility of on-demand television viewing that permits users to record television to watch later. For example, in panel (B) the advertisement may well have aired at the time permitted by the regulations, but was later viewed at a time not permitted.

Figure 31: Examples of exposure to television alcohol marketing, (A) *Tui* (B) *Countdown* (supermarket chain)

Exposure via games on screens

Another, less common, form of screen-based exposure observed was via games. Figure 32 demonstrates examples of a screen-based game that requires users to correctly name the brand displayed. In Figure 32 panel (A), the spirit *Jack Daniels* is the brand being displayed, and the user must type in the letters to correctly identify the brand. Likewise, in Figure 32 panel (B) *Bacardi* spirit brand is the brand being displayed, and the child is correctly entering the appropriate letters. These types of games are potentially more pervasive than traditional forms of marketing as they require user engagement and conflate the enjoyment of playing the game with the alcohol brand. The banner advertisements at the base of both panel (A) and (B) could also be used to promote alcohol brands such as those seen in Figure 29, but in this case, it displays advertisements for a music event and communications company.

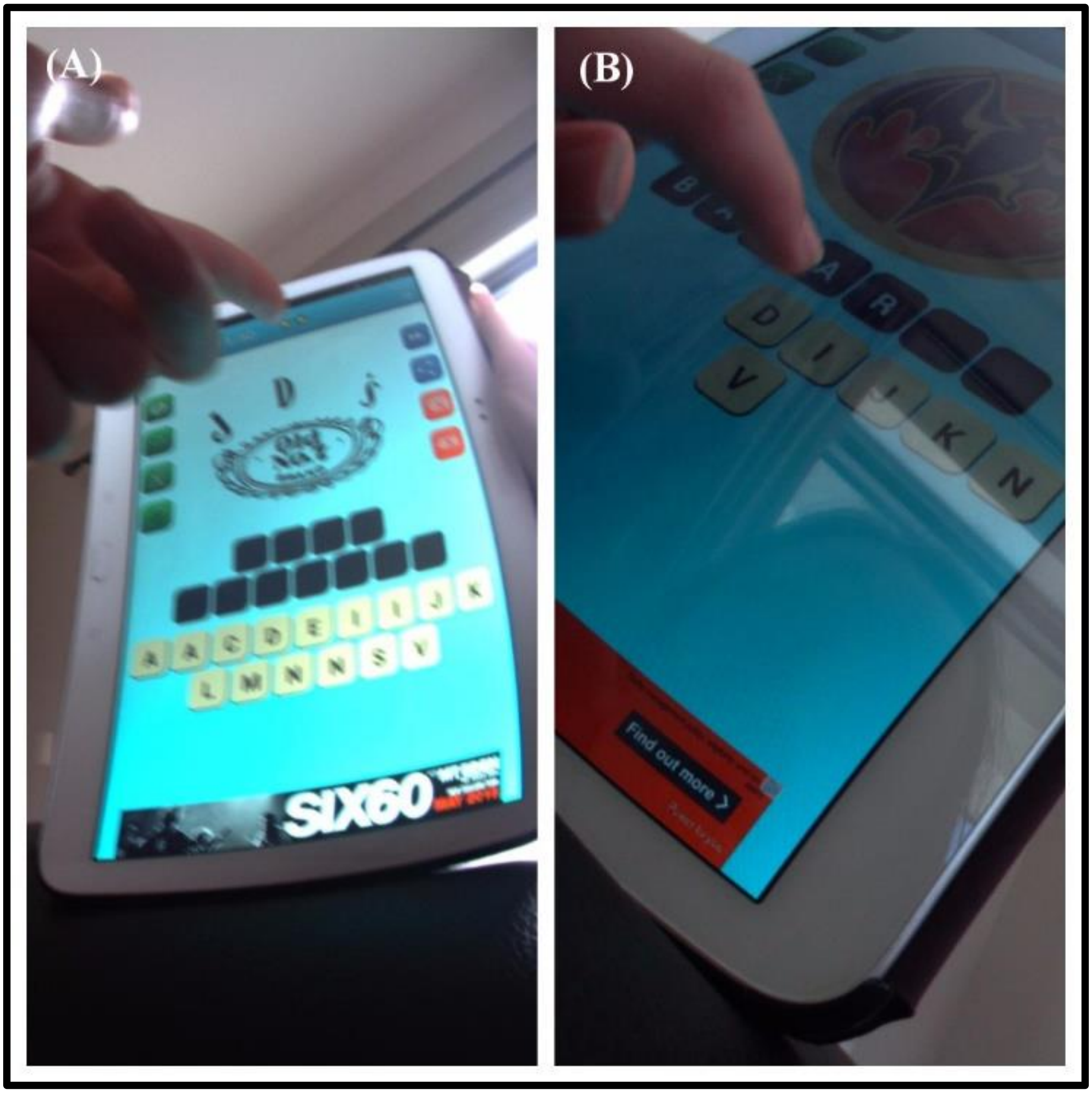


Figure 32: Examples of alcohol marketing on screen-based games

7.5 Marketing encounters

This section presents the results from children's exposure to alcohol marketing within off-licence alcohol outlets, previously defined as marketing encounters in Chapter Five. Further analysis using spatial data is reported in Chapter Eight. A large number of individual marketing exposures occurring within off-licence alcohol outlets influenced the decision to investigate these exposures as separate marketing encounters. The first results presented are marketing encounters by outlet type, with examples of marketing encounters captured by participants. Second, the median rates of marketing encounters are presented. The median rates provide an insight into the distribution and frequency of marketing encounters across the study sample. Third, the total number of encounters (from Poisson regression) and total time exposed per encounter, accounting for the complex sampling strategy and variations in observation time, are reported. Finally, rates of marketing encounters by sociodemographic characteristics are presented (from Poisson regression), mutually adjusted for sex, ethnicity and neighbourhood deprivation.

7.5.1 Exposure to alcohol marketing within alcohol outlets by outlet type

In total, there were 68 marketing encounters over the study period, all of which occurred within supermarkets (100%). Not one child was exposed to alcohol marketing within a liquor store. Consequently, off-licence outlets will now be referred to as supermarkets. As discussed in Chapters Three and Four, in 1989, NZ supermarkets were permitted to sell alcohol. Further, in 2012, the SSAA contained clauses to protect customers from undue exposure to alcohol marketing within NZ supermarkets.

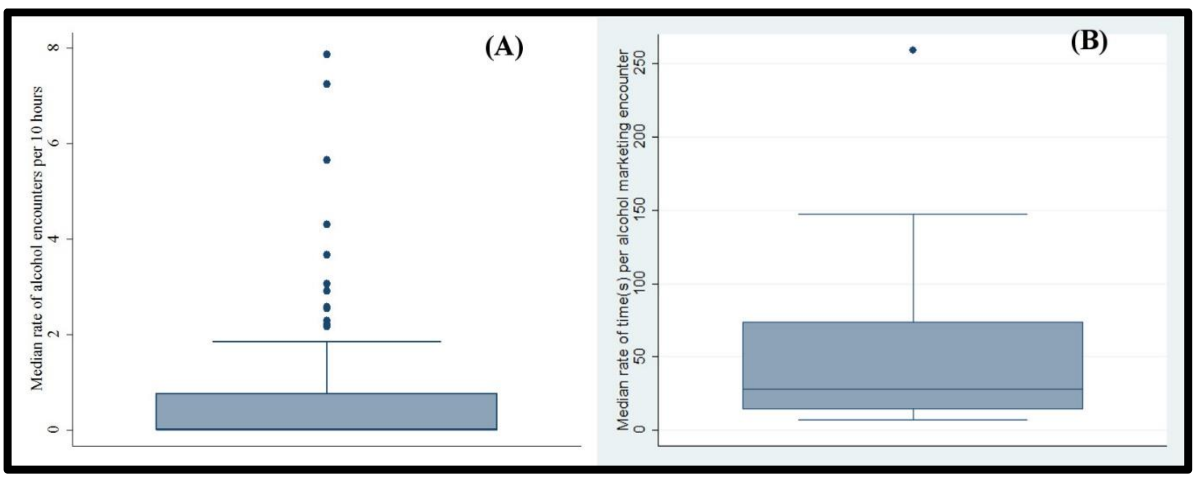
Figure 33 shows examples of children's exposure to alcohol marketing within supermarkets captured by participants. The examples presented here include three different supermarket chains visited by children throughout the study. In Figure 33 panel (A), a child moves through the designated alcohol area unsupervised with two 12 packs of alcohol in their trolley. In Figure 33 panel (B) a child is with an adult and friend/sibling in the alcohol area. The child in Figure 33 panel (C) is passing by the alcohol area as they browse the frozen goods section, typically the closest aisle to the alcohol area in most supermarkets observed. Figure 33 panel (D) is taken at an independent supermarket. The layout is much more constrained, leading to alcohol being located close to the entry/exit and appearing as another everyday consumer product, such as those adjacent to it. Exposures differed between the direct exposure observed in Figure 33 panels (A) and (B), where children actively engaged in the alcohol area, and the indirect form of exposure seen in Figure 33 panel (C) and (D), where children's exposure was more circumstantial as they shopped for other products located close to the alcohol area.

Figure 33: Examples of exposure to alcohol marketing within supermarkets (see main text for explanations)

7.5.2 *Median rates of exposure to alcohol marketing within supermarkets*

The median rate of exposure to alcohol marketing within supermarkets was 0.0 (IQR 0, 0.8) per 10 hours (Figure 34, A). As noted earlier, 10 hours is children's out of school time, not per 10 hours spent within supermarkets. Over 50% of the sample were not exposed to alcohol marketing within a supermarket during the study period. The upper quartile value shows that at least 25% of children were exposed to alcohol marketing for a minimum of 0.8 times per 10 hours. The highest rate of exposure was 68.6 encounters per 10 hours observed by one child, which has been excluded from Figure 34 (A) to preserve the detail in the figure. These results highlight the skewed distribution of the exposure data towards zero. However, children who were exposed to alcohol marketing within supermarkets appeared to be exposed frequently, almost once per 10 hours.

Figure 34 (B) shows that the median rate of time spent exposed to alcohol marketing was 28 seconds (IQR 14, 74) per marketing encounter, for those children who had a marketing encounter over the study period. There was only one outlier, with a value over 250 seconds per encounter. Apart from this value, time spent exposed per marketing encounter was more normally distributed and with fewer outliers than the marketing encounters themselves.



*One outlier was removed from (A) with a value of 68.6 to preserve the detail in the figure

Figure 34: Median rates, with IQR (shaded area), of marketing encounters within supermarkets per 10 hours (A) and seconds exposed per marketing encounter (B)

7.5.3 *Mean rates of exposure to alcohol marketing within supermarkets*

Table 29 displays the results from Poisson regression showing the mean rate of marketing encounters within supermarkets per 10 hours, by sociodemographic characteristics. Poisson regression models were used due to model fit tests indicating they were better positioned to explain the data than negative binomial regression models. The mean rate of exposure was 0.5 (95% CI 0.3, 0.7) marketing encounters per 10 hours. There were no statistically significant differences detected by sociodemographic characteristics. The lack of differences detected by sociodemographic characteristics may highlight that this current alcohol-related study was underpowered.

Table 29: Univariate models showing the mean rate (per 10 hours, 95% CI, from Poisson regression) of marketing encounters and the differences (RR) by sociodemographic characteristics

Sociodemographic characteristics		Mean rate per 10 hours	Rate ratio (95%CI)	p value*
Total		0.5 (0.3, 0.7)		
Sex	*Male*	0.4 (0.3, 0.7)	1 (reference)	
	Female	0.5 (0.3, 0.8)	1.16 (0.91, 1.49)	0.221
Ethnicity	*NZE*	0.4 (0.3, 0.7)	1 (reference)	
	Māori	0.5 (0.3, 0.8)	1.17 (0.60, 2.29)	0.628
	Pacific	0.7 (0.4, 1.3)	1.64 (0.72, 3.71)	0.223
Neighbourhood deprivation (NZDep2013)	*Low*	0.5 (0.3, 0.8)	1 (reference)	
	Moderate	0.3 (0.1, 0.6)	0.57 (0.28, 1.13)	0.100
	High	0.6 (0.4, 1.1)	1.24 (0.66, 2.28)	0.479

* p value for difference calculated using Poisson regression, accounting for complex sampling strategy and participant observation time

In Table 30, the rate ratios for children's exposure to alcohol marketing encounters, mutually adjusted for sex, ethnicity and neighbourhood deprivation are presented. The adjusted estimates are relatively unchanged from the univariate estimates, suggesting there is little confounding by sociodemographic characteristics.

Table 30: Multivariable models (MV, 95% CI, from Poisson regression) showing the differences (RR) in children's marketing encounters by sociodemographic characteristics, mutually adjusted for sex, ethnicity and neighbourhood deprivation (displayed against the UV RR)

Sociodemographic characteristics		UV RR (95% CI)	p value*	MV RR (95% CI)	p value*
Sex	*Male*	1 (reference)		1 (reference)	
	Female	1.16 (0.91, 1.49)	0.221	1.12 (0.81, 1.56)	0.466
Ethnicity	*NZE*	1 (reference)		1 (reference)	
	Māori	1.17 (0.60, 2.29)	0.628	1.23 (0.65, 2.34)	0.501
	Pacific	1.64 (0.72, 3.71)	0.223	1.63 (0.77, 3.42)	0.187
Neighbourhood	*Low*	1 (reference)		1 (reference)	
deprivation	*Moderate*	0.57 (0.28, 1.13)	0.100	0.54 (0.27, 1.07)	0.073
(NZDep2013)	*High*	1.24 (0.66, 2.28)	0.479	1.08 (0.61, 1.90)	0.777

* p value for difference calculated using Poisson regression, accounting for complex sampling strategy and participant observation time

7.5.4 Mean extent of time exposed per supermarket marketing encounter

Table 31 reports the average time spent exposed to alcohol marketing per marketing encounter, stratified by sociodemographic characteristics. These analyses were only conducted with participants who had at least one marketing encounter. The mean duration of a marketing encounter was 53 seconds (SD=59). The large standard deviation compared to the mean demonstrates that there was a considerable degree of variability in the time exposed per encounter. As such, the Kruskal-Wallis equality-of-population rank test was used to detect any differences between sociodemographic groups. No significant differences by sociodemographic characteristics were detected in these analyses. A combination of the considerable variability in exposure data (indicated by the large standard deviations) and analyses being underpowered (only 52 children had marketing encounters) may have contributed to the null findings by sociodemographic characteristics.

Table 31: The mean extent of time exposed to alcohol marketing per marketing encounter by sociodemographic characteristics

Sociodemographic characteristics		Mean extent per encounter, s (SD)	p value*
Total		53 (59)	
Sex	*Female*	29 (24)	
	Male	77 (73)	0.303
Ethnicity	*NZE*	61 (65)	
	Māori	21 (17)	
	Pacific	37 (29)	0.176
Neighbourhood deprivation (NZDep2013)	*Low*	66 (68)	
	Moderate	38 (31)	
	High	28 (23)	0.959

* p value for difference calculated using Kruskal-Wallis equality-of-populations rank test, accounting for complex sampling strategy

7.5.5 Supervision status

As outlined in Chapter Five and further in Appendix 2, during every alcohol marketing exposure, images were also coded for the presence of a supervising adult. During children's alcohol marketing encounters (n=68), children were supervised by an adult on 52 (76%) of them. Children were unsupervised on 24% of these marketing encounters, suggesting children's exposure to alcohol marketing at supermarkets is not merely a by-product of their parents' consumer behaviour, for example, purchasing alcohol.

7.6 Conclusion

In summary, this chapter has presented the results of the content analysis of image data from 167 children aged 11-13, to answer the central research question of this thesis "What is the extent and nature of children's real-time exposure to alcohol marketing?" On average, children were exposed to alcohol marketing at 12.4 times per 10 hours. However, this finding does not include alcohol marketing within off-licence alcohol outlets nor does it sufficiently account for screen-based exposures.

This chapter also provided a breakdown of where and how children were being exposed to alcohol marketing, that is, the nature of their exposure. The majority of exposures occurred within the home, followed by on-licence alcohol outlets, sports venues and off-licence shop fronts. The majority of exposures occurred via product packaging, followed by sports sponsorship and shop front signage. The sociodemographic differences in children's exposure by place and promotion type highlight areas that policy, with a health equity focus, could be implemented. For example, Māori and Pacific children were exposed to alcohol marketing more often through sports sponsorship than their NZE counterparts. Determining the nature of children's exposure highlights possible areas to intervene in order to reduce children's exposure to alcohol marketing.

A large number of exposures via product packaging and limited capacity of the cameras to accurately quantify screen-based exposures prompted a secondary analysis with these two promotion types excluded. The analysis revealed children had 4.5 exposures per 10 hours and that there were stark sociodemographic differences in exposure by overall exposure, place and promotion type. For example, without product packaging, boys had significantly higher rates of exposure than girls, while Māori and Pacific children had significantly higher rates than NZE children. The removal of product packaging enhances the comparability of the results to previous studies (214), which do not include product packaging, and in this current study, enabled a closer examination of sociodemographic differences in exposure. While the cameras failed to quantify screen-based exposures they did provide useful qualitative insights into the nature of screen-based exposures. The cameras indicatedthat children were exposed to alcohol marketing on screens through digital marketing, televised sports sponsorship, television advertisements and via games.

The content analyses also revealed that children were exposed frequently to intense periods of alcohol marketing exposure within supermarkets. In contrast, not one child visited a liquor store over the study period, thus there were no exposures occurring within liquor stores. On average, children encountered alcohol marketing within supermarkets three times per week, lasting for an average of 53 seconds per encounter. The univariate and multivariable models failed to detect any significant differences in exposure to alcohol marketing within supermarkets based on sociodemographic characteristics.

This chapter provides a relatively comprehensive and real-time account of children's exposure to alcohol marketing. Moreover, it has highlighted areas in which to act to reduce children's exposure to alcohol marketing, namely the removal of alcohol sponsorship of sports, regulation of product packaging and further restrictions on alcohol outlets' promotion of alcohol discussed in Chapter Nine. While this chapter provides strong evidence for the extent and nature of children's exposure to alcohol marketing, there are still aspects of their exposure that cannot be explained based only on analysis of image data. The spatial dynamics of children's exposure may provide further explanation of the nature of their exposure, such as spatial relationships between their movement patterns, the built environment and neighbourhood features. The next chapter seeks to answer the research questions focused on the spatial relationships that may be influencing children's exposure to alcohol marketing.

CHAPTER EIGHT: RESULTS - SPATIAL ANALYSES

8.1 Introduction

This chapter presents the spatial analysis of children's exposure to alcohol marketing in their neighbourhoods and within supermarkets. Using a combination of linked image and GPS data, and GIS, the spatial results aim to answer the research questions:

- What factors predict children's exposure to alcohol marketing in their residential and school neighbourhoods?
- What is the frequency, duration and nature of children's exposure to alcohol marketing within off-licence alcohol outlets?

First, this chapter presents the results of children's exposure to alcohol marketing in their residential and school neighbourhoods. The neighbourhood results highlight spatial inequalities that cannot be captured through the content analysis results alone. Second, the results from a micro-spatial analysis of children's exposure to alcohol marketing within supermarkets are provided. The micro-spatial analysis results support the marketing encounter results presented in Chapter Seven, by highlighting the extent and nature of children's exposure to alcohol marketing within supermarkets.

8.2 Children's neighbourhood exposure to alcohol marketing

This section presents the results of the children's exposure to alcohol marketing in their residential and school neighbourhoods. Based on the PSNB results presented in Chapter Six, residential neighbourhood extent is defined by a 500m buffer around the children's primary residence. Based on alcohol control policies in NZ, a 500m buffer was also used in this study for the school neighbourhood extent. Negative binomial regression models account for the complex sampling strategy and variations in observation time. First, results of alcohol availability, including alcohol outlet density and proximity, in children's residential neighbourhoods are presented. As discussed in Chapter Five, alcohol availability measures were calculated using the MoJ registry of alcohol outlets.

As previous studies demonstrate differences in the impact of particular licence types, for alcohol availability measures, outlets are analysed as all licences combined, and separated into on- and off-licences. Second, neighbourhood exposure (excluding exposures within the primary residence) to alcohol marketing is analysed using alcohol availability measures and sociodemographic characteristics. Third, negative binomial regression models mutually adjusted for alcohol availability, sex, ethnicity and neighbourhood deprivation examine neighbourhood predictors of children's exposure to alcohol marketing. Finally, results of the school neighbourhood are presented in the same analytical order as for the residential neighbourhood.

8.2.1 Residential neighbourhood exposure to alcohol marketing

Residential neighbourhood alcohol availability

The number of alcohol outlets within each child's home neighbourhood was summed to calculate outlet density (per km^2) and the distance from the home to the nearest outlet (in metres) calculated for outlet proximity. Table 32 presents the descriptive statistics of children's neighbourhood outlet density and proximity. On average, children had 4.0 alcohol outlets per km^2, or 2.2 outlets within their residential neighbourhood. Within children's neighbourhoods, 23% of outlets were off-licences, and 77% were on-licences. Outlet density measures ranged from a maximum of 53.5 outlets per km^2 in one child's neighbourhood to zero outlets in 49% of children's neighbourhoods. The minimum distance to the nearest alcohol outlet was 10m, while the maximum distance to the nearest outlet was over 3,000m (for one child). On-licences were closer to children's homes, with the average distance to the nearest on-licence of 685m (SD = 464), whereas for the nearest off-licence it was 860m (SD = 707). Despite a 3:1 ratio in the total number of on- compared to off-licence outlets, there were more children with an off-licence outlet within 500m of home (n = 63) than an on-licence outlet (n = 61).

Table 32: Residential neighbourhood alcohol outlet density and proximity, descriptive statistics

Alcohol availability measures*		Min and max	Mean	SD
Outlet density, km^2 (count within 500m of home)	*All licences*	0 to 53.5 (0 to 42)	4.0 (2.2)	9.7 (5.2)
	On-licences	0 to 47.1 (0 to 37)	3.1 (1.6)	8.5 (4.5)
	Off-licences	0 to 6.4 (0 to 5)	0.9 (0.6)	1.4 (5.2)
Outlet proximity, m	*All licences*	10 to 3,080	558	389
	On-licences	10 to 3,080	685	464
	Off-licences	60 to 5,091	860	707
Alcohol availability measures		**n**		
Count of participants by nearest outlet, n	*All licences +500m*	80		
	250m-499m	43		
	0m-249m	39		
	On-licences +500m	101		
	250m-499m	31		
	0m-249m	30		
	Off-licences +500m	99		
	250m-499m	42		
	0m-249m	21		

*Measured using Euclidean distance

Table 33 presents the differences in residential neighbourhood alcohol outlet density and proximity by sociodemographic characteristics. On average, boys (521m) lived closer to an on-licence alcohol outlet than girls (708m) ($p < 0.001$). Boys also lived in areas of higher density of on-licence alcohol outlets than girls, on average, 3.9 on-licence outlets per km² and 2.5 per km² ($p = 0.022$), respectively. There were no statistically significant differences by ethnicity, although NZE children had on average 5.1 alcohol outlets per km², and Māori and Pacific children had 2.2 and 1.6 per km², respectively. Children living in the least (596m) and moderately (559m) deprived neighbourhoods lived closer to on-licence outlets than children in the most deprived neighbourhoods (741m) (p 0.041). However, the pattern was reversed for off-licence outlets, with children living in the most deprived neighbourhoods (603m) living closer to an off-licence outlet than children in the least deprived neighbourhoods (959m) ($p = 0.004$).

Table 33: Differences in residential neighbourhood outlet density (n per km^2) and proximity (m to nearest outlet) by sociodemographic characteristics

Sociodemographic characteristics		Outlet density (n per km^2) All licences	On-licences	Off-licences	Outlet proximity (m) All licences	On-licences	Off-licences
Sex, mean°	*Female*	3.2	2.5	0.7	572	708	931
	Male	4.8	3.9	1.0	489	521	828
	p value	(0.059)	(0.022)*	(0.296)	(0.060)	(<0.001)*	(0.263)
Ethnicity, mean±	*NZE*	5.1	4.1	0.9	509	557	880
	Māori	2.2	1.5	0.7	601	680	959
	Pacific	1.6	0.9	0.7	540	676	778
	p value	(0.831)	(0.421)	(0.980)	(0.559)	(0.345)	(0.800)
Neighbourhood deprivation, mean± (NZDep2013)	*Low*	2.4	1.8	0.6	571	596	959
	Moderate	7.0	6.0	1.0	513	559	948
	High	3.7	2.5	1.2	416	741	603
	p value	(0.770)	(0.500)	(0.075)	(0.354)	(0.041)*	(0.004)*

° p value for difference calculated using Mann-Whitney U-Test, accounting for complex sampling strategy
± p value for difference calculated using Kruskal-Wallis Equality-of-Populations Rank Test, accounting for complex sampling strategy
*Statistically significant differences at the p < 0.05 level or greater

Unadjusted models

This section presents the results from negative binomial regression models that examine the influence of alcohol availability measures or sociodemographic characteristics on children's residential neighbourhood exposure to alcohol marketing. Table 34 presents the results from unadjusted negative binomial regression models examining the impact of potential predictors on children's exposure to alcohol marketing in their residential neighbourhood. Interestingly, the higher density of on-licence outlets (RR 0.87, 95% CI 0.78, 0.97) was associated with lower exposure to alcohol marketing. While not statistically significant, the upper range of the 95% CI for off-licence outlet density (2.03) suggests the effect of outlet density on alcohol marketing exposure may differ by outlet type.

Of all neighbourhood exposures, 28% occurred at off-licence outlets and 32% at on-licence outlets. Accounting for the unequal distribution of alcohol outlets (23% off-licence, 77% on-licence), off-licence outlets are more likely sites of alcohol marketing exposure than on-licence outlets. This is reinforced by the association between decreased off-licence outlet proximity and increased exposure to alcohol marketing (RR 0.83, 95% CI 0.74, 0.91). That is, for every 100m increase in the distance to the nearest off-licence alcohol outlet, there was an expected decrease, of 17%, in children's exposure to alcohol marketing in their neighbourhoods. The proximity variable using incremental concentric residential buffers shows that children with an off-licence outlet within 250m of the home had five times (RR 5.79, 95% CI 0.93, 36.02) higher rates of exposure to alcohol marketing in their neighbourhood than children without an off-licence outlet within 500m of home. While not statistically significant, the high rate ratios and the upper limit of the confidence interval suggest off-licence alcohol outlets may play an important role in children's neighbourhood exposure to alcohol marketing.

Māori children were 7.9 times more likely to be exposed to alcohol marketing in their residential neighbourhood than NZE children (RR 7.92, 95% CI 1.79, 35.08). Children living in neighbourhoods of the highest deprivation had 3.3 times higher rates of exposure than children living in the lowest stratum of neighbourhood deprivation (RR 3.28, 95% CI 1.01, 10.63). There were no significant associations detected by sex, on-licence outlet proximity or off-licence outlet density. These results show that Māori children, children living in neighbourhoods of higher deprivation and children living near off-licence outlets had higher rates of neighbourhood exposure to alcohol marketing than their NZE or less deprived counterparts.

Table 34: Univariate models (with 95% CI, from negative binomial regression) of potential predictors of exposure to alcohol marketing in the residential neighbourhood

Predictors		Rate ratio (95% CI)		p value‡
Outlet density (n per km^2)	*All licences*	0.91	(0.84, 0.98)	0.012*
	On-licences	0.87	(0.78, 0.97)	0.018*
	Off-licences	0.99	(0.49, 2.03)	0.980
Outlet proximity (per 100m increments)	*All licences*	0.86	(0.76, 0.97)	0.016*
	On-licences	1.04	(0.90, 1.19)	0.608
	Off-licences	0.83	(0.74, 0.91)	0.001***
Outlet proximity (incremental concentric buffers)	*All licences +500m*	1(reference)		
	250m-499m	0.69	(0.15, 3.22)	0.628
	0m-249m	2.79	(0.56, 14.02)	0.198
	On-licences +500m	1(reference)		
	250m-499m	0.47	(0.12, 1.81)	0.255
	0m-249m	0.58	(0.16, 2.09)	0.389
	Off-licences +500m	1 (reference)		
	250m-499m	0.78	(0.15, 4.03)	0.753
	0m-249m	5.79	(0.93, 36.02)	0.059
Sex	*Female*	1 (reference)		
	Male	1.61	(0.61, 4.24)	0.315
Ethnicity	*NZE*	1 (reference)		
	Māori	7.92	(1.79, 35.08)	0.009**
	Pacific	2.27	(0.35, 14.82)	0.369
Neighbourhood deprivation (NZDep2013)	*Low*	1 (reference)		
	Moderate	1.23	0.11, 13.09	0.858
	High	3.28	1.01, 10.63	0.048*

* p < 0.05 ** p < 0.01 *** p < 0.001
‡ p value for difference calculated using negative binomial regression, accounting for complex sampling strategy and participant observation time

Adjusted models

Multivariable negative binomial regression models determine the impact of alcohol availability measures and/or sociodemographic characteristics on children's neighbourhood alcohol marketing exposure, with adjustments for potential confounding variables (sex, ethnicity, neighbourhood deprivation and alcohol availability) (Table 35). For every 100m increase in the distance to the nearest off-licence alcohol outlet there was an expected decrease, of 13%, in children's neighbourhood exposure to alcohol marketing, when accounting for sex, ethnicity and neighbourhood deprivation (RR 0.87, 95% CI 0.78, 0.97). The associations observed for on-licence outlet density in the univariate model did not persist in adjusted models.

In every adjusted model, boys had higher rates of neighbourhood exposure to alcohol marketing than girls, when adjusted for ethnicity, neighbourhood deprivation and alcohol availability. For example, boys had rates of exposure three times (RR 2.99, 95% CI 1.39, 6.43) higher than girls when adjusted for off-licence alcohol outlet proximity, ethnicity and neighbourhood deprivation. Māori children had 14.75 times (95% CI 5.61, 38.82) higher rates of neighbourhood exposure to alcohol marketing than NZE children when adjusted for sex, neighbourhood deprivation and off-licence outlet proximity. Pacific children also had higher rates of exposure than NZE children (RR 5.21, 95% CI 1.20, 24.97) when adjusting for off-licence alcohol outlet proximity, sex and neighbourhood deprivation. The positive association between neighbourhood deprivation and alcohol marketing exposure observed in the unadjusted models disappeared after adjustment for alcohol availability, sex and ethnicity.

Table 35: Multivariable models (with 95% CI, from negative binomial regression) of potential predictors of alcohol marketing exposure in the residential neighbourhood, mutually adjusted for alcohol availability, sex, ethnicity and neighbourhood deprivation

Potential predictors		**Rate ratio (95% CI) All licences**		**Rate ratio (95% CI) On-licences**		**Rate ratio (95% CI) Off-licences**	
Outlet density‡	*N per Km²*	0.96	(0.87, 1.04)	0.94	(0.84, 1.05)	0.94	(0.54, 1.67)
Sex‡	*Female*	1 (reference)		1 (reference)		1 (reference)	
	Male	2.57	(1.37, 4.82)**	2.53	(1.38, 4.37)**	2.86	(1.38, 5.90)**
Ethnicity‡	*NZE*	1 (reference)		1 (reference)		1 (reference)	
	Māori	16.86	(5.17, 55.00)***	16.25	(5.12, 51.57)***	20.55	(6.08, 69.42)***
	Pacific	4.14	(0.90, 18.93)	4.12	(0.91, 18.79)	4.86	(1.01, 23.42)*
Neighbourhood	*Low*	1 (reference)		1 (reference)		1 (reference)	
deprivation‡	*Moderate*	0.26	(0.05, 1.53)	0.26	(0.04, 1.51)	0.24	(0.05, 1.23)
(NZDep2013)	*High*	1.26	(0.29, 5.56)	1.20	(0.28, 5.21)	1.23	(0.32, 4.71)
Potential predictors		**Rate ratio (95% CI) All licences**		**Rate ratio (95% CI) On-licences**		**Rate ratio (95% CI) Off-licences**	
Outlet proximity‡	*Per 100m increment*	0.87	(0.74, 1.03)	0.95	(0.79, 1.38)	0.87	(0.78, 0.97)*
Sex‡	*Female*	1 (reference)		1 (reference)		1 (reference)	
	Male	3.20	(1.46, 7.05)**	3.17	(1.53, 6.58)**	2.99	(1.39, 6.43)**
Ethnicity‡	*NZE*	1 (reference)		1 (reference)		1 (reference)	
	Māori	20.24	(6.84,59.86)***	22.60	(5.98, 85.42)***	14.75	(5.61, 38.82)***
	Pacific	6.24	(1.48, 26.25)*	5.42	(1.18, 24.85)*	5.41	(1.20, 24.97)*
Neighbourhood	*Low*	1 (reference)		1 (reference)		1 (reference)	
deprivation‡	*Moderate*	0.21	(0.05, 0.94)	0.23	(0.04, 1.13)	0.23	(0.05, 1.03)
(NZDep2013)	*High*	0.83	(0.26, 2.70)	1.16	(0.26, 5.14)	0.83	(0.23, 2.96)

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

‡ p value for difference calculated using negative binomial regression, accounting for complex sampling strategy and participant observation time

8.2.2 School neighbourhood exposure to alcohol marketing

This section presents the results of children's exposure to alcohol marketing in their school neighbourhoods. First, the proximity and density of alcohol outlets in school neighbourhoods are presented. Second, univariate models test for potential predictors of school neighbourhood exposure to alcohol marketing using alcohol availability and sociodemographic characteristics. Third, models mutually adjusting for sociodemographic characteristics and alcohol availability examine potential predictors of children's exposure to alcohol marketing in their school neighbourhoods.

School neighbourhood alcohol outlet density and proximity

The number of alcohol outlets within each child's school neighbourhood (defined as 500m Euclidean distance around the school) was summed to calculate outlet density, and the distance from the school to the nearest outlet (in metres) calculated for outlet proximity. On average, there were 2.6 alcohol outlets within 500m of children's schools (Table 36). On-licence outlets accounted for 85% of all the outlets within 500m of children's schools, with 15% being off-licences. The closest on-licence outlet was 100m from the school, with an average of 519m (SD 387m). The closest off-licence outlet was 382m, with an average of 729m (SD 342m). There were no children with more than one off-licence outlet within 500m of their school. In total, 116 children had either an on-licence or off-licence outlet within 500m of their school. More children had an on-licence outlet (116) than an off-licence outlet (51) within 500m of their school.

Table 36: School neighbourhood alcohol outlet density and proximity, descriptive statistics

Alcohol availability measures		**Range**	**Mean**	**SD**
Outlet density, outlet per km^2 (count per 500m)	*All licences*	0 to 21.7 (0 to 17)	3.3 (2.6)	5.3 (4.2)
	On-licences	0 to 21.7 (0 to 17)	2.8 (2.2)	5.3 (4.2)
	Off-licences	0 to 1.3 (0 to 1)	0.5 (0.4)	0.6 (0.5)
Outlet proximity, m	*All licences*	100 to 1,031	444	276
	On-licences	100 to 2,017	519	387
	Off-licences	382 to 1,332	729	342
Alcohol availability measures		**n**		
Count of participants by nearest outlet, n	*All licences +500m*	51		
	250m-499m	66		
	0m-249m	50		
	On-licences +500m	51		
	250m-499m	66		
	0m-249m	50		
	Off-licences +500m	106		
	250m-499m	61		
	0m-249m	0		

Unadjusted models

Table 37 presents the results from unadjusted negative binomial regression models testing potential predictors of alcohol marketing exposure within children's school neighbourhoods. Children with a higher on-licence outlet density in their school neighbourhood had lower rates of alcohol marketing exposure. Each extra on-licence outlet per km² in the school neighbourhood was associated with a 19% decrease (RR, 0.81, 95% CI 0.71, 0.91) in children's exposure to alcohol marketing. Conversely, each additional off-licence per km² in the school neighbourhood was associated with 16 times (RR 16.01, 95% CI 3.40, 75.38) higher rates of exposure to alcohol marketing. Similar trends are observed by outlet proximity, with on-licence outlets associated with reduced exposure and off-licence outlets associated with increased exposure, albeit not statistically significant. When splitting the proximity variable into a binary variable, that is, whether or not an outlet was present within 500m, having an on-licence was a strong predictor of lower exposure rates to school neighbourhood alcohol marketing exposure (RR 0.11, 95% CI 0.02, 0.79). In contrast, having an off-licence outlet within 500m of school was associated with exposure rates 34 (RR 34.20, 95% CI 4.76, 245.93) times that of children without an off-licence outlet within 500m of school. No statistically significant differences by sex, ethnicity or neighbourhood deprivation were detected, although higher rates of exposure were observed in boys, Māori and children who attended schools in less deprived neighbourhoods. However, the confidence intervals for these groups are wide, suggesting there was a considerable degree of variability in children's exposure by sociodemographic characteristics.

Table 37: Univariate models (with 95% CI, from negative binomial regression) of potential predictors of school neighbourhood alcohol marketing exposure

Potential predictors		Rate ratio (95% CI)		p value
Outlet density, n per km^2	*All licences*	0.82	(0.72, 0.94)	0.007**
	On-licences	0.81	(0.71, 0.91)	0.002**
	Off-licences	16.01	(3.40, 75.38)	0.001***
Outlet proximity, per 100m increment	*All licences*	1.95	(0.94, 4.03)	0.071
	On-licences	1.57	(0.91, 2.70)	0.099
	Off-licences	0.74	(0.52, 1.03)	0.075
Outlet proximity (dual variable)	*All licences +500m*	1 (reference)		
	0m-499m	1.29	(0.05, 33.30)	0.872
	On-licences +500m	1 (reference)		
	0m-499m	0.11	(0.02, 0.79)	0.030*
	Off-licences +500m	1 (reference)		
	0m-499m	34.20	(4.76, 245.93)	0.001***
Sex	*Female*	1 (reference)		
	Male	1.61	(0.80, 3.26)	0.168
Ethnicity	*NZE*	1 (reference)		
	Māori	7.85	(0.77, 80.10)	0.079
	Pacific	0.42	(0.03, 5.90)	0.501
Neighbourhood deprivation (NZDep2013)	*Low*	1 (reference)		
	Moderate	0.43	(0.03, 5.73)	0.499
	High	0.37	(0.23, 5.97)	0.460

* p < 0.05 ** p < 0.01 *** p < 0.001

‡ p value for difference calculated using negative binomial regression, accounting for complex sampling strategy and participant observation time

Adjusted models

The results from adjusted models testing the association between potential predictors of school neighbourhood exposure to alcohol marketing, mutually adjusted for alcohol availability, sex, ethnicity and neighbourhood deprivation, are presented in Table 38. Every additional on-licence outlet per km^2 within 500m of school was associated with a 15% decrease in children's exposure to alcohol marketing, even when adjusted for sex, ethnicity and neighbourhood deprivation (RR 0.85, 95% CI 0.73, 0.99). In contrast, each additional off-licence outlet per km^2 around the school was associated with a 19-fold increase in exposure rates (RR 19.24, 95% CI 3.51, 105.5) when adjusted for sex, ethnicity and neighbourhood deprivation. Higher rates of exposure, with wider confidence intervals, were observed by sociodemographic characteristics in models adjusting for on-licence compared to off-licence outlet density. This suggests that off-licence outlet density may account for more of the variability in children's exposure to alcohol marketing than on-licences. For example, Māori children had higher exposure rates than NZE children in the model adjusted for on-licence outlet density, however, the rate ratio was large with extremely wide confidence intervals (RR 10.85, 95% CI 0.43, 274.21). In contrast, in the model accounting for off-licence density, sex and neighbourhood deprivation, the rate ratio was almost halved and the confidence intervals substantially reduced (RR 5.46, 95% CI 1.22, 24.40), to the point of statistical significance.

The lower half of Table 38 presents the results from adjusted models, with alcohol outlet proximity as the measure of alcohol availability. As for density measures, the proximity of the nearest on-licence outlet to school was associated with lower rates of alcohol marketing exposure (RR 1.52, 95% CI 1.14, 2.03). In fact, every 100m decrease to the nearest on-licence outlet was associated with a 52% decrease in alcohol marketing exposure. The proximity to the nearest off-licence was associated with increased alcohol marketing exposure, with every 100m increase in the distance to the nearest outlet being associated with a 25% decrease in exposure to alcohol marketing (RR 0.75, 95% CI 0.55, 1.03), when adjusted for sex, ethnicity and neighbourhood deprivation. While not statistically significant, the sizeable rate ratio and the lower end of the confidence interval suggest an association exists, but that the sample may be underpowered to detect it in the current analysis.

Furthermore, given the strong relationship observed via outlet density and the dual-proximity measure, it is possible off-licence outlets in the school neighbourhood may increase children's exposure to alcohol marketing.

In all models, boys had higher rates of exposure to alcohol marketing near their school neighbourhood than girls, when adjusting for alcohol outlet availability, ethnicity and neighbourhood deprivation. Statistically significant associations were observed for boys in models that accounted for on-licence density and proximity, but not in models adjusting for off-licence density and proximity. However, despite the latter not being statistically significant, exposure rates among boys were still 2.4 times higher than girls when accounting for off-licence density and 4.2 times that of girls when accounting for off-licence proximity. In every adjusted model, Māori children had higher rates of exposure than NZE children in their school neighbourhoods. However, the models accounting for on-licence outlets produced estimates with extremely wide confidence intervals in comparison to those models accounting for off-licence outlets, again suggesting off-licence outlets account for a significant portion of exposure in the school neighbourhood. School neighbourhood deprivation did not impact exposure to alcohol marketing in any of the adjusted models, a finding consistent with the unadjusted models.

Table 38: Multivariable models (with 95% CI, from negative binomial regression) of potential predictors of alcohol marketing exposure in children's school neighbourhood, mutually adjusted for alcohol availability, sex, ethnicity and neighbourhood deprivation

Potential predictors		**Rate ratio (95% CI) All licences**		**Rate ratio (95% CI) On-licences**		**Rate ratio (95% CI) Off-licences**	
Outlet density ‡	*N per km²*	0.87	(0.74, 1.03)	0.85	(0.73, 0.99)*	19.24	(3.51, 105.5)**
Sex‡	*Female*	1 (reference)		1(reference)		1(reference)	
	Male	3.61	(1.13, 11.55)*	3.35	(1.01, 11.06)*	2.45	(0.89, 6.68)
Ethnicity‡	*NZE*	1 (reference)		1(reference)		1(reference)	
	Māori	13.06	(0.55, 310.8)	10.85	(0.43, 274.21)	5.46	(1.22, 24.40)*
	Pacific	0.35	(0.02, 6.77)	0.33	(0.02, 5.32)	4.25	(0.19, 92.91)
Neighbourhood	*Low*	1 (reference)		1(reference)		1(reference)	
deprivation ‡	*Moderate*	1.48	(0.12, 17.64)	1.37	(0.10, 18.05)	0.40	(0.09, 1.88)
(NZDep2013)	*High*	2.24	(0.14, 36.22)	2.27	(0.12, 41.35)	1.54	(0.04, 56.31)
Potential predictors		**Rate ratio (95% CI) All licences**		**Rate ratio (95% CI) On-licences**		**Rate ratio (95% CI) Off-licences**	
Outlet proximity‡	*Per 100m increment*	1.80	(1.25, 2.58)**	1.52	(1.14, 2.03)*	0.75	(0.55, 1.03)
Sex‡	*Female*	1 (reference)		1(reference)		1(reference)	
	Male	3.43	(1.44, 8.19)**	3.92	(1.57, 9.80)*	4.19	(0.93, 18.8)
Ethnicity‡	*NZE*	1 (reference)		1(reference)		1(reference)	
	Māori	8.93	(1.49, 53.61)*	9.09	(1.47, 56.19)*	12.05	(3.21, 45.29)***
	Pacific	0.05	(<0.01, 1.01)	0.08	(<0.01, 1.33)	2.86	(0.10, 79.77)
Neighbourhood	*Low*	1 (reference)		1(reference)		1(reference)	
deprivation ‡	*Moderate*	0.93	(0.18, 4.92)	1.13	(0.20, 0.64)	0.72	(0.21, 4.21)
(NZDep2013)	*High*	0.81	(0.13, 5.16)	1.06	(0.18, 6.36)	1.64	(0.09, 31.59)

*< p 0.05 ** p < 0.01 *** p < 0.001

‡ p value for difference calculated using negative binomial regression, accounting for complex sampling strategy and participant observation time

8.2.3 Summary

Exposure to alcohol marketing within the residential neighbourhood, outside of participants' primary residence, was patterned by alcohol availability and sociodemographic characteristics. Most notably, the proximity to nearest off-licence alcohol outlet was strongly associated with higher rates of residential neighbourhood alcohol marketing exposure. The same associations were not observed when all types of alcohol outlets were collapsed into a single category, nor were there associations with on-licence outlets. Boys and Māori children had higher rates of exposure than girls and NZE children, respectively. In the school neighbourhood, on-licence outlets were associated with lower exposure to alcohol marketing, while off-licence outlets were associated with higher exposure rates. Boys and Māori children had higher rates of exposure than girls and NZE children, respectively, in the school neighbourhood. Overall, off-licence outlet density and proximity, being male and Māori appear useful predictors of children's residential and school neighbourhood exposure to alcohol marketing.

8.3 Children's exposure to alcohol marketing within supermarkets

This section focuses on children's exposure to alcohol marketing within supermarkets, expanding on the marketing encounter results presented in Chapter Seven. First, it looks at the frequency of exposure to alcohol marketing within supermarkets using the visits made to each supermarket as the denominator. Second, micro-spatial analyses examine how alcohol exposures are spatially patterned within supermarkets. Specifically, the first micro-spatial analysis compares supermarkets with low and high rates of exposure. To examine differences before and after the implementation of the SSAA, the second micro-spatial analysis uses a case study of a supermarket that had obvious changes to its promotional environment before and after the implementation of the SSAA.

8.3.1 *Analysis of children's visits to supermarkets and their exposure to alcohol marketing*

Of the study sample, 56 children (34% of total sample) made at least one visit to a supermarket (Table 39), of whom 51 (91% of children making visits) were exposed to alcohol marketing. The 56 children who visited a supermarket made a total of 78 visits to 30 different alcohol-retailing supermarkets. On 68 of the 78 visits (87%, 95% CI 78.3, 93.3) children were exposed to alcohol marketing. There were no significant differences by sociodemographic characteristics between the children who visited and who did not visit supermarkets over the study period. Similarly, there were no differences by sociodemographic characteristics between children exposed to and not exposed to alcohol marketing at supermarkets; however, it is possible the analysis is underpowered to detect such differences.

Table 39: Sociodemographic characteristics of children visiting and not visiting supermarkets, and children exposed to and not exposed to alcohol marketing at supermarkets

Sociodemographic characteristic		Visits, n (%) Yes	No	p value*	Exposures, n (%) Yes	No	p value*
Total	*Children*	56 (34%)	111 (66%)		51 (31%)	116 (69%)	
	Total (n)	78			68		
Sex	*Male*	30 (53%)	54 (49%)	0.624	28 (55%)	56 (45%)	0.705
	Female	26 (47%)	57 (51%)		23 (45%)	60 (55%)	
Ethnicity	*NZE*	24 (43%)	42 (38%)	0.748	23 (45%)	43 (37%)	0.479
	Māori	18 (32%)	42 (38%)		15 (29%)	45 (39%)	
	Pacific	14 (25%)	27 (24%)		13 (26%)	28 (24%)	
Neighbourhood deprivation (NZDep2013)	*Low*	26 (46%)	32 (29%)	0.073	24 (47%)	34 (29%)	0.096
	Moderate	16 (29%)	31 (28%)		14 (27%)	33 (28%)	
	High	14 (25%)	43 (39%)		13 (26%)	44 (38%)	

* p value for difference calculated using Pearson chi-squared test

Figure 35 presents the spatial distribution of the supermarkets that children visited over the study period. The number of visits to each supermarket is represented by the size of the points. The geographic distribution of children's visits and exposures was relatively consistent across the study area and reflected the spatial distribution of children's residences, which are aggregated and displayed by census area unit (CAU, an administrative unit containing between 3,000 and 5,000 people, green polygons). Children made the most visits to Wellington City supermarkets (n=38) and were exposed to alcohol marketing on almost all visits (with alcohol exposures on 84% of visits; 95% CI 70.0 to 93.3), followed by supermarket visits in Porirua City (n=22: with alcohol exposures on 95% of visits; 95% CI 79.6 to 99.8) and Hutt City (n=18: with alcohol exposures on 72% of visits: 95% CI 48.7 to 89.0). The three supermarkets in which children had no marketing exposures (0% exposure rate) are represented in white. In contrast, in 19 of the 30 different supermarkets visited (63.3%, 95% CI 45.2 to 79.0), children were exposed on nearly every visit represented in red.

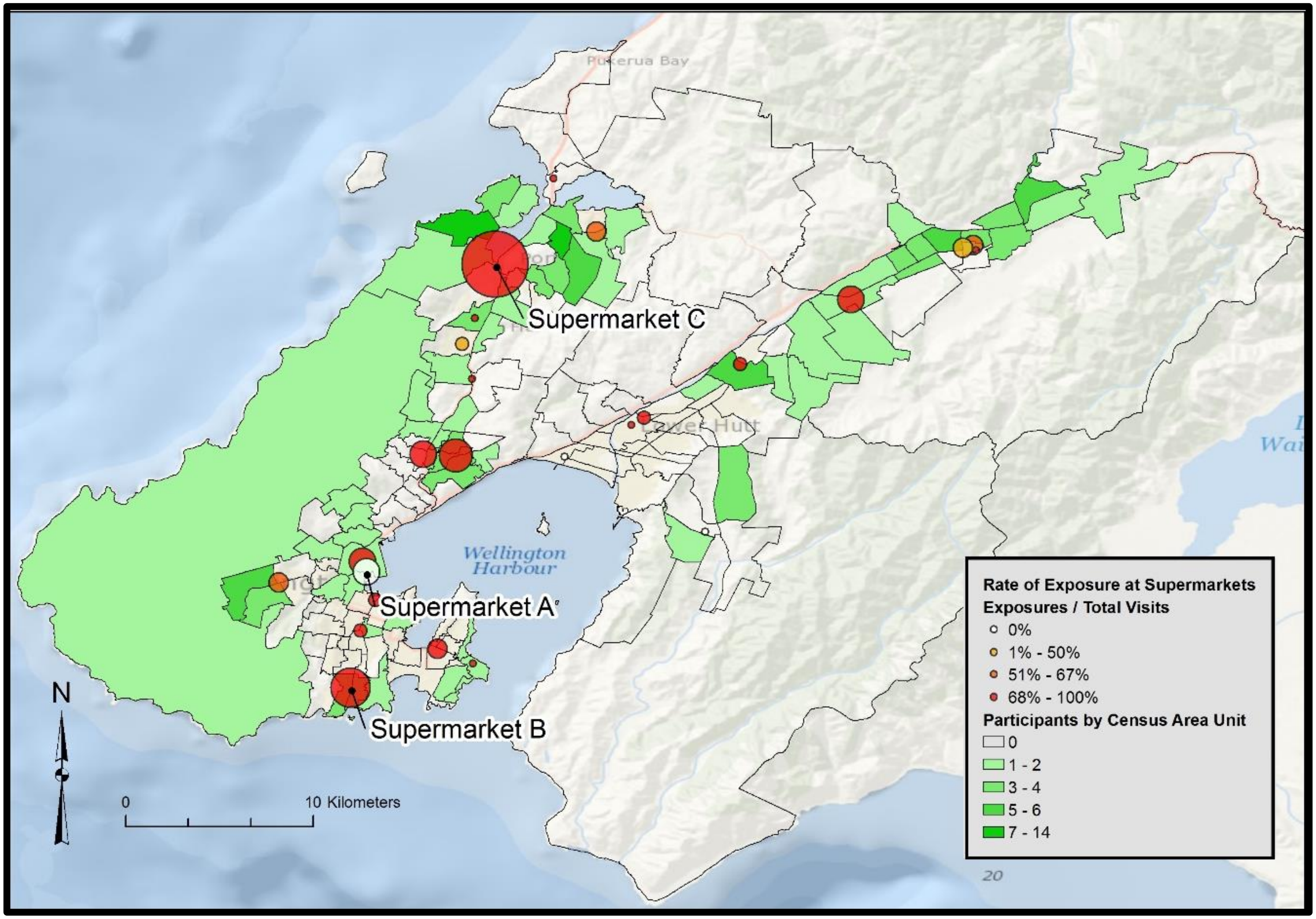


Figure 35: Rate of exposure (per visit) to alcohol marketing within Wellington supermarkets, showing the location of supermarkets used in micro-spatial analyses. Source: Chambers, Pearson, et al. (399)

8.3.2 Micro-spatial analysis of children’s exposure to alcohol marketing within supermarkets

Comparing supermarkets with low and high rates of exposure

As discussed in Chapter Five, two supermarkets were purposively chosen to explore the reasons for different rates of exposure to alcohol marketing. Supermarket A had four visits and no exposures, whereas Supermarket B had six visits and had an exposure on every visit. Children spent much less time in Supermarket A than Supermarket B, as represented by the boldness of the red hot spots in Figure 36. Further, children in Supermarket A never ventured past the aisles closest to the entry/exit. Children in Supermarket B travelled extensively throughout the supermarket, covering all but one aisle (cleaning products) on their visits. Moreover, children in Supermarket B regularly stuck to the racetrack of the supermarket layout, that is, the aisles on the perimeter of the supermarket that resemble a horse race track. Supermarkets with alcohol sections as part of the racetrack are likely to expose consumers to alcohol marketing more frequently. In contrast, having the alcohol section in the far corner of the supermarket and away from the checkout appeared to reduce exposure in Supermarket A.

Children were often standing (blue dots represent the location of the child when exposed) in the dairy section or near the checkout when exposed to alcohol marketing in Supermarket B. The location of everyday consumer goods (bread and dairy products) as well as items that appeal to children (stationary, toys) near the alcohol section contributed to the high exposure in Supermarket B. In Supermarket B the alcohol area was close to the express checkouts which also made exposure more likely. In addition, the shelving or cabinets in the aisle closest to the alcohol section (frozen goods) in Figure 36 (B) were low lying, allowing the alcohol area to be visible over them. Consequently, children were exposed to alcohol marketing when standing some distance from the alcohol area. In summary, the placement of the alcohol area, and the products that are sold in close proximity to it, appeared to influence children’s exposure to alcohol marketing.

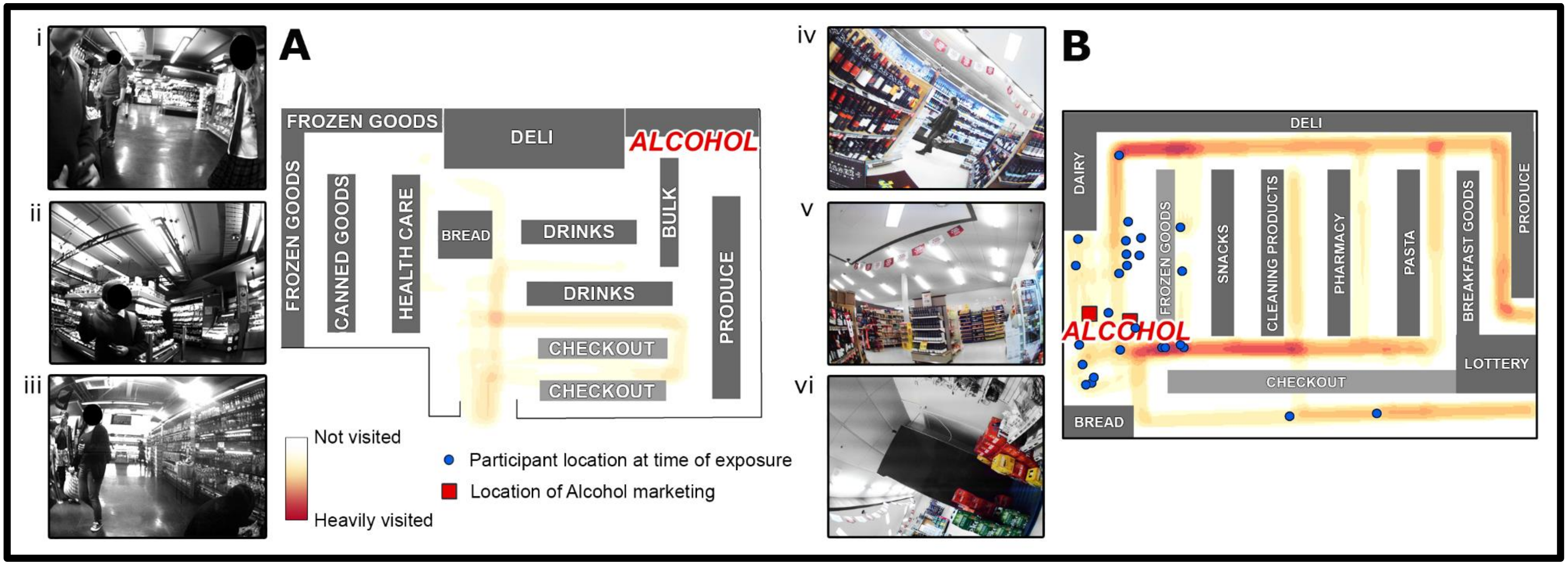


Figure 36: Micro-spatial analysis of a supermarket with 0% alcohol marketing exposure rate (supermarket A, four visits, zero exposures) and a supermarket with an exposure rate of 100% (supermarket B, six visits, exposure on every visit). Source: Chambers, Pearson et al. (399)

Effects of the 2012 Sale and Supply of Alcohol Act (SSAA) implementation

As a consequence of the enactment of the 2012 SSAA in NZ, changes to the location and promotion of alcohol occurred at Supermarket C in the middle of the study period. As discussed in Chapter Three, the SSAA requires alcohol to be isolated in a single designated alcohol area that is not on the direct path from the entrance to exit. A total of 11 visits were made to Supermarket C before the changes required from the SSAA, and five after its implementation. Figure 37 shows the two major changes: 1) the removal of the entire liquor store and its associated marketing from the entrance of the supermarket (Figure 37, i), and 2) the establishment of a dedicated alcohol area for the promotion and sale of alcohol (Figure 37, v).

The marketing exposure rate, the total number of exposures per visit, and exposures by marketing type pre- and post-legislation implementation are presented in Table 40. In both pre- and post-legislative implementation, children had a marketing exposure on every visit to the supermarket (100% exposure rate). The mean rate of marketing exposures per visit increased slightly after the introduction of the SSAA from 4.8 (95% CI 3.2, 7.2) to 5.0 (95% CI 3.1, 7.9) per visit (RR 1.03, 95% CI 0.60, 1.82). In this case study, the changes from the SSAA appeared to have no substantive impact on the frequency of children's exposure to alcohol marketing. Prior to legislative changes, the alcohol marketing associated with the in-supermarket liquor store was the most common exposure (100% exposure rate; mean 2.9 (95% CI 1.9, 4.3) exposures per visit). The second most prevalent exposure was to a promotional banner stationed on the wall above the alcohol area (81% exposure rate; mean, 1.1 (95% CI 0.6, 2.2) exposures per visit) that could be seen from as far as the back left corner of the store (blue dots in Figure 37). After the legislative change, the promotional banner became the predominant marketing exposure (100% exposure rate; mean, 3.6 (95% CI 2.7, 5.0) exposures per visit). There were no statistically significant differences in the frequency of exposure to the primary alcohol area, aisle displays, liquor store marketing or total exposure between pre- and post-legislation conditions. Children were three times as likely to be exposed to the promotion banner after legislative implementation as they were before the change in legislation (RR 3.20, 95% CI 1.66, 6.19).

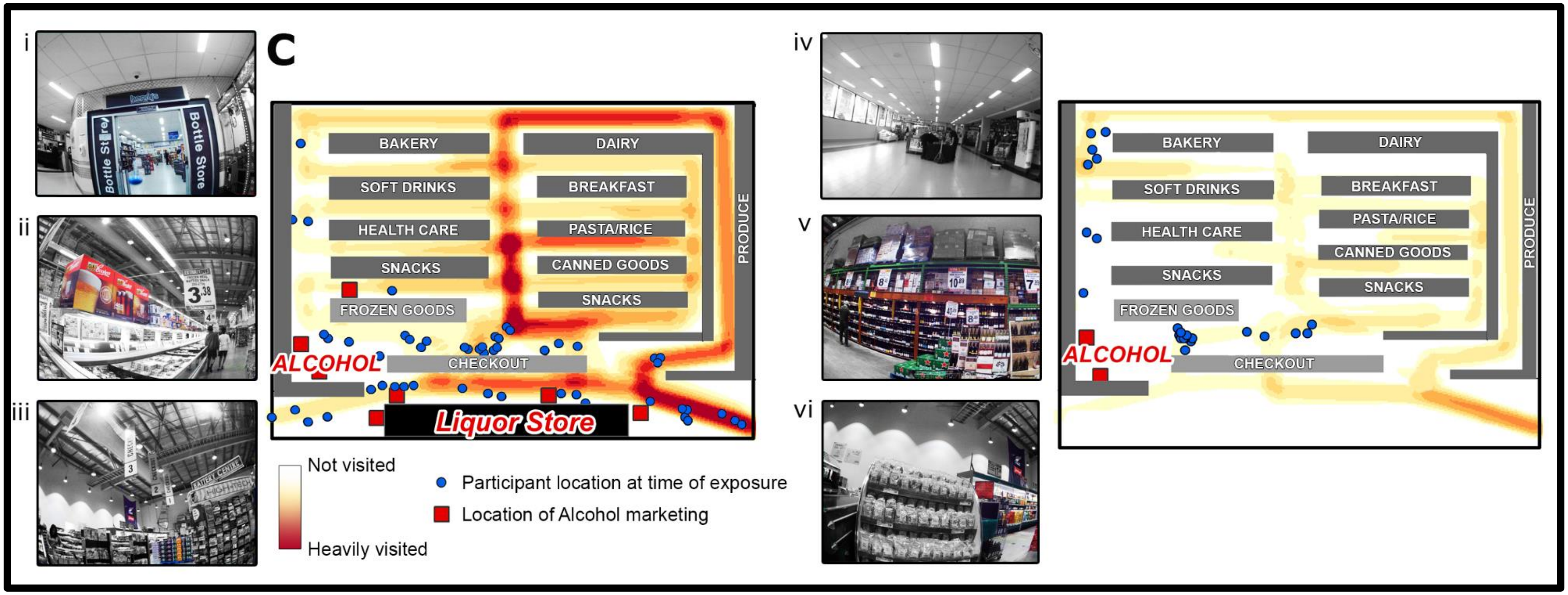


Figure 37: Micro-spatial analysis of visits to supermarket C pre- and post- legislation implementation (2012 Sale and Supply of Alcohol Act). Source: Chambers, Pearson et al. (399)

Table 40: Micro-spatial analysis of alcohol marketing at supermarkets pre- and post- 2012 Sale and Supply of Alcohol Act (SSAA) legislation implementation, mean rate (per visit, with 95% CI, from Poisson regression) of exposure to alcohol marketing

Supermarkets	Supermarket C pre SSAA legislation (2014)	Supermarket C post SSAA legislation (2015)	Rate ratio (95%CI) ‡
Visits	11	5	
Number of visits exposed to alcohol marketing	11	5	
<u>Marketing exposures</u> (mean rate per visit, 95% CI)			
Liquor store signage	2.9 (1.9, 4.3)	0 (0, 0)	0
Beer brand flag	1.1 (0.6, 2.2)	3.6 (2.7, 5.0)	3.20 (1.66, 6.19)*
Alcohol area	0.6 (0.3, 1.3)	1.3 (0.5, 3.5)	2.15 (0.72, 6.46)
Aisle displays	0.2 (.04, 0.8)	0 (0, 0)	0
Total marketing exposures	4.8 (3.2, 7.2)	5.0 (3.1, 7.9)	1.03 (0.60, 1.82)

* $p < 0.05$
‡ p value for difference calculated using Poisson regression, accounting for complex sampling strategy

8.3.3 Summary

In summary, children in this study frequently visited supermarkets, indicating that they are an important setting in children's lives. The study findings show that when children visit supermarkets, they are likely to be exposed to alcohol marketing. The micro-spatial analysis revealed that the children who were not exposed at supermarkets only spent small amounts of time within the premise and only travelled a short distance into the store, mostly hovering around the stores' entry/exit. Further, children were frequently exposed to alcohol marketing within the supermarket when not in the designated alcohol area, a consequence of it being visible throughout the supermarket due to low standing shelving or cabinets that separated aisles, and its prominent positioning. The natural experiment observed in the second micro-spatial analysis provided a case study to evaluate the effectiveness of the 2012 SSAA implementation. There was no difference between the pre- and post-legislative conditions, suggesting that the current legislative protections related to alcohol marketing in supermarkets are ineffective.

8.4 Conclusion

This chapter started by presenting results examining the spatial distribution of children's exposure to alcohol, specifically looking at the predictors of children's exposure to alcohol marketing in their residential and school neighbourhoods. The results revealed that boys, Māori children and children living closer to an off-licence alcohol outlet, were more likely to be exposed to alcohol marketing than girls, NZE children and children living further away from off-licence alcohol outlet. Differences by sociodemographic characteristics and off-licence proximity and density were mirrored in the school neighbourhood, albeit not statistically significant for differences by sex and neighbourhood deprivation in the adjusted analyses. These results build on, and reinforce, those presented in Chapter Seven. Specifically, they reveal the spatial patterns in exposure that highlight the impact of alcohol availability on neighbourhood exposure to alcohol marketing.

This chapter then presented a spatial analysis of children's exposure within supermarkets. First, children were exposed to alcohol marketing on almost all of their visits to supermarkets, regardless of the city in which the supermarket was located. The spatial distribution of exposures at supermarkets mirrored the geographic distribution of participants' addresses, suggesting children visit their local supermarket. The first micro-spatial analysis presented differences between supermarkets in which children were and were not exposed to alcohol marketing. Children who were not exposed did not spend much time within the premise and only hovered near the exit/entry. The second micro-spatial analysis revealed the ineffectiveness of the SSAA by using a case study of a supermarket that had enforced changes mid-way through the study period. The legislative changes made no difference to participants' exposure status. Overall, the spatial results presented here provide a greater understanding of children's exposure to alcohol marketing than that provided by the image data alone.

CHAPTER NINE: DISCUSSION

9.1 Introduction

Globally, alcohol has major physical, social and financial costs. Alcohol contributes to an estimated 3.3 million deaths (2), impacting individuals' work, social and family life (1), and costs countries' between 1.3% and 3.3% of their GDP (27). Children are particularly vulnerable to the adverse and toxic effects of alcohol given their developing brains, susceptibility to social pressure and inexperience with the risks of alcohol (56, 61).

Multiple systematic reviews have demonstrated a positive association between children's exposure to alcohol marketing and alcohol consumption (9-11). However, few studies have attempted to quantify the extent and nature of children's exposure to alcohol marketing. Most studies measuring the extent of alcohol marketing exposure use Likert scale self-report data (213, 216), a method that may be unreliable. Further, exposure studies often focus on a single place or promotion type, overlooking the full extent of children's exposure to alcohol marketing. Therefore, there is little knowledge about the extent of children's real-time exposure to alcohol marketing, in multiple places, and via a range promotion types. This thesis contributes to addressing this gap. Wearable cameras and GPS devices were used to determine the real-time exposure of 168 NZ children to alcohol marketing.

This chapter provides a discussion of the study findings in the context of previous research on alcohol marketing. First, the findings from children's exposure to alcohol marketing are discussed answering the central research question of this thesis:

- What is the extent and nature of children's real-time exposure to alcohol marketing?

In addition, this discussion seeks to answer the following research sub-questions related to exposure to alcohol marketing:

- How does children's exposure to alcohol marketing differ by sociodemographic characteristics?

- What is the frequency, duration and nature of children's exposure to alcohol marketing within off-licence alcohol outlets?
- What factors predict children's exposure to alcohol marketing in their residential and school neighbourhoods?

Second, this chapter discusses this thesis' methodological contributions. Specifically, it examines and discusses the tandem use of wearable cameras and GPS devices, an imputation method for missing GPS data, and using PSNB to measure the extent of children's neighbourhoods and destination detection analysis. These methodological contributions aim to answer the following research questions:

- Can wearable cameras and GPS devices be used to accurately and reliably measure children's exposure to alcohol marketing?
- Can an effective imputation method be developed for missing GPS data?
- What is the extent of children's neighbourhoods?
- What destinations do children visit that may be important for their health?

Third, the findings are discussed in the context of the theoretical models used to inform this thesis, a socio-ecological model of health and CST. The strengths and limitations of this research are then considered, followed by the implications of the findings for future research. Finally, the implications of the findings at local, national and international levels are discussed.

9.2 Children's exposure to alcohol marketing: what place is safe?

This section discusses the results that aim to answer the research questions related to children's exposure to alcohol marketing, including the central research question of this thesis. Initially, the extent of children's exposure to alcohol marketing is discussed, followed by a discussion on its nature by place and promotion type. Next, children's exposure to alcohol marketing in their neighbourhoods and within off-licence alcohol outlets are discussed.

9.2.1 What is the extent of children's real-time exposure to alcohol marketing?

Children in this study were exposed to alcohol marketing 12.4 times per day on average, or 4.5 times per day with product packaging removed from the analysis. These results are higher than found in previous research that estimated children's exposure to alcohol marketing ranged from 0.1 to 3.1 times per day (213, 214, 216). Most previous studies that measured the extent of children's exposure to alcohol marketing used self-report data using a Likert scale (160, 213, 216), and reported relatively low estimates. These studies also excluded product packaging. There appears to be only one other study using real-time exposure data that found children were exposed to alcohol marketing 3.1 times per day on average (214). However, the study findings are limited due to the analysis of fewer places and promotion types (particularly product packaging) than the current research, and the requirement that participants recognised the alcohol marketing. Therefore, it is likely that, Kids'Cam Alcohol currently provides one of the most accurate measures of the extent of children's exposure to alcohol marketing.

9.2.2 The nature of children's exposure to alcohol marketing: place

In this study, children's exposure to alcohol marketing occurred in multiple places including the home, on-licence outlets, off-licence shop fronts and sports venues. The majority of exposures occurred within the home, where children were exposed to alcohol marketing 9.1 times per day on average (73% of all exposures). Children were exposed on average to alcohol marketing at on-licence alcohol outlets 1.2 times per day, and off-licence shop fronts 1.1 times per day (2.3 per day, combined as alcohol outlets). Sports venues contributed a similar rate of exposure to alcohol marketing as off-licence shop fronts, with 1.1 exposures per day. Is it likely these results are best estimate of rates of exposure by place as even Collins, Martino et al. (214) were unable to unpick exposure by place.

These findings provide a quantified rate of exposure within the home and highlight possible areas for intervention. For example, 70% of all home exposures were from product packaging, while merchandise and sports sponsorship contributed 14% and 12% of all home exposures, respectively. The next most common place where children were exposed to alcohol marketing was at alcohol outlets (on-licence and off-licence shop fronts combined, 2.3 exposures per day on average). Alcohol outlets are often among the most common places of exposure reported in previous research (214, 225), a finding that is mirrored in this current study. However, an average of 2.3 exposures per day at alcohol outlets is substantially higher than the 0.3 exposures per day reported by Collins, Martino et al. (214). Other exposure studies only report the proportion of children exposed to alcohol marketing at such outlets (104, 225, 230), with no quantifiable rates of exposure.

Children were exposed to alcohol marketing at sports venues 1.1 times per day on average, the same rate of exposure as off-licence shop fronts. It appears there are no comparable results for exposure at sports venues, but the high exposure rates are predictable given the high rates of alcohol marketing exposure reported in numerous frequency analyses of televised sport (128, 129, 200, 211). The high rate of exposure to alcohol marketing at sports venues is particularly concerning. Sports venues are traditionally health-promoting places, however they are also used to promote a harmful product (128).

Overall, these findings suggest that children are exposed to alcohol marketing in multiple places, primarily at home, alcohol outlets and sports venues.

9.2.3 The nature of children's exposure to alcohol marketing: promotion type

Children were exposed to alcohol marketing via a range of promotion types including product packaging, sports sponsorship, shop front signage and merchandise. Product packaging was the most prevalent promotion type, with 7.7 exposures per day on average, or 61% of all exposures. Alcohol sports sponsorship and shop front signage each typically contributed 1.4 exposures per day.

This research appears to provide the first quantified evidence of the extent of children's exposure to alcohol marketing via product packaging. Further, it suggests that other exposure studies that have omitted product packaging may substantially underestimate children's overall exposure to alcohol marketing. Product packaging is a vital part of the alcohol industry's marketing strategy (241). Alcohol is a product often consumed from its packaging, providing multiple opportunities for exposure to alcohol marketing (194).

Sports sponsorship exposed children to alcohol marketing in their homes, via their sporting heroes, on their clothing, and in traditional health-promoting environments (eg, sports venues). Kids'Cam Alcohol gives a quantified rate of exposure of non-televised exposure to alcohol sports sponsorship of 1.4 exposures per day; an aspect of sports sponsorship of which little is known. These findings address a gap in knowledge left by the many studies examining potential exposure to alcohol marketing via televised sports sponsorship (129, 200, 211). A previous frequency analysis of televised sport in NZ found that alcohol marketing appeared between 1.8 and 3.8 times per minute (129), while a US study estimated children see 7.8 alcohol marketing exposures per day through televised sport (178). Therefore, it is reasonable to assume that the rates of exposure to alcohol marketing via sports sponsorship are much higher when accounting for televised sport; based on previous research (178).

The findings of this research appears to report one of the only quantifiable rates of children's exposure to alcohol marketing via shop front signage. Similar to product packaging, shop front signage is often overlooked in exposure studies (215). If it is included, it is often conflated with exposure to alcohol marketing within alcohol outlets (214). The findings from this study demonstrate children do not necessarily need to enter an alcohol outlet to be exposed to its associated marketing.

In the current study, exposure via screens was reported to be very low due to coding limitations, discussed later in this chapter. However, a qualitative analysis showed children were exposed to screen-based alcohol marketing via sports sponsorship, social media, online games and television. As discussed in Chapter Three, studies investigating children's exposure to alcohol marketing via television and digital media suggest it is common (9, 10), with quantified rates of exposure from 0.5 to 1.3 per day (178, 214, 400). There appears to be only one previous estimate of children's exposure via digital marketing, which found children were exposed 0.1 times per day (214).

Overall, these findings highlight children are exposed to alcohol marketing via a range of promotion types, with product packaging being the predominant type of exposure, followed by sports sponsorship and shop front signage.

9.2.4 How does children's exposure to alcohol marketing differ by sociodemographic characteristics?

Children's exposure to alcohol marketing was patterned by sociodemographic characteristics. Overall, boys, Māori children and children living in the highest neighbourhood deprivation had the highest rates of exposure to alcohol marketing. However, in the current study, no statistically significant differences in overall exposure were detected by sociodemographic characteristics when product packaging and screens were included in the analyses. This finding may be attributable to the highest rates of exposure via product packaging being observed in girls and NZE children, while boys and Māori children had higher rates of exposure via every other promotion type. Thus, sociodemographic trends in exposure to product packaging may disguise other patterning in children's exposure. As a result, the following section discusses the results with product packaging removed from the analysis.

Sex

Overall, boys had 96% higher rates of exposure to alcohol marketing than girls when product packaging and screen exposures were removed. In contrast, Collins, Martino et al. (214) found that girls had significantly higher rates of exposure to alcohol marketing than boys. The authors attributed differences by sex to boys using gaming consoles more than girls, and therefore boys spent more time indoors away from potential alcohol marketing exposures. Likewise, previous NZ research showed boys spend almost twice as much time as girls on screens (401), suggesting that time spent indoors on gaming consoles is not a sufficient explanation for differences by sex.

It is likely differences in overall exposure to alcohol marketing between boys and girls are driven by exposure by place and promotion types. Boys had rates of exposure at home and via sports sponsorship six times and five times higher than girls, respectively. The higher rates of exposure to alcohol marketing within the home for boys is primarily driven by sports sponsorship, which accounted for over 50% of home exposures. In a US study, Stacy, Zogg et al. (178) found that boys were exposed to alcohol marketing via televised sport more than girls. In NZ, sports that appeal more to boys, such as rugby (secondary school participation numbers, 23,000 boys v 3,800 girls) and cricket (7,800 boys v 1,700 girls), are more likely to have alcohol sponsorship than sports that are more appealing to girls, such as netball (27,000 girls v 700 boys) and volleyball (11,000 girls v 6,000 boys) (402).

Ethnicity

Ethnicity was a strong predictor of differences in children's exposure to alcohol marketing. Māori and Pacific children had five times and three times higher rates of exposure to alcohol marketing than NZE children, respectively. US research found a smaller ethnic difference with African American and Hispanic children having twice the exposure to alcohol marketing as Caucasian children (214).

In addition to overall exposure, statistically significant differences were detected by place and promotion type by ethnicity. Māori children had higher rates of exposure at sports venues than NZE children. A potential explanation is that Māori children visit sports venues more often than NZE children. This interpretation is supported by the finding in this study that Māori children had three times higher rates of exposure via sports sponsorship than NZE children.

Māori children also had higher rates of exposure from off-licence shop fronts than NZE children. In NZ, alcohol availability is highest in neighbourhoods with high numbers of younger Māori and Pacific populations (318). Thus, Māori children may be more likely to encounter shop front marketing than NZE children. There is other research examining ethnic differences in exposure to alcohol marketing (178, 214, 403), however, research on differences by place and promotion type are limited.

Neighbourhood deprivation

Children living in the highest deprivation neighbourhoods had the highest rates of exposure to alcohol marketing. However, when adjusting for sex and ethnicity, there were no significant differences by neighbourhood deprivation. The findings suggest neighbourhood deprivation may influence exposure to alcohol marketing, but the current study may be underpowered to detect such an association. There appears to be no previous research examining neighbourhood deprivation and children's exposure to alcohol marketing.

Overall, these findings suggest that children's exposure to alcohol marketing differs by sex and ethnicity but not neighbourhood deprivation. Boys and Māori children had significantly higher rates of overall exposure, exposure from sports venues and off-licence shop fronts, and via sports sponsorship and shop front signage, than girls and NZE children.

9.2.5 *What is the frequency, duration and nature of children's exposure to alcohol marketing within off-licence alcohol outlets?*

On average, children had 0.5 alcohol marketing encounters within off-licence outlets per day. All marketing encounters took place within supermarkets where in NZ it is legal to sell beer and wine. Not one child in this study was exposed to alcohol marketing within a dedicated liquor store, nor did they visit such places. Liquor stores are places that children do not visit independently nor does it appear that parents felt it appropriate to take their children to such places. Exposure to alcohol marketing within supermarkets is arguably more problematic than exposures within liquor stores when considering the normalising process that occurs when children see alcohol promoted and sold next to everyday consumer goods in supermarkets (102, 199).

Further analyses of all supermarket visits revealed that children were exposed to alcohol marketing on 85% of their visits. Results from previous studies suggest children are exposed to alcohol marketing within off-licence outlets between once per week and once per month (102, 105, 191, 404). Such estimates are substantially less than those of the current study, suggesting previous studies may not accurately quantify the frequency of such exposure (102, 105, 404).

On average, children's alcohol marketing encounters lasted for 46 seconds on average. There appear to be no previous studies addressing the duration of children's exposure to alcohol marketing within off-licence alcohol outlets. The duration of exposure is an important component of exposure within off-licence alcohol outlets, as prolonged periods of exposure to marketing are likely more influential than incidental exposure (128, 405).

One in three marketing encounters occurred without the supervision of an adult, suggesting children's exposure to alcohol marketing within off-licences is not merely a result of parents' consumer behaviours (purchasing alcohol or shopping in supermarkets).

A micro-spatial analysis of the indoor supermarket environment showed children's exposure to alcohol marketing occurred near everyday consumer goods, such as dairy products, bread and stationary. Moreover, it showed that exposure is limited in those supermarkets in which children spent little time, where children stayed close to the entry/exit and that had the alcohol section in the back of the store. This study appears the first to spatially analyse children's exposure to alcohol marketing within supermarkets using real-time data.

In this research, a case study using micro-spatial analysis demonstrated that the SSAA single-designated areas made no significant difference in children's exposure. This finding provides some of the first evidence that such restrictions are unlikely to prevent children or any customers from undue exposure to alcohol marketing. This is pertinent in NZ given that multiple court proceedings, lodged by major supermarket chains, have watered down existing regulations by permitting end-of-aisle displays within definitions of single-designated areas that expose customers standing in any adjacent area to alcohol marketing (137).

Overall, children were exposed to alcohol marketing within supermarkets frequently, for prolonged periods and in the abstence of adult supervision. Alcohol marketing was often placed near everuday consumer goods and the SSAA was shown ineffective at preventing children's exposure to alcohol marketing.

9.2.6 What factors predict children's exposure to alcohol marketing in their residential and school neighbourhoods?

Children's residential neighbourhood exposure to alcohol marketing was patterned by sex, ethnicity and alcohol availability, but not neighbourhood deprivation. Ethnicity and alcohol availability largely pattern school neighbourhood exposure.

The children's sex predicted their exposure to alcohol marketing in the residential neighbourhood, but not in the school neighbourhood. Boys had three times higher rates of exposure in their residential neighbourhood than girls when adjusting for ethnicity, neighbourhood deprivation and alcohol availability. A potential explanation for this difference is that boys generally experience greater independence and capacity to explore their neighbourhoods than girls (406, 407), and thus are more likely to be exposed to neighbourhood features such as alcohol marketing.

Ethnicity was a significant predictor of alcohol marketing exposure in both residential and school neighbourhoods. Māori and Pacific children had 14 times and five times higher rates of exposure in their residential neighbourhoods than NZE children, respectively. The ethnic disparities in neighbourhood exposure are mirrored in a previous

US study (403). A possible explanation is that Māori and Pacific children have more opportunities to explore their neighbourhoods than NZE children (407, 408), leading to higher levels of exposure to neighbourhood features, such as alcohol marketing on alcohol outlet shop fronts. In the school neighbourhood, Māori children had five times higher rates of exposure to alcohol marketing than NZE children, mirroring the residential neighbourhood, a finding that is consistent with US findings (409).

Off-licence proximity was associated with increased exposure to alcohol marketing in the residential neighbourhood, while off-licence density increased exposure to alcohol marketing in the school neighbourhood. In the residential neighbourhood, for every 100m increase in the distance to the nearest off-licence outlet, there was a 13% decrease in the rate of exposure to alcohol marketing. In the school neighbourhood, children with a higher density of off-licence alcohol outlets within 500m of the school had 19 times higher rates of exposure to alcohol marketing. Several studies have found an association between alcohol availability and childhood drinking (86, 87, 284, 296, 301). However, they do not explain why this association exists when children rarely attempt to acquire alcohol from alcohol outlets. It is possible that the presence of alcohol outlets in children's environments normalises alcohol in their lives and the exposure to the associated marketing increases their intentions to drink (188, 190, 212, 285). The findings in this thesis reinforce the analytic framework proposed by Campbell, Hahn et al. (285) outlined in Chapter Four that suggests alcohol availability increases exposure to alcohol marketing and thus increases demand for alcohol. This current study appears to be the first to directly investigate the link between neighbourhood alcohol availability and exposure to alcohol marketing.

Interestingly, there were no associations between neighbourhood alcohol marketing and other measures of alcohol availability (eg, all licence). This finding reinforces previous conclusions that different alcohol availability measures may impact alcohol-related outcomes differently. For example, the strongest associations between childhood drinking and alcohol availability exist in studies using off-licence outlets as the measure of alcohol availability (101, 286, 294, 296), a finding supported by this current study.

A surprising finding was that the increased density of on-licence alcohol outlets was associated with decreased exposure to alcohol marketing. One explanation could be that in areas with higher numbers of on-licence outlets there are fewer off-licence outlets.

Off-licence shop fronts are a primary driver of children's exposure to alcohol marketing, substantially higher than on-licences. Thus, the decreased number of off-licences in areas with high numbers of on-licences may be driving this interesting result.

Overall, these results demonstrate that ethnicity and alcohol availability predict children's exposure to alcohol marketing in home and school neighbourhood contexts. The direct relationship between alcohol availability and exposure to alcohol marketing provides a potential explanation for the link between alcohol availability and children's alcohol-related outcomes proposed by Campbell, Hahn et al. (285).

9.3 Methodological contributions

In attempting to address the central research question of this thesis, several methodological challenges led to the development of additional research questions. This section addresses those questions.

9.3.1 Can wearable cameras and GPS devices be used to accurately and reliably measure children's exposure to alcohol marketing?

As outlined previously, the use of wearable cameras enabled a real-time analysis of children's exposure to alcohol marketing. In total, the Kids'Cam dataset consists of approximately 1.3 million images, which were clear and codable, with approximately 700,000 used for analysis in this current study (non-school time). The wearable cameras permitted unprecedented access into children's lives (380) and enabled the analysis of exposure to alcohol marketing in places (eg, within the home), and via promotion types (eg, product packaging) that previous studies were unable to measure (214). By demonstrating the cameras' accuracy and reliability in analysing children's exposure to alcohol marketing, this current study builds on previous research demonstrating the utility of wearable cameras (329, 332, 410-412) to study health-related behaviours and exposures.

The GPS devices gathered precise data on children's location that, when linked to image data, provided the exact location of children's exposure to alcohol marketing. GPS data was successfully linked with over 95% of images with alcohol marketing. Thus, linking GPS data with image data provided a substantial improvement on previous methods of neighbourhood audits to conduct spatial analyses (212, 403).

9.3.2 Can an effective imputation method be developed for missing GPS data?

The Kids'Cam GPS dataset contained modest amounts of missingness, which was partly accounted for using a novel mixed imputation method. Automated imputation produced 344,849 coordinates, for small gaps in GPS data (<5 minutes) and small movements (<100m). Image data provided information about the potential sources of missing data and validated the methodological assumptions and spatial accuracy of automated imputation. The accuracy of automated imputation suggests that the rules set in this study may apply to other studies with similar missing GPS data. The flexible nature of the imputation method enables the associated Python script to undergo continual development and adaption as research methodology for spatial data evolves, a likely advance on previous methods (389, 390).

Manual imputation produced a further 307,440 GPS coordinates using the image data captured by the wearable cameras. Manual imputation addresses larger data gaps when participants were relatively immobile. The image data provided actual study start times that accounted for cold starts, that is, the period between turning a GPS device on to the time it receives a satellite connection (348). Cold starts are a complication that other imputation processes fail to account for, contributing up to an estimated 15% of data loss (389). Another advantage of manual imputation was that it used known locations, ensuring the spatial accuracy of every imputed point was within the normal GPS tolerance (<5m). Finally, manual imputation was more effective than automated imputation at retrieving GPS points for image data missing spatial data.

In summary, the mixed imputation method was effective at recovering a modest amount (16%) of all potentially missing GPS data. Automated imputation was more effective and time-efficient for recovering total amounts of GPS data, while manual imputation was more effective at retrieving specific spatial information, that is, GPS data associated with image data.

9.3.3 What is the extent of children's neighbourhoods?

In this current study, neighbourhood extent analysis using multiple buffers at incremental distances, and clear and replicable criteria, revealed that children's neighbourhood extent was 500m. The constrained nature of children's mobility found in this study echoes existing neighbourhood research (99, 307-309). The use of GPS data informed decisions about children's neighbourhood extent based on their actual mobility patterns, a likely improvement on previous studies that often rely on arbitrary decisions on buffer sizes from 200m to 1,600m (99, 307-309).

The use of PSNB was first used by Oliver, Mavoa et al. (99), albeit without definable criteria. In this current study, criteria included 1) children spending over 50% of their time within this buffer, and 2) the largest absolute increase in the percentage of time spent from adjacent buffers. Given there is no universal measure of neighbourhood extent, the use of PSNB (based on replicable criteria) could enhance comparability between studies. This thesis reinforces the value of shifting away from attempting to define a single measure of neighbourhood extent and instead focusing on determining people's neighbourhood extent based on how and where they spend their time.

9.3.4 *What destinations do children visit that may be important for their health?*

In this current study, children most commonly left their neighbourhood to visit schools, other residential locations and food retail outlets. These findings were made possible through the development and use of a destination detection application (called GPSAS_Destinations), based on the ST-DBSCAN algorithm, and wearable camera image data. The development of an open-source destination detection application makes destination analyses more accessible to researchers unfamiliar with Python.

While other studies have been able to detect the number of participants' visits to destinations using ST-DBSCAN (372, 373), a more difficult methodological challenge is correctly identifying such destinations. Previous research has either not attempted to identify destinations (373) or has used geocoded amenities data to identify destinations (372). In this study, the increased accuracy achieved in identifying the destinations that children visit is a substantial improvement on previous methods.

9.3.5 *Micro-spatial analysis*

The use of wearable cameras in this study enabled a micro-spatial analysis of the indoor supermarket environment. By demonstrating the feasibility of spatially examining participants' actual movements within an indoor space using real-time data, the micro-spatial analyses conducted in this study builds on those conducted in previous studies

(377-379) and provides a template for future research investigating the spatial elements of indoor environments. For example, many professions require employees to wear wearable cameras, eg, police or nightclub bouncers. Image or video data could be used in micro-spatial analyses to identify spatial patterns of violent offences within buildings/clubs.

9.3.6 Summary

This section has discussed the methodological research questions of this thesis. First, the findings provide further evidence of the feasibility of using wearable cameras to conduct health research, specifically, their accuracy and reliability to study children's exposure to alcohol marketing. They also demonstrate the advantage of using GPS data to analyse the spatial patterns in children's exposure to alcohol marketing. Second, a mixed imputation method was shown to be effective at retrieving missing GPS data, with automated imputation being more time-efficient than manual imputation. Third, the neighbourhood extent analysis showed that children are relatively constrained in their residential neighbourhoods, spending over 50% of their time within 500m of home. Fourth, focusing on the destinations visited by children provides a greater understanding of the broader influences on children's health and potential places to intervene, eg, school and food retail outlets. Finally, the current study appears to be the first to conduct micro-spatial analysis on indoor environments using real-time data, an approach that highlights the spatial patterns within smaller geographic units.

9.4 Theoretical models

This thesis uses two theoretical models to explain how children's environmental exposure to alcohol marketing could potentially influence children's alcohol-related outcomes. The first is a social-ecological model of health that posits that behaviour is influenced at multiple levels from intrapersonal to public policy. The second is CST that posits children's understanding of the commercial world changes according to developmental stages and is influenced by socialising agents, including marketing.

9.4.1 Socio-ecological model of health

As discussed in Chapter Two, a socio-ecological model of health provides a useful conceptual framework to understand the broader influences on an individual's alcohol-related behaviours. That is, our behaviour and health are influenced by our environment, at multiple levels, including intrapersonal, organisational and public policy, as illustrated in Figure 38. This study found that children's homes, neighbourhoods and popular destinations (sports venues, supermarkets) were sites of frequent exposure to alcohol marketing, demonstrating the influence of organisational contexts on children's exposure to alcohol marketing that may increase their chances of drinking. Further, a socio-ecological model helps demonstrate how public policy approaches to alcohol marketing could reduce children's exposure to alcohol marketing. The policy implications of the study findings at local, national and international levels are discussed later in this chapter, informed by a socio-ecological model of health.

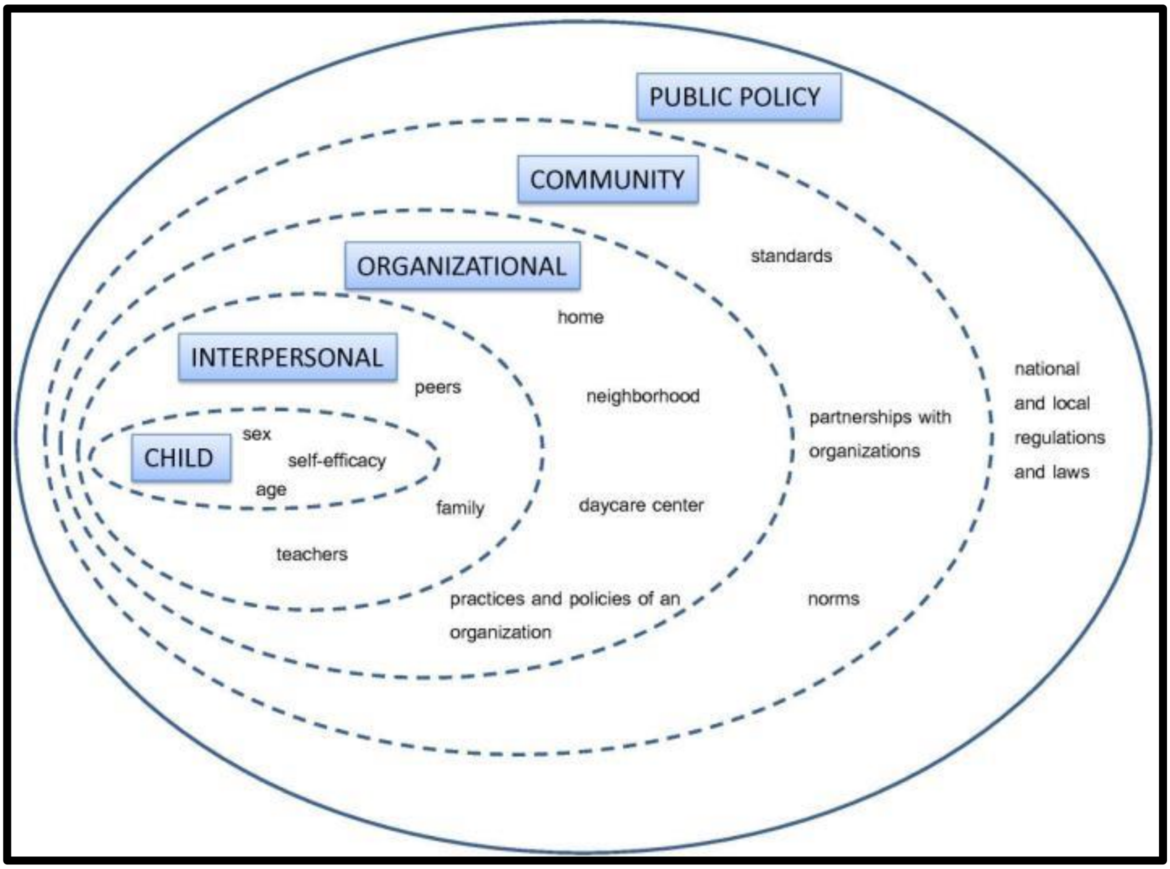


Figure 38: A socio-ecological model of health. Source: Mehtälä, Sääkslahti et al. (82)

9.4.2 Consumer Socialization Theory (CST)

As discussed in Chapter Three, CST posits children are socialised as consumers by several socialising agents, including marketing. CST suggests children aged 11-16 are susceptible to the persuasive messages in marketing and are vulnerable to such marketing. Further, children aged 11-16 link their self-identity to the brands they use, and make inferences about others based on the brands they use (166, 167). In this current study, children were on average exposed 12.4 times per day to alcohol marketing in a range of places, potentially socialising children to, and normalising, alcohol. Children in this study were aged 11-13 and unlikely to have developed sufficient defence mechanisms to marketing.

Children were exposed to alcohol marketing via a number of promotion types, some of which utilised other powerful socialising agents (eg, athletes via sports sponsorship). Previous research has shown that exposure to alcohol marketing is associated with measures of consumer socialisation (172, 404), with one such study demonstrating children's socialisation to alcohol is also influenced by the number of different types of alcohol promotion (172). Given that the extent and range of media are increasing, marketing is becoming an increasingly important socialisation agent. Additionally, alcohol marketing uses other socialising agents that may increase the persuasiveness of marketing messages, such as children's favourite sporting heroes or teams, strategies that have been shown to lead to positive attitudes towards alcohol brands (112).

Overall, CST helps to highlight the vulnerability of children in this study to alcohol marketing due to their age. Further, CST helps explain the potential mechanism behind children's exposure to alcohol marketing and later alcohol consumption (9-11) and helps demonstrate why the findings in this thesis are a public health concern.

9.5 Strengths and limitations

This study is likely the first to provide a quantifiable rate of children's everyday exposure to alcohol marketing, in real-time, using wearable cameras and GPS devices. The Kids'Cam methodology provided comprehensive information about the place in which the exposure occurred and the promotion type. Moreover, GPS data enabled the analysis of the spatial patterning of alcohol marketing exposures by providing the exact location of each exposure. As a result, this study provided a robust and replicable method for quantifying children's exposure to alcohol marketing. However, some methodological challenges to the Kids'Cam dataset limit the findings' generalisability and highlight areas for improvement in future studies.

9.5.1 *Strengths*

Several strengths of the Kids'Cam Alcohol methodology improve on those of previous alcohol marketing studies. These include: providing a quantifiable rate of exposure, using real-time exposure data from wearable cameras and GPS devices, and having a robust neighbourhood definition and sampling design that highlighted inequity, including for Māori.

Wearable cameras

To our knowledge, this study using wearable cameras is the first to provide accurate rates of children's real-time exposure to alcohol marketing, particularly in those places (home) and via promotion types (product packaging, non-televised sponsorship) that are difficult to access. Previous research has often relied on self-report Likert scale data. Such methods may not completely capture the extent of children's exposure to alcohol marketing as they are subject to recall bias and measurement error (213, 215, 216). The wearable cameras also enabled the capture of repeated exposures, which is a key aspect of how marketing influences an individual's perception and attitudes towards a brand or product (158-160). Researchers and policymakers can use these findings to inform future research and policy.

The image data from wearable cameras provided a robust validation tool for the mixed imputation method for GPS data and the destination detection application. This is one of the first studies to use wearable camera data to validate methodological assumptions about GPS data loss, building on the work done by Meseck, Jankowska et al. (389). Further, image data provided objective information to validate the destination detection application and to identify the exact destinations children visited, that is an improvement on using amenities data (372).

GPS devices

The use of GPS devices was another strength of this thesis. Spatial data was used to locate the precise site of children's exposure to alcohol marketing that was subsequently used in neighbourhood alcohol marketing analyses, an improvement on neighbourhood marketing audits (212, 403). GPS data also provided spatial information on the alcohol marketing exposure in supermarkets. Further, GPS data provided information on children's real-time movements that were subsequently used to inform the neighbourhood extent analysis, a method that is more robust than basing neighbourhood definitions on assumptions about children's mobility patterns.

Neighbourhood extent definition

Building on previous methods, this research used clear and replicable criteria to define children's neighbourhood extent (99). Using replicable criteria for defining the neighbourhood extent could enhance the comparability between studies investigating children's neighbourhoods. These criteria should acknowledge different populations likely have different neighbourhood extents. Therefore, the criteria used to define the neighbourhood extent should incorporate how people spatially and temporarily use the area around them.

Data quality

Over 95% of images captured by participants could be used in the content analysis for alcohol marketing (380). This is a relatively high rate of usable images considering the limitations of the cameras, discussed later in this chapter. Further, numerous studies have successfully used the Kids'Cam dataset to study a range of different health-related behaviours and exposures. For example, other Kids'Cam studies investigate blue space (329), greenspace (413), screen time (401), tobacco (414), food marketing (332) and sun safety (410).

Sampling design

The sampling design provided near equal explanatory power for Māori and Pacific groups that enabled analysis of potential social inequalities. Sampling to gain near equal explanatory power enables greater understanding of the experiences of Māori and Pacific children than a sampling design that included Māori and Pacific children relative to their proportion in the population. The over-sampling of Māori and Pacific children was accounted for by sampling weights included in analyses. The study findings show that an equal explanatory power sampling design highlighted Māori and Pacific children's exposure to alcohol marketing and ensured comparisons with NZE. Highlighting these social inequalities is a crucial step towards addressing them. Furthermore, equally reporting and highlighting the experiences of Māori is consistent with the Memorandum of Understanding between Te Runanga o Ngai Tahu and the University of Otago, and Te Tiriti o Waitangi.

9.5.2 Limitations

The study has several limitations that may have implications when interpreting the findings. These included statistical imprecision, response rates, missing GPS data, social desirability bias, coding limitations and the issue of potential exposure.

Statistical precision

The lack of statistical precision is reflected in the relatively broad confidence intervals presented in the results chapters, particularly those analyses in Chapter 7 that compared exposure rates among sociodemographic groups for individual places or promotion types. Consequently, these results should be interpreted with caution. However, this is still one of the largest observational studies of children's real-time exposure to alcohol marketing ever conducted, with 167 participants and over 700,000 images analysed.

Some factors including the sample size, participant observation time and the sampling strategy limited the statistical precision of analyses in this thesis. The sample size in Kids'Cam was calculated using estimates of children's exposure to food marketing (estimated 60 per day). Children in this study were exposed to alcohol marketing 12.4 times per day, substantially less than the 60 predicted for food marketing. Thus, this current study may be underpowered. As outlined below, providing a reliable estimate for a sample size for future studies is a difficult task as other factors also influence statistical precision.

Another factor influencing the statistical precision of the analyses was the variability in participants' observation time. Increasing the quantity of participants' observation time would likely increase the statistical precision of analyses. Negative binomial regression models were required to account for the over-dispersion in children's exposure to alcohol marketing towards zero. Such over-dispersion is likely to limit the statistical precision of the analyses to detect differences between groups, as there is a concentration of children with the same values. Children with zero alcohol marketing exposures tended to have the least amount of observation time. Thus, increasing participants' observation time is likely to reduce this over-dispersion, and in turn, increase the statistical precision of estimates.

The Kids'Cam sampling strategy involved recruiting children from schools, which introduced clustering of children as a potential limitation. That is, children from the same school are possibly more alike than children from another school. We recruited 168 children from 16 different schools. Recruiting children from more schools would likely reduce the influence of clustering and improve the statistical precision of the subsequent analyses. Alternatively, individual recruitment would overcome the clustering limitation. However, individual recruitment methods may not be as practical as they can be more burdensome and time-consuming than clustered approaches.

Response rates

Overall, 43% of the children invited to participate in Kids'Cam consented. The revealing nature of Kids'Cam method raises concerns about privacy that may have limited the appeal of participation for children and parents. However, a 43% response rate is comparable to other studies. For example, a systematic review of 35 studies comparing response rates between email and mail surveys found the average response rate for email surveys was 33%, while mail surveys was 53% (415). Other studies adopting more intrusive study methodologies using wearable cameras or portable electronic computers include purposely selected small samples (n < 60) (330, 411) or do not report on the response rate (214). In sum, such sparse evidence of response rates from similar studies limits the ability to contextualise the response rate for Kids'Cam, however, considering the intrusive nature of the method it is likely a relatively strong response.

The sampling design aimed to recruit equal numbers of NZE, Māori and Pacific participants from the three school decile strata. However, there were fewer Pacific (25%) and Māori (35.7%) children than NZE (39.3%) children recruited over the study period, particularly Pacific children in high decile schools are underrepresented (only seven children recruited, 11 fewer than required for an equal distribution). This limitation may be explained by the lack of high decile schools with sufficient numbers of Year 8 Pacific students on their role. The social patterning of housing in NZ, whereby Pacific people are more likely than NZE to live in the most deprived areas (416), is a possible reason for the difficulty in recruiting Pacific children from the least deprived areas. For example, over 35% of all Pacific people live in areas of high deprivation compared to just over 5% of all NZE (416). Therefore, the conclusions made about the experiences of Pacific children are over-represented by children from low and medium decile schools, which reflects the reality of Pacific children in NZ.

It is possible there were differences between the children who did and did not consent to participate in Kids'Cam, thereby potentially introducing selection bias. However, the random selection of the children and schools likely mitigates such bias.

Urban study population

The children in this study were from urban centres in the Wellington region, thus the findings may not be relevant to children living in rural locations. In future studies, the inclusion of children from rural settings may enhance the generalisability of the findings to children living outside major urban centres. However, in NZ, only 14% of people live in rural settings (417), so it is likely the current findings are applicable to most NZ children (86%). Further, there is little difference in alcohol policies between urban environments. The findings may also be applicable to children living in urban centres in other countries with similar alcohol marketing policies, such as Australia and the UK.

Missing data

In Kids'Cam, the children collected over 1.3 million images and 2.3 million GPS points during the study period. However, there was still a substantial amount of potential missing data (64% for GPS data). The word potential is used as the reasons for the devices being turned off are unknown, eg, because the participant was sleeping, they were asked to switch it off or because they forgot to turn it on. As a result, missing data could be due to participant compliance with the study protocol or differences in children's waking hours over the four days, factors that are hard to quantify.

NZE children collected significantly more image data than Māori and Pacific children. Similarly, children from the least deprived neighbourhoods collected significantly more image data than children from moderate and the most deprived neighbourhoods. Thus, it is possible the data over-represents the experiences of NZE children and children from the least deprived neighbourhoods, particularly as estimates were weighted towards those children with more observation time. Given that NZE children and children from the least deprived neighbourhoods had the lowest rates of exposure to alcohol marketing, it is likely that, due to missing data, the observed exposure rates may be an underestimate of children's overall exposure.

To mitigate the impact of potential missing data, a mixed imputation method compensated for smaller amounts of GPS data caused by GPS unit signal loss, non-participation and unit malfunction. However, the imputation method had its limitations. Imputed GPS data may have been biased towards places where children were relatively spatially and temporally constrained (travelling less than 100m in five mins). Therefore, the imputation method was less likely to impute trips to destinations than time spent at destinations themselves. This is a bias that has implications for research investigating children's trips to destinations (eg, trips to and from school).

Imputation also increased the differences in data missingness by sociodemographic groups, with further over-representation from NZE children and children from the least deprived neighbourhoods. Considering imputation relies on known locations, it is reasonable to assume that such imputation methods will bias data missingness towards those groups collecting more data (eg., NZE children and children from the least deprived neighbourhoods). Sociodemographic bias in imputation has implications for future studies adopting a similar method. Consequently, in this study, the full dataset (with imputed data) over-represents the experiences of NZE children and children from the least deprived neighbourhoods.

Social desirability bias

Social desirability bias has been raised as a potential limitation of some visual research methods such as the use of wearable cameras (418, 419). That is, participants might change their behaviour while under surveillance. While an important consideration, based on the amount of data, and the sensitive nature of some of the images (including images of children viewing pornography and visiting gang houses with Nazi flags) it is unlikely social desirability bias had a substantial effect on the results in this study. Furthermore, the children were blinded to the research interest in alcohol marketing and were therefore unlikely to change their behaviour when exposed to alcohol marketing. In addition, if social desirability bias was a factor in this study, it is likely the observed findings underestimate children's actual exposure to alcohol marketing, as children would be more likely to turn off devices when exposed to adverse health exposures such as alcohol marketing.

Coding limitations

The extent of children's exposure to alcohol marketing found in this study is also likely underestimated due to the study's conservative coding rules. First, the requirement to clearly identify > 50% of the alcohol marketing led to many uncoded alcohol marketing exposures. The 50% requirement was based on other frequency analyses (128, 129) and to ensure consistency with Kids'Cam (332). However, often marketing is recognisable and effective when < 50% of it is visible (Figure 39, A). Second, due to camera image resolution, often images were too blurry to code marketing, even though they were identifiable to an experienced coder (Figure 39, B). Third, to limit coder fatigue, multiple exposures of the same type were coded as a single exposure, reducing the number of actual exposures. For example, in Figure 39 (C), all the *Jim Beam* product packaging would be coded as a single exposure, rather than six independent exposures. Finally, when more than three brand exposures were visible (n = 165 times over study period), such as in Figure 39 (C), the image was coded as 3+ brand exposures.

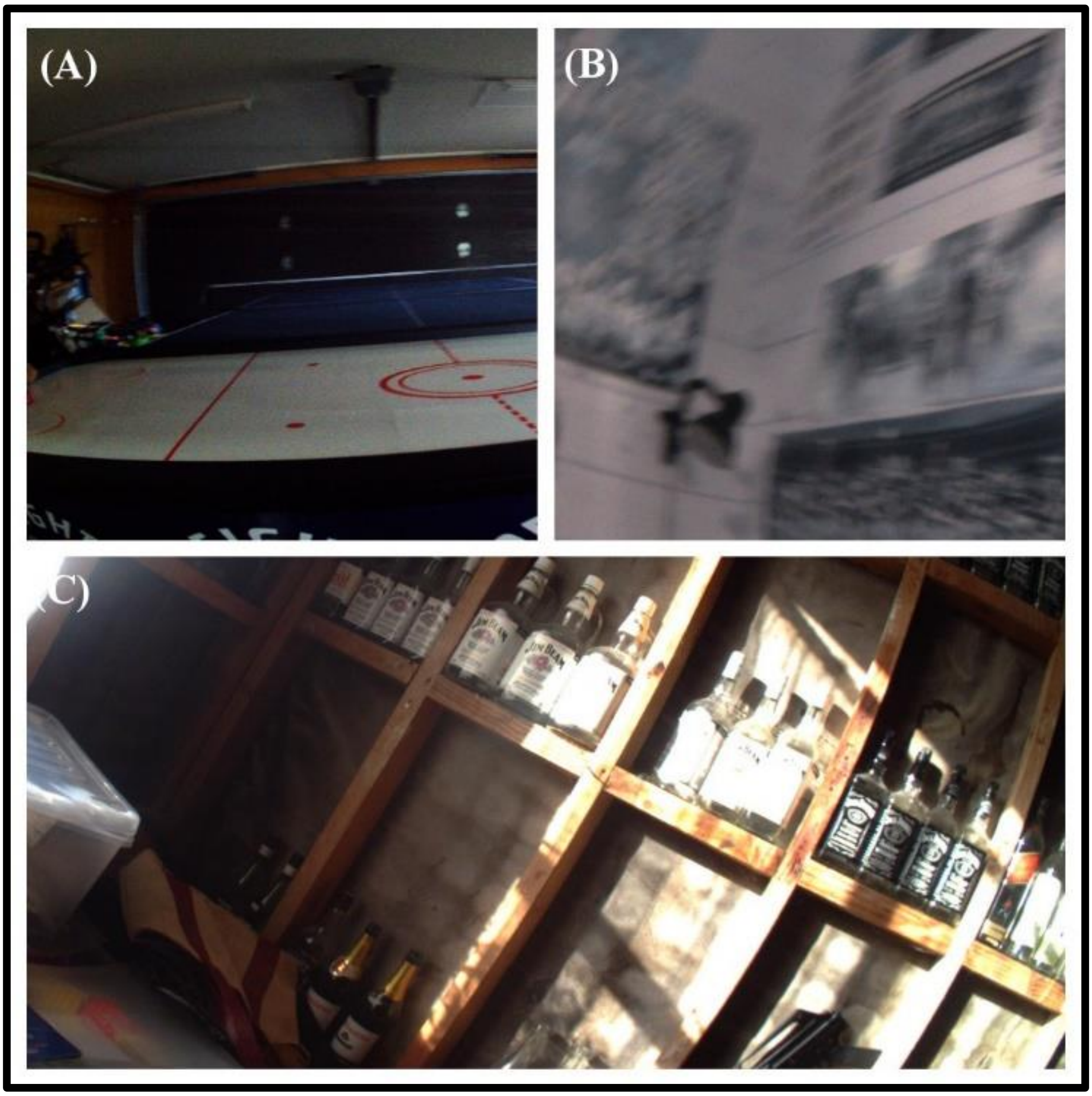


Figure 39: Examples of coding limitations and conservative coding criteria

Another coding-related limitation was the inability to consistently capture content displayed on screens due to poor lighting, low screen resolution or bad camera positioning. For example, Figure 40 (A) and (C) are examples of poor screen resolution. Figure 40 (B) is an example of both poor lighting and bad camera positioning resulting in the content on the screen being unidentifiable. Figure 40 (D) is an example of a video that has alcohol content (*Steinlager Pure* alcohol bottle), but it is not codable due to the lack of screen resolution and small screen size. However, there is evidence of the extent of children's exposure to alcohol marketing via television (420) and digital alcohol marketing (182). To address this limitation, and highlight areas for intervention, a qualitative assessment of the nature of screen-based exposures was conducted.

Figure 40: Examples of problems with seeing content on screens including poor resolution (A), poor lighting/camera angle (B), poor resolution (C), and not clear enough to code (D)

While 95% of images were codable, some codable images had important features blocked due to camera positioning. For example, in Figure 41 (A), the child is viewing two screens, however, due to the positioning of the camera and the child’s leg blocking the television, the content of both is obscured or not viable. Likewise, the positioning of the camera on the child's chest resulted in the camera position often being lower than car windows. Consequently, it is likely the cameras did not capture children’s exposure to alcohol marketing when they were travelling in a car, eg, Figure 41 (B).

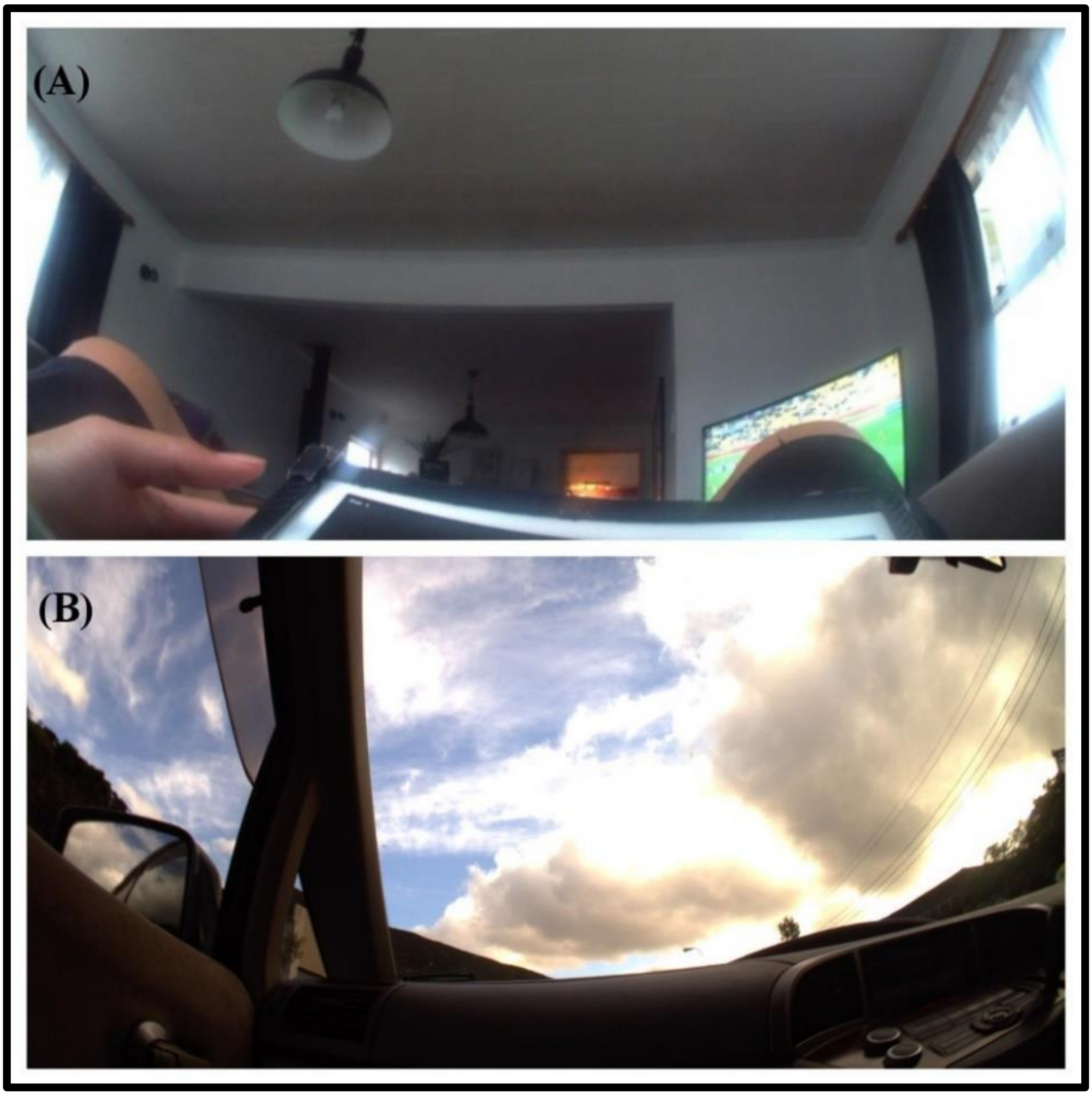


Figure 41: Examples of images where camera positioning prohibited coding

Another limitation was the decision to code exposure to alcohol marketing within off-licence collectively as *marketing encounters*. It is likely the hundreds of marketing exposures that occur within off-licence outlets have a greater effect than a single exposure to alcohol marketing; equally, it may not be equivalent to 100 exposures.

Consequently, marketing encounters were deemed conceptually and fundamentally different from other marketing exposures. Given the multiple marketing exposures in off-licences were not accounted for, the daily rates of 12.4 exposures in this study are an underestimate.

The manual content analysis of all images (n = 700,000) for Kids'Cam Alcohol took around three months of full-time work or 480 hours. Kids'Cam estimated manual coding took around 1,440 person-hours (380). However, this analysis required coding every image using the custom-built software developed by DCU, which was slow and prone to crashing. In contrast, Kids'Cam Alcohol only required coding images with alcohol marketing. Subsequent Kids'Cam studies benefited from Kids'Cam codes, extracting images based on place codes and substantially reducing the pool of images for content analysis. For example, a researcher may extract images that are in outdoor places, reducing the total pool of images from 1.3 million to 100,000. Furthermore, all blocked or blurry images were coded and not included in future studies. Other Kids'Cam studies avoided using the time-intensive coding software and opted for a combination of viewing images in any standard image software (eg, *Windows Photo Viewer*) and coding images in an Excel file (329, 410).

Another potential limitation was having only one coder. It is possible that exposures were missed due to coder fatigue or tendency to miss certain types of exposures. However, efforts were made to reduce the error associated with having a single coder, such as enforced breaks during the coding process. If exposures were missed as a result of coder fatigue, it is likely the estimates produced in this research may underestimate children's true exposure.

Potential exposure

While the data provides real-time data on the presence of alcohol marketing in children's environments, it does not establish that children 'saw' the marketing. For example, it is possible the child was looking away when the alcohol marketing was present and therefore was not exposed to it. However, the opposite could be true; children could be exposed to alcohol marketing that is not captured within the camera's line of vision. Considering children have a greater range of vision than the Autographer, the latter scenario is more probable.

9.5.3 Summary of strengths and limitations

On balance, the tandem use of wearable cameras and GPS devices provided one of the most reliable and accurate measures to-date of children's real-time exposure to alcohol marketing. There appears to be only one other study that attempted to quantify children's real-time exposure to alcohol marketing (214). Kids'Cam Alcohol builds on this previous study by 1) removing the need for children to consciously recognise and record marketing exposures, 2) including a greater range of places and promotion types and 3) analysing the spatial patterns of children's exposure to alcohol marketing. However, it appears the conservative coding criteria and inability to quantify screen-based exposures led to underestimates of children's overall exposure. Therefore, while this study provides one of the most reliable estimates of children's exposure to alcohol marketing, given the study limitations it is likely that children's true exposure to alcohol marketing may be higher.

9.6 Implications for further research

This research investigated the extent and nature of children's real-time exposure to alcohol marketing, but there were gaps not addressed in this current research that future research could explore. The school environment was excluded in this study as schools should be free of alcohol marketing. Yet, the preliminary analysis found posters of sports teams with their associated alcohol sponsorship in classrooms.

Further research should investigate the extent of alcohol marketing on screens. As discussed in Chapter Three, extensive research has investigated television alcohol marketing, with 18 of the 25 longitudinal studies in the three systematic reviews focusing on television (9-11). Yet, as television restrictions become more common and children's media preferences are changing from television to digital media, the importance of television marketing is waning. Therefore, future research should investigate the extent of digital alcohol marketing and if possible, its impact on children's alcohol consumption. This is becoming increasingly possible with the ability to record screen activity (421). Screen recording could enable a detailed analysis of children's interaction with, and exposure to, digital alcohol marketing thereby extending the work of this thesis.

In this research, alcohol availability was associated with exposure to alcohol marketing, providing evidence to support the hypothesis proposed by Campbell, Hahn et al. (285) that alcohol availability may influence alcohol-related outcomes via exposure to alcohol marketing. Thus, future research could explore alcohol availability as a possible driver of demand for alcohol. For example, Table 41 presents an adapted version of the taxonomy developed by Kypri (110) which was presented in Chapter Two, positioning alcohol availability as a demand-side policy intervention.

Table 41: Taxonomy of population-based alcohol policy interventions. Adapted from Kypri (110)

Policy paradigm		**Population-based interventions** Policies and interventions applied to whole populations without regard to individual risk
Demand-side	*Regulated*	Alcohol marketing
		Drink-driving laws and enforcement
	Voluntary	Public health messaging
		School-based education
	Physical	**Alcohol availability (outlet density/proximity)**
Supply-side	*Physical*	Alcohol availability (outlet density/proximity)
		Minimum purchase/drinking age >18
		Alcohol service laws
	Economic	Taxes on alcohol
		Minimum unit pricing

* **Bolded** = changes to original taxonomy

Future studies could attempt to recruit a larger sample of participants, increase observation time and introduce a less limiting sampling strategy to increase the statistical precision of analyses. A major limitation to recruiting the appropriate sample size is a lack of evidence of the predicted number of alcohol marketing exposures per day. Despite the likely underestimate, the results in this current study provide an improved estimate over previous studies of children’s exposure to alcohol marketing that could inform power calculations for future studies.

This current study focused on quantifying children’s exposure, and did not attempt to draw associations between children’s exposure to alcohol and alcohol-related outcomes. Previous exposure studies, particularly those using longitudinal study designs, have built the foundations for this current study. Longitudinal research provides valuable evidence to build on the existing literature (9-11). Ideally, future studies would include an alcohol-related outcome and incorporate a longitudinal design so reverse-causality can be excluded as a potential limitation. For example, Collins, Martino et al. (214) have the opportunity to conduct such research as their cross-sectional analysis of children's real-time exposure to alcohol marketing is part of a larger longitudinal study.

This current study used conservative rules for both coding alcohol marketing exposures and rules for imputation. To reduce the underestimation of children's exposure to alcohol marketing, future studies could use less restrictive coding criteria. Likewise, the spatial and temporal constraints of automated imputation were conservative and may be extended in future studies. For example, it is possible that temporal constraints of static settings (where little movement has occurred) could be extended well beyond five minutes, particularly as manual imputation demonstrated these types of data gaps were common.

The utility of visual research methods is increasing as visual technology improves and becomes more accessible. New models of wearable cameras possess greater battery life, better image quality and larger storage capabilities. For example, Table 42 compares the specifications for the *Narrative Clip 2* with *the Autographer* used in this study. The more recent *Narrative Clip 2* has greater sensor resolution (image quality), more storage capacity and substantially better battery life than the *Autographer*. The battery capacity of the *Narrative Clip 2* suggests that GPS and image capture could occur simultaneously, removing the need for two devices and cumbersome data linkage. Improving technology increases the validity of visual research methods and overcomes some of the limitations cited above, particularly concerning image quality and the ability to analyse content on screens. Furthermore, improvements in analytic systems, such as image recognition software, highlight exciting opportunities that could substantially reduce the time and cost required to analyse visual data (339).

Table 42: Comparing specifications of wearable cameras, *Narrative Clip 2* v *Autographer*

Specifications	Narrative Clip 2	Autographer
Sensor resolution	8 Megapixel	5 Megapixel
Hard disk storage	8GB + 10 GB cloud storage	8GB
Battery life	30 hours	10 hours
Water resistant	Yes	No
Image capture frequency	1/10s, 1/30s, 1/120s	1/s, 1/10s/ 1/60s
Sensors	Accelerometer GPS	Accelerometer GPS Light and temperature

9.7 Preventing children's exposure to alcohol marketing: implications for public policy

The global burden of alcohol-related harm includes a raft of physical, social and financial costs (2), which is mirrored in the NZ context (48). There is a large body of evidence demonstrating children's exposure to alcohol marketing is associated with alcohol consumption (1, 9-11). Restrictions on alcohol marketing is one of WHO's 5+ population-based solutions and one of the three best buys to reducing alcohol-related harm (14). The findings of this thesis demonstrate children are frequently exposed to alcohol marketing in places and promotion types amenable to policy intervention. Thus, they strengthen the arguments for more restrictive alcohol marketing policies to reduce children's exposure to alcohol marketing and its associated alcohol-related outcomes.

This section discusses the policy implications of the study findings at local, national and international levels. At a local level, the discussion focuses on areas where local by-laws can reduce children's exposure to alcohol marketing such as banning outdoor marketing and zoning policy. At a national level, the feasibility and justification of implementing legislative restrictions on alcohol marketing are addressed. The international response looks at the feasibility of a FCAC and the development of international marketing codes for alcohol.

9.7.1 Community approaches

The 2012 Sale and Supply of Alcohol Act intended to give communities greater control over local licencing decisions. However, as discussed in Chapter Four, the law is often hard for local communities to understand, it is time intensive and places the burden of proof upon the community (422). These results, particularly those demonstrating a direct link between off-licence alcohol outlets and exposure to alcohol marketing, provide communities much needed local evidence to inform local licencing decisions. In addition to new evidence, more supportive environments for participation and action for communities are required (423).

Given the high rates of exposure at sports venues and via sports sponsorship, these results suggest sport may be an effective point of intervention for local communities. In Australia, the Good Sports Program in local sports clubs promotes responsible alcohol policies (424). This programme could be introduced in NZ. Alternatively, community sports clubs are free to implement alcohol control policies that would reduce exposure such as not serving alcohol at events attended by children, not accepting sponsorship from alcohol companies and limiting the promotion of alcohol.

9.7.2 Local government approaches

This research showed that children are frequently exposed to alcohol marketing in places, and via promotion types, regulated by local governments in NZ and may be applicable to local governments in other countries with similar alcohol marketing policies. Thus, local government policies for outdoor marketing and zoning regulation have the potential to reduce children's exposure to alcohol marketing and potentially reduce alcohol-related harm. Local governments acknowledge that alcohol causes substantial harm within their cities and as such have mechanisms to reduce these harms (326, 425). For example, the Wellington City Council's provisional LAP states, "excessive alcohol consumption and alcohol-related harm threaten residential amenities and the economic vitality of the city. Where this occurs, or there is the potential for it to occur, the Council will act to protect the health of the community" (425, p.5).

Ban or restricting outdoor marketing

Given the children in this study were exposed to outdoor marketing (shop front signage and signs) around 1.8 times per day bans or restrictions are warranted. The most effective bans on outdoor alcohol marketing come from cities implementing complete bans on all forms of outdoor marketing, including alcohol, such as São Paulo (Brazil) and Grenoble (France). In São Paulo, the city council removed over 15,000 billboards and 300,000 over-sized shop front signs in a single year (426). Grenoble became the first European city to ban outdoor marketing, replacing 326 billboards with trees and areas for public expression (427).

In Chapter Eight, this study showed that children were frequently exposed to alcohol marketing in their residential neighbourhood. As discussed in Chapter Three, zoning policy can guide the location of alcohol outlets and marketing by restricting such marketing in residential areas, such as those implemented in Baltimore (258). Such an approach could substantially reduce children's overall exposure to alcohol marketing. In contrast, self-regulatory models on outdoor marketing in the US have been shown to be ineffective (258) and should be avoided.

In NZ, as discussed in Chapter Three, local councils can regulate outdoor marketing. However, most councils have limited restrictions on outdoor marketing and none for alcohol. As this research demonstrates, alcohol marketing is openly promoted on outdoor signs, billboards and public transport across the four councils in the Wellington region. There are few limitations imposed by councils on the content of user-made signs, such as sandwich boards or shop front signage. Councils could prohibit the promotion of alcohol on any custom outdoor signage. While there would be likely resistance from local businesses and the alcohol industry, restrictions on shop front signage and signs could reduce children's daily exposure to alcohol marketing by an average of 1.8 exposures per day.

Restricting alcohol marketing near sensitive sites

The study findings showed that the density of off-licence alcohol outlets in their school neighbourhood was a strong predictor of children's exposure to alcohol marketing. Prohibiting the sale and promotion of alcohol around sensitive sites, such as schools, churches and playgrounds (clean zones), is another policy action for local governments. Schools are the most common point of interest for alcohol clean zones. For example, in Bangkok, Thailand, the sale of alcohol is prohibited within 300m of any educational facility, including schools, colleges and universities (428).

In NZ, local governments can regulate alcohol sales near sensitive sites, but this is rare and poorly executed. In the Wellington region, Hutt City Council's accepted LAP does not contain restrictions related to sensitive sites. Porirua City Council's accepted LAP does not permit new alcohol licences near sensitive sites (with no definition of near) unless exposure is mitigated. Supermarkets are exempt (142). Wellington City Council's provisional LAP proposes all new licenses within 100m to sensitive sites be closely reviewed (425). However, this provisional policy has yet to undergo judicial review and be ratified. Upper Hutt City Council has not produced a LAP. Further, it should be noted that at the time of writing, six years after the introduction of the SSAA, the majority of New Zealanders live in a region without a LAP (142). Additionally, Māori are more likely to live in jurisdictions without a LAP than non-Māori. Therefore, these findings demonstrate that the SSAA needs urgent revision to avoid increasing health inequalities and to protect children (429).

Public transport

Restricting marketing at public transport facilities and on public transport vehicles is one method used by councils to control outdoor alcohol marketing. For example, the New York Metropolitan Transport Agency removed all alcohol marketing from its public transport facilities and vehicles, including in subways, bus stops and on trains and buses (259). Likewise, in Australia, the ACT State Government removed all alcohol marketing on public buses and bus shelters (430). These international examples provide evidence of local governments' capacity to introduce effective alcohol marketing regulation via restrictions on public transport.

In NZ, the Auckland City Council has a policy prohibiting alcohol marketing on any council infrastructure, facilities or services. However, a contract with *NZ Bus*, a private transport company, has removed the council's ability to control marketing on Auckland buses (431). Likewise, in Wellington, *NZ Bus* runs the bus services, and therefore the council does not directly control the associated marketing (432). Councils could buy back the rights to marketing on buses when contracts come up for renewal with *NZ Bus*, as is the case for the Auckland City Council (431). Further, local councils could regulate alcohol marketing at bus shelters, which they own.

In summary, currently, there are no city-level restrictions on alcohol marketing in the Wellington region. However, local governments can implement effective alcohol marketing policy. A complete ban on all outdoor marketing would substantially reduce children's overall exposure to alcohol marketing and the normalisation of alcohol in their environments. Furthermore, there are the added benefits of having a de-commercialised environment that supports mental and physical health. In the absence of a complete ban, implementing clear proximity guidelines for alcohol outlets near schools, (eg, no alcohol outlets within 500m of schools) through LAPs is one avenue to reduce children's exposure. Finally, it is likely the findings of this research, and the possible interventions, are applicable to local governments throughout NZ and in other countries with similar alcohol marketing policies.

9.7.3 Central government approaches

In NZ, multiple government-initiated reports (133, 134), including the comprehensive Law Commission report (48), have concluded strict government intervention is required to curb alcohol-related harm in NZ, particularly restrictions on alcohol marketing. Since the publication of these reports, additional evidence of the association between children's exposure to alcohol marketing and alcohol-related outcomes has emerged (10), supporting stricter restrictions than those proposed by the Law Commission. This is further supported by this study that found children were on avergae exposed to alcohol marketing 12.4 times per day in numerous places via a range of different promotion types. These findings suggest that the current self-regulatory model of alcohol marketing regulation does not adequately protect children from harm. This section examines possible central government policy actions, starting with a discussion of Te Tiriti o Waitangi, then restrictions by promotion type and finishing by discussing a complete ban on all alcohol marketing.

Te Tiriti o Waitangi

The NZ Government is obligated to ensure that Māori have the same level of health as non-Māori under Te Tiriti o Waitangi. However, there are health inequities between Māori and non-Māori, including alcohol-related inequities. The findings of this study suggest Government intervention on alcohol marketing is likely to reduce the health inequities between Māori and non-Māori. For example, Māori children were exposed to more alcohol marketing than NZE children, primarily via sports sponsorship, at sports venues, at alcohol outlets, within their neighbourhoods and around their schools. These are all places and promotion types where Government intervention is possible. Children's exposure to alcohol marketing is likely to increase consumption and, in turn, its associated harms and disproportionate levels of exposure to alcohol marketing between

Māori and non-Māori is likely to perpetuate existing health inequity. The findings of this thesis provide further evidence that could support the current Waitangi Tribunal claim against the NZ Government for failing to sufficiently implement the Law Commission recommendations, including restrictions on alcohol marketing and sponsorship (150).

Regulating alcohol product packaging

In this study, product packaging was the most prevalent type of marketing in children's environments, contributing around two-thirds of the overall exposure to alcohol marketing. Thus, adjusting alcohol product packaging provides an opportunity for governments to reduce children's exposure to alcohol marketing and for health promotion. For example, health warnings send children information about the health risks associated with alcohol consumption and assist them to differentiate alcohol from the hundreds of other consumer goods. Many countries enforce basic nutrition labelling and health warnings on alcohol packaging, without legal action, suggesting countries may enforce such regulations without the threat of litigation (433). Countries such as Israel, Kenya, Russia, US and France enforce health warnings through legislation. For example, Kenyan legislation requires alcoholic beverages to include two of five health warnings that must comprise no less than 30% of the total surface area of the package (235).

No country has implemented plain packaging of alcohol. Arguments for alcohol plain packaging are primarily based on the successful implementation of tobacco plain packaging (241). If the effects of alcohol plain packaging mirror those for tobacco (198, 243), it could reduce children's positive attitudes towards alcohol and heighten awareness of associated health warnings. In 2016, England produced a Government report recommending research into plain packaging for alcohol, one of the only countries to do so (434).

In NZ, FSANZ regulates product packaging, under self-regulatory codes. Currently, alcohol packaging requires a health warning about the consumption of alcohol during pregnancy. However, these have had limited effect on increasing consumer awareness of the risks of drinking while pregnant as the labels cover a small section on the back of the bottle and do not appear on all alcohol packaging. Further, given the focus on pregnancy, the labels are not likely to be effective in de-normalising alcohol among children (244). In contrast, statutory regulation of alcohol packaging that enforces strong warnings about the health risks associated with alcohol consumption (including cancer, injury or death), that cover a minimum of the packaging (eg, no less than 30%) and are positioned on the front of the packaging are likely to have a greater impact (236-238).

Kenya and South Korea have effective health warnings on alcohol packaging, providing exemplars for NZ. Moreover, NZ could extend beyond these models and attempt to introduce graphic health warnings, such as those on tobacco products and as proposed by Thailand for alcohol. NZ could also follow their own example set with tobacco packaging and implement plain packaging of alcohol products (435). However, such regulation appears unlikely given NZ is one of a group of countries referring Thailand to WTO, citing their graphic health warning labels as a barrier to free trade (239). Further, a report on the self-regulatory trial period due in 2016 has yet to be produced. Although with a new Government in 2017, changes to the current system of industry self-regulation may be a possibility in NZ.

Overall, over two-thirds of children's exposure to alcohol marketing is through product packaging. Governments can regulate alcohol product packaging and defend such actions in international courts based on the experiences with tobacco plain packaging and graphic health warnings. The findings in this research suggest plain packaging and health warnings are required to protect children from exposure to alcohol marketing and harm.

Bans on alcohol sports sponsorship

Children in this study were exposed to alcohol marketing via sports sponsorship 1.4 times per day on average, more than any other promotion type, other than product packaging. While the extent of televised sports sponsorship could not be quantified in this current study, the images showed children were exposed to televised alcohol sports sponsorship. The extent of alcohol marketing exposure via televised sport is extensively reported in international (200, 211) and NZ (128, 129) literature, however, less is known about other forms of promotional activity associated with alcohol sports sponsorship. This current study addresses this gap by highlighting children's exposure to alcohol marketing via non-televised sports sponsorship, such as team posters and replica player jerseys.

Removing alcohol sports sponsorship could reduce children's exposure to alcohol marketing by an average of 1.4 exposures per day, in addition to the substantial exposure that occurs via televised sports sponsorship. Moreover, most exposures to alcohol marketing via non-televised sports sponsorship occur within children's homes and often within children's bedrooms. Therefore, restrictions on alcohol sports sponsorship are likely to reduce home-based exposures to alcohol marketing, a place that is often difficult to regulate via public policy. Further, given the association between exposure to alcohol sports sponsorship and childhood alcohol consumption, reducing exposure is likely to reduce childhood drinking and, in turn, alcohol-related harm (112, 190, 210).

Currently, most self-regulatory systems either do not cover, or they have ambiguous codes for, alcohol sports sponsorship (128). France is one of the only countries to implement a complete ban on alcohol sports sponsorship. However, recent amendments to France's alcohol marketing legislation permit alcohol marketing at some sports venues (225). Likewise, Norway has a complete ban on alcohol sports sponsorship (232). The major challenge to Norway's ban is that international broadcasts of sporting fixtures permit alcohol sponsorship.

Many other countries are considering bans on alcohol sports sponsorship, including Australia (281), Scotland (249) and NZ (134). In NZ, the MFAAS and the Law Commission recommended banning alcohol sports sponsorship because of the link between exposure to alcohol marketing and alcohol consumption, and the large numbers of children watching sport (48, 134). The value of alcohol sports sponsorship is estimated at NZ$23 million per year, split into NZ$13 million of direct cash sponsorship and NZ$10 million of non-cash sponsorship (such as merchandise and playing gear) (436). Therefore, replacing the investment of alcohol sports sponsorship would require diverting 0.2% of the NZ$1 billion revenue generated from alcohol excise tax in 2017. Currently, a special levy on alcohol contributes over $11 million to Health Promotion Agency's alcohol work. The levy currently adds 1.7 cents per litre of beer over 2.5% alcohol content (437). A trebling of the tax would add only a small amount to the cost of an alcohol product (5.1 cents per litre or 1.7 cents per standard 330ml beer), yet has the potential to bring about significant public health gains from the removal of alcohol sports sponsorship.

Ban on outdoor marketing (including shop front signage, streets, public places)

Children in Kids'Cam Alcohol were typically exposed to outdoor alcohol marketing around 1.8 times per day, which included exposure at alcohol outlet shop fronts, in the street and other public places. Further, these findings show Māori and Pacific children are more likely to be exposed to outdoor alcohol marketing than NZE children, suggesting restrictions on outdoor alcohol marketing could promote health equity. As discussed in Chapter Three, few countries ban outdoor alcohol marketing at a national level. Most recently, Lithuania introduced a ban on all outdoor alcohol marketing as part of a comprehensive ban on all alcohol marketing, an initiative that has yet to be challenged in international courts (223). Finland has a similar ban, although it excludes alcohol marketing associated with sports' teams, athletes and stadia (224). Initially, France only permitted outdoor marketing at sites of alcohol production and sales. However, an amendment to the *Loi Evin* in 1994 permitted other forms of outdoor marketing. Gallopel-Morvan, Spilka et al. (225) suggest that France's amendment on outdoor alcohol marketing resulted from lobbying by alcohol (mainly wine) producers and retailers. Such examples demonstrate restricting outdoor alcohol marketing is possible at a national level, but may be subject to industry lobbying, which can interfere with the effective implementation of the policy.

In NZ, restrictions on outdoor marketing such as those implemented in Lithuania and Finland are possible. To achieve this, the NZ Government must legislate a ban on outdoor marketing, including at shop fronts, in the streets and other public places. Further, to overcome the limitations in the Finnish model, a NZ ban should include marketing associated with sports' teams, athletes and stadia. The MFAAS recommended banning shop front signage and alcohol sports sponsorship (134), providing support for Lithuanian-like regulation in NZ.

Restrictions on in-store marketing

In this study, children were on average exposed to alcohol marketing via in-store marketing three times per week and on nearly every visit to supermarkets. Regulations in the SSAA did not prevent children's exposure to alcohol marketing within supermarkets. Given the evidence of the association between exposure to in-store alcohol marketing and childhood drinking (102, 105, 191, 193), the findings of this study highlight the need for intervention.

As discussed in Chapter Three, in some jurisdictions, legislation prevents supermarket alcohol sales based on availability arguments, that is, reducing alcohol availability reduces alcohol consumption (109). The findings in this thesis provide another angle for arguments against supermarket sales of alcohol. Banning supermarket sales of alcohol is likely to both prevent childhood exposure to alcohol marketing and remove the normalisation process that occurs when children see alcohol sold next to ordinary commodities.

As discussed in Chapter Three, 18 NZ licensing trusts still function; in two licensing trusts supermarket sales of alcohol are not permitted (438, 439). The licensing trust system is a valid model in these regions. For example, in 2017, the Invercargill Licensing Trust generated a NZ$10 million profit while prohibiting supermarket sales of alcohol (439). Children's frequent exposure to alcohol marketing reinforces calls by the New Zealand Medical Association, Alcohol Healthwatch (a NZ NGO), and the NZ Police to remove alcohol sales from supermarkets (440, 441). A solution would be to remove supermarket licences via an amendment to the SSAA. Such legislation is likely to face significant challenges from supermarkets, which sell 60% of all wine and 30% of all beer in NZ (116). However, the findings of this thesis provide strong evidence that removing alcohol sales from supermarkets would reduce children's exposure to alcohol marketing. Further, it is likely there would be additional benefits to removing supermarket sales of alcohol, by reducing alcohol availability (i.e. the number of alcohol outlets and the convenience of alcohol being sold with other consumer products). Removing supermarket alcohol sales may also indirectly increase the average price as supermarkets can operate with smaller margins on alcohol than other off-licence outlets.

Overall, the study findings demonstrated that supermarket sales of alcohol exposed children to alcohol marketing on nearly every supermarket visit. Supermarket sales of alcohol were not permitted in NZ before 1989, thus, it is possible to sell alcohol without supermarkets. The study findings are likely relevant to other jurisdictions that permit supermarket sales and provide evidence for other nations to implement bans on supermarket sales of alcohol.

Bans on digital marketing

In this study, the methodology could not quantify the extent of children's exposure to alcohol marketing via digital marketing. However, the qualitative analysis of digital marketing showed children were exposed to alcohol marketing on social media and online games. Children's high internet usage and the limited safeguards against digital alcohol marketing, particularly on social media and via user-generated content, are concerning. Norway is one of the only countries to impose a complete ban on digital alcohol marketing (232), permitting alcohol marketing only on restricted websites requiring unique passwords used by licensees or other employees within the alcohol industry. Finland bans alcohol marketing on social media content that encourages consumer engagement such as contests, 'liking' or 'sharing' alcohol promotion material on Facebook (234). These examples provide a model for how digital marketing could be restricted in other jurisdictions.

In NZ, the ASA codes regulate digital alcohol marketing. As discussed in Chapter Three, NZ research demonstrates children frequently see digital alcohol marketing and the inadequacy of the ASA codes to protect children from it (193). Short of a complete ban, as implemented in Norway and Finland, national legislation must provide additional safeguards to protect children from digital alcohol marketing. Preferably, legislated restrictions would include appropriate monitoring and enforcement mechanisms, imposing meaningful financial sanctions on those marketers that violate the regulations. However, the global and information-sharing nature of the internet poses significant challenges to restrictions on digital media, which no country has sufficiently addressed. As such, international action on digital marketing is required which is discussed later in this chapter.

Bans on television marketing

As with digital marketing, the Kids'Cam methodology was not able to quantify television marketing. However, the qualitative findings show that children watch television after the ASA time restrictions and that on-demand viewing may have weakened the effectiveness of such restrictions on alcohol marketing, a finding that supports previous NZ research (229, 230). Comprehensive bans on televised alcohol marketing exist in many countries including Finland, Norway, Turkey and Sri Lanka (12, 234). Partial restrictions, such as limits on broadcast times and content, are ineffective at preventing childhood exposure to alcohol marketing (12), even when such restrictions are enforced by law (228). Consequently, bans on television marketing are the most effective means of preventing children's exposure to televised alcohol marketing. However, the global nature of marketing television presents challenges to such bans. For example, in Sweden, programmers broadcasting from outside Sweden are permitted to market alcohol on television, circumventing Sweden's television ban (227).

In NZ, the watershed times and controls on the content of televised alcohol marketing regulated by the ASA do not prevent some children's exposure (229, 230). While bans and legislative restrictions on the extent and nature of alcohol marketing have limitations, either option is preferable to the self-regulatory codes produced by the ASA. Neither the Law Commission nor the MFAAS recommended a complete ban on televised alcohol marketing (48, 134). Instead, both reports recommended introducing legislative restrictions on television marketing that go beyond the self-regulatory codes, including reduced hours, content restrictions and financial penalties for code violations. However, since these reports were published, additional longitudinal evidence of the impact of alcohol marketing on children's drinking has emerged (10, 112), strengthening arguments for a complete ban on televised alcohol marketing. The New Zealand Liquor Advertising (Television and Radio) Bill proposed a legal framework for a complete ban in the NZ context but failed at its first reading (131). This Bill has the same legal loophole as Sweden's television legislation, thus improvements are required. In addition, to avoid legal loopholes, such television bans need to incorporate alcohol sports sponsorship, as recommended by the MFAAS (134).

Complete bans on all alcohol marketing

The findings of this thesis showed children are exposed to alcohol marketing 12.4 times per day on average, at multiple places, via a range of promotion types. These findings suggest that targeting any singular place or promotion will only be a partial solution to ending harm to children from alcohol marketing. In contrast, a complete ban on all forms of alcohol marketing could prevent children's exposure to virtually all alcohol marketing. However, very few countries have attempted, let alone enforced, complete bans on alcohol marketing. For example, in January 2018, Lithuania implemented a complete ban on alcohol marketing including via television, radio, print, sponsorship and merchandise (223). However, the ban has met early opposition. The Lithuanian President criticised the new legislation after global magazines such as *Vogue* and *National Geographic* had content with alcohol marketing torn out or painted over that angered the publishers, retailers and readership (442). Furthermore, no one has challenged Lithuania's ban in international courts yet; however, based on similar legal challenges to alcohol marketing regulations in Denmark and Finland, it is likely to face legal opposition in the European Court.

While a ban is the most effective way of preventing childhood exposure to alcohol marketing, there is limited political will and public pressure in most countries for such an intervention (1). For example, in NZ, while public opinion supports increased restrictions, the public has not been surveyed for their opinion on a complete ban (230). Likewise, the Law Commission and the MFAAS concluded that a complete ban on alcohol marketing was not feasible. However, the examples cited above demonstrate complete bans on alcohol marketing are feasible, even on product packaging. In addition, countries such as Australia and NZ are implementing complete bans on tobacco marketing, judged by international courts as being consistent with international trade agreements. Another setback to a complete ban includes the conclusions of the Law Commission and the MFAAS that the current evidence does not support such severe intervention (48, 134). However, as more research emerges, the evidence base for the impact of alcohol marketing becomes more compelling and suggests there is now sufficient evidence to support stricter restrictions on alcohol marketing.

As discussed in Chapter Three, there are substantial challenges to implementing comprehensive tobacco-like marketing restrictions for alcohol. First, governments must defend their policies in international courts against a well-resourced alcohol industry and pro-alcohol industry governments (271). Second, overcoming the alcohol industry, which is well-resourced and effective at directly and indirectly lobbying against, delaying and preventing effective alcohol control policies (279). Third, the alcohol industry has built a coalition with other industries, such as the sports and marketing industries, against alcohol marketing regulations (281). The findings of this thesis demonstrate that such restrictions are required to prevent children's exposure to alcohol marketing.

Summary of policy options for central government regulation of alcohol marketing in New Zealand

There is mounting evidence between exposure to alcohol marketing and childhood drinking (9-11, 112). Children are particularly vulnerable to the damaging effects of alcohol and can experience life-altering consequences from alcohol consumption. In this research, NZ children were exposed to alcohol marketing over 12 times per day on average, in a range of places, via various promotion type. These results support other NZ evidence of children's exposure to alcohol marketing (193, 230), although using a more robust exposure measurement.

There is a range of options available at a national level to regulate alcohol marketing including complete bans, restrictions on product packaging, sports sponsorship, outdoor marketing, in-store marketing, digital marketing and television marketing. If NZ is serious about curbing alcohol-related harm and protecting children, further statutory restrictions on alcohol marketing are required. Preferably, a complete ban on all forms of alcohol marketing, including alcohol sports sponsorship. Such a ban would prohibit alcohol marketing via sports sponsorship, outdoor marketing, in-store marketing, digital marketing, televised marketing, and include plain packaging, with the flexibility to restrict emerging or new promotion types.

In addition, more restrictive alcohol licensing policies could reduce children's exposure to alcohol marketing via alcohol outlets. For example, potential policy actions include amending the SSAA to remove supermarket licences, and mandating proximity requirements for alcohol outlets around sensitive sites such as schools, churches and community venues.

These recommendations also address the governments' obligations to Te Tiriti o Waitangi, as Māori experience greater levels of exposure to alcohol marketing than non-Māori. The implementation of the interventions cited above could promote health equity by reducing the gap in alcohol-related harm between Māori and non-Māori.

The findings of this thesis and the international examples of national level policy interventions provide a template for action for other governments that are concerned with harm to children caused by alcohol marketing.

9.7.4 International approaches

The global nature of alcohol-related harm and alcohol marketing reinforces the need for an international response (13). As discussed in Chapter Three, the marketing strategies of transnational alcohol companies function on a global scale. Alcohol marketing conducted in one country permeates into another via global communication channels. Previous studies highlight alcohol marketing is increasingly hard to regulate due to globalisation and the cross-border promotion that occurs (10). Proposed international approaches to restricting alcohol marketing include establishing a FCAC and introducing international marketing codes for alcohol.

A binding agreement under international law: FCAC

Calls by health researchers and advocates for a FCAC regularly cite the global burden of alcohol-related harm and the success of the FCTC developed by WHO in addressing harm from smoking (13, 274, 275). As discussed in Chapter Three, a FCAC could reduce alcohol-related harm by reducing the influence of WTO agreements that potentially challenge countries' alcohol control policies (274). Using specific international laws (as in tobacco) to recognise alcohol as a particularly harmful product would enable alcohol control policies to better withstand potential challenges under international agreements (274). For example, Australia's defence to the challenge by Philip Morris to its plain packaging law for tobacco, relies on international recognition of tobacco's health burden and need to restrict tobacco marketing through the Articles 11 and 13 of the FCTC (443).

Article 13 of the FCTC links tobacco marketing with tobacco use and recommends countries ban all tobacco advertising, promotion and sponsorship (444). A FCAC with equally strong directives would embolden countries to take action on alcohol. While questions about the feasibility of a FCAC exist, Casswell (13) argues a FCAC is not only feasible but necessary to prevent cross-border alcohol marketing. Furthermore, Casswell argues that alcohol and tobacco are more similar in relation to their impact on global health than is generally recognised. The FCTC should not, therefore, be seen as justified by 'tobacco exceptionalism', that is, the claim that the exceptional harm from tobacco justifies strict measures. This thesis adds further evidence to arguments that the extent and nature of the global burden of alcohol-related harm warrants similar recognition under international law through a convention that would provide directions for measures to address that harm.

Non-binding international agreements

To date, no binding instruments of international law for alcohol control exist. However, with growing concerns about alcohol-related harm, in 2010 WHO issued a non-binding Global Alcohol Strategy (14). The Global Alcohol Strategy is a policy document endorsed by all members of World Health Assembly that summarises the most effective evidence-based policy interventions for reducing alcohol-related harm, including restrictions on alcohol marketing. Specifically, it recommends nations adopt a precautionary approach to protecting young people against alcohol marketing with legislative restrictions on all forms of alcohol marketing (14). In addition to the Global Alcohol Strategy, the UN Special Session on Non-Communicable Disease (445) cites alcohol as a global health burden, which is amenable to cost-effective interventions (109). The UN Non-Communicable Disease Report recommends countries adopt cost-effective alcohol control policies, of which, restricting alcohol marketing is one of the most cost-effective (14).

While there is a consensus among health researchers that an international solution to alcohol-related harm is required, the nature of the solution is contested. Many health researchers argue that a FCAC is not plausible (276-278), with Zeigler (278) arguing that attempting to develop a FCAC could delay any effective international response. Instead, these authors argue for a non-binding international agreement. This would take less time to achieve and involve greater participation (eg, from countries with high volumes of alcohol exports). This could serve to de-normalise alcohol by confirming the health risks of alcohol consumption on an international stage and encouraging local jurisdictions to implement effective alcohol control policies (276-278).

Recently, researchers proposed an international code of practice for alcohol marketing as an alternative to a FCAC (446). Like the Global Alcohol Strategy, an international code of marketing practice would be a non-binding international agreement but would focus specifically on alcohol marketing. Similar international non-binding agreements exist for marketing of breast-milk substitutes (447) and for food and non-alcoholic beverage marketing to children (448). The 1981 International Code of Marketing of Breast-milk Substitutes has been implemented in part (n=96) or in full (n=39) in national legislation of 135 countries (eg, Brazil, India) (449). However, only 32 countries include systems for monitoring code violations. In 2014, the UN led the creation of a global network for monitoring and supporting the implementation of the Code of Marketing of Breast-milk Substitutes (referred to as the NetCode) (449). The NetCode provides practical tools and guidelines for establishing an effective monitoring system for code violations. Similar codes and global monitoring systems could be developed for alcohol marketing.

The ineffectiveness of non-binding codes may in some cases prompt moves to promote measures with greater legal status. For example, the non-binding UN Guiding Principles on Business and Human Rights are criticised for failing to effectively prevent and punish human rights violations committed by companies (450). In 2014, partly in response to the inadequacies of the non-binding agreement, a UN resolution established an intergovernmental working group mandated to develop an internationally binding instrument to regulate human rights in business operations (451).

Summary of policy options for an international approach

The findings of this study support the need for an international approach to alcohol marketing regulation. Tackling the global nature of alcohol marketing by transnational alcohol companies requires international collaboration as the alcohol industry's marketing strategy crosses borders and often bypasses domestic legislation. Ideally, a FCAC would provide countries with an international framework on which to base their domestic legislation. It would also be important in defending (as seen in relation to Australia's tobacco plain packaging law) any challenges to alcohol control measures made under international law. Currently, soft law approaches, such as the Global Alcohol Strategy, provide countries, policymakers and health researchers with a useful evidence-based framework for curbing alcohol-related harm. However, without any legally binding effect, the effectiveness of soft law approaches are limited to providing informed policy options via shared resources and collaboration. Non-binding international codes on alcohol marketing could influence policy by starting to 1) de-normalise alcohol on a global scale, 2) provide a template for national legislation, and 3) prompt legally binding legislation.

As discussed in Chapter Two, the global burden of alcohol-related harm to children supports the need for an international approach. The link between alcohol marketing exposure and childhood drinking discussed in Chapter Three provides further evidence for the need for a precautionary approach to alcohol marketing. The results of this thesis show that children are frequently exposed to alcohol marketing and that current protections are inadequate. Therefore, countries, policymakers, and health researchers and advocates should actively explore the possibility for the implementation of a FCAC, despite the substantial challenges to its development and implementation.

9.8 Conclusion

Globally, alcohol causes tremendous harm via its adverse health, social and financial costs. Children are particularly vulnerable to the adverse effects of alcohol due to their developing brains, lack of experience with alcohol and social pressure to consume alcohol. Furthermore, children are particularly susceptible to the persuasive messages in alcohol marketing because of their inability to identify biases inherent in marketing and their limited consumer knowledge. WHO (14) promotes restrictions on alcohol marketing as one of five best evidence-based solutions and one of the three 'best buys' for curbing alcohol-related harm.

There is mounting evidence that children's exposure to alcohol marketing increases their subsequent consumption and likelihood of alcohol-related harm in later life (9-11, 112), reinforcing the need for a precautionary approach to alcohol marketing. The findings of this study show children are frequently exposed to alcohol marketing in multiple places, via various promotion types in their everyday lives. Such findings demonstrate that existing policies to prevent children's exposure to alcohol marketing are insufficient and are likely to apply to other jurisdictions implementing similar policies.

Local and national governments are obligated to ensure people's, including children's, right to health by implementing effective alcohol control policies. The harm caused by alcohol and the mounting evidence of the best policy options to curb alcohol-related harm should compel governments to act. In NZ, the disproportionate alcohol-related harm experienced by Māori and the Government's inaction on the Law Commission recommendations appear to be breaches of Te Tiriti o Waitangi.

An international approach is required to ensure we protect children from alcohol marketing and reduce the global burden of alcohol-related harm. The inability to implement effective alcohol control policies, especially on alcohol marketing, leaves children vulnerable to the adverse effects of alcohol and has severe consequences for population health and health equity.

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Appendix 1: Kids'Cam information and consent forms, demographic information sheet and participant equipment manual

Ethics Approval 13/220

Kids'Cam: Viewing Young People's Environments

INFORMATION SHEET FOR PARTICIPATING SCHOOLS

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not you would like your school to participate. If you allow your school to participate we thank you. If not, we thank you for considering our request.

What is the project about?

This project aims to explore the world children live in, their environment and how it impacts them by documenting what children see and where they go throughout the day - while at home, at school and during most other activities (except personal activities). To directly and objectively capture the environment in which children live, we will be asking approximately 200 Wellington children to wear a GPS recorder, and a camera that hangs around the neck that automatically takes still photographs every 10 seconds. We will also be inviting 60 of the children to take part in a brief interview to determine what they think about their environment. This project is one of the first in the world to use these cutting-edge technologies to explore children's environments.

This study is funded by the Heath Research Council of New Zealand and led by researchers from the University of Otago, Wellington, in collaboration with researchers from the University of Auckland and Dublin City University, Ireland. It has been approved by the University of Otago Human Ethics Committee (13/220).

What are the benefits of taking part?

We know children have unique knowledge of the world and can provide valuable insights into our understanding of their lives and the environment in which they live and play. This project provides children with an opportunity to participate in research so that we may learn more about their world, what they think about it, and how it might be improved. To specifically inform Kids'Cam, we conducted two pilot studies, one in 2012 and another in April 2014, to explore the feasibility of using automated cameras and GPS recorders to capture children's worlds. The children who participated in those studies were keen to take part and said that it was "fun" and "exciting" to be involved in a research project, and that they felt "important" and "trusted". It was also an opportunity for them to learn about research. In addition, it may also be possible to incorporate the children's participation into elements of the curriculum – as the school involved in the feasibility study did. We received very positive feedback from the teachers and the school principal we worked with on those projects.

At the completion of the project, we will provide each participating school with a report of the overall findings. The findings from similar research projects have provided schools with information about children's activities within schools as well as those out-of-school factors which have a potential impact on school life. The findings have, on occasions, been used to inform school policy and practice.

What will the children be asked to do?

We will be inviting between 12 and 36 Year 8 children from your school to participate in this study, from which a total of 6 to 18 consenting children will be selected to participate. It is possible that some consenting children will not be selected to participate. We will be asking those who are selected to take part in the study to wear a camera (as shown in the pictures below) and small GPS recorder for 4 days (from Thursday to Sunday) to take pictures of the things they see and record the places they go during a typical day, including while they are at school.

The project involves two sessions with the children, conducted over one week. The first session (Wednesday) is a one-off group meeting of about 45 minutes. At this meeting all the children involved in the study will meet the researchers, learn about what they will be doing and how to use the equipment, and be briefed on the ethical issues associated with the use of cameras. During this session they will also be given an equipment kit containing their cameras, GPS recorder, chargers, plugboard and an information booklet. On the following Monday, a researcher will collect the equipment so that the information captured can be downloaded and stored securely on a University computer. The second session involves meeting with each child individually during that week so that they can review their images, which takes about 20-30 minutes, and to weigh them and measure their height.

We may also be briefly interviewing some children to determine what they think about their environments. A set of general questions we want to ask during the interview has been reviewed by the University of Otago Human Ethics Committee, but because this will be an open discussion they cannot review all of the questions that may come up as a result of the ideas raised during the interview. Notes will be taken during the interview, and it will also be recorded so that it can be analysed later. If the children feel uncomfortable answering any of the questions at any stage, they can choose to stop talking or leave the leave the room. They will be told this at the start of the interview.

At the completion of the second session, each participant will be given a certificate of participation.

As well as asking the children to wear the equipment for 4 days, they will also be asked to charge the equipment each night. So that we can remind the children to wear, recharge and return their equipment kit, we will also ask each child and parent for a contact phone number. The equipment kit and its contents are the property of the University of Otago, Wellington and must be returned to the researchers at the completion of each data collection period. Your school will not be liable for any loss or breakage of equipment.

What will the school be asked to do?

First, we would seek your advice about the potential of undertaking the research at your school and in gaining consent from the school community. We would be available to answer any questions parents and children might have. We would also ask for your assistance with participant recruitment, including distributing and collecting participant and parental consent forms and information sheets in class. We would also require a quiet space somewhere in the school to meet with the children for their two sessions. As this project aims to document children's environments across a number of everyday settings, including while they are at school, we are asking the school to allow the children to wear the camera and the GPS recorder during the school day, on school grounds.

How will we keep the information safe?

We have several safeguards in place to protect the privacy of the participants and anyone who may appear in the images:

- To ensure control over the use and security of the information, only the researchers involved in the study will have access to the information collected. All researchers must abide by the confidentiality agreements of the Universities involved and the approved ethical protocol. Also, after each child has had the opportunity to view their images and delete those that are personal or sensitive, they will have no further access to the information they have collected. The data collected then becomes the property of the University of Otago, Wellington.
- In any published material, we will blur out the faces of anyone who is captured in the pictures and may be recognisable, including all staff and other students and any signage

or other identifying features that would reveal which school the child attended or their home.

- The collected data will be stored on a secure server at the University of Otago, Wellington. Only members of the research team have access to this server. At the end of the project the recordings of the interview will be destroyed. The typed copies of the interview, the images and all other information collected will be kept in secure storage for five years and then destroyed (as per the requirements of the approved ethical protocol).
- The camera only takes still images (every 10 seconds). There is no audio recording. We are only interested in children's everyday surroundings not the people captured in the images.

If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479 8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

You may withdraw your school from participating in the project at any time up until the data is analysed.

What will we do with the information?

The results of the project may be published and will be available in the University of Otago Library (Wellington). Any information published will have all identifying details, for example the name of your school and the names of the child participants removed. As noted previously, upon completion of the project you will be provided with a copy of the results.

If you have any questions about our project either now or in the future, please feel free to contact:

Assoc. Prof. Louise Signal Department of Public Health University of Otago, Wellington Email: louise.signal@otago.ac.nz Phone: 021 0324720	Dr. Moira Smith Department of Public Health University of Otago, Wellington Email: moira.smith@otago.ac.nz Phone: 021 0851 3535

This study has been approved by the University of Otago Human Ethics Committee (Ref.13/220). If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479 8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Ethics Approval 13/220

Kids'Cam: Viewing Young People's Environments

CONSENT FORM FOR PARTICIPATING SCHOOLS

I have read the Information Sheet concerning this project and understand the purpose and aims of this study and what will be asked of the school. All my questions have been answered to my satisfaction. I recognise that I can ask for further information at any stage.

I acknowledge that:

1. The schools' involvement in this study is entirely voluntary.

2. This study aims to explore the world children live in, their environment and how it impacts them by documenting what children see and where they go throughout the day.

3. Our school can withdraw from this study at any time up until the data has been analysed.

4. I understand that not all the consenting children will be selected to participate.

5. Student participants will be using the cameras and GPS devices during school time, on school grounds and in other contexts.

6. The equipment kit, including the cameras and GPS devices are the property of the University of Otago, Wellington and will be returned to the research team following data collection.

7. Members of the research team will be meeting with the participants on school grounds, during school hours.

8. The results of the project, including images, and quotes from interviews may be published in journals, talked about at conferences, and will be available in the University of Otago Library (Wellington). Any information published will have all identifying details, for example your school name, and the names of staff and students removed. The camera will capture staff and students in the pictures it takes, but any identifiable faces will be blurred out in any photographs used subsequently in any publications from the study to protect the privacy of those who appear in the images.

9. Upon completion of the project, a copy of the results of the study can be provided if we would like them. ❑ Yes ❑ No

10. To thank them for their participation, participants will receive a certificate of participation, at the completion of the project.

SCHOOL COPY

I agree for our school to participate in this study

Facilitating Teacher

....
Signed Date

School Principal

....
Signed Date

This study has been reviewed and approved by the University of Otago Human Ethics Committee Ethics Approval (Ref. 13/220). If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479 8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Kids'Cam: Viewing Young People's Environments

INFORMATION SHEET FOR PARENTS / GUARDIANS

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not you would like your child to participate. If you allow them to participate we thank you. If you decide that you do not want your child to take part there will be no disadvantage to you or your child and we thank you for considering our request.

What is the project about?
We know the world that young people live in impacts their health but we do not have a comprehensive picture of young people's environments. This project aims to explore the world children live in, their environment and how it impacts them. To do this, we will be asking approximately 200 young people from the Wellington region to wear a GPS device, and a camera that hangs around the neck that automatically takes still photographs every 10 seconds. We will also be inviting 60 of the children to take part in a brief interview to determine what they think about their environment. This project is one of the first in the world to use these cutting-edge technologies to explore young people's environments.

Your child has been randomly selected, along with several other children from their school, to be invited to take part in this project. We would like 6 children from your child's school to participate. Please note, it is possible that even though you and your child agree to take part, your child may not be selected in the final participating group.

This study is funded by the Health Research Council of New Zealand and led by researchers from the University of Otago, Wellington, in collaboration with researchers from the University of Auckland and Dublin City University, Ireland. It has been approved by the University of Otago Human Ethics Committee (Ref. 13/220).

What are the benefits of taking part?
This project provides children with an opportunity to participate in research so that we may learn about their world, what they think about it, and how it might be improved, from them. Two smaller studies were conducted in 2012 and April 2014 to inform Kids'Cam. These studies explored the feasibility of using automated cameras and GPS devices to capture children's worlds. The children who participated in those studies were keen to take part and at their completion said that it was "fun" and "exciting", and that it made them feel "important" and "trusted" to be involved in a research project. It was also an opportunity for them to learn about research.

What type of participants are being sought?
The participants being sought for this study are intermediate school-aged young people in Year 8 who wish, and have consented, to participate. Your child's school has agreed to be involved in the study, and we have invited some Year 8 students from the school.

What will participants be asked to do?
If your child takes part in this project, they will be asked to wear a small camera and a GPS device for 4 days to take pictures of the things they see and record the places they go during a typical day. They will not be asked to change their behaviour or places they visit during the study. The project involves two sessions at school, conducted over one week. In the first session (which takes about 45 minutes and is held on a Wednesday) all the participants will be fully briefed about the project, given instructions on what to do and learn how to use the equipment. They will be given an equipment kit containing two cameras and a GPS device, chargers, plug board, and instruction booklet and information card. Participants will then be asked to wear a camera and GPS device for 4 full days (Thursday – Sunday inclusive) while at home, at school and during most other activities. They will be advised to take them off before doing vigorous sporting activities or personal activities (such as getting changed, and toileting). The camera only takes still images. There is no audio recording.

The camera is relatively discrete, but it may generate some interest from members of the public. If your child takes part in the study they will be provided with information cards that they can give to interested members of the public, if approached and asked about the device. These cards will outline the nature of the study and prompt interested people to contact the researchers at the University of Otago if they have any further questions about the study.

On the following Monday, a researcher will collect the equipment at school so that the information captured can be downloaded and stored securely on a University computer. The second session involves meeting with your child individually sometime during that week at school so they can review their images, and to weigh and measure their height. This session takes about 20-30 minutes.

If your child has been invited to be interviewed, the interview will also be conducted at this session and will take about 15-20 minutes. A set of general questions we want to ask during the interview has been reviewed by the University of Otago Human Ethics Committee, but because this will be an open discussion they cannot review all of the questions that may come up as a result of the ideas raised during the interview. Notes will be taken during the interview, and it will also be audio taped so that it can be analysed later. If your child feels uncomfortable answering any of the questions at any stage, they can choose to stop talking or leave the room. They will be told this at the start of the interview.

As well as asking participants to wear the equipment for 4 days, they will also be asked to charge it each night. So that we can remind the participants to wear, recharge and return their equipment kit, we will ask you for a contact phone number. The equipment kits are the property of the University of Otago, Wellington and must be returned to the researchers. The participants, caregivers or the school will not be liable for any equipment loss or damage.

Along with the consent form, we have included a brief questionnaire for you to complete. This questionnaire will provide demographic information so that we can describe the group of participants. It will not be used to describe your child individually.

How will we keep the information safe?

It is important that we keep the information the young people gather secure and protect their privacy and that of anyone who may appear in the images.

To ensure control over the use and security of the information, only the researchers involved in the study will have access to the information collected. All researchers must abide by the confidentiality agreements of the Universities involved and the approved ethical protocol. Also, after your child has had the opportunity to view their images and delete those that are personal or sensitive, they will have no further access to the information they have collected. The data then becomes the property of the University of Otago, Wellington.

In any published material, we will blur out the faces of anyone who is captured in the pictures and may be recognisable, including all school staff and other students as well as any signage or other identifying features that would reveal which school your child attended or your home.

Any information that is provided to us including: the pictures taken by the camera, the interview recordings, and that from the demographic questionnaire, will be stored on a secure server at the University of Otago, Wellington. Only members of the research team have access to this server. At the end of the project the interview recording will be destroyed. The typed copies of the interview, the images and all other information collected will be kept in secure storage for five years and then destroyed (as per the requirements of the approved ethical protocol).

You may withdraw your child from participating in the project at any time and without any disadvantage. You may also withdraw any information that you or your child have already provided, up until the analysis of this information begins.

If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479 8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

What will we do with the information?

The results of the project may be published and will be available in the University of Otago Library (Wellington), any published information will have all identifying details, for example your child's name and school, removed. You are most welcome to request a copy of the results of the project should you wish.

Do you have any Questions?

If you or your child have any questions about our project either now or in the future, please feel free to contact:

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UNIVERSITY of OTAGO

SAPERE AUDE

Te Whare Wānanga o Otāgo

NEW ZEALAND

Ethics Approval 13/220

Kids'Cam: Viewing Young People's Environments

CONSENT FORM FOR PARENTS / CAREGIVERS OF PARTICIPANTS

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I can ask for further information at any stage.

I know that:-

1. My child's participation in the project is entirely voluntary.
2. This study is looking at the world children live in, their environment and how it impacts them.
3. I am free to remove my child from the project at any time without any disadvantage.
4. I understand that my child may not be selected in the final participating group of children from their school.
5. My child will be asked to wear a camera and GPS device for 4 days and will be asked to recharge the equipment every night for 4 days.
6. The camera will be taking pictures of my child's environment at home, at school and during most other activities.
7. My child will not be asked to change their behaviour or the places they visit during the study.
8. My child will be briefed on situations where they will need to remove the camera and turn it off, to protect their privacy and the privacy of those around them.
9. My child can take off the camera and GPS device at any time if they do not feel comfortable.
10. My child may be interviewed about what they think about their environment.

11. If my child is interviewed, the research team knows the general areas that they want to cover but the exact questions, which will be asked, have not been determined in advance, and will depend on the ideas my child brings up.

12. If my child is interviewed, they do not have to answer any of the interview questions if they don't want to, and they can leave the interview at any time.

13. My child's height and weight will be measured.

14. I will be asked to provide a contact phone number to remind my child to wear, recharge and return the equipment.

15. My child will be provided with information cards about the project that can be given to members of the public in the event they are approached, and asked why they are wearing a camera. These cards will have the contact details of the researchers at the University of Otago, and will encourage interested parties to contact the researchers for further information about the project.

16. After my child has reviewed the photographs they have taken and removed any images they do not want the researcher to see, they will no longer have access to the photographs they have taken; they will become the property of the research team. This is to ensure that my child's privacy and the privacy of anyone that appears in the pictures are protected, and to ensure that the images do not enter the public domain.

17. The equipment kit, including the cameras and GPS device, are the property of the University of Otago, Wellington, and will be collected by the researcher after my child has worn the devices for 4 days. The participants, caregivers or the school will <u>not</u> be liable for any equipment loss or damage.

18. Typed copies of the interview recording, the photographs and other information will be kept in secure storage for at least five years and then destroyed.

19. The results of the project, including images from the camera, and quotes from interviews may be published in journals, talked about at conferences, and will be available in the University of Otago Library (Wellington). Any information published will have all identifying details, for example my child's name, removed.

20. I would be happy to be contacted within the next 18 months about the possibility of my child participating in other aspects of this research project? Saying yes to this question would not commit them to participating; it just means that we can contact you to ask.

- ❑ Yes I am happy to be contacted again
- ❑ No, don't contact me again

I would like to receive a copy of the key findings of this study

- ❑ Yes
- ❑ No

I agree for .... to take part in this project
(Child's name)

....

(Signature of parent/guardian) (Date)

Kids'Cam: Viewing Young People's Environments

INFORMATION SHEET FOR PARTICIPANTS

Hi, we are doing a study about all the things young people see in their everyday surroundings. Thank you for showing an interest in this project. Before you decide if you want to take part in this study please read this information sheet carefully because it is important that you understand why we are doing this study and what you might be asked to do. You do not have to take part in this study. If you decide to take part, talk to your parents or caregiver. If they agree that you can participate, please ask your parent or caregiver to complete the parent's consent form that says it's ok for you to be involved in the study and bring it back to school.

What is this project about?

Our project aims to learn about the world young people live in - the things they see in the different places they go, during a normal day. For example, we want to see what you see on the way to school, while you're at home or at school, and what you see when you're out in your community. To do this, we will be asking participants to wear a small camera that hangs around their neck and automatically takes a picture every 10 seconds throughout the day. Participants will also be asked to wear a small GPS device which will record where they go.

You, and several of your Year 8 classmates, have been invited to take part in this project. It is possible that we will have more children who want to participate than we need from your school. That means that even though you may agree to take part in the project, there is a chance that you may not be included in the final group of children who do take part.

This study is funded by the Health Research Council of New Zealand and is being run by researchers from the University of Otago in Wellington, as well as the University of Auckland and Dublin City University, Ireland.

Why have you been invited to take part?

Your school has agreed to be involved in this project. We are looking for approximately 200 Wellington students to take part in our study. We have invited some Year 8 students from your school, including you, to consider participating. You do not have to take part in this study if you do not want to.

If you take part in the study what will you be asked to do?
To take part in this study you will need to be able to attend two meetings which will be held at your school during one week.

You will be asked to wear a camera and GPS device for 4 days during all of your normal daily activities, except for during some physical activities and any personal activities like getting changed, or going to the toilet etc. You will have to recharge the camera and GPS device overnight, each night, for 4 days.

You can take off the camera and GPS device any time you don't want to wear it.

At the first meeting, which will be about 45 minutes long and held on a Wednesday, all those who are participating will meet the researchers, learn about the study and learn how to use the camera and GPS device. You will be given an equipment kit containing two cameras, GPS device, plugbaord and chargers. Starting from the next morning, you will be asked to wear a camera and GPS device on Thursday, Friday, Saturday and Sunday. On the following Monday, you will bring the devices back to school and the researcher will collect them and download all of the information you have collected onto a secure computer.

Later that week, we will come to the school for the other meeting, which will last about 45 minutes. You will be able have a look at all the images the camera recorded and delete any that you do not want the researcher to see, and measure your height and weight. We will also be inviting some of the participants to answer some questions about what they think about their everyday surroundings.

Can I change my mind and withdraw from the study?
If you decide to be part of the study, you can stop at any time and you don't have to give us a reason.

What data or information will be collected and how will you use it?
The pictures taken will be used to show us the sorts of things you see in your everyday surroundings.

To keep all of the pictures taken and other information you collect safe and private, only the researchers will have access to the information you collect. Once you have looked at the pictures from the camera and deleted the ones you don't want anyone else to see, the researchers will look after them and all the other information you have collected. The researchers must keep everything confidential and they are not allowed to share the information with anyone else.

All your information will be kept on a secure computer protected with a password.

If any of the photos taken have people in them, for example your family and friends, or teachers, and we wish to use the photos in our reports, we will blur out their faces to protect their privacy. We will also blur out any signage or other features that would identify your school or home.

The camera only takes photographs. It doesn't record video, or your conversations.

If you have been invited to be interviewed, there will be a tape recorder on while we are talking, and we will write down some of the things you say. If you don't want to answer some of the questions, that's OK too, you don't have to answer any question that you don't want to.

After the interview, we will type out the words on the recording and after we have finished writing the report we will delete the recordings. The typed out copies of the interview will only be seen by the researchers at Otago University. After we have finished writing up the study, the data collected and the typed copies of the interview will be stored securely for at least five years and then destroyed.

The results of this study will be used to help us write a report for the University and may be published in reports and journals, and might be talked about at conferences. We might publish some of your photographs and write about some of the things you have talked about during the discussion, but we will not use your name, or any of the information you give us to identify you in any way.

What if I have any questions?
If you have any questions now, during or after the study you can talk to us, on your own or with a parent or caregiver, please feel free to contact:

Louise Signal

Department of Public Health

University of Otago, Wellington

Email: louise.signal@otago.ac.nz

Phone: 04 9186040

Moira Smith

Department of Public Health

University of Otago, Wellington

Email: moira.smith@otago.ac.nz

Phone: 021 0851 3535

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CONSENT FORM FOR PARTICIPANTS

I have been told about this study and understand what it is about.

I know that:

1. I don't have to take part in this research project if I don't want to.

2. Nothing will happen to me if I choose not to take part in the project.

3. I understand that I may not be included in the final group of participating children from my school.

4. The researchers will be asking me to wear a camera and a GPS device for 4 days during all of my normal daily activities, except for during private things like getting changed and going to the toilet. They might also be interviewing me about what I think about my everyday surroundings and the world I live in.

5. I will wear the camera and GPS device to the best of my ability for 4 days.

6. I can take off the camera and GPS device any time I don't want to wear it.

7. I will be able to delete any pictures that I don't want anyone else to see. But after I've looked through all of the pictures and deleted the ones I don't want anyone to see, I won't be able to access the pictures again. They will be given to the research team to look after.

8. The researchers will measure my height and weight.

9. The researchers will contact me or my parents to remind me to wear and recharge the camera and GPS device and to return them.

10. The equipment kit, including the cameras and GPS device, belong to the University of Otago and must be given back to the researcher after I have worn them for 4 days.

11. During the interview there are no right or wrong answers and I don't have to answer any questions if I don't want to.

12. The researcher team will write up the results from this study for University work. The results may also be written up in journals and talked about at conferences.

13. The research team will write about some of the pictures I took and some of the things I talked about, but won't use my name or anything that might identify me in any published material.

14. The recording of the interview and the written copy of the words on the recording will only been seen by the researchers at Otago University.

15. If I have any questions about any part of the study I can talk to the researchers about them.

16. I would be okay to be contacted again to see if I would like to do more research on this project. Saying yes does not mean that you would have to do it, it just means that you are okay with us asking you about doing more.
    - ❑ Yes I am happy to be contacted again
    - ❑ No, don't contact me again

I agree to take part in the study.

....

Signed Date

Thank you!

This study has been reviewed and approved by the University of Otago Human Ethics Committee Ethics Approval (Ref. 13/220). If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479 8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Ethics Approval 13/220
Ppt #:

Kids'Cam Participant Demographic Information Sheet

1. Is your child?

- [ ] Male
- [ ] Female

2. What is your child's date of birth? ________________

3. Which ethnic group does your child belong to? (*Mark all the spaces that apply)*

- [ ] New Zealand European
- [ ] Māori
- [ ] Samoan
- [ ] Cook Island Maori
- [ ] Tongan
- [ ] Niuean
- [ ] Chinese
- [ ] Indian
- [ ] Other such as DUTCH, JAPANESE, TOKELAUAN.

Please state:

____

4. What is your child's home address?

____

____

____

5. Please provide a telephone number so that we can contact you or your child to remind them to wear, recharge and return the devices.

Parent's number ___________________________

Child's number ___________________________

6. In the <u>last 12 months</u> have you <u>personally</u> been forced to buy cheaper food so that you could pay for other things you need?	Yes / No
In the <u>last 12 months</u> have you <u>personally</u> have you been out of paid work at any time for more than one month? *No if retired and for full-time care-givers/homemakers	Yes / No
In the <u>12 months ending today</u> did you <u>yourself</u> receive payments from any of these three benefits: Jobseeker Support, Sole Parent Support or Supported Living Payment?	Yes / No
In the <u>last 12 months</u> have you <u>personally</u> put up feeling cold to save heating costs?	Yes / No
In the <u>last 12 months</u> have you <u>personally</u> made use of special food grants or food banks because you did not have enough money for food?	Yes / No
In the <u>last 12 months</u> have you <u>personally</u> continued wearing shoes with holes because you could not afford replacements?	Yes / No
In the <u>last 12 months</u> have you <u>personally</u> gone without fresh fruit and vegetables, often, so that you could pay for other things you needed?	Yes / No
In the <u>last 12 months</u> have you <u>personally</u> received help in the form of clothes or money from a community organisation (like the Salvation Army?)	Yes / No

Thank you!

Kids'Cam

Project Instruction Booklet

Project instructions

Welcome to Kids'Cam!

Thanks for being part of this exciting project.

We hope you have fun and enjoy being part of a world-leading research project about young people's lives.

If at any time during the project you don't want to be part of the study anymore, that's fine, either your parent or caregiver just need to contact a member of the research team and let us know.

In this booklet you will find:

- Project instructions – what you need to do
- Instructions on how to use the Autographer
- Instructions on how to use the GPS device
- Where and when you should turn off or take off the camera
- A checklist for the equipment kit for when you return it.

If you are having problems with the equipment or if you or your parents have any other questions please call:

Tim Chambers	021 0852 4524
Tolotea Lanumata	021 0856 9827

Project Instructions

- Wear the camera and the GPS for 4 full days – Thursday to Sunday.

- Go about your day as normal. Don't change anything you do during the day. Even if you think it may be uninteresting and boring!

- The Autographer needs to be worn on top of your clothing.

- Hang the Autographer around your neck AND clip it to your clothing. It keeps it safe and is more comfortable to wear.

- Remember to put all the devices on to charge before you go to bed each night.

- On Monday please bring all of the equipment back to school so that we can collect it.

In the mornings:

- Turn on your morning Autographer – the one with a 'morn' sticker on it and an odd number - and start wearing it.
- Turn on your GPS and start wearing it.
- Make sure you have your information cards to give out.
- Take your second camera with you.
- Before you leave school, turn on your afternoon camera – the one with a 'aftern' sticker and even an even number – and start wearing it. On the weekends do this at 1pm.

During the day:

- check every now and then that the Autographer is working:
    - the blue circle will be blinking, or
    - press the top button once quickly - words will come up on the front of the camera. They will go off automatically.
- If it isn't working the battery may be flat, so put it on to charge and start using your second camera.

Before going to bed:

- Plug in both of the Autographers and the GPS device to charge.

Where and when should you take the Autographer off?

You can turn off or take off the Autographer anytime you don’t feel comfortable wearing it.

You will need to turn off or take off the Autographer in the following places:

- Before going to the bathroom or getting changed.
- In public bathrooms and changing rooms and showers (including those at school, sports clubs, and swimming pools).
- Public swimming pools.
- Anytime you are around anyone that is not fully clothed.
- In hospitals, hospices, and doctors’ offices.
- In shops, supermarkets and other buildings where there is a notice or sign that says you can’t take photos.
- If on a marae, check with the person in charge to make sure it is okay to wear the camera.
- If someone asks you to take it off.
- Before playing contact sports (like rugby). You shouldn’t need to take it off at lunchtime or break times, unless you are doing something you think might damage the Autographer.
- Before you go swimming. The Autographer is not waterproof.
- If it is raining really heavily and you think it might get wet while you are outside.

BUT PLEASE REMEMBER TO PUT IT BACK ON!

Don’t worry if you forget to take it off - you will be the first person to see the photos and you will be able to delete anything you don’t want us to see.

Instructions for camera

Instructions for camera

How do I turn it on?	Press and hold the ON / OFF button for 5 seconds until the blue words ‘AUTOGRAPHER’ and ‘Hello’ come on the front of the camera
How do I turn it off?	Press and hold the ON / OFF button for 5 seconds until the blue words ‘Goodbye’ come on the front of the camera and it turns off
How do I know it’s working?	The blue light will blink or Press the TEST BUTTON ONCE; the blue words will show if on
What if it won’t turn on?	The battery could be flat – put it on to charge and use the other camera
How do I know it’s charged?	The ‘battery’ symbol will be solid

NOTE: If the privacy dial is turned to yellow or the lens is covered for more than 5 minutes the cameras will shut off. You will need to open the privacy dial and turn the camera on.

Instructions for GPS

How do I turn it on?	Press and hold the ON / OFF button for 5 seconds until the 2 symbols come on

	Release button
How do I know it's working?	The GREEN symbol will be flashing The ORANGE symbol will be flashing or on
How do I turn it off?	Press and hold the ON /OFF button for 5 seconds until the symbols flash and then disappear
How do I know it's fully charged?	The battery symbol will be flashing when plugged in for charging

Equipment Kit Checklist

1 x GPS device and armband

2 x Autographers

3 x chargers

1 x 4-pin plugboard

Instruction booklet

Appendix 2: Python script for automated imputation for GPS data

The Kids'Cam GPS dataset had moderate GPS data missingness. A Python script was developed to account for smaller amounts of missingness and to quantify the extent of the missingness. First, all 5-second intervals were first identified and added as blank rows into participants' shapefiles. Following this, data gaps that met the spatial and temporal constraints of automated imputation had GPS points assigned coordinates of the last valid GPS point.

```
##########################################################################################
######################################
#Chris Lowrie
                                                            #
#Add rows
                                                                      #
#For the analysis of data regarding the visibility of blue space and alcohol advertisements by children in
New Zealand        #
##########################################################################################
######################################
#import the necessary modules
import arcpy, math, os
#Get the points to use
table = arcpy.GetParameterAsText(0)
#Store the table name
desc = arcpy.Describe(table)
name = desc.baseName
#The workspace where new and complete shapefile layers will be saved
ws = arcpy.GetParameterAsText(1)
arcpy.env.workspace = ws
#The fields used by the cursors
fields = ["Latitude","Longitude", "HMS", "Day", "Time", "DateTimeS", "Original"]
date_fld = "DateTimeS"
#A file for writing while the table is processed, this needs to include file directory.
f = open("Bluespace_report.txt", "r+")
#Will contain the table
total_lst = []
#Will become the new, complete shapefile layer
new_table = arcpy.CreateFeatureclass_management(ws, name[0:10] + "_rows_added", "POINT", table,
"SAME_AS_TEMPLATE", "SAME_AS_TEMPLATE", table)
#Calculate the distance between two points near Wellington, New Zealand
def calculate_distance(x0, x1, y0, y1):
        #111,200 meters per degree of latitude
        #67,097 meters per degree of longitude at 41 degrees latitude (Wellington)
                #Can be made more accurate by formula, but unnecessary for this analysis
        dx = abs(x1-x0)*67097
        dy = abs(y1-y0)*111200
        distance = math.sqrt(math.pow(dx,2) + math.pow(dy,2))
        return distance
#Converts ints to strings, so they can be concatenated back into DateTimeS for
```

```
def int_to_str(num):
	if num < 10:
		num_str = "0" + str(num)
	else:
		num_str = str(num)
	return num_str
#Populates the hms field with time as a single integer
def process_time():
	update_rows = arcpy.da.UpdateCursor(table, fields)
	for row in update_rows:
		full_date = row[5]					#Get the date and time
		date_lst = full_date.split("T")				#Split into date and time
		row[3] = (str(date_lst[0]))				#Set the date to be the first half
		full_time = date_lst[1]					#Full time is the second
		row[4] = (str(full_time).strip("Z"))
		time_lst = full_time.split(":")				#Split the time
		hr = int(time_lst[0])					#into hours
		mn = int(time_lst[1])					#into minutes
		sec = int(time_lst[2][0:2])				#into seconds, cut off the "Z"
		hms = 3600*hr + 60*mn + sec				#make the integer time
		row[2] = hms						#store the integer time
		row[6] = 1						#mark as an original
row
		update_rows.updateRow(row)				#save the row
#Called by process_table, to load the rows for every five second interval into total_lst
def compile_rows_to_add(row, rows_to_add, time, distance):
	#starting with the initial row
	pending_lst = [row]
	#These points are given an automatic lat and long
	if distance < 100 and time < 300:
		i = 1
		while i < rows_to_add+1:
			hms = row[2] + 5*i
			hr_int = hms/3600			#Hours
			hr_str = int_to_str(hr_int)
			ms = hms%3600
			min_int = ms/60				#Minutes
			min_str = int_to_str(min_int)
			sec_int = ms%60				#Seconds
			sec_str = int_to_str(sec_int)
			T = hr_str + ":" + min_str + ":" + sec_str	#Time as string
			DTS = row[3] + "T" + T + "Z"				#Data as string
			to_insert = (row[0], row[1], hms, row[3], T, DTS, 0)	#Lat, Long, HMS, Day,
Time, DTS, Original
			pending_lst.append(to_insert)
			i += 1
	#These points are also given an automatic lat and long
	elif distance >= 100 and time < 60:
		i = 1
		while i < rows_to_add+1:
			hms = row[2] + 5*i
			hr_int = hms/3600			#Hours
			hr_str = int_to_str(hr_int)
			ms = hms%3600
			min_int = ms/60				#Minutes
			min_str = int_to_str(min_int)
			sec_int = ms%60				#Seconds
			sec_str = int_to_str(sec_int)
			T = hr_str + ":" + min_str + ":" + sec_str	#Time as string
			DTS = row[3] + "T" + T + "Z"				#Data as string
```

```
			to_insert = (row[0], row[1], hms, row[3], T, DTS, 0)  #Lat, Long, HMS, Day,
Time, DTS, Original
			pending_lst.append(to_insert)

			i += 1
	#These points do not have a spatial component automatically generated, marked with Original =
2
	else:
		i = 1
		while i < rows_to_add+1:
			hms = row[2] + 5*i
			hr_int = hms/3600			#Hours
			hr_str = int_to_str(hr_int)
			ms = hms%3600
			min_int = ms/60			#Minutes
			min_str = int_to_str(min_int)
			sec_int = ms%60			#Seconds
			sec_str = int_to_str(sec_int)
			T = hr_str + ":" + min_str + ":" + sec_str	#Time as string
			DTS = row[3] + "T" + T + "Z"				#Data as string
			to_insert = (0, 0, hms, row[3], T, DTS, 2)	#Lat, Long, HMS, Day, Time,
DTS, Original
			pending_lst.append(to_insert)

			i += 1

	#load the pending_lst into the total_lst
	for x in pending_lst:
		total_lst.append(x)
#Creates a new shapefile with complete rows
def create_new_shape():
	insert_cursor = arcpy.da.InsertCursor(new_table, fields)
	#If the number of rows is 10 larger or smaller than expected.  46080 is expected if rows every
five seconds, 6:00 - 22:00, for four days
	#In the future should be turned into an expected value variable
	if len(total_lst) > 46090 or len(total_lst) < 46070:
		f.write(name + "\n")
	#Insert Cursor to create the new shape
	else:
		edit.startOperation()
		for i in total_lst:
			insert_cursor.insertRow(i)
		edit.stopOperation()
#Calls compile_rows_to_add to
def process_table():
#Can change five seconds into a variable time in final product
	rows = arcpy.da.SearchCursor(table, fields)
	prev_t = 0
	prev_x = 0
	prev_y = 0
	prev_day = ""
	first = True
	rows_to_add = 0


	#Iterator
	for row in rows:
		#the time
		hms = row[2]
		if first == False:
```

```
                    if prev_day == row[3]:
                #Same day
                        delta_t = hms-prev_t
                        distance = calculate_distance(prev_x, row[1], prev_y, row[0])
                        rows_to_add = delta_t/5 - 1
                        compile_rows_to_add(prev_row, rows_to_add, delta_t, distance)
                    else:
                        #New day
                        delta_t = 79200-prev_t
                    #10 at night = 3600 sec/hr * 22 hr
                        distance = 0
                        rows_to_add = delta_t/5 - 1
                        compile_rows_to_add(prev_row, rows_to_add, delta_t, distance)
                        first = True
                    f.write('rows_to_add')

                if first == True:
                    delta_t = hms-21600
                    #6 in the morning = 3600 sec/hr * 6 hr
                    distance = 0
                    rows_to_add = delta_t/5 - 1
                    dummy_row = [0,0,21600,row[3],"06:00:00",row[3]+"T"+"06:00:00Z", 3]
                    compile_rows_to_add(dummy_row, rows_to_add, delta_t, distance)
                    first = False
                prev_t = hms
                prev_day = row[3]
                prev_x = row[1]
                prev_y = row[0]
                prev_row = row
                rows_to_add = 0
        delta_t = 79200-prev_t                                                  #10 at
night = 3600 sec/hr * 22 hr
        distance = 0
        rows_to_add = delta_t/5 - 1
        compile_rows_to_add(prev_row, rows_to_add, delta_t, distance)
        create_new_shape()
workspace = os.path.dirname(table)
edit = arcpy.da.Editor(workspace)
edit.startEditing(False, False)
process_time()
process_table()
edit.stopEditing(True)
f.close()
```

Appendix 3: Kids'Cam Alcohol coding protocol

KIDS'CAM ALCOHOL

CODING PROTOCOL (V.3)

Study objective:

To examine the extent and nature of children's real-time exposure to alcohol marketing, specifically:

The **extent** and **nature** of children's exposure to alcohol marketing, documenting differences by **place**, **promotional type** and **sociodemographic** characteristics.

Study definitions

Marketing is defined using the European Alcohol Policy Alliance definition "a mix of sophisticated, integrated strategies, grouped around four main elements: the product, its price, its place (distribution) and its promotion. For example, product design and brand name (product), pricing strategy and wholesale (price), distribution channels and placing within retail establishments (place) and promotional strategy, advertising, sales promotion and public relations (promotion)." (1, p.6).

A **Marketing Exposure** is coded when 50% or more of a logo or brand name or registered trademark of an alcohol product is visible. Colours and shapes of the product count towards the 50% criteria and are identifiable features of the product's marketing. This included all alcohol marketing exposure except those occurring within off-licence alcohol outlets, see definition for *marketing encounter*. For marketing exposures, the extent and nature of exposure were recorded.

Extent of Marketing Exposures is the number of independent marketing exposures that contribute to the total number of exposures to alcohol marketing per day, excluding within off-licence alcohol outlets.

Nature of Marketing Exposures is the place of exposure and promotional type used to market alcohol, excluding within off-licence alcohol outlets.

A **Marketing Encounter** is an exposure to a single or numerous types of alcohol marketing within an off-licence alcohol outlet (eg, liquor stores or supermarkets). The encounter begins from the first exposure to alcohol marketing within an alcohol outlet and includes every image where alcohol marketing is present. Once the setting changes a new marketing encounter may occur. For marketing encounters, the extent, nature and duration of exposure were recorded.

Extent of Marketing Encounters is the number of independent marketing encounters occurring per day.

Nature of Marketing Encounters relates to the place (type of off-licence outlet or place of exposure within an outlet).

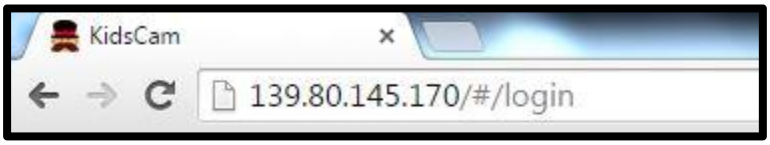
Duration of Marketing Encounters is the number of images with alcohol marketing present during each marketing encounter. The number of images are summed and multiplied by seven seconds to generate the duration of exposure.

Coding an image

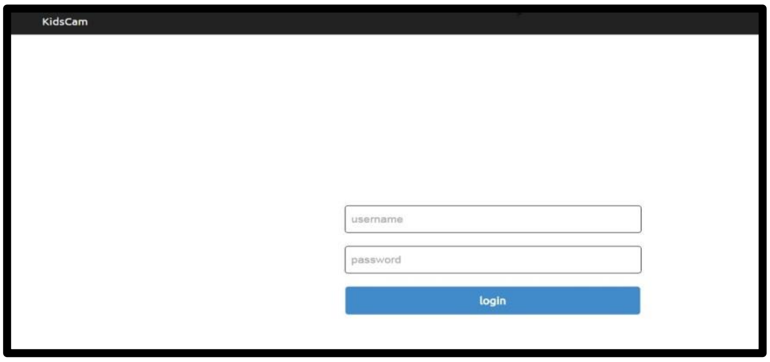
Steps to logging into the coding interface and accessing images are outlined below including logging in as a user, accessing images and coding an image.

Logging in as a user

1) Type in the Kids'Cam URL http://139.80.145.170 into the web browser (Google Chrome) of a computer connected to the University of Otago Server.

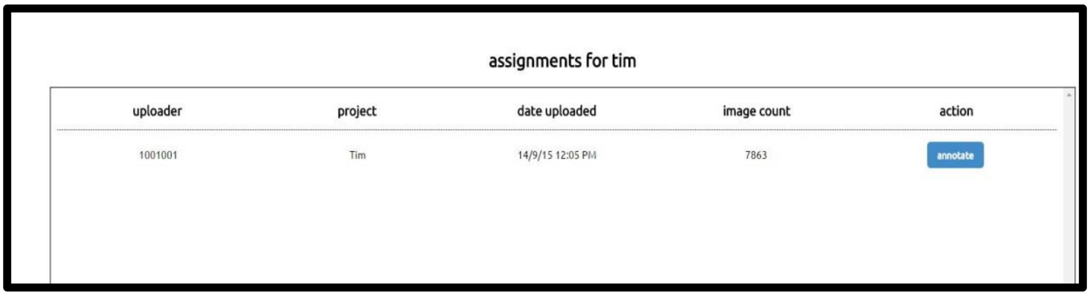


2) Type in your username and password to access the images

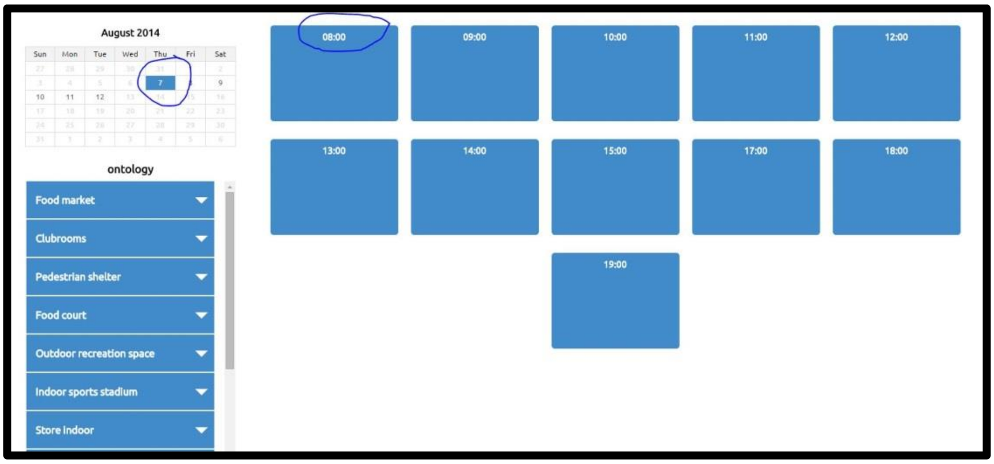


Accessing images

1) Once logged in your assignments will appear. In order to access a participant's images click on the annotate button.



2) Next click on the date you are interested in by using the calendar function and then select the time by clicking on the appropriate hour.



Coding an image

This section outlines how to code images using the coding software. First, images are to be coded in the following sequence:

Place > *Promotional Type* > *Exposure Variables*

To code an image please refer to the directions below and Figure 1.

A. First the image must be coded for place (see *place* definitions) using the coding bar to the left of your screen (Figure 1, A).

B. Once the place is selected the coding bar will open up a selection for promotional type (Figure 1, B) Once determined (see *promotion type* definitions) select the appropriate promotional type.

C. Once the promotional type is selected a number of exposure variables will appear (Figure 1, C), see *exposure variables* definitions. Once determined select the appropriate exposure variable and the image will be coded. A green marker will appear to inform you the image has been coded (Figure 1, E)

D. Make sure you deselect the images before coding another image by hitting the 'deselect' button (Figure 1, D)

E. To delete a code click the red X.

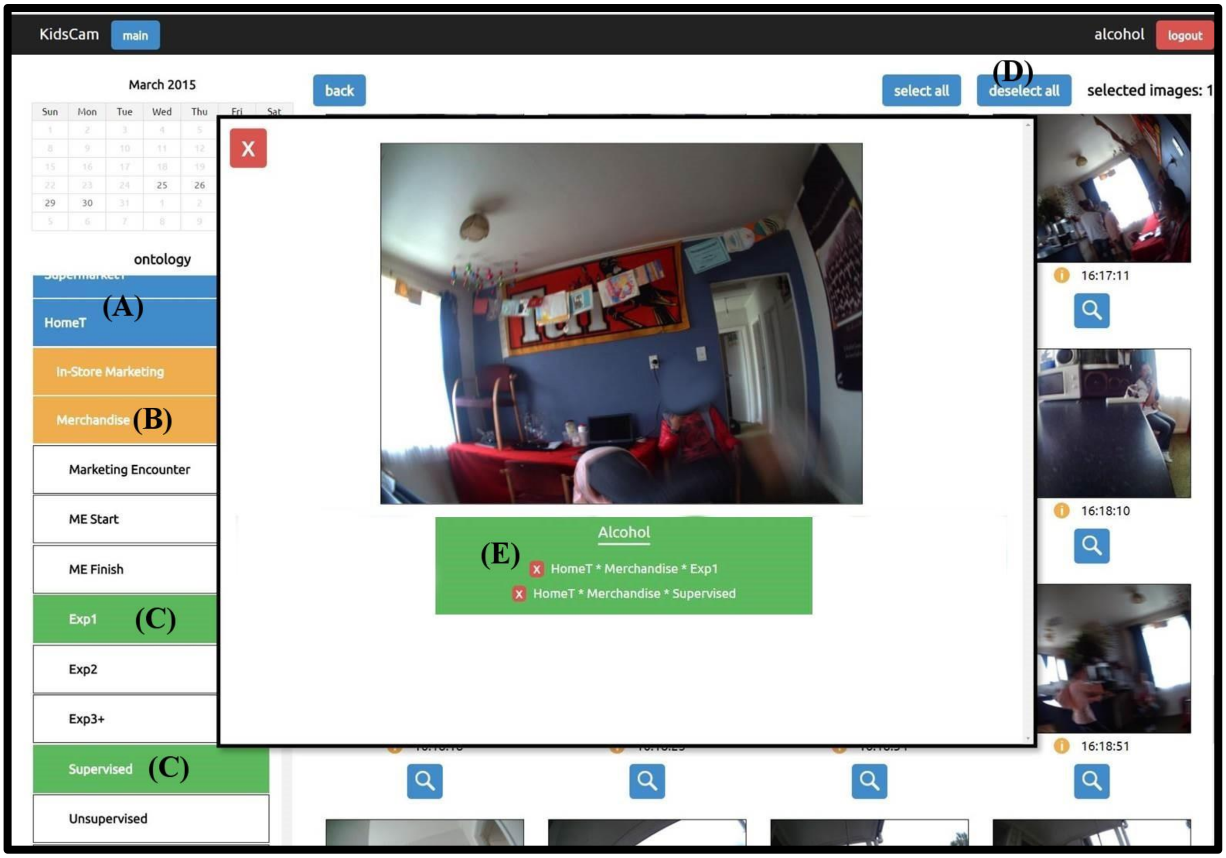


Figure 1: Coding an image for alcohol marketing using the coding software

Coding rules

General rules

If it takes you longer than 10 seconds to determine whether marketing is clearly present then do not code the image.

From the 28th of September 2014 to the 5th of April 2015 the times have not been adjusted for daylight savings. For example, the coding framework will show 6.00am when it is really 7.00am. Participant numbers 600800-190120 affected.

Alcohol marketing exposure rules

There are a number of rules for coding alcohol marketing exposures. The following section outlines the key rules.

A. The coder must see 50% of the **logo or brand name or registered trademark** to code an alcohol marketing exposure (Figure 2, A).

B. Marketing on the outside of off-licence outlets is coded as a marketing exposure as it is a similar exposure to other exposures (Figure 2, B).

Figure 2: Alcohol marketing exposure coding rules A and B

C. If an exposure is the same place, promotional type and brand then it is counted as a single exposure. For example, in Figure 3, there are multiple exposures of the exact same type that would be counted as single exposures. The image would be interpreted as follows:

Exposure 1)The two Woodstock signs would be coded as a single exposure (red).

Exposure 2) The three Liquor Centre logos would be coded as a single exposure (Blue).

Exposure 3) The liquor sign on the front (Green).

The image would be coded as:

Liquor store shop front→ Shop front signage→ 3+ unsupervised.

Figure 3: Alcohol marketing exposure coding rules C and D

D. The place is coded by where the marketing is, not where the participant is standing. For example, in Figure 3, the marketing is occurring on the shop front of an off-licence outlet this image would be coded:

Liquor store (**place**, not street) → Shop front signage (promotion type)→ 3+, unsupervised (exposure variables)

E. Marketing could not be coded again until there was a period of greater than 30 seconds in image sequence where the brand was completely absent. For example, in Figure 4, only the first alcohol marketing exposure in this sequence was coded (A). The subsequent images (Figure 4, B, C, D) were not coded until a gap in exposure of over 30 seconds (approximately three images) occurred.

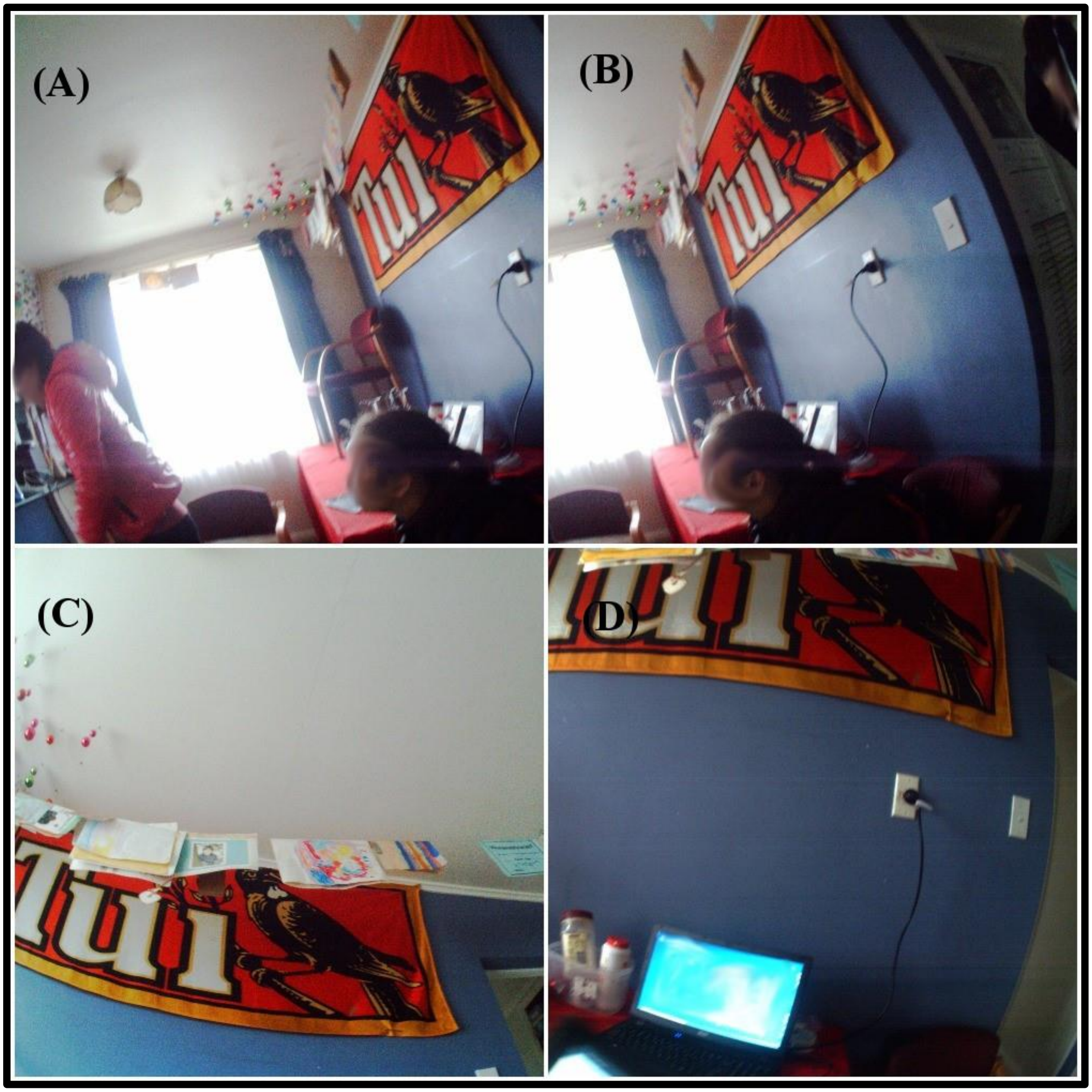


Figure 4: Example of image sequence (A =1st, B = 2nd, C= 3rd, D = 4th) coded as a single exposure

This thesis was particularly interested in sports sponsorship as a form of alcohol marketing. Thus, sports sponsorship was coded separate from other forms of alcohol merchandise. Figure 5 demonstrates the differences between sports sponsorship and merchandise using rules F and G.

F) Sports merchandise that has alcohol sponsorship should be coded as sport sponsorship

G) Alcohol merchandise should be coded as merchandise

Figure 5: Alcohol marketing exposure coding rules F and G

Alcohol marketing encounters

Due to exposures within off-licence alcohol outlets being fundamentally different from alcohol marketing exposures (usually single brand exposures) they were coded as marketing encounters.

Figure 6 displays a marketing encounter lasting three images. The first image that contains alcohol marketing within the off-licence is coded as a marketing encounter and marketing encounter start to signal the start of the marketing encounter (Figure

6, A). Every subsequent image that contains alcohol marketing should be coded as a marketing encounter in order to gauge the duration of the marketing encounter (Figure 6, B). The final image with alcohol marketing within an off-licence alcohol outlet is coded as marketing encounter finish to signal the end of an encounter (Figure 6, C). If children were accompanied by an adult then the marketing encounter was coded as supervised. If no adult was present during the marketing encounter then it would be coded as unsupervised.

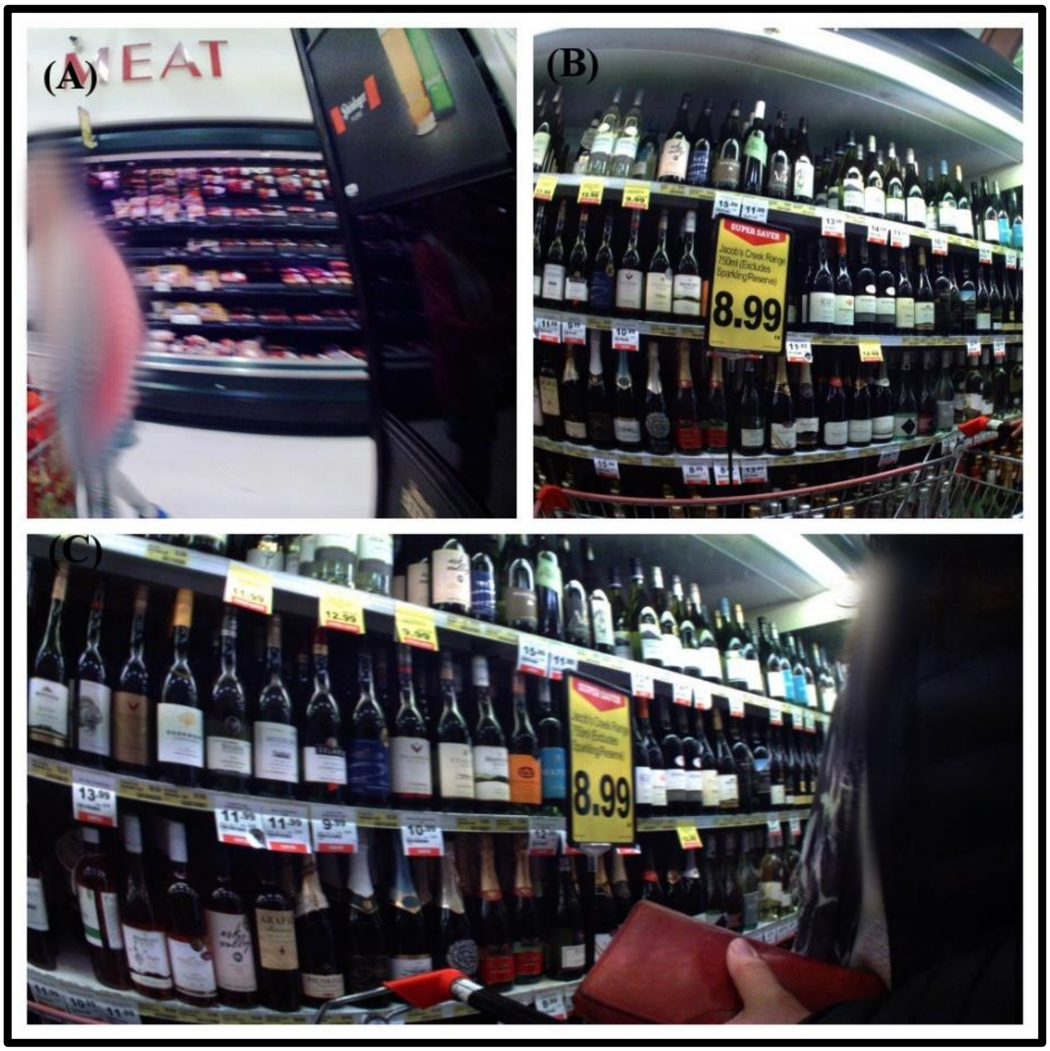


Figure 6: Example of a marketing encounter

The marketing encounter in Figure 6 would be coded as follows

A) Supermarket→In-Store Marketing → Marketing Encounter Start
Supermarket→In-Store Marketing → Marketing Encounter
Supermarket→In-Store Marketing → Supervised

B) Supermarket→In-Store Marketing → Marketing Encounter
C) Supermarket→In-Store Marketing → Marketing Encounter Finish
Supermarket→In-Store Marketing → Marketing Encounter

Uncodable images

Uncodable images were coded in Kids'Cam. Uncodable images were removed from analysis in Kids'Cam Alcohol. The types of uncodable images are reported here to gain an understanding of such images.

1) **Camera taken off** – When the participant has removed the camera. Generally, the position of the image or a set of images remains the same in relation to fixed objects. Lighting commonly changes without the movement of the camera (Figure 7)

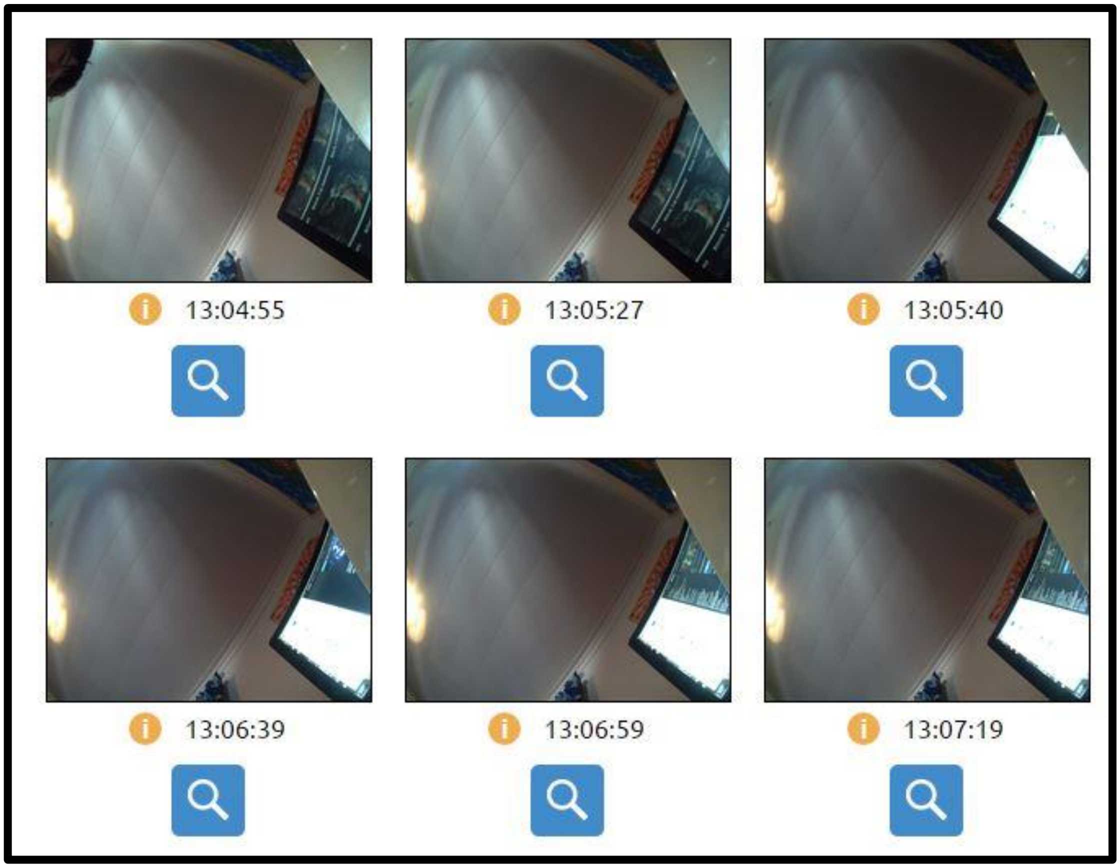


Figure 7: Example of camera being removed

2) Any image or set of images where the quality is so poor the coder is unable to accurately determine what is happening in the image or series of images in question. Could be due to blurred or dark (Figure 8).

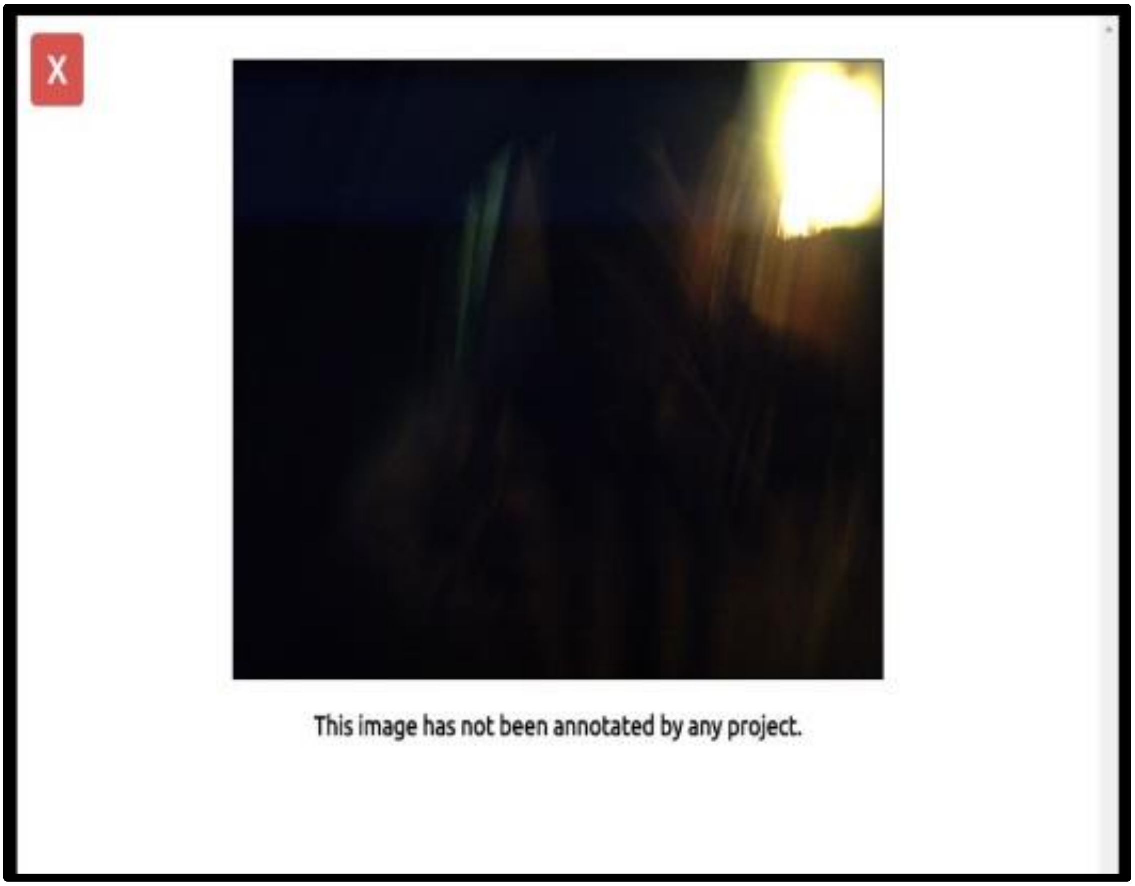


Figure 8: Example of poor lighting

Computers

1) Images are only to be coded using an external computer screen no larger or smaller than 22'. Do not code using a laptop screen.
2) **Always** use the *Google Chrome* internet browser to access and analyse the images as the coding framework has been optimised for this platform

Ethics

1) Keep the identifiable features of the data **confidential;** these features of the data should not be discussed with anyone outside the research team.
2) Do not leave data or equipment containing unsecured data unattended. If you leave your computer for any amount of time you must **log out.**
3) The University of Otago (Wellington) owns all image data. Applicants cannot copy data without the written approval of the Principal Investigator or retain copies of the data after completion of work. Any data copied or released must be stored on a

password protected device and must have gone through the appropriate anonymised procedure.

4) Protect the anonymity of all participants, third parties and their environments. To protect the privacy of those who may be inadvertently captured in the images, all images used in disseminated material will have identifiable people, street names, places, retail outlets, businesses and school names blurred.

Study definitions

Place

Definition: The location of alcohol marketing to which children are exposed

Place	Definition
Home	The place where one lives permanently, especially as a member of a family or household. Includes all spaces within the home gates and boundaries i.e. indoor and outdoor spaces. Also includes all private residence (friends and extended family residences).
Liquor store	A store with the main purpose of selling alcohol Is an off-licence alcohol outlet where alcohol is sold but consumed elsewhere (2).
On-licence alcohol outlet	An alcohol outlet where alcohol is sold and consumed on the premise. Examples include bars, clubs, restaurants and cafes (2).
Public spaces	Library- A building or room containing collections of books, periodicals, and sometimes films and recorded music for use or borrowing by the public or the members of an institution. Recreation centre/community hall - a public space where meetings are held Marae - includes the meeting house, dining hall, education and associated facilities and residential accommodation associated with the Marae. Church - A building used for public Christian worship. Other retail outlets (other than alcohol outlets)

	Includes all public transport facilities and vehicles All spaces that are not private residence, the street or part of structured sport. Eg parks or outdoor recreation spaces
Street	Roads, footpath and courtyards. The roads or public areas of a city or town.
Structured sport	Swimming pool - council facility/publically accessible swimming pool Indoor sports stadium - sports stadiums that are used for recreational sporting games eg ASB stadium Outdoor sports stadium - large regional stadiums where professional matches are held eg Westpac Stadium Sports clubrooms - club emblems and colours are on display Sports ground - outdoor area designed primarily for the purpose of playing sport (buildings and other associated structures) Where "an activity involving physical exertion and skill in which an individual or team competes against another or others for entertainment" takes place.
Supermarket	Inside a supermarket with three or more checkouts. Sells fresh fruit and vegetables. Has long opening hours. (3). Eg Countdown, Pac'n'Save, New World, Moore Wilsons. Is an off-licence alcohol outlet where alcohol is sold but consumed elsewhere(2).
School (for exclusion)	Indicated by the presence of classroom features such as desks, tables and chairs, other children, teaching staff, school buildings and playgrounds. School grounds are delineated by a gate and/or fence. School is an institution for educating children and includes the building used by the school.

Promotional type

Definition: "Any single marketing vehicle comprising commercial messages or brands."

Promotional type	**Definition**
In-store marketing	On-shelf displays. Displays at check-outs, pay-points, and end-of-aisles in supermarkets. Special offers and pricing incentives (4). Examples include: branded drinks fridges and branded stands, end-of-isle displays, price signs, point-of-sale, promotional activity in-store.
Merchandise	Branded products used to promote an alcohol product eg vouchers, t-shirts, caps, bowls, glasses, drinks bottles. This only includes merchandise that is produced and distributed by the alcohol company or other stores. Does not include sport merchandise that has associated alcohol branding acquired through sponsorship deals. Examples include: T-shirts and caps for alcohol brands, companies or distributors.
Print media	Marketing and editorial content, gifts and promotions offered by the print media (4). Examples include: newspapers, flyers, magazines.
Product packaging	Product labelling and packaging designs (5). Examples include: includes bags, wrappers, and boxes with alcohol logos.

Screen	Advertisements for alcohol products during commercial breaks, programmes and sports events on television (4). A promotion activity that occurs on the internet, which connects consumers to companies' brands and products for the purpose of stimulating sales (4). Examples includes: television, games console, mobile handheld device including smartphones and iPods, computer screen-desktop or laptop, tablet, kindle.
Shop front signage	Where signs with branded information, pictures or logos displayed within a shop window or attached to the shop front. This includes posters, stickers, signs, neon signs and electronic boards. This does not include *movable signs* such as sandwich boards. Includes large signs above the door/veranda of shop.
Sign	Any word, letter, model, banner, placard, board, hoarding, billboard, poster, symbol, emblem, notice, name, image, character, outline, spectacle, display, delineation, announcement, device or representation, or any other means of a similar advertising nature intended to principally attract attention, whether a specially constructed device, structure or apparatus, whether painted, printed, written, carved, inscribed, endorsed or projected onto a place or otherwise fixed or attached to any wall, roof, fence, rock, stone, structure, canvas or stationary vehicle. Aerial signs (for example, blimps) and free standing signs are included (6).
Sports sponsorship	Any agreement or part of an agreement involving payment or other consideration in lieu of payment by an alcohol producer, distributor or retailer to support a sporting property, event or activity, in return for which the sponsored party agrees to be associated with or promote the sponsor's drink(s) or outlet (7). All sports merchandise that has associated alcohol branding will be coded within this definition as the merchandise is that of the sport's team, player or stadia not the alcohol company.

Exposure variables

Exposure 1	Number of marketing exposures occurring in a single image.
Exposure 2	Number of marketing exposures occurring in a single image.
Exposure 3+	Number of marketing exposures occurring in a single image.
Supervised	A child supervised by a guardian (who looks 18 or over) when a marketing exposure occurred within an off-licence alcohol outlet.
Unsupervised	A child unsupervised (guardian who looks 18 or over) when a marketing exposure occurred within an off-licence alcohol outlet.
Marketing encounter start	The first image with alcohol marketing within an off-licence alcohol outlet.
Marketing encounter	When a children is exposed to alcohol marketing within an off-licence alcohol outlet. Every image with alcohol marketing is coded to give the duration of exposure but it counts as a single encounter regardless of the time lapse between alcohol marketing exposures.
Marketing encounter finish	The final image with alcohol marketing within an off-licence alcohol outlet.

Coding schedule

Table 1. Coding schedule for marketing exposures and encounters in Kids'Cam Alcohol

Place	**Promotion type**	**Exposure variables**
Home	In-store marketing	Exposure 1
Liquor store	Merchandise	Exposure 2
On-licence	Print media	Exposure 3+
Public spaces	Product packaging	Supervised (for all marketing)
Street	Screen	Unsupervised (For all marketing)
Structured sport	Shop front signage	Marketing encounter start
Supermarket	Sign	Marketing encounter
	Sports sponsorship	Marketing encounter finish

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