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Investigation of the Food Environment Surrounding Primary Schools in New Zealand

A thesis presented in partial fulfilment of the requirements of the degree of
Master of Science
In
Nutrition and Dietetics

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ABSTRACT

Background: Childhood obesity is a prominent issue in New Zealand (NZ). Children's daily exposure to their food environment significantly influences their health, dietary patterns, and preferences. With children spending a substantial portion of their time on school grounds, the quality of the food environment within and around schools emerges as a crucial factor. Efforts have been made to enhance the food environment within schools. However, limited action has been taken to improve the food environment surrounding schools. Therefore, a comprehensive understanding of the food environment surrounding schools, encompassing both advertisements and stores and exploring correlations with internal food environments, is needed. This knowledge is paramount for informing policymakers and catalysing targeted actions to address childhood obesity comprehensively.

Aims: To investigate food and beverage advertising and stores surrounding NZ primary schools and to explore correlations between the external food environment (food and beverage advertisements) and the internal food environment (Healthy Active Learning food menu and policy data) for these schools.

Methods: Food and beverage advertisements (n=479) and stores (n=215) within 800 m of 18 primary schools were collected via Google Street View in August 2023. Advertisement and store characteristics were compared across different school deciles (low, medium and high). To determine the healthiness of the advertisement, food and beverage advertisements were separated into 'core' and 'non-core' depending on whether they are considered part of the everyday diet.

Results: 'Non-core' advertisements (n=426, 89.0%) outnumbered 'core' advertisements (n=53, 11.0%), with sugar-sweetened beverages (n=192, 40.1%) the most common category, and Coca-Cola the most common brand (n=158, 33.0%). The majority of advertisements were found near low (n=406, 43.0%) and medium (n=208, 43.4%) decile schools, with low decile schools having more nearby (0-400 m) advertisements (n=111, 57.5%). Advertisement characteristics varied by school decile including; distance from school, brand and secondary

marketing classifications. The number of advertisements strongly correlated with the number of stores ($r_s=0.879$, $n=18$, $p<0.001$), with most advertisements (97.1%) located on food stores. The most common food and beverage stores near schools were local fast-food restaurants (44.7%) and convenience stores (24.2%). Low and medium-decile schools have more convenience stores, fast food outlets and bakeries within 800 m, while high-decile schools have more supermarkets and cafés.

Conclusions: ‘Non-core’ food and beverage advertising, fast food stores, and convenience stores are highly prevalent surrounding primary schools, particularly surrounding low and medium-decile schools.

Key words: *Food advertising, food stores, Google Street View, child obesity, Healthy Active Learning initiative.*

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CONTRIBUTIONS

This study used the menu and policy data collected during baseline data collection for the Healthy Active learning initiative by the Massey University project team. I did not participate in the data collection for this project. With permission, I used the collected policy and menu data to compare these results with the data I collected for this project.

I used a combination of established data collection protocols for my project's methods. Including the "INFORMAS protocol: Outdoor Advertising" and "Data Collection Protocol Using Google Street View to Capture Outdoor Advertising at Dairies and Bakeries Near Schools" kindly given to me by Victoria Egli.

I analysed and reported statistics data myself. Karen Mumme checked over my statistics to ensure accuracy.

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LIST OF ABBREVIATIONS

a,b	Subscript letters
ASA	Advertising Standards Authority
BMI	Body Mass Index
e.g.	For example
GIS	Geographic Information System
GSV	Google Street View
HAL	Healthy Active Learning
INFORMAS	International Network for Food and Obesity/Non-communicable Diseases Research, Monitoring, and Action Support
MoE	Ministry of Education
MoH	Ministry of Health
MPI	Ministry for Primary Industries
n	Sample size
NZ	New Zealand
OECD	Organisation for Economic Co-operation and Development
P-value	The probability of rejecting the null hypothesis when it is true
r^s	Spearman's rank correlation coefficient
SPSS	Statistical package for the Social Sciences
V	Cramer's V
WHO	World Health Organisation

GLOSSARY

Cramer's V	Measures the strength of the association between categorical variables.
'Core' food and beverages	Foods and beverages which considered to be a core part of the everyday diet according to the WHO nutrient profiling system.
Chi-square test	Determines associations between categorical variables.
Convenience store	A small retail business that typically operates extended hours, offering a diverse range of everyday items such as snacks, beverages, groceries, and household essentials.
Dairy	A convenience store
Decile	An indication of the level of deprivation. Decile 1 schools have the highest proportion of students from low socioeconomic communities, whereas Decile 10 schools have the lowest proportion. Deciles were organised into three groupings: low (1-3), medium (4-7) and high (8-10).
Fast-food chain	Quick service restaurants, like KFC, which operates multiple outlets under the same name and consistent branding, offering a uniform experience across locations.

Fisher's exact test	Determines associations between categorical variables when chi-square test assumptions are not met.
Food environments	The interplay of physical, economic, policy, and sociocultural factors, influencing individuals' dietary patterns. Within the scope of this project, food environment's refer to both the foods and beverages advertised (outdoors and on a stationary object) surrounding schools and the food and beverage stores including; convenience stores, bakeries, fast-food chains, local fast-food, café, supermarkets/produce stores surrounding schools.
Food and beverage stores investigated for both advertisements and stores	Within the scope of this project food and beverage stores included; convenience stores, bakeries, fast-food chains, local fast-food, cafés, supermarkets/ produce stores and other.
Healthy Active Learning	A government-backed initiative, involving Sport NZ, the Ministry of Health (MoH), and the Ministry of Education, which aims to improve the health and well-being of children by enhancing the food and drink environment and implementing quality physical activity within schools nationwide
Local fast-food	Quick service restaurants, which are unique to a specific locality without replication elsewhere.
'Non-core' food and beverages	Foods and beverages which considered to not be a core part of the everyday diet

	according to the WHO nutrient profiling system.
Primary marketing classifications	The audience in which products are marketed at, either 'child only' or 'child and adult'
Primary school	School for children from years 1-8
Post hoc testing	Comparisons between groups to identify which specific groups differ significantly from each other.
Secondary marketing classifications	Different types of marketing techniques used to convince the consumer to buy such as discounts and promotions.
The Healthy Food and Drink Policy	A policy which aims to increase the availability of healthy food options within schools. It utilises a traffic light model, in which products are either 'green' (most nutritious), 'amber' (moderately nutritious) or 'red' (least nutritious). In this policy $\geq 75\%$ of all products offered in schools must fit into the 'green' category. Red items should not be made available. There are also other guidelines on foods made available.
The Water and Milk only Policy	A policy designed specifically for NZ schools, making water and plain milk the only drinks available
The Healthy Food and Drink Guidance traffic light system	Devised by the Ministry of Health, this system categorises foods into 'green', 'amber' or 'red' depending on how nutritious they are, with red being the least nutritious and green the most.

CHAPTER 1: INTRODUCTION

1.1 Background

Childhood obesity is a significant global health issue that affects children worldwide (OECD, 2017; WHO, 2013). It is linked to non-communicable diseases like diabetes and cardiovascular disease. Obesity in childhood also increases the risk of obesity, disability, and premature death in adulthood (WHO, 2021). In NZ childhood obesity is a severe problem, with one in ten children being affected, particularly among Pacific and Māori children and in areas marked by socioeconomic disadvantage (Ministry of Health, 2022).

The World Health Organization (WHO) has developed an action plan consisting of six strategic objectives to tackle the issue of non-communicable diseases such as obesity (WHO, 2013). One of these objectives emphasises the creation of health-promoting environments as a means to mitigate modifiable risk factors associated with non-communicable diseases, such as obesity. This can be achieved by implementing policies and initiatives that promote healthy lifestyles and behaviours.

Food environments are a complex interplay of physical, economic, policy, and sociocultural factors that significantly influence individuals' dietary choices and nutritional well-being (Mackay et al., 2020). Children, in particular, are highly susceptible to external influences such as their food environment (Tsochantaridou et al., 2023). Schools are the main places children spend their time, both during the school day and after for the recreational spaces (Badland et al., 2015). However, evidence suggests that schools have disproportionately higher amounts of unhealthy food and beverage advertisements than other areas (Kelly et al., 2008; Vandevijvere et al., 2018). This is concerning as research has shown that exposure to unhealthy food and beverage advertisements (Boyland et al., 2016; Cairns et al., 2013; Egli et al., 2020; Sadeghirad et al., 2016) as well as a high prevalence of stores that sell unhealthy products (Egli et al., 2020; Ni Mhurchu et al., 2013; Xin et al., 2021) within their environments can have detrimental impacts on their dietary patterns and health.

Research conducted in NZ has shown that, the food environment in which children live, such as surrounding primary schools, is unhealthy, mainly constituting a high volume of both unhealthy food and beverage advertisements (Brien et al., 2022; Egli et al., 2019; Huang et al., 2020; Maher et al., 2005; Signal et al., 2017; Vandevijvere et al., 2018; Walton et al., 2009) and stores such as convenience stores and fast-food (Clark et al., 2014; Day & Pearce, 2011; Day et al., 2015; Maher et al., 2005; Vandevijvere et al., 2016; Walton et al., 2009). An issue that is only getting worse, as demonstrated by one study examined the food environment over time, finding that the median number of fast food outlets over a ten-year period increased from 1 to four (Day et al., 2015). Of particular concern are the inequities seen in food environments, with a higher prevalence of unhealthy food and beverage advertisements and stores in lower socioeconomic neighbourhoods (Brien et al., 2022; Day & Pearce, 2011; Day et al., 2015; Huang et al., 2020; Vandevijvere et al., 2018; Vandevijvere et al., 2016).

NZ has taken measures to promote healthy environments, particularly in schools. The Healthy Active Learning (HAL) initiative, launched in 2020, is a noteworthy example of such efforts. This government-backed initiative, a collaborative endeavour involving Sport NZ, the Ministry of Health (MoH), and the Ministry of Education, aims to improve the health and well-being of children by enhancing the food and drink environment and implementing quality physical activity within schools nationwide (Ali et al., 2022).

While the Healthy Active Learning (HAL) initiative stands as a cornerstone in the endeavour to cultivate healthier environments within educational settings, its effectiveness hinges on the recognition of the interconnectedness between school-based interventions and the broader food environment. Research underscores the imperative of extending efforts beyond the confines of school premises to effectively foster and sustain dietary intake and Body Mass Index (BMI) (Pineda et al., 2021).

In 2017, the Advertising Standards Authority (ASA) introduced the Children and Young People's Advertising Code, a significant step towards promoting a healthy and supportive environment for children. The code is specifically designed to protect children's well-being

by regulating advertisements for occasional food and beverage products. It stipulates that such advertisements should not be targeted towards children or placed in areas where children usually gather, such as schools (Advertising Standards Authority, 2017). Despite its intentions, a 2020 review found that the code didn't effectively limit children's exposure to unhealthy food and drink advertising due to its vague nature and inadequate regulation (Sing et al., 2020). Additionally, the Food Industry Task Force in NZ made recommendations at the end of 2019 to restrict food and beverage advertisements high in saturated fat, salt, and added sugars near schools (The Food Industry Taskforce, 2018). However, these recommendations are yet to be implemented. In 2023, the WHO released new guidelines recommending that countries should implement mandatory and comprehensive policies to protect children from unhealthy food and beverage advertising (WHO, 2023a), as 16 countries have done to date (Taillie et al., 2019) implications of which are unresearched (Boyland et al., 2022).

Similarly, several countries worldwide, including South Korea, the UK, Ireland, the United States, and The Philippines, have implemented zoning measures to regulate food and beverage stores primarily offering unhealthy products around school premises. While the effectiveness of these zoning policies in reducing the number of such stores near schools has produced mixed results (Brown et al., 2021; Brown et al., 2022), the long-term impact remains to be fully understood, as this area of study is still largely underexplored.

Currently, research conducted in NZ that has examined the food environment, encompassing advertisements surrounding primary schools, has focused on specific regions, such as Auckland (Brien et al., 2022; Egli et al., 2019; Huang et al., 2020) or Wellington (Maher et al., 2005; Signal et al., 2017; Walton et al., 2009). A few of them collected data on advertisements in one location, such as at bus stops (Huang et al., 2020) or convenience stores (Brien et al., 2022). Only one study has examined primary schools across NZ, investigating all outdoor advertisements (Vandevijvere et al., 2018). Similarly, only a handful of studies have investigated the type and number of stores surrounding primary schools in NZ (Clark et al., 2014; Day & Pearce, 2011; Day et al., 2015; Maher et al., 2005; Vandevijvere et al., 2016; Walton et al., 2009), of which, only two examined stores across NZ (Pearce et al., 2007; Vandevijvere et al., 2016).

In NZ, a single study investigated the food environment within schools and their surroundings, encompassing food and beverage advertising and outlets. The results indicated that a high concentration of advertisements and outlets substantially impacted efforts to enhance the school food environment (Walton et al., 2009). However, research has yet to explore whether a relationship exists between the healthiness of the food environment within schools and the food environment in the surrounding vicinity.

Therefore, this study aims to contribute to the existing literature investigating food and beverage advertising and stores (convenience stores, bakeries, fast food chains, local fast food, café, supermarkets/produce stores) near primary schools across NZ. Additionally, it seeks to investigate potential correlations between the internal school environment, including menus and policies derived from data collected from the HAL initiative, and the surrounding food environment, encompassing advertising and stores.

1.1.1 Scope

The present study will investigate food and beverage advertisements and stores surrounding primary schools in NZ, as well as identifying potential socioeconomic differences.

In addition, the study will examine correlations between the external food environment (advertisements) and the internal food environment (food menus and policies) collected as part of the HAL initiative. The food menus and policy data utilised from the HAL initiative was collected as part of the baseline data in 2020.

The results of the study will provide insight into the prevalence and characteristics of food and beverage advertisements and stores surrounding primary schools in NZ. As well as providing insight into whether there are correlations between the external food environment encompassing advertisements, and the internal food environment within schools including food menus and policies.

1.2 Aim and objectives

1.2.1 Aims

1. To investigate food and beverage advertisements and stores within 800 m walking distance from primary schools involved in the HAL initiative in NZ.
2. To explore correlations between the external food environment (food and beverage advertisements) and the internal food environment (HAL food menu and policy data) for primary schools in NZ.

1.2.2 Objectives

1. To use existing protocols (Egli, 2020; Mackay et al., 2017) to investigate all food and beverage advertisements and stores within 800 m walking distance of primary schools in NZ.
2. To discuss the relationship between school socioeconomic status (using deprivation score) and food and beverage advertisement characteristics, including:
 - Distance from school (0-400 m or 401-800 m)
 - Food and beverage category ('core' or 'non-core')
 - Brand
 - Primary marketing classification ('child only' or 'child and adult')
 - Secondary marketing classification
3. To discuss the relationship between school socioeconomic status (using deprivation score) and food and beverage store category (convenience, bakery, fast-food chain, local fast-food, café or supermarket/produce store).
4. To use the MoH *Healthy Food and Drink Guidance* to determine if the proportions of 'green', 'amber' and 'red' advertisements correlate with the proportions of corresponding menu items for each primary school.
5. To investigate whether the presence or absence of both the *Healthy Food and Drink Policy* and the *Water and Milk Policy* correlate with the number of advertisements for each primary school.

1.2.3 Thesis Structure

This thesis comprises four chapters. Chapter 1 provides an overview of the background, scope, aims, objectives, and the researcher's contributions. In Chapter 2, a comprehensive literature review explores the various aspects of children's food environments, examining implications and efforts for improvement. Chapter 3 presents the manuscript of the data collected for this thesis, including an abstract, introduction, methods, results, discussion, and conclusions. Finally, Chapter 4 concludes the thesis, discussing the study's strengths and limitations and providing recommendations for future research and policy.

1.2.4 Researcher Contribution

Kate Nicholls is the primary researcher and author of this thesis. Professor Carol Wham, the primary academic supervisor and Professor Ajmol Ali, the secondary academic supervisor, both provided valuable guidance and expertise in crafting, structuring, implementing, and writing the entire thesis and manuscript.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Childhood obesity is a significant concern in NZ and is associated with an increased risk of severe health conditions such as heart disease, type 2 diabetes, and cancer (WHO, 2021). Obesity statistics reveal social and ethnic disparities, with children of Māori or Pacific descent and those in regions of higher socioeconomic deprivation at significantly elevated risks (Egli et al., 2020; Ministry of Health, 2003). The cause is multifaceted, stemming from dietary habits, lifestyle, genetics, environment, socioeconomic status, and psychological elements (WHO, 2021). The National Children's Health Survey shows that children in NZ have unhealthy dietary patterns (Ministry of Health, 2003), which may predispose them to obesity.

Given that children dedicate a substantial amount of time on school grounds (Badland et al., 2015), optimising the school food environment is a pivotal opportunity to enhance their overall health (Mackay et al., 2020). Nonetheless, the current state of the food environment within NZ schools is disconcerting, marked by a prevalent lack of healthiness (Carter & Swinburn, 2004; D'Souza et al., 2022; Richards et al., 2005).

Initiatives such as HAL strive to improve NZ schools' food and drink environment (Ali et al., 2022). Supported by government agencies, HAL has made an impact, reflected in the fact that 83% of schools now implement a healthy food and drink policy (Sport New Zealand, 2022a). However, it is important to look beyond the bounds of the school food environment, as research has demonstrated that unhealthy food environments around schools can impede positive initiatives within (Pineda et al., 2021).

Extensive research has found children's health, dietary patterns, and preferences to be negatively affected by the food environment encompassing food and beverage advertisements or stores (Boyland et al., 2022; Cairns et al., 2013; Clark et al., 2014; Kraak & Story, 2015; Sadeghirad et al., 2016; Smets & Vandevijvere, 2022; Xin et al., 2021).

Nevertheless, studies conducted in NZ, most of which utilise Google Street View (GSV), reveal a high prevalence of unhealthy food and beverage advertisements surrounding schools, surpassing their healthier counterparts (Brien et al., 2022; Egli et al., 2019; Huang et al., 2020; Maher et al., 2005; Signal et al., 2017; Vandevijvere et al., 2018; Walton et al., 2009) with a more pronounced presence in lower socioeconomic areas (Brien et al., 2022; Huang et al., 2020; Vandevijvere et al., 2018). Similarly, the density of unhealthy food stores tends to be high in the surrounding schools (Vandevijvere et al., 2016). These results align with other smaller studies conducted in NZ (Clark et al., 2014; Day & Pearce, 2011; Day et al., 2015; Maher et al., 2005; Vandevijvere et al., 2018; Walton et al., 2009), with higher accessibility to schools of lower socioeconomic status (Day & Pearce, 2011; Day et al., 2015; Vandevijvere et al., 2016).

While the World Health Organization recommends comprehensive policies to shield children from harmful food marketing (WHO, 2023a), NZ lacks mandatory regulations. Existing guidelines by the Advertising Standards Authority have fallen short, emphasising the need for more robust regulations (Sing et al., 2020). In addition, different countries worldwide, including South Korea, the UK, Ireland, the United States, and the Philippines, have recognised the impacts of having food outlets and convenience stores near schools and have implemented zones where food stores that sell predominantly unhealthy food and drinks or unhealthy food and drink products are limited or prohibited (World Cancer Research Fund International, 2021), a consideration for future policy in NZ.

Overall, it is critical to consider both the internal and external food environment surrounding schools as the external food environment has an impact on the success of internal initiatives (Pineda et al., 2021; Walton et al., 2009), as well as children's health and dietary patterns (Boyland et al., 2022; Cairns et al., 2013; Clark et al., 2014; Kraak & Story, 2015; Sadeghirad et al., 2016; Smets & Vandevijvere, 2022; Xin et al., 2021). Currently, the external food environment surrounding schools, consisting of outdoor food and beverage advertising and stores is unhealthy (Brien et al., 2022; Clark et al., 2014; Day & Pearce, 2011; Day et al., 2015; Egli et al., 2019; Huang et al., 2020; Maher et al., 2005; Signal et al., 2017; Vandevijvere et al., 2018; Vandevijvere et al., 2016; Walton et al., 2009). Therefore, it is

recommended that NZ takes action, such as the recommendations made by the WHO regarding developing a robust policy to protect children from the harmful impact of food marketing (World Health Organisation, 2023a), as well as following in the steps of other countries to restrict the number of food stores surrounding schools (World Cancer Research Fund International, 2021).

2.2 Childhood obesity

Childhood obesity, characterized by a BMI at or above 30 kg/m² (WHO, 2021) stands out as a significant concern in NZ, where the country grapples with one of the highest childhood obesity rates among OECD nations (OECD, 2017). Recent data from the 2020/2021 NZ Health Survey underscore the severity of the issue, revealing a notable increase in the prevalence of childhood obesity. Alarming figures show that 13% of NZ children, or one in eight, are now classified as obese, a stark rise from 9.5% recorded in the previous year (Ministry of Health, 2023).

The escalating trend in childhood obesity is unsettling, given its well-established correlation with heightened risks of developing severe health conditions such as heart disease, type 2 diabetes, and specific forms of cancer (WHO, 2021).

Notably, obesity statistics unveil social and ethnic disparities among children. Those residing in the least deprived neighbourhoods exhibit a lower mean waist to height ratio (0.44) compared to those living in middle to high deprivation areas (0.49) (Egli et al., 2020). Furthermore, a higher percentage of children of Pacific (males 26.1%, females 31%) and Māori (males 15.7%, females 16.7%) descent are obese in contrast to children of NZ European descent (males 4.7%, females 6%) (Ministry of Health, 2003).

Recognized as a multifaceted condition, obesity stems from a complex interplay of factors, including dietary habits, lifestyle, genetics, environment, socioeconomic status, and psychological elements. Behavioural risk factors, such as an unhealthy diet and insufficient physical activity, contribute significantly to the obesity epidemic (WHO, 2021)

Findings from the National Children's Health Survey emphasise dietary patterns, with 57.4% of children consuming fast food at least once a week, 37.4% indulging in fizzy drinks weekly, and a mere 4.9% meeting the recommended daily intake of fruits and vegetables (Ministry of Health, 2003). This paints a compelling picture of widespread unhealthy dietary practices among children, substantially elevating their vulnerability to obesity.

2.3 Food environments within schools

The school food environment provides an opportunity to improve the health of children (Mackay et al., 2020), as the foods made available to children promote healthy or non-healthy food and beverage choices. However, the condition of the food environment within NZ schools presents a prevailing concern, characterized by an overarching lack of healthiness (Carter & Swinburn, 2004; D'Souza et al., 2022; Richards et al., 2005).

Assessment of the foods offered and available to students on school premises reveals substantial room for improvement. Unhealthy and occasional items persistently find their way into school sales (Carter & Swinburn, 2004; Megan et al., 2012), with unhealthy foods and beverages often used as incentives, in fundraising efforts, and for sponsorship within the school setting (D'Souza et al., 2022; Richards et al., 2005). Nonetheless, there are positive strides, as many schools integrate nutrition education into their curriculum and maintain fruit and vegetable gardens (D'Souza et al., 2022).

A study conducted in 2016 shed light on the inadequate implementation of nutrition policies in NZ primary and secondary schools, with less than half having established policies, most of which were relatively weak. Despite a modest increase from figures reported in 1999 (Carter & Swinburn, 2004), the prevalence of schools with nutrition policies remains disconcertingly low.

The NZ Healthy Food and Drink Guidance for schools (Ministry of Health, 2020) was introduced in 2020 to help schools create and utilize policies to create a healthier environment. This guidance utilises a traffic light system to promote 'green' foods, which are

the most nutritious, and discourage 'amber' (moderately nutritious) and 'red' (least nutritious) items. However, research conducted in Wellington schools (Walton et al., 2010) has shown that 'amber' and 'red' foods are more prevalent, comprising a higher proportion of total sales.

The Ka Ora Ka Ako initiative, launched in 2019, exemplifies NZ's strides toward improving the school food environment by providing free school lunches nationwide (Ministry of Education, 2023). While the impact of this program on the food environment within schools is yet unknown due to its recent implementation, prior to the initiative, many children lacked vegetables in their lunches (72.5%). Research indicates that parents/caregivers, particularly Māori and Pacifica children, faced challenges in affording food and finding time to prepare school lunches (Morton et al., 2017).

2.3.1 Healthy active learning

The HAL initiative, launched in 2020 as a part of the Child and Youth wellbeing strategy. The initiative is supported by government agencies including Sport NZ, the MoH, and the Ministry of Education. HAL aims to improve the health and well-being of children by enhancing the food and drink environment and implementing quality physical activity within schools, kura and early learning services nationwide (Ali et al., 2022). The success of the initiative in improving the internal school environment for NZ children has resulted in its continual funding and expansion until 2024. The HAL evaluation found that a majority of the schools and kura saw healthy eating and drinking as well as physical activity as an important part of student wellbeing, with 83% of schools now implementing a healthy food and drink policy (Sport New Zealand, 2022b).

2.4 Food environments surrounding schools

2.4.1 Impacts on initiatives within schools

While initiatives implemented in schools have a significant impact on improving children's health, it is equally vital to evaluate the nutritional quality of the environments where children reside. A comprehensive meta-analysis, involving 100 studies, examined the food

environments both within and around schools. The findings revealed that obesogenic food environments in the vicinity of schools diminish the effectiveness of the positive initiatives undertaken within schools (Pineda et al., 2021).

One of these studies was conducted in NZ (Walton et al., 2009) indicating that a high concentration of advertisements and outlets substantially impacted efforts to enhance the school food environment. Nevertheless, a critical gap persists in the literature as research has yet to examine whether a correlation exists between the healthiness of the food environment within schools and the food environment in the surrounding vicinity.

2.4.2 Impacts on children's health

Numerous research studies have delved into the potential impacts of the external food environment on children's health and dietary patterns. In Belgium, a recent study (Smets & Vandevijvere, 2022) uncovered a significant correlation between the concentration of fast food and convenience outlets surrounding primary schools and the prevalence of overweight children. These findings align with a systematic review (Xin et al., 2021), which investigated the association between convenience stores and childhood obesity, revealing positive correlations with the density and proximity of convenience stores in residential and school neighbourhoods influencing unhealthy eating behaviours. When investigating whether takeaways near schools affected children's diets in the UK, it was discussed that reducing the number of takeaway stores near schools should logically improve children's diets. However, it was noted that observing such changes may prove challenging due to the multifaceted nature of the issue (Rustin, 2017).

In NZ, a study in Otago explored the association between food outlets and adolescent diet quality (Clark et al., 2014). While the findings indicated a small effect size with variations between females and males, it is crucial to acknowledge the study's limitations, including its confined focus within NZ and a relatively modest sample size.

Several systematic reviews and meta-analyses have scrutinized the effects of food and beverage advertising on children's health, dietary patterns, and behaviours. Four of these

reviews (Boyland et al., 2022; Cairns et al., 2013; Kraak & Story, 2015; Sadeghirad et al., 2016) found that exposure to food and beverage advertising is associated with increased food intake. Additionally, two studies revealed that increased advertising of high-energy density, low-nutritional-value foods correspond to a heightened preference for these products (Cairns et al., 2013; Sadeghirad et al., 2016). One also reported that advertising influences children's purchase behaviour and diet-related health (Cairns et al., 2013). Another study investigated the influence of food company brand mascots on children's health (Kraak & Story, 2015), revealing a significant impact on food preferences, choices, and intake, particularly for energy-dense and nutritionally poor foods.

Interestingly, one systematic review (Matsuzaki et al., 2020) found that obesogenic food environments surrounding schools are associated with increased body weight of children, with a higher correlation often observed for younger children.

These collective findings underscore the vast and profound effects of the food environment on children's health, dietary patterns, and behaviours.

2.4.3 Food and beverage advertisements

Outdoor advertising of food and beverages is common, particularly in children's environment's such as surrounding schools. This is of concern as exposure to unhealthy food and beverage advertising can lead to an increase in intake and preference, which ultimately increases the risk of developing non communicable diseases such as obesity (Lapierre et al., 2017; Sadeghirad et al., 2016; WHO, 2016).

Research on food and beverage advertising surrounding schools in NZ has been relatively scarce, and geographically limited as indicated in Table 1. As with the exception of a single nationwide study conducted in 2016 (Vandevijvere et al., 2018), all other research focuses within a specific region of NZ, including Auckland and the Wellington and Wairarapa regions. Nevertheless, there is consistent trend in the research, with similar patterns emerging regarding the nature of food and beverage advertisements and their prevalence concerning location and the socioeconomic status of the neighbourhoods.

Unhealthy food and beverage advertisements have been found to prevail over their healthy counterparts (Brien et al., 2022; Egli et al., 2019; Huang et al., 2020; Maher et al., 2005; Signal et al., 2017; Vandevijvere et al., 2018; Walton et al., 2009). The most common category, for many research studies was sugar-sweetened beverages (Brien et al., 2022; Maher et al., 2005; Signal et al., 2017; Vandevijvere et al., 2018), the consumption of which has been linked to adverse health outcomes including weight gain and dental caries in children (Nguyen et al., 2023). The National Children's Health Survey conducted in 2002 shows that sugar sweetened beverage consumption in children is high as it contributes over one quarter of their average sugar intake (Ministry of Health, 2003). Given the impact of advertising on preference, it is expected that the high proportion of sweetened beverage advertising will only continue to make this statistic worse.

Additionally, more extensive studies conducted in NZ have consistently reported statistically significant findings regarding the prevalence of unhealthy or 'non-core' food and beverage advertisements near schools, particularly in lower socioeconomic neighbourhoods (Brien et al., 2022; Huang et al., 2020; Vandevijvere et al., 2018). Findings which have also been seen in other countries (Kelly et al., 2008; Olsen et al., 2021). One study identified a similar pattern but lacked statistical significance (Egli et al., 2019). Conversely, three studies failed to discern such patterns, introducing variability to the findings. Two of which, presented contrasting results, indicating that schools in higher socioeconomic areas had a higher prevalence of food and beverage advertisements than those in lower socioeconomic areas (Maher et al., 2005; Walton et al., 2009). It is crucial to note that both studies were geographically confined to the Wellington region, with a limited sample size of four and ten schools. Consequently, caution is warranted in generalizing these results to reflect socioeconomic differences across NZ. Using a distinctive approach, another study utilised wearable cameras for data collection. It revealed higher exposure rates to core foods for children in high decile schools than low decile schools (Signal et al., 2017). Notably, this study was the first in NZ to explore ethnic disparities in marketing exposures, uncovering that Māori children experienced higher exposure to all types of marketing compared to their NZ European counterparts. This is an example of health inequities, as mentioned prior, both Māori and Pacific children are at higher risk of childhood obesity.

Research has indicated that the school's geographic location, specifically whether it is situated in a rural or urban area, can exert a notable influence on the quantity of advertisements in its vicinity. There also appears to be more unhealthy food advertising surrounding urban schools, than rural (Vandevijvere et al., 2018). These findings are expected as urban schools are likely to be in closer proximity to shops and food outlets which are common places for food and beverage advertisements.

2.4.4 Food and beverage stores

It is essential to consider the type and location of food stores surrounding schools as it impacts the foods available to children and, ultimately, their diets.

In the city of Perth, Australia, a notable abundance of fast-food outlets in close proximity to schools has been observed (Trapp et al., 2023). Research indicates that the proximity of these establishments strongly influences students' purchasing behaviour regarding available food options (Trapp et al., 2021).

In 2014, a national study in NZ analysed the proximity and density of fast food, takeaway and convenience stores relative to schools. The findings revealed that most schools were close to fast food, takeaway or convenience stores (Vandevijvere et al., 2016). These results align with other smaller studies conducted in NZ (Clark et al., 2014; Day & Pearce, 2011; Day et al., 2015; Maher et al., 2005; Vandevijvere et al., 2018; Walton et al., 2009). Nonetheless, one study concluded that only 43% of schools were near convenience stores. However, it is essential to note that this particular study focused solely on primary schools in Auckland, examining a radius of 500 meters from one school entrance and specifically considering convenience stores rather than other establishments offering unhealthy food options (Brien et al., 2022).

The school's location influences the proximity and density of the food establishments nearby, whether in an urban or rural environment, as well as the socioeconomic status of the surrounding neighbourhood.

As expected, schools in urban areas tend to have a higher accessibility to food stores than schools in rural areas (Day & Pearce, 2011; Maher et al., 2005). This discrepancy can likely be attributed to the correlation observed between population density and the presence of retail stores. The enhanced availability of food options may impact the dietary habits of children. As evidenced by the 2002 National Children's Health Survey, children living in urban areas tend to consume more food during their journey to school and consume more takeaway foods during the week compared to children living in rural areas (Ministry of Health, 2003).

Correlations have been observed between socioeconomic status and accessibility of food stores. Multiple studies have concluded that stores are positioned in closer proximity and are more densely distributed around schools situated in the most disadvantaged areas (Day & Pearce, 2011; Day et al., 2015; Vandevijvere et al., 2016). However, one study did not draw such conclusions, which may be due to the limited scope of the research preventing it from being representative at a populational level (Walton et al., 2009). When investigating deprivation, it is important to consider that not all areas will have stark socioeconomic gradients. For example, significant differences are observed in Auckland, whereas minimal distinctions are observed in Otago. Thus, research done in Otago could not investigate such correlations (Clark et al., 2014).

The results varied when examining the predominant type of food stores surrounding NZ schools. Most research studies found convenience stores to be the most common (Brien et al., 2022; Clark et al., 2014; Day & Pearce, 2011; Vandevijvere et al., 2016), with one study concluding that fast food and takeaway outlets were just as common (Vandevijvere et al., 2018). A couple of studies found fast food to be the most common, followed by convenience stores (Day et al., 2015; Walton et al., 2009). However, both studies were conducted in a limited geographical region of NZ, with one focusing solely on four schools, thus potentially limiting the generalizability of these findings. Interestingly, research in Christchurch, NZ, investigating the change in the number of food outlets found the number of convenience stores to decrease over time, whilst the number of fast-food outlets increased, which could be due to population growth as well as the increase in the price of land (Day et al., 2015).

2.4.5 Utilising Google Street View

In recent years, GSV has emerged as a powerful and cost-effective tool for delving into the intricate dynamics of food environments. Numerous studies have leveraged Google Street View, highlighting its reliability, time-saving capabilities, and cost-effectiveness (Egli, 2020; Huang et al., 2020)

A prominent strength of GSV is its capacity to provide a dynamic and visual representation of the real-world environment. Researchers have effectively utilised this feature to conduct spatial analyses, particularly in mapping the spatial distribution of food outlets (Egli et al., 2019). Integrating geographic information systems (GIS) and GSV data enables the creation of detailed visualizations that facilitate a nuanced understanding of how food environments are structured and how they evolve with time. Various travel options, encompassing different modes of transportation and walking, have enabled researchers to calculate walking distances from key points in the food environment, such as convenience stores or fast-food outlets to schools.

However, GSV does have inherent limitations. For safety and ethical considerations, facial features and license plate details are intentionally blurred (Google, 2023). Moreover, owing to capturing images from bird's-eye and street-level perspectives, occasional obstructions from pedestrians or vehicles may hinder a clear view of specific objects (Egli et al., 2019; Rundle et al., 2011). Image quality, especially for smaller objects, may be compromised. It is crucial to acknowledge these limitations even as GSV evolves and improves over time (Egli et al., 2019). Continuous enhancements in usability are anticipated, contributing to the ongoing refinement of this valuable tool for researching food environments.

Table 2.1 Evaluation of food environment (advertising and/or stores) surrounding schools in NZ.

Author (year)	Location	Design	Relevant aim/objective	Method & distance from school	Type and location of advertisements and/or stores.	Number & type of school	Relevant findings (advertisement and/or store related)
Brien et al. (2022)	Auckland	Cross sectional	Describe outdoor food and beverage advertising on convenience stores.	GSV, 500 m.	All advertisements on convenience stores.	n = 371 Primary schools.	Unhealthy food and beverage advertisements were more common (84.5%) than healthy. With twice as many advertisements surrounding low-decile schools than high decile ($p < 0.001$). Superettes were the most common store type (n=140, 47.3%) and were likelier to have medium or high coverage of unhealthy advertisements.
Clark et al. (2014)	Otago	Cross sectional	Investigate the relationship between exposure to food outlets around local schools diet quality in adolescents.	GSV, yellow pages, 800 m & 1500 m.	Food outlets including; convenience stores, café's, restaurants, supermarkets, takeaways	n = 11 secondary schools.	Convenience stores were the most common (median=7, 800 m) and closest (405 m) to schools. The closest food outlets to each school ranged from 289 m to 419 m. No differences in decile were seen.
D'Silva. (2017)	Auckland	Cross sectional	To examine the relationship between school level socioeconomic deprivation and the density of unhealthy food advertising in the areas surrounding a selection of Auckland schools.	GIS and ground truthing, 500 m.	All unhealthy food and beverage advertisements	n = 60, primary, intermediate, secondary, high schools.	Higher proportions of unhealthy food advertising surround low (51.6%), compared to high (48.4%) decile schools (not statistically significant $p=0.13$). Coca-Cola was the most prevalent brand (n=338), with similar proportions seen in the highest decile (24.8%) compared to the lowest decile (24.3%) schools.

Day et al. (2011)	North Shore, Waitakere, Lower Hutt, Wellington and Christchurch.	Cross sectional	To determine whether food outlets are clustered around schools.	GIS, 400 m & 800 m.	Fast food and convenience stores.	n = 406, primary, middle and secondary schools.	There were three times the number of outlets surrounding the most socially deprived quintile of schools compared to the least, with a ratio of 2.8 for convenience stores and 2.3 for fast-food outlets.
Day et al. (2015)	Christchurch	Longitudinal	To explore changes in urban food environments near schools.	GIS, 800 m & 1600 m.	Outlets (supermarket/grocery; convenience; fast food)	All primary, intermediate and secondary schools. n = 116 in 1966, n = 133 in 1976, n = 135 in 1986, n = 138 in 1996, n = 142 in 2006.	Between 1966 and 2006, the median number of supermarkets near schools dropped from 5 to 1, convenience stores decreased from 2 to 1, and fast-food outlets rose from 1 to 4. The clustering of fast-food outlets was higher around the most socially deprived schools.
Egli et al. (2019)	Auckland	Cross sectional	Examine outdoor food and beverage advertising.	GSV, 800 m.	All advertisements in public places.	n = 10 primary schools, n = 9 intermediate schools.	Of all food and beverage advertisements, 50.1% were unhealthy. There was a higher prevalence of unhealthy advertisements surrounding low decile schools (although no statistical significance $p>0.05$). Children are exposed to higher amounts of unhealthy advertising as opposed to other advertising.
Huang et al. (2020)	Auckland	Cross sectional observational	To assess advertising of food and beverages on bus shelters	GSV, 500 m.	All food and beverage advertisements on bus shelters.	n = 573 primary, intermediate and secondary schools.	Non-core food and beverages made up 50.2%. Higher proportions of non-core food and beverage advertisements were found near low decile schools (33.3%), followed by high (28.7%), then medium (25.0%). However, no statistical significance was observed $p>0.05$.
Maher et al. (2005)	Wellington & Wairarapa region	Cross sectional	To examine the extent and content of outdoor food advertisements	GPS, 1 km.	All food and beverage advertisements and outlets.	n = 10 secondary schools.	70.2% of food and beverage advertisements were unhealthy, with sugar-sweetened beverages being the most common (21.6%).

			and food availability from outlets in the vicinity of secondary schools.				<p>Advertisements were found in larger numbers and closer to low socioeconomic areas than high ($p < 0.0001$).</p> <p>96.5% of advertisements were located on food stores, with 52.2% on convenience stores.</p> <p>The most common brand was Coke Cola (17.6%).</p> <p>Most outlets sold food (56.3%), located 70 m closer to schools than other outlets ($p = 0.02$).</p>
Pearce et al. (2007)	NZ	Cross sectional	To investigate the accessibility of fast-food retailing by neighbourhood socioeconomic status (SES)	Data was obtained from local Territorial Authorities.	All fast food outlets, supermarkets and convenience stores	n = 2652 primary, intermediate and secondary schools.	Higher school social deprivation was associated with shorter travel distance access to fast-food outlets ($p < 0.001$, with fast-food outlets at least twice as far away.
Signal et al. (2017)	Wellington	Cross sectional	To examine the frequency and nature of everyday exposure to food marketing across multiple media and settings.	Wearable cameras on children.	All advertisements.	n = 16 schools.	<p>Children were exposed to non-core food marketing 27.3 times per day, twice as frequently as core food marketing.</p> <p>Children in high decile schools were exposed to a higher prevalence of core foods than children in low decile schools, with a rate ratio of 1.05 instead of 0.90.</p> <p>Sugary drinks were the most common category, comprising 33.4%.</p>
Vandevijve re. (2016)	NZ	Cross sectional	To investigate retail food environments around schools.	Council information, GIS, 800 m.	All fast food, takeaway and convenience outlets.	n = 625 primary, n = 20 secondary schools.	<p>The most common food stores surrounding schools were takeaways (42.9%), dairies (25.1%), bakeries (14.1%) and fast-food outlets (8.5%).</p> <p>Convenience stores were closer to the most deprived schools (521 m) compared to the least (617 m), as well as more prevalent ($p < 0.01$).</p>

Vandevijvere et al. (2018)	NZ	Cross sectional	Analyse, the extent and nature of food marketing around NZ schools.	ArcGIS, 500 m.	All food and beverage advertisements and convenience stores.	n = 950 primary, secondary and intermediate schools.	55.2% of the advertised foods and beverages were junk food. A statistically significant difference ($p > 0.001$) between the proportions of junk food advertisements surrounding more deprived schools (50.7%) compared to least deprived schools (37.4%). Sugar-sweetened beverages were the most common category (20.4%). Unhealthy food outlets and advertisements were correlated ($p < 0.001$). The median number of convenience and fast food stores surrounding schools was 2.
Walton et al. (2009)	Wellington	Cross sectional	To document the food environment and to consider whether this has an impact on the food environment within schools.	Street travel and GIS, 2 km.	All food and beverage advertisements and food stores.	n = 4 primary schools.	Most advertisements were for occasional food products (64.1%). The school with the highest deprivation had a lower proportion of students passing food advertisements and outlets (21.2%) compared to the other schools (74.1%-87.5%). Schools with high proportions of students passing food advertisements or outlets found this affects efforts made within the school to improve the food environment.

2.5 Food environment policies and regulations

2.5.1 Advertising

The heightened concern regarding children's exposure to extensive advertising of unhealthy food and beverages has prompted the World Health Organization (WHO) to issue new guidelines for policies designed to protect children from the harmful impact of food marketing. The guidelines recommend that countries have comprehensive, mandatory policies to safeguard children from marketing foods and non-alcoholic beverages high in saturated fats, trans-fats, free sugars, and salt (WHO, 2023a).

The Food Industry Taskforce in NZ has proposed some recommendations to restrict outdoor advertising of products high in saturated fat, salt, and added sugars within a 300-meter radius of the main gate of primary and intermediate schools. Additionally, convenience store owners within a certain distance of primary schools should also restrict advertising of these products, as per the recommendations, by the end of 2019 (The Food Industry Taskforce, 2018). However, action has yet to be taken so far.

Currently, NZ has no specific legislation, referring to law's enacted by governmental authorities, which prohibits advertising to children. However, there are general regulations and guidelines in place that aim to protect children from inappropriate or harmful advertising practices. These regulations are overseen by different entities, including the Ministry for Primary Industries (MPI) and the Advertising Standards Authority (ASA) in NZ. MPI is responsible for ensuring food advertising and labelling are not misleading to the consumer and regulating additives, colourings, and preservatives within food to ensure they are safe for consumption (Ministry for Primary Industries, 2022). Meanwhile, the ASA oversees and regulates all advertising, including food advertisements (Advertising Standards Authority, 2017).

In 2017, the ASA developed a new code called the Children and Young People's Advertising Code (Advertising Standards Authority, 2017). While this code establishes a framework for acceptable conduct, it is important to note that it does not hold the status of legislation

enacted by a governmental body. The code is based on the United Nations Convention on the Rights of the Child (UNCROC) to protect children and young people from misleading, deceptive, or harmful advertising (Ministry of Social Development, 2023). Rule 1 covers food and beverage advertisements, of which Rule 1 (i) of the code explains that advertisements must not promote 'occasional food and beverage products' to children or be advertised in any media where children are the significant proportion of the expected audience (Advertising Standards Authority, 2017). 'Occasional food and beverage products' are classified under the Food and Beverage Classification System and include confectionary, deep fried foods, energy drinks, full sugar drinks and products containing more than 56mg of caffeine per serve (Advertising Standards Authority, 2013). Children are considered a significant proportion if they make up 25% or more of the expected audience, the advertisement is in child-viewing time zones, the content appeals to children specifically, or the advertisement is placed in locations where children gather, such as schools, family, and child clinics and during children's sporting and cultural events. Rule 1 (k) of the code states that portion sizes for food and drink advertisements should comply with the MoH guidelines (Ministry of Health, 2012), and Rule (L) refers to promotional offers, stating that advertisements must not entice children and young people to purchase the product. However, this code is voluntary, meaning companies, brands, and advertised products do not have to follow it as it is not legally binding. Action can be taken against advertisements; however, a complaint must be filed for investigation. A critical review done in 2020 found that the code did not reduce the amount of marketing children are exposed to, likely due to the unregulated nature of the code (Sing et al., 2020).

Globally, 16 countries worldwide have legislation restricting unhealthy food advertising and marketing to children. The most common legislation put in place is restrictions on television advertising, which are typically observed during children's programming. Additionally, restrictions in schools are widespread. However, regulations on media, such as cinema, mobile phone applications, print, packaging, and the internet, are rare. In particular, legislation developed by Chile and the United Kingdom has been implemented to prevent childhood obesity (Taillie et al., 2019).

The policy by the Chilean government is the most stringent, as it restricts all food and beverages that surpass sugar, sodium or saturated fat thresholds from being advertised across all communication channels and settings. It is prohibited to target children under 14 years, sell and advertise these restricted food products in schools, on TV between 6 am and 10 pm, and on TV programmes and websites where children make up more than 20% of the audience. The packaging of these products which surpass thresholds must also be clearly labelled with a warning sign (Taillie et al., 2019).

The policy implemented in the UK restricts products based on the Nutrient profiling model, in which each food and beverage is scored depending on how healthy it is. Each food and beverage is allocated points for energy, saturated fat and sugar content, with more energy-dense foods getting a higher score. Then points for vegetables, fruit, nuts, fibre and protein are subtracted from this score to give the food and beverage an overall score in which a higher score (>4 for foods and >1 for drinks) means the food is classified as less healthy and is subjected to restrictions to children on TV (UK Department of Health, 2011). These products classified as less healthy are prohibited from being advertised during children's programmes or programmes where children make up more than 20% of the viewers. Advertisements must also not target children using licenced characters or celebrities popular with children (Taillie et al., 2019).

Studies examining whether the prevalence of advertising for unhealthy food and beverages has decreased after the implementation of regulations have produced mixed results (Taillie et al., 2019). Some studies suggest that restrictions could lead to a reduction in the purchasing of unhealthy foods and a decrease in marketing exposure and power (Boyland et al., 2022). However, further research and standardization in research protocols are necessary to comprehend the impact of these policies fully (Boyland et al., 2022; Taillie et al., 2019).

2.5.2 Stores

Schools in different countries worldwide, including South Korea, the UK, Ireland, the United States, and the Philippines, have implemented zones where food stores that sell

predominantly unhealthy food and drinks or unhealthy food and drink products are limited or prohibited. The most stringent policy has been developed in South Korea, where a special 'green food zone' act was put in place in 2008, prohibiting a list of almost 3,000 energy-dense, nutrient-poor or high-caffeine foods from being sold within a 200 m radius from schools (Ministry of Food and Drug Safety, 2014). In alignment with South Korea, the government of Quezon City in the Philippines has also prohibited the sale and promotion of all junk food and sugary drinks within 100 m of all schools (Perlada, 2018).

In the UK, hot food takeaways are highly prevalent; hence, select local councils have limited new stores from opening 400-800 m away from schools and other areas where children gather, such as youth centres and parks (Cavill & Rutter, 2014). In 2019, it was found that half (50.5%) of local councils had policies in place that specifically targeted takeaway stores. Of these, a third (34.1%) had exclusion zones around where children gather, such as schools (World Cancer Research Fund International, 2021). The town of Wicklow in Ireland and some cities in the United States have taken a similar approach of banning new fast-food outlets from being built close to schools. Ireland has restricted fast food outlets within 400 m of schools (Wicklow Country Council, 2019), whilst states in the United States have chosen a shorter distance of 150 m (Rummo et al., 2020; World Cancer Research Fund International, 2021).

Only a few research studies have been conducted to assess the impacts of these policies. In one local council in the UK where zoning policy was implemented in 2015, a longitudinal research study spanning from 2012 to 2019 captured the difference the policy made, concluding that the number of unhealthy food retailers near schools reduced (Brown et al., 2022). However, a shorter research study spanning the years of 2016 to 2019 conducted in a different local council in the UK, where the policy was implemented in 2016, found no change in the number of food outlets after three years (Brown et al., 2021), similar findings to another research study conducted in Los Angeles in the United States (Sturm & Hattori, 2015). Therefore, changes in the built food environment may only be seen in the long term, and more long-term studies are required. Impacts seen downstream on children's health are yet to be determined, with one study conducted in Korea investigating the impacts on

dietary patterns finding no change (Bae et al., 2012). However, the policy was fully implemented in 2009, and this study was conducted soon after its implementation in 2011.

2.6 Summary of Literature

Childhood obesity is a pressing concern in NZ (Ministry of Health, 2023; OECD, 2017). Children spend most of their time in schools (Badland et al., 2015); hence, efforts have been made within schools to improve the internal school food environment, such as the HAL initiative. However, efforts have stopped here thus far, with action yet to be taken to address the food environment surrounding schools (Mackay et al., 2022). The external food environment should be considered just as important as the internal school food environment as it impacts upon the success of initiatives within schools (Pineda et al., 2021; Walton et al., 2009), children's health, dietary patterns, and behaviours (Boyland et al., 2022; Cairns et al., 2013; Clark et al., 2014; Kraak & Story, 2015; Sadeghirad et al., 2016; Smets & Vandevijvere, 2022; Xin et al., 2021). Past research conducted in NZ, most of which utilised GSV, has shown there to be a high density of both advertisements and stores surrounding schools (Brien et al., 2022; Clark et al., 2014; Day & Pearce, 2011; Day et al., 2015; Egli et al., 2019; Huang et al., 2020; Maher et al., 2005; Signal et al., 2017; Vandevijvere et al., 2018; Vandevijvere et al., 2016; Walton et al., 2009). Overseas, similar findings have prompted policymakers to take action (Taillie et al., 2019), restricting areas surrounding schools from food and beverage advertising and stores. However, thus far, NZ has only developed a self-regulatory advertising and marketing code (Advertising Standards Authority, 2017), which has proven ineffective (Sing et al., 2020). Hence, NZ might consider taking on board the WHO's (World Health Organisation, 2023a) recommendations to implement mandatory policies to protect children from the harmful impact of food advertising. In addition, policies could be developed to limit the number of food stores surrounding schools as done by select countries (World Cancer Research Fund International, 2021).

CHAPTER 3: MANUSCRIPT

The forthcoming chapter has been formatted as a manuscript for submission for publication in the Health Promotion Journal of Australia. It is important to note that abstracts submitted to this journal must adhere to a 250-word limit, while the complete article, including the title and abstract, should be at most 6,000 words. Additionally, the article should contain under six tables and graphics and reference at most 50 sources.

Investigation of the Food Environment Surrounding Primary Schools in New Zealand

3.1 Abstract

Objective: To examine food and beverage advertising and stores around NZ primary schools and explore the relationship between advertisements and the school menus and policies (Healthy Food and Drink Policy and the Water and Milk only Policy)

Methods: Food and beverage advertisements (n=479) and stores (n=215) within 800 m of 18 primary schools were collected via Google Street View in August 2023. Advertisement and store characteristics were compared across different school deciles (low, medium and high). To determine the healthiness of the advertisement, food and beverage advertisements were separated into 'core' and 'non-core' depending on whether they are considered part of the everyday diet.

Results: 'Non-core' advertisements (n=426, 89.0%) outnumbered 'core' advertisements (n=53, 11.0%), with sugar-sweetened beverages (n=192, 40.1%) the most common category, and Coca-Cola the most common brand (n=158, 33.0%). The most common advertisement setting was on food stores (97.1%). More advertisements were found surrounding low (n=406, 43.0%) and medium (n=208, 43.4%) decile schools, with low-decile schools having more nearby (0-400 m) advertisements (n=111, 57.5%). The most common food and beverage stores near schools were local fast-food (44.7%) and convenience (24.2%). Low and medium-decile schools had more convenience stores, local fast-food, fast-food chains and

bakeries around them, while high-decile schools had more supermarkets/produce stores and cafés.

Conclusions: ‘Non-core’ food and beverage advertising, local fast-food, fast-food chains and convenience stores were prevalent surrounding primary schools, particularly low and medium-decile schools.

So what: These findings highlight high levels of exposure to unhealthy food and beverage advertising especially surrounding low and medium-decile schools.

Key words: *Child obesity, food and beverage advertising, Google Street View, unhealthy.*

3.2 Introduction and objective

Childhood obesity is a prevalent global health concern (OECD, 2017). In NZ, the impact is profound, affecting one in ten children (Ministry of Health, 2022). The World Health Organization (WHO) has outlined a comprehensive action plan featuring six objectives to address this issue, one of which emphasises the creation of health-promoting environments as a means to mitigate modifiable risk factors associated with obesity (WHO, 2013).

Food environments are a complex interplay of physical, economic, policy, and sociocultural factors that influence individuals' dietary patterns and health (Mackay et al., 2020). Exposure to unhealthy food and beverage environment's including advertising (Boyland et al., 2016; Cairns et al., 2013; Egli et al., 2020; Sadeghirad et al., 2016) as well as stores that sell unhealthy products (Ni Mhurchu et al., 2013; Xin et al., 2021) can have detrimental impacts on their dietary patterns and health.

The NZ food environment in which children live is unhealthy, mainly constituting a high volume of both unhealthy food and beverage advertisements and stores (Brien et al., 2022; Clark et al., 2014; Day & Pearce, 2011; Day et al., 2015; Egli et al., 2019; Huang et al., 2020; Maher et al., 2005; Signal et al., 2017; Vandevijvere et al., 2018; Vandevijvere et al., 2016; Walton et al., 2009). An unhealthy food environment is known to be accentuated in lower socioeconomic neighbourhoods (Brien et al., 2022; Day & Pearce, 2011; Day et al., 2015; Huang et al., 2020; Vandevijvere et al., 2018; Vandevijvere et al., 2016).

NZ has taken measures to promote healthy environments. The HAL initiative, launched in 2020, is an example of such efforts. This government funded initiative, involving Sport NZ, the MoH, and the Ministry of Education, aiming to improve the health and well-being of children by enhancing the food and drink environment and implementing quality physical activity within schools (Ali et al., 2022). However, evidence suggests that focusing solely on interventions within school premises may not be enough to produce significant results and it is essential to also consider the broader school food environment (Pineda et al., 2021).

The Advertising Standards Authority (ASA) introduced the Children and Young People's Advertising Code in 2017 to regulate advertisements for occasional food and beverage products, especially those targeting children or in areas where children gather, including schools (Advertising Standards Authority, 2017). However, the code's vagueness and inadequate regulation have prevented its success (Sing et al., 2020). Additionally, recommendations by the Food Industry Task Force to restrict unhealthy food and beverage advertisements near schools (The Food Industry Taskforce, 2018) have yet to be implemented. The WHO released new guidelines recommending that countries implement mandatory policies to protect children from unhealthy food and beverage advertising (WHO, 2023a), similar to measures implemented by 16 countries (Taillie et al., 2019). Several countries have also implemented zoning measures to regulate food and beverage stores near schools (World Cancer Research Fund International, 2021).

Currently, research conducted in NZ that has examined the food environment, encompassing advertisements surrounding primary schools, has focused on specific regions, such as Auckland (Brien et al., 2022; Egli et al., 2019; Huang et al., 2020) or Wellington (Maher et al., 2005; Signal et al., 2017; Walton et al., 2009). A few of them collected data on advertisements in one location, such as at bus stops (Huang et al., 2020) or convenience stores (Brien et al., 2022). Only one study has examined outdoor advertisements surrounding primary schools in NZ (Vandevijvere et al., 2018). Similarly, only a handful of studies have investigated the type and number of stores surrounding primary schools in NZ (Clark et al., 2014; Day & Pearce, 2011; Day et al., 2015; Maher et al., 2005; Vandevijvere et

al., 2016; Walton et al., 2009), of which, only two examined stores across NZ (Pearce et al., 2007; Vandevijvere et al., 2016).

In NZ, a single study investigated the food environment within schools and their surroundings, encompassing food and beverage advertising and stores. The results indicated that a high concentration of advertisements and outlets substantially impacted efforts to enhance the school food environment (Walton et al., 2009). However, research has yet to explore whether a relationship exists between the healthiness of the food environment within schools and the food environment in the surrounding vicinity.

Therefore, this study aims to contribute to the existing literature investigating food and beverage advertising and stores near primary schools across NZ. Additionally, we aim to explore potential associations between the external food environment (food and beverage advertisements) and the internal food environment (HAL food menus and policies) for primary schools in NZ. In exploring these associations, we seek to determine whether the external and internal school food environments are related.

3.3 Methodology

3.3.1 Study design

This is an observational cross-sectional study involving 18 primary schools across NZ. Utilising GSV, a distance of 800 m surrounding each school was travelled from each school's main entrance, gathering data on stores and advertisements surrounding. Relevant characteristics for both stores and advertisements were collected and analysed.

3.3.2 School selection

Data was collected from 18 primary schools where food menu and policy data acquired from the HAL initiative overlapped. The characteristics of each school, compared to all NZ primary schools (Education Counts, 2022), are shown in Table 3.1.

In NZ, until 2023, schools used the decile score system to assess the socioeconomic context of the student population. This score influenced funding allocation and resource distribution to address educational disparities. Decile 1 schools had the highest proportion of students from low socioeconomic communities, while Decile 10 schools had the lowest proportion (Ministry of Education, 2022).

Deciles were grouped into three categories according to 2018 NZ deprivation scores: low (1-3), medium (4-7), and high (8-10), aligning with similar studies in NZ (Brien et al., 2022; Egli et al., 2019; Huang et al., 2020).

Table 3.1 School characteristics

		Sample n (%)	All NZ primary schools n (%)
Characteristic	Total	18 (100)	1,825 (100)
Type of school	Contributing (years 1-6)	12 (66.6)	768 (42.1)
	Full primary (years 1-8)	6 (33.3)	1,057 (57.9)
Region	Northland	2 (11.1)	105 (5.8)
	Auckland	9 (50.0)	369 (20.2)
	Bay of plenty	3 (16.7)	112 (6.1)
	Wellington	2 (11.1)	175 (9.6)
	Otago/Southland	2 (11.1)	178 (9.8)
Urban/rural	Urban	13 (72.2)	1222 (67.0)
	Rural	5 (27.8)	603 (33.0)
Decile	Low (1-3)	4 (22.2)	-
	Medium (4-7)	7 (38.9)	-
	High (8-10)	7 (38.9)	-

3.3.3 Google Street View

Google Street View's (GSV) omnidirectional imagery was utilised for data collection, chosen for its ethical attributes (Google, 2023) and efficiency in gathering information on outdoor food environments (Egli et al., 2019; Huang et al., 2020). The most recent images uploaded to GSV were used, between August 2019 to May 2023.

3.3.4 Data collection – advertisements

Eligibility for advertisements was determined by referencing both the INFORMAS (International Network for Food and Obesity/Non-communicable Diseases Research, Monitoring, and Action Support) protocol (Mackay et al., 2017) and protocol developed to capture advertisements near schools (Egli, 2020). Advertisements were eligible for data collection if they: a) contained a food or non-alcoholic beverage, b) were within 800 m walking distance from the school studied, c) were branded, and d) were outdoors on a stationary object. Advertisements that featured a food/non-alcoholic beverage brand without referring specifically to the product were included. However, advertisements that primarily served as store identification were excluded.

Data collected for each eligible advertisement included: a) distance from the school, b) setting of the advertisement, c) food and beverage store category, d) type of the advertisement, e) brand name, f) food/beverage category ('core'/'non-core'), g) food/beverage category (green, amber, red), h) primary marketing classification, i) secondary marketing classifications and j) GSV date.

A walking distance of 800 m from each school was investigated, as this is considered a walkable distance for primary school-aged children, equating to approximately 10 minutes (Clark et al., 2014; Egli et al., 2019). Using the school entrance specified by Google Maps (Egli, 2020), each street was travelled in both directions, up to 800 m, to avoid missing any advertisements (Huang et al., 2020). To determine the distance of the advertisement from the school's main entrance, the walking distance function on Google Maps provided a distance between the two points. The collected data, being categorical, was grouped into 0-400 m or 401-800 m to assess the proximity of advertisements to the school.

INFORMAS is an international collaboration of researchers and health organisations committed to monitoring and researching food environments, policies and initiatives associated with obesity and non-communicable diseases. They have developed a protocol for collecting outdoor food and beverage advertisements, which was utilised for data collection, encompassing details about each advertisement's setting, type, and brand (Mackay et al., 2017). Additionally, the data collection protocol specifically designed for capturing advertisements near schools (Egli, 2020) informed the categorisation of advertisements within the food and beverage category ('core'/ 'non-core') and the primary marketing classifications of these advertisements.

Food and beverage advertisements were categorised into 'core' and 'non-core' terminology using the WHO nutrient profiling system (WHO, 2023b), a model specifically created to limit the marketing of foods to children. Additionally, these advertisements were categorised according to the Healthy Food and Drink Guidance traffic light system (Ministry of Health, 2020), enabling a comparison between the proportions of 'green', 'amber', and 'red' advertisements near schools and the corresponding proportions of 'green', 'amber', and 'red' food menu items available within the schools.

Primary marketing classifications specified the use of promotional characters by their target audience as either "child only" or "child and adult." Secondary marketing classifications refer to other specific niche marketing techniques that may be seen, including promotion/discount, contest, limited/special edition, gift or collectable, loyalty programmes, supporting charities, app marketing and exaggerated portion sizes. These secondary marketing categories were adapted from established protocols (Egli, 2020; Mackay et al., 2017).

Food and beverage store category was recorded for all advertisements within the property boundaries of a food store, including on the footpath in front of the food store. The categories include convenience stores, bakeries, fast-food chains, local fast-food, café, supermarkets/produce stores, and others. Convenience stores included dairies, superettes, mini-marts, and food marts. Bakeries were local or a chain (e.g., Baker's Delight). A fast-food chain was any food store within a chain, such as KFC, McDonald's, or Subway. Local fast-food

included any food store not part of a chain or franchise, including local restaurants and food trucks. Supermarkets included all large stores such as Pak'nSave and New World, fruit and vegetable stores and other produce stores.

3.3.5 Data collection - stores

Food and beverage stores were eligible for data collection if they: a) were within 800 m walking distance of the school selected and b) sold primarily food or non-alcoholic beverages. The following was collected for each food and beverage store: a) distance from the school, b) store category, and c) GSV date.

3.3.6 Analysis of HAL data

The food menus and policies baseline data were collected from primary schools across NZ as part of the HAL project by the team at Massey University between November 2020 and March 2021.

The school menus assessed within the HAL initiative utilised a food classification system established by the MoH (Ministry of Health, 2020). This system employs a traffic light model which allows for comparison of different menu items as either 'green' (most nutritious foods), 'amber' (moderately nutritious), or 'red' (least nutritious). The proportions of each of these foods on the school menus were calculated.

The same classification system was applied to food and beverage advertisements around each school, determining the overall proportions of 'green', 'amber' and 'red' advertisements. The proportions of 'green,' 'amber,' and 'red' advertisements were compared with the proportions of menu items to identify potential correlations.

Food policy data collected from HAL was also utilised, including the presence of the Healthy Food and Drink Policy and the Water and Milk only Policy within each school investigated. The healthy food and drink policy aimed to increase the availability of healthy food options within environments such as primary schools. It utilises the same traffic light system, stating

that $\geq 55\%$ of all products on offer must fit into the 'green' category, as well as providing other guidelines on foods made available (Ministry of Health, 2020). The water and milk-only policy is designed specifically for schools, making water and plain milk the only drinks available (Regional Public Health, 2023). The analysis aimed to explore potential correlations between the healthiness of school environments and the advertising surroundings by comparing the presence of these policies with the number of advertisements around each school.

3.3.7 Statistical analysis

Data was downloaded from Microsoft Excel and analysed using IBM SPSS statistical package version 29 (IBM Corporation, New York, USA). Descriptive statistics assessed the number of advertisements and stores surrounding schools. Chi-square testing and post-hoc testing determined whether school decile was associated with advertisement characteristics. Cramer's V assessed the strength of the association, categorised as weak for 0 to 0.3, moderate ≥ 0.3 to < 0.5 , and strong ≥ 0.5 to 1 (Field, 2018). Categories were condensed to adhere to Chi-square test assumptions. 'Core' food and beverage advertisements were combined, as were 'non-core' food and beverage advertisements. Primary marketing classifications were separated into 'child only' and 'child and adult' categories. Secondary marketing classifications were categorised as 'none present' and 'present'. Fisher's-exact testing determined the association between decile and food and beverage store categories as Chi-square test assumptions were unmet.

Spearman's rank correlation analysis was used to investigate the relationships between 'green,' 'amber,' and 'red' menu items and advertisements. Furthermore, correlations were undertaken between the number of advertisements around schools and the presence of school policies, including healthy food and drinks or water and milk only. Statistical significance was determined with a threshold of $p < 0.05$.

3.4 Results

3.4.1 Characteristics of advertisements

A total of 479 food and beverage advertisements were collected. The majority were found near low (n=406, 43.0%) and medium (n=208, 43.4%) decile schools, particularly in Auckland (n=375, 78.3%). More advertisements were located beyond 400 m (n=286, 59.7%) compared to within 400 m (n=193, 40.3%). Most were on food and beverage stores (n=465, 97.1%), primarily convenience stores (n=361, 80.4%). Signage and free-standing signs were the most common types. In total, 45 different brands were identified, with Coca-Cola as the most prevalent (n=158, 33.0%), followed by Tip-top, Monster, Anchor, and Streets. The top categories were beverage 'non-core': sugar-sweetened (n=192, 40.1%) and 'non-core' foods (n=152, 31.7%). Few were marketed to children with cartoon (n=13, 2.7%) or licensed characters (n=2, 0.4%), while the majority targeted both children and adults. The most common type of secondary marketing seen was promotion/discounts (n=33, 6.9%).

Table 3.1 Characteristics of food and beverage advertisements

Characteristic	Subcategory	Number of advertisements n (%)
School decile	Low (1-3)	206 (43.0)
	Medium (4-7)	208 (43.4)
	High (8-10)	65 (13.6)
Region	Northland	2 (0.4)
	Auckland	375 (78.3)
	Bay of Plenty	67 (14.0)
	Wellington	27 (5.6)
	Otago/Southland	8 (1.7)
Walking distance from school (m)	0-400	193 (40.3)
	401-800	286 (59.7)
Setting	Food and beverage store	465 (97.1)

	Road/footpath	0 (0)
	Building	8 (1.7)
	Bus shelter	2 (0.4)
	Train station/stop	4 (0.8)
	Mobile cart/stall or vending machine	0 (0.0)
Food and beverage store category‡	Convenience	361 (80.4)
	Bakery	14 (3.1)
	Fast-food chain	33 (7.3)
	Local fast-food	36 (8.1)
	Cafe	0 (0.0)
	Supermarket	5 (1.1)
	Other	0 (0)
Type	Billboard	0 (0)
	Sign/poster/banner	340 (80.0)
	Free standing sign	138 (28.8)
	Painted building/wall	1 (0.2)
	Digital signs/LED	0 (0)
	Other	0 (0)
Food/beverage brand name§	Coca-Cola	158 (33.0)
	Tip-top	58 (12.0)
	Monster	34 (7.0)
	Anchor	32 (7.0)
	Streets	29 (6.0)
	Other	168 (35.0)
Food/beverage category ('core'/ 'non-core')	Food 'non-core'	152 (31.7)
	Food 'core'	16 (3.3)
	Beverage 'non-core': sugar sweetened	192 (40.1)
	Beverage 'non-core': energy drink	77 (16.1)
	Beverage 'non-core': coffee	5 (1.0)
	Beverage 'core'	37 (7.7)
	Other	0 (0)

Food/beverage category (green, amber, or red) ¶	Green	56 (11.7)
	Amber	13 (2.7)
	Red	410 (85.6)
Primary marketing classification	Child only: company owned cartoon character	13 (2.7)
	Child only: licenced TV or movie character	2 (0.4)
	Child and adult: brand/product	431 (90.0)
	Child and adult: random person	28 (5.8)
	Child and adult: famous non-sports people/influencers/celebrity	3 (0.7)
	Child and adult: amateur Sportsperson/team	1 (0.2)
	Child and adult: famous sportsperson/team	1 (0.2)
Secondary marketing classification	No premium/portion distortion present	430 (89.8)
	Promotion/discount	33 (6.9)
	Contest	5 (1.0)
	Limited/special edition	0 (0)
	Gift or collectable	0 (0)
	Loyalty programme	1 (0.2)
	Supporting charity	0 (0)
	App marketing	2 (0.4)
	Exaggerated portion size	8 (1.7)

‡ This includes only advertisements associated with a food and beverage store, excluding those not associated (n=30, 6.3%).

§ Includes top 5 brands found, all other brands listed as “other.”

¶ Based on the Healthy Food and drink guidance in schools, advertisements are classified into colour codes of green, amber, and red (Ministry of Health, 2020).

3.4.2 Characteristics of stores

A total of 215 food and beverage stores were identified. The majority were situated near low (n=86, 40.2%) and medium (n=85, 39.5%) decile schools, with fewer near high-decile schools (n=44, 20.5%). More food and beverage stores were located further away from schools,

between 401-800 m (n=127, 59.1%), as opposed to 0-400 m from schools (n=88, 40.9%). Local fast-food outlets were the most prevalent (n=96, 44.7%), followed by convenience stores (n=52, 24.2%).

Table 3.3 Characteristics of food and beverage stores.

Characteristic	Subcategory	Number of food and beverage stores n (%)
School decile	Low (1-3)	86 (40.0)
	Medium (4-7)	85 (39.5)
	High (8-10)	44 (20.5)
Region	Northland	1 (0.5)
	Auckland	185 (86.0)
	Bay of Plenty	18 (8.4)
	Wellington	8 (3.7)
	Otago/Southland	3 (1.4)
Walking distance from school (m)	0-400	88 (40.9)
	401-800	127 (59.1)
Food and beverage store category	Convenience	52 (24.2)
	Bakery	20 (9.3)
	Fast-food chain	16 (7.4)
	Local fast-food	96 (44.7)
	Cafe	22 (10.2)
	Supermarket	8 (3.7)
	Other	1 (0.5)

3.4.3. Correlation between advertisements and stores

There was a strong positive correlation between the number of food and beverage advertisements and stores surrounding schools ($r_s=0.879$, $n=18$, $p<0.001$). Therefore, subsequent data analysis will focus exclusively on advertisements.

3.4.4. Decile vs advertisement characteristics

School decile demonstrated a moderate association with the proximity of advertisements ($X^2(2) = 47.856$, $p<0.001$, $V=0.316$). For the 0-400 m subcategory, low ($n=111$, 57.5%) and medium-decile schools ($n=47$, 24.4%) exhibited a statistically significant difference compared to high-decile schools ($n=35$, 18.1%). For the 400-800 m category, low ($n=95$, 33.2%) and medium-decile schools ($n=161$, 56.3%) also had more advertisements than high-decile schools ($n=30$, 10.5%).

For Coca-Cola advertisements, a weak association with school decile was observed ($X^2(2) = 6.816$, $p=0.033$, $V=0.119$). Differences were found between low-decile ($n=81$, 51.3%) and medium-decile ($n=57$, 36.1%) schools. However, no difference existed between the number of advertisements surrounding high compared to low and medium-decile schools.

There was a weak association observed between the presence of secondary marketing classifications of advertisements and school decile ($X^2(2) = 8.696$, $p=0.013$, $V=0.135$).

Medium decile schools had a higher proportion of advertisements both with ($n=29$, 59.2%) and without ($n=179$, 41.6%) secondary marketing classifications than high decile schools ($n=1$, 2.0% and $n=64$, 14.9%).

No significant associations were found between school decile and food/beverage category or primary marketing classifications.

Table 3.4 Decile vs advertisement characteristics

		Decile					
Advertisement characteristic	Subcategory	Low n (%)	Medium n (%)	High n (%)	Total n (%)	P value	Effect size (interpretation)
Distance from school (m)	0-400	111 (57.5) _a	47 (24.4) _a	35 (18.1) _b	193 (100)	<0.001	0.316 (moderate)
	401-800	95 (33.2) _a	161 (56.3) _a	30 (10.5) _b	286 (100)		
Food and beverage category	‘Non-core’ food and beverages	184 (42.7) _a	189 (43.9) _a	58 (13.5) _a	431 (100)	0.852	-
	‘Core’ food and beverages	22 (45.8) _a	19 (39.6) _a	7 (14.6) _a	48 (100)		
Brand §	Coca-Cola	81 (51.3) _a	57 (36.1) _b	20 (12.7) _{a,b}	158 (100)	0.033	0.119 (weak)
	Other	125 (38.9) _a	151 (47.0) _b	45 (14.0) _{a,b}	321 (100)		
Primary marketing classification	‘Child only’	7 (46.7) _a	4 (26.7) _a	4 (26.7) _a	15 (100)	0.222	-
	‘Child and adult’	199 (42.9) _a	204 (44.0) _a	61 (13.1) _a	464 (100)		
Secondary marketing classification	Present	19 (38.8) _{a,b}	29 (59.2) _b	1 (2.0) _a	49 (100)	0.013	0.135 (weak)
	None present	187 (43.5) _{a,b}	179 (41.6) _b	64 (14.9) _a	430 (100)		

Statistical analysis conducted using a Chi-square test with post hoc Cramer’s V showing the strength of association.

§ Only the brand Coca-Cola is displayed, as it was most common brand.

_{a,b} Subscript letters indicate the presence of statistical significance between each decile in each subcategory. Categories assigned different subscript letters are statistically significant (p<0.05)

3.4.5. Decile vs store characteristics

School decile is associated with food and beverage store characteristics ($p < 0.001$).

Proportions of convenience stores, bakeries, local fast-food and fast-food chain are higher surrounding low- and medium-decile schools. High-decile schools have larger numbers of supermarkets and cafés.

Table 3.5 Decile vs food and beverage store characteristics

		Decile				
Store characteristic	Subcategory	Low n (%)	Medium n (%)	High n (%)	Total n (%)	P value
Food and beverage store category	Convenience	27 (51.9%)	22 (20.6)	3 (5.8%)	52 (100)	<0.001
	Bakery	8 (40.0%)	10 (50.0%)	2 (10.0%)	20 (100)	
	Fast-food chain	13 (81.3%)	3 (18.8%)	0 (0.0%)	16 (100)	
	Local fast-food	31 (32.3%)	42 (43.8%)	23 (24.0%)	96 (100)	
	Cafe	5 (22.7%)	4 (18.2%)	13 (59.1%)	22 (100)	
	Supermarket	1 (12.5%)	4 (50.0%)	3 (37.5%)	8 (100)	

Statistical analysis conducted using a Fisher's exact test.

3.4.6. Relationship between menus, policies and advertisements.

There was no significant correlation between proportions of 'green' ($r_s=0.019$, $n=18$, $p=0.940$), 'amber' ($r_s=0.145$, $n=18$, $P=0.565$), and 'red' ($r_s=-0.124$, $n=18$, $p=0.623$) menu items and the prevalence of corresponding 'green', 'amber' and 'red' advertisements. Additionally, there was no significant difference in the number of advertisements surrounding schools based on the presence or absence of a Water and Milk only Policy ($p=0.877$) or a Healthy Food and Drink Policy ($p=0.476$).

3.5 Discussion

The investigation has provided insights into the food environment surrounding a sample of primary schools in NZ. While acknowledging the study's limited scope, encompassing 18 schools out of an estimated 2500 (as reported by Education NZ), the findings present a high prevalence of unhealthy 'non-core' advertisements as well as fast-food and convenience stores.

Overall we observed that 'non-core' advertisements ($n=426$, 89.0%) outnumbered 'core' advertisements ($n=53$, 11.0%), with sugar-sweetened beverages ($n=192$, 40.1%) the most common category, and Coca-Cola the most common brand ($n=158$, 33.0%). Most advertisements were found near low ($n=406$, 43.0%) and medium ($n=208$, 43.4%) decile schools, with low-decile schools having more nearby advertisements ($n=111$, 57.5%). Advertisement characteristics and food and beverage store type varied by school decile.

The 18 primary schools investigated were from five regions across NZ, covering both the North and South Islands, urban and rural areas. Auckland primary schools comprise 20.2% of the total number of primary schools, equalling 50% of the sample population, resulting in slight over-representation. Equal numbers of schools from each decile grouping were investigated; therefore, there was a fair representation of NZ's overall population regarding socioeconomic status.

Nearly two-thirds (61%) of schools had advertisements within 800 m. Notably, most of the schools lacking advertisements were in rural areas, corroborating the outcomes of prior research (Vandevijvere et al., 2018). The limited availability of food and beverage stores and advertisements in rural regions may account for this pattern. Other schools without advertisements in urban areas were of medium and high-decile, situated in areas with fewer roads and lower housing density, resulting in fewer food and beverage stores and advertisements. Most advertisements were observed around Auckland schools, NZ's largest city (n=375, 78.3%).

There were slightly more advertisements further away (n=286, 59.7%) than close to schools (n=193, 40.3%), a pattern consistent with earlier research conducted in NZ (Brien et al., 2022; Huang et al., 2020). This could suggest that advertisers may be intentionally minimising marketing in the immediate vicinity to the school's entrance (Brien et al., 2022).

Nearly all advertisements were concentrated on food and beverage stores (97.1%, n=465), particularly convenience stores (80.4%, n=361), despite their representation of only 24.2% of all stores. This observation is consistent with prior research (Maher et al., 2005; Vandevijvere et al., 2018), underscoring convenience stores as primary locations for food and beverage advertisements. Small food store owners often receive incentives, such as discounted products or signage, to promote specific items (Ayala et al., 2017). For some proprietors, these incentives and associated revenue are pivotal to business success, potentially justifying the prevalence of food and beverage advertising in these stores. Additionally, suppliers of high-energy density products, commonly found in convenience stores, exhibit more active involvement in stocking and advertising than fruit and vegetable distributors (Jetter & Cassady, 2010). The heightened engagement likely contributes to the increased advertising frequency on convenience stores relative to other food and beverage stores.

Most advertisements (89%, n=426) featured 'non-core' foods and beverages, in line with previous NZ studies (Brien et al., 2022; Egli et al., 2019; Huang et al., 2020; Maher et al., 2005; Signal et al., 2017; Vandevijvere et al., 2018; Walton et al., 2009). Sugar-sweetened options dominated the 'non-core' beverages (40.1%), in agreement with findings from

previous studies (Brien et al., 2022; Maher et al., 2005; Signal et al., 2017; Vandevijvere et al., 2018). The high demand for soft drinks, especially among children, is unsurprising, given their prevalence as the primary source of sugar in children's diets, with 45% consuming them weekly, particularly in more deprived areas and among Pacific and Māori populations (Ministry of Health, 2003). These statistics are outdated, and it is expected that the situation has deteriorated over the past decade due to the growth of the soft drink industry (Wood et al., 2021) and rising childhood obesity rates (OECD, 2017). Globally, 16 countries have implemented policy to restrict unhealthy food and beverage advertisements to children (Taillie et al., 2019), in line with WHO guidelines (World Health Organisation, 2023a). Such policy would be recommended for implementation in NZ as a means to reduce the amount of unhealthy advertising children are exposed to.

The most prominently featured brand advertised was Coca-Cola, with 33% representation, followed by Tip Top (n=58, 12%), Monster (n=34, 7%), Anchor (n=32, 7%), and Streets (n=29, 6%). A previous study also highlighted Coca-Cola as the dominant brand, accounting for 17.6% of all food and beverage advertisements (Maher et al., 2005). However, as alcoholic beverage advertisements were also included, this may have reduced the overall percentage. Given its significant advertising budget and vast resources, it is no surprise that Coca-Cola dominates the market (Wood et al., 2021).

Out of the 430 collected advertisements, 49 (11.4%) utilised secondary marketing techniques, consistent with a recent study where promotions and discounts constituted 10.1% of all advertisements (Brien et al., 2022). Of the 49 advertisements that employed secondary marketing techniques, the most common found was promotions/discounts, which comprised 67.3% of all marketing techniques. Promotions/discounts hold considerable sway over consumers, particularly children, who are more susceptible to persuasion and potential consumption impact (Lapierre et al., 2017).

The NZ Advertising Standards Authority (ASA) has a code regulating advertising to children and young people. Rule 1(i) prohibits occasional food and beverage advertisements from being targeted to children or in locations where children gather, such as schools (Advertising Standards Authority, 2017). Nevertheless, the current study reveals that advertisements

marketed as 'child only' featuring the Cookie Time Monster appear near schools (n=13, 2.7%), with all other advertisements surrounding schools marketed at both children and adults. These findings mimic previous research, in which 'child only' marketing accounted for 2.4% of advertisements (Brien et al., 2022). As a systematic review has demonstrated that brand mascots, such as the Cookie Time Monster, wield a considerable influence on children's preferences, choices, and consumption patterns, which poses a significant concern (Kraak & Story, 2015). In addition, eight advertisements were found to have exaggerated portion sizes, which contravenes Rule 1 (K) of the ASA code. This rule requires advertised food quantities to align with appropriate portion sizes as defined by the MoH. Hence, these advertisements present a false notion of the correct portion size to children, which could encourage them to consume more than is recommended. Inconsistency between the code and the advertisements surrounding schools suggests that the self-regulatory nature of the code is ineffective (Sing et al., 2020). It relies on individuals filing complaints for enforcement, making it a social rather than a governmental responsibility. Hence, there's a pressing need for increased government intervention to address limitations on occasional food and beverage advertising, especially in children's environments (Healthy Auckland Together, 2018).

Studies investigating types of food and beverage stores surrounding schools in NZ have yielded mixed results. While some studies suggest a higher prevalence of convenience stores compared to fast-food stores surrounding schools (Clark et al., 2014; Day & Pearce, 2011; Vandevijvere et al., 2016), other research (Day et al., 2015) as well as results of this study have found fast-food stores to dominate (52.1%), over convenience stores (24.2%). Comparing studies is challenging, however, due to variations in the definitions of convenience stores across studies. Some studies include service stations within the category of convenience stores (Clark et al., 2014; Day & Pearce, 2011; Vandevijvere et al., 2016), while one included fruit and vegetable stores as convenience stores (Day et al., 2015). Additionally, differences in the location of these studies, with two in specific regions of NZ (Clark et al., 2014; Day et al., 2015) may have resulted in differential results.

A higher proportion of advertisements were observed within the 0-400 m category surrounding low (57.5%), followed by medium (24.4%) and high (18.1%) decile schools,

trends also revealed in previous research (Brien et al., 2022; D'Silva, 2017; Maher et al., 2005; Vandevijvere et al., 2018). Statistical testing revealed school decile to be associated with advertisement proximity. Although both low and medium-decile schools did not differ significantly from each other, they did differ significantly from high-decile schools in both the 0-400 m and 400-800 m category, demonstrating a socioeconomic gradient. These findings could be attributed to the significant wealth gap in NZ, separating low and medium-decile schools, notably from high-decile schools (Rashbrooke, 2013). Moreover, the pattern may be influenced by the geographic placement of these schools on main roads. A Canadian study found that schools with lower median income are often closer to main roads than their higher-income counterparts, potentially explaining the observed differences in advertisement proximity, as main road areas are frequently characterized by a high prevalence of food and beverage stores and advertisements (Amram et al., 2011).

The present study found no significant differences in the amount of 'core' and 'non-core' food and drinks advertised in schools across different decile categories. While one study (Egli et al., 2019) supports these findings, others (Brien et al., 2022; Huang et al., 2020) do not. To fully understand this trend, there is a need for further research that examines all advertisements, not just those featuring non-core foods and beverages.

Advertisements were most found surrounding low (43.0%) and medium (43.4%) decile schools. However, an examination of Coca-Cola advertisements relative to school decile revealed significant differences seen in the number of Coca-Cola advertisements between low (51.3%) and medium (36.1%) decile schools. Recent research has revealed that Coca-Cola has increased its market activities in low-income groups of people as part of its marketing strategy due to the stagnant sales among people of high socioeconomic status (Wood et al., 2021). In addition, Coca-Cola is recognised for its marketing efforts directed at children and young adults (Backholer et al., 2022). Therefore, the increased number of Coca-Cola advertisements around low-decile schools in low socioeconomic neighbourhoods is unlikely to be coincidental.

The absence of a significant association between school decile and primary marketing classification is consistent with the outcomes of a recent study conducted in NZ (Brien et al.,

2022). However, the proportion of advertisements categorised as 'child only' was higher around low-decile schools (46.7%) than medium and high-decile schools (26.7%). This finding is supported by evidence suggesting lower-income communities and children are target markets for various brands, products, and advertisers; these communities are likely subject to intentional targeting (Wood et al., 2021).

Secondary marketing classifications were weakly associated with decile, with differences observed between medium and high-decile schools. Medium decile schools had a higher percentage of advertisements with secondary marketing categories (59.2%) than high decile schools (2.0%). On the other hand, medium decile schools had a higher percentage of advertisements without secondary marketing categories (41.6%) compared to high decile schools (14.9%). These results show a complex relationship between the decile level and advertisements, highlighting the need for further investigation.

Low-decile schools had higher proportions of convenience stores (51.9%) and fast-food chains (81.3%) compared to than medium and high-decile schools, mirroring other NZ studies (Day & Pearce, 2011; Day et al., 2015; Sushil et al., 2017; Vandevijvere et al., 2016). This pattern may be due to the geographic proximity of low-decile schools to main roads, where these establishments are typically situated (Amram et al., 2011). Additionally, the heightened demand for these stores in lower-income neighbourhoods prompts retailers to choose these areas (Pearce et al., 2007). In contrast to earlier research, supermarkets were more prevalent around medium and high-decile schools than low-decile schools (Pearce et al., 2007; Sushil et al., 2017). Increased access to supermarkets has been found to be associated with healthier dietary patterns (Moore & Diez Roux, 2006). Therefore, limited access to supermarkets in low socioeconomic areas highlights inequities. Additionally, cafes are more numerous around high-decile schools, likely driven by higher-income households' increased spending on such establishments (French et al., 2010).

We found no correlation between the proportion of 'green', 'amber', and 'red' menu items with corresponding advertisements or between the number of advertisements surrounding schools and the presence or absence of food and drink policies within schools. This may be

attributed to factors such as small sample size, government funding and support allocated to lower socioeconomic schools, and the geographical placement of schools.

Limitations of the study include GSV's four-year data gap, image obstruction, and the inability to capture areas such as parks. The analysis solely accounted for the distance from the main school entrance, possibly overlooking advertisements and stores located near alternative entrances. Categorical data, whilst enhancing reader comprehension, sacrificed detail. The small sample size may result in findings not fully representing NZ primary schools. In addition, categories were condensed to meet chi-square test assumptions, potentially affecting result precision. The study focused solely on outdoor advertisements, excluding other mediums.

In conclusion, we found 'non-core' food and beverage advertising, local fast-food, fast-food chains and convenience stores were prevalent surrounding primary schools. Regulatory approaches are needed to circumvent these occurrences, particularly those that target low and medium-decile schools.

3.6 So what?

The present study found that primary school-aged children in NZ are exposed to high levels of unhealthy food and beverage advertising and stores surrounding schools. Given the high childhood obesity rates and evidence which links adverse school food environments to children's health, implementing WHO recommended policies, restricting advertising to children as well as restricting new fast-food and convenience stores near schools are recommended.

CHAPTER 4: CONCLUSIONS AND RECOMMENDATIONS

4.1 Summary of findings

This study aimed to investigate the food environment, including food and beverage advertising and stores surrounding primary schools across NZ and investigate whether correlations exist between the external food environment and the internal school food environment, including menus and policies.

A total of 471 food and beverage advertisements within 800 m of each all schools investigated were collected using established protocols. Notably, most schools (61%) featured advertisements within this vicinity. Most of these advertisements displayed ‘non-core’ products (89%), with sugar-sweetened beverages constituting the most prevalent category (40.1%).

Despite including an equal representation of low, medium, and high decile schools in the study, the research revealed associations between school decile and various advertisement characteristics. These characteristics encompassed proximity to the school, the presence of Coca-Cola branding, and secondary marketing classifications.

A distinct variation appeared in the distribution of advertisements, revealing a higher concentration closer (0-400 m) to low decile schools (57.5%), followed by medium (24.4%) and high (18.1%) decile schools. This pattern aligns with findings from previous NZ studies (Brien et al., 2022; D’Silva, 2017; Maher et al., 2005; Vandevijvere et al., 2018). Chi-square testing revealed school decile to be associated with advertisement proximity ($p < 0.001$), with more advertisements observed both closer (0-400 m) and further away (400-800 m) from low and medium-decile schools as opposed to high-decile schools. Post-hoc analysis revealed that both low and medium-decile schools did not differ significantly from each other. However, they did differ significantly from high-decile schools, demonstrating a socioeconomic gradient. This pattern could be attributed to the wealth gap seen in NZ (Rashbrooke, 2013) and the geographical placement of schools with lower median income

near main roads, typically characterised by a high prevalence of advertisements (Amram et al., 2011).

Coca-Cola, representing a third (33%) of all advertisements, was associated with school decile ($\chi^2(2) = 6.816$, $p = 0.033$, $V = 0.119$). The proportions of Coca-Cola advertisements around low decile schools (51.3%) exceeded those around medium (36.1%) and high (12.7%) decile schools. Given Coca-Cola's known strategy targeting low-income groups and children (Backholer et al., 2022), these findings are unlikely to be coincidental.

Secondary marketing classifications, encompassing specific or niche marketing techniques, were associated with school decile ($p=0.013$). More advertisements with secondary marketing classifications were observed in medium (59.2%) and low (38.8%) decile schools compared to high decile schools (2.0%). Marketing techniques significantly influence consumers, especially children, who are more susceptible to persuasion and potential consumption impact (Lapierre et al., 2017). Although primary marketing classifications were not associated with decile ($p>0.05$), the percentage of advertisements with 'child only' marketing consisting of the Cookie Time Monster was found to be higher for low (46.7%), compared to medium and high (26.7%) decile schools. Brand mascots, like the *Cookie Time Monster*, have been found to have a significant influence on children's preferences and consumption patterns (Kraak & Story, 2015).

The overarching trend of higher proportions of advertisements near low and medium compared to high decile schools and associations with school decile and advertisement characteristics poses a concern given the existing health disparities among children in lower socioeconomic neighbourhoods (Ministry of Health, 2022).

Upon investigating food and beverage stores surrounding schools, it was found that the number of advertisements strongly correlated with the number of stores, with most advertisements located on food stores (97.1%), despite their representation being only 24.2% of all stores. This finding is not surprising, given that store owners are often incentivised to advertise certain consumer products (Ayala et al., 2017). Out of the 215 food and beverage stores identified, the most common store was local fast-food restaurants

(44.7%), followed by convenience stores (24.2%). Hence, when formulating policies, it is imperative to consider restricting both convenience stores and fast-food outlets, as both substantially influence the food environment.

Associations were seen between store category and decile ($p < 0.001$) with higher proportions of convenience stores, bakeries, fast food chains and local fast food surrounding low and medium-decile schools. Cafés and supermarkets were observed in more significant numbers near high decile schools. Convenience stores, fast food, and bakeries tend to stock high-energy-density foods, whereas supermarkets offer a greater variety of typically healthier products (Moore & Diez Roux, 2006). Therefore, it demonstrates the differential levels of accessibility to healthy food options depending on socioeconomic status, revealing further health inequities.

Advertisements were categorised into 'green,' 'amber,' and 'red' groups for comparison with the corresponding 'green,' 'amber,' and 'red' food menus observed within the school. Nevertheless, no significant correlations were identified between advertisements and menus in each category ($p > 0.05$). Similarly, no significant correlations were found between the number of advertisements surrounding schools and the presence or absence of policies, including the water and milk policy and healthy food and drink policy ($p > 0.05$). Reasoning for the lack of correlation could be attributed to various factors, including small sample size, government funding and support allocated to lower socioeconomic schools, and the geographical placement of schools. It is essential to consider the food environment surrounding schools when implementing initiatives like HAL. Research has shown that unhealthy food environments around schools can hinder the effectiveness of such initiatives (Pineda et al., 2021).

4.2 Strengths

The study boasts several strengths that enrich its reliability and contribute to a comprehensive understanding of the outdoor food and beverage advertising and store landscape surrounding NZ schools. A notable strength lies in the nationwide representation

of schools, providing a valuable snapshot across diverse regions. Equally distributed among decile categories, the study enables insightful comparisons between schools of varying socio-economic status.

A significant methodological strength is the comprehensive data collection approach, encompassing all food and beverage advertisements near schools, avoiding restrictions to specific advertising mediums. This inclusive method ensures a holistic and detailed analysis of the food environment.

The use of GSV is an evident strength, as supported by previous studies (Brien et al., 2022; Egli et al., 2019; Huang et al., 2020). GSV is cost-effective and efficient for gathering information, enabling consistent and systematic data collection across the investigated sites. The alternative method to data collection is ground truthing, which would be much more timely and costly. GSV allowed a single researcher to collect data over one month, minimising potential biases that could arise from multiple analysts, further enhancing the reliability of the research findings.

The study's adherence to established protocols (Egli, 2020; Mackay et al., 2017) ensured consistency and reliability in categorising advertisements, enhancing the study's methodological rigour and allowing meaningful comparison between other studies that utilised these protocols.

To the best of our knowledge, this is the second NZ study investigating the association between the advertising of foods and beverages surrounding schools and the internal school food environment, including the healthiness of the school's menus and existing policy. The only other study was conducted in 2009 (Walton et al., 2009), with no significant correlations. Further research between the external and internal school environments is recommended to explore these potential correlations.

4.3 Limitations

While GSV exhibits evident strengths, it has limitations. The collected data comprises images from August 2019 to May 2023, resulting in a four-year gap. As a result, some data collected will be more outdated than others (Huang et al., 2020). Constraints in image capture, especially with GSV, represent an additional limitation. The presence of obstructing objects may have limited the comprehensiveness of the dataset. Technological advancements, such as 3D and virtual reality solutions, offer more accurate data collection opportunities in future research endeavours. It is important to note that GSV's limitations extend to its inability to capture areas like parks, which might have featured additional advertising. This constraint should be considered when interpreting the study's findings.

Choosing categorical data exclusively for the results, rather than a mix of categorical and numerical, aimed to enhance reader comprehension and provide clearer findings. However, this decision comes at the cost of reduced precision in the data. For example, previous studies have provided average distances of advertisements and stores to schools, presenting an opportunity for comparison that would have been feasible had numerical data been used for distances.

A significant limitation of the study is its relatively small sample size, involving only 18 schools. To meet the assumptions of the chi-square test, categories had to be condensed, leading to less precise findings. Additionally, when comparing stores to decile characteristics, Fisher's exact testing was employed, as the assumptions of the chi-square test, including instances of fewer than 5 in a cell, were not met. Given the constraints on time resulting in a reduced sample size, the findings may offer only a partial representation of primary schools in NZ. Caution is warranted when generalising the results to the broader population. Moreover, due to the limited sample size, not all regions across New Zealand were included in the study. Consequently, the findings may not be fully representative of all regions across the country.

Another noteworthy limitation is the omission of online food and beverage advertising, a substantial facet of modern marketing. In the digital era, children are increasingly exposed to significant levels of online advertising, an aspect not considered in this study. Future research should devise protocols to evaluate the influence of digital advertising and delve into regulatory strategies to address it.

Advertisement data was exclusively gathered from the main school entrance instead of all school entrances. This may affect the data's reliability, as all entrances could have rendered more advertisements eligible for data collection.

4.4 Future research directions

These findings contribute to the existing body of research in this field, demonstrating that children, especially those who live in low socioeconomic areas are exposed to high levels of food and beverage advertising and nearby stores every day. This is of concern as previous research has consistently indicated, the healthiness of the food environment has an impact on both children's health and dietary patterns (Cairns et al., 2013; Egli et al., 2020; Sadeghirad et al., 2016). Although this topic has recently gained more attention, it is still largely under-researched in NZ, hence more research in this field would be highly beneficial. Specifically, research which follows standardised data collection protocols such as those used for this study (Egli, 2020; Mackay et al., 2017), would not only help to simplify data collection, but to also standardise results. Additionally, future research studies with large sample sizes could explore regional disparities seen across NZ, as this is largely unexplored.

It is important to recognise that outdoor advertisements are just one advertising medium. To fully understand the advertising landscape children are exposed to, it is essential to consider other mediums, including online and TV advertisements, which are the most common globally (Taillie et al., 2019). However, there has been limited research in this area, likely due to the need for standardized research protocols. Therefore, future research needs to develop a standardized protocol to facilitate research in this area.

Thus far, this is only the second study conducted in NZ investigating correlations between the internal and external food environment. The previous study was conducted in 2009, discovering that the external food environment influenced efforts undertaken within schools to enhance the overall school food environment (Walton et al., 2009). It would be interesting to examine this correlation with a larger sample size as it is known that misalignments in internal and external food environments may impact efforts undertaken to improve food environments within schools (Pineda et al., 2021).

4.5 Implications for policy change

To protect children from the high amount of food and beverage advertising and stores surrounding primary schools, policy change should be considered.

Creating a zone surrounding schools where food stores that sell predominantly unhealthy food and drinks or unhealthy food and drink products are limited or prohibited has been trialled worldwide, including in South Korea, the UK, Ireland, the US, and the Philippines. The distances chosen for these zones surrounding schools differed for each country, depending on what was most appropriate. The strictest policy was seen in South Korea, which prohibits almost 3,000 energy-dense, nutrient-poor or high-caffeine foods from being sold within a 200 m radius of schools (Ministry of Food and Drug Safety, 2014), which, by effect, should reduce the number of unhealthy food retailed immediately surrounding schools. Similarly, Quezon City in the Philippines has prohibited the selling and promoting of all junk food and sugary drinks within 100 m of all schools (Perlada, 2018). In the UK, hot food takeaways are highly prevalent; hence, select local councils have limited new stores from opening 400-800 m away from schools and other areas where children gather, such as centres and parks (Cavill & Rutter, 2014). The town of Wicklow in Ireland and some cities in the US have taken a similar approach of banning new fast-food outlets from being built close to schools. Ireland has chosen a distance of 400 m (Wicklow Country Council, 2019), whilst states in the US have chosen a shorter distance of 150 m (World Cancer Research Fund International, 2021).

Limited research studies have been conducted worldwide to determine the effects of these zoning policies. However, of the few longitudinal studies conducted, there are mixed results, with one concluding that the number of unhealthy food retailers near schools is reduced (Brown et al., 2022) and another finding no short-term change after three years (Brown et al., 2021). Similarly, few research studies have investigated the impacts of these zones on children's health and thus far found no change (Bae et al., 2012; Sturm & Hattori, 2015). However, the topic remains unresearched.

In the present study, the most common food stores surrounding primary schools in NZ were local fast food followed by convenience stores. A policy which restricts the opening of new fast food stores both local and chain as well as convenience stores from opening 800 m away, a 10-minute walking distance from primary schools could be put in place. As, although local fast food as most common, convenience stores have the highest amount of advertising, and fast-food chains are more commonly located near low decile schools. A distance of 800 m should be used, as this study, as well as other studies conducted in NZ (Clark et al., 2014; Day & Pearce, 2011; Day et al., 2015; Maher et al., 2005; Vandevijvere et al., 2018; Vandevijvere et al., 2016) show high numbers of said stores up to 800 m away which is equivalent to a 10-minute walk.

In 2017, the Advertising Standards Authority (ASA) introduced the Children and Young People's Advertising Code in NZ with the aim of protecting children and young people from misleading, dishonest, or harmful advertising. Nevertheless, research suggests that the code has been ineffective at reducing the amount of advertising to children, likely due to the voluntary and unregulated nature of the code (Sing et al., 2020). Additionally, the Food Industry Task Force released recommendations to restrict outdoor food advertising surrounding schools by the end of 2019 (The Food Industry Taskforce, 2018); however, thus far, action has yet to be taken.

The present study has revealed that there are large amounts of unhealthy outdoor food and beverage advertisements surrounding primary schools, as supported by existing research (Brien et al., 2022; Egli et al., 2019; Huang et al., 2020; Maher et al., 2005; Signal et al., 2017;

Vandevijvere et al., 2018; Walton et al., 2009). This is of concern as research has demonstrated correlations between the healthiness of the food environment and children's well-being (Ni Mhurchu et al., 2013).

Globally, 16 countries (Taillie et al., 2019) have implemented statutory food and beverage advertisement regulations for children, commonly restricting television advertising during children's programming and restrictions within school settings. Other restrictions, including those on various media platforms, signs and outdoor print and packaging, are infrequently encountered (Taillie et al., 2019). The effectiveness of these policies has been shown to be mixed and largely unresearched, likely due to the need for more standardization in research protocols (Boyland et al., 2022).

In 2023, WHO released a new guideline outlining policies to protect children from unhealthy food and non-alcoholic beverage food marketing. In this guideline, it is recommended that countries implement mandatory and comprehensive policies using a government-led nutrient profile (World Health Organisation, 2023a), such as the policies put in place in Chile and the UK (Taillie et al., 2019). The Food Industry Task Force in NZ has already made recommendations, including restricting products high in saturated fat, salt, and added sugars within a 300 m radius of primary and secondary schools and restricting these advertisements in convenience stores within a certain distance from schools (The Food Industry Taskforce, 2018). However, these recommendations are yet to be implemented.

In line with the guidelines of the WHO (World Health Organisation, 2023a) and the recommendations of the Food Industry Taskforce (The Food Industry Taskforce, 2018), it would be advantageous to establish and enforce a comprehensive and mandatory policy to restrict food and beverage advertising to children. Such a policy would be overseen by a governmental body like the MoH. This would help reduce the amount of advertising exposure that children are exposed to daily.

In summary, the study highlights the unhealthy nature of food environments surrounding New Zealand primary schools. Future research and policy initiatives are crucial for improving these environments and promoting the health of children.

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