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Informing a policy response to reduce socioeconomic inequalities in overweight and obesity among Australian children

Alexandra Catherine Chung

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ABSTRACT

BACKGROUND

Childhood obesity is a significant public health issue with detrimental health and wellbeing effects that extend beyond the childhood years. In Australia, one in four children aged two to 17 years are overweight or obese. The burden of excess weight is disproportionately carried by children from lower socioeconomic backgrounds, giving rise to the need to identify policies that address socioeconomic inequalities in childhood obesity. Despite evidence and consensus on proposed actions, childhood obesity remains a public health challenge, and a strong socioeconomic gradient in childhood obesity persists. In order to address socioeconomic inequalities in childhood obesity there is a need to understand and describe existing inequalities and understand and act upon the proximal and underlying determinants of these inequalities.

AIM

The overall aim of this thesis is to generate evidence to inform the implementation of obesity prevention policies most likely to reduce socioeconomic inequalities in childhood obesity. Four research objectives form the basis of the research;

1. Identify and describe the extent to which trends in childhood overweight and obesity differ according to socioeconomic position;
2. Identify the role of dietary behaviours, particularly consumption of unhealthy food and drinks, on the development of socioeconomic inequalities in obesity among Australian children;
3. Understand parents' perceptions of the factors influencing sweet drink consumption among preschool-age children;
4. Critically examine the representations of childhood obesity and health inequalities in Australian obesity prevention and public health policy.

METHODS

In **Chapter Four**, a systematic literature review was undertaken to assemble and analyse the data relating to trends in childhood overweight and obesity according to socioeconomic position, between 1990 and 2015 across high-income countries. **Chapter Five** used longitudinal mediation methods to identify the contribution of unhealthy dietary behaviours to the development of socioeconomic differences in children's weight among a nationally representative cohort of Australian children. In **Chapter Six**, focus groups and qualitative data analysis were utilised to explore and understand

parents' perspectives of factors influencing sweet drink consumption among preschool-age children. Finally, in **Chapter Seven**, a critical policy analysis was conducted to examine how the issue of inequalities in childhood obesity is represented in a sample of 18 Australian national, state and territory obesity prevention and public health policy documents.

RESULTS

The systematic review demonstrated that trends in child and adolescent overweight and obesity differ across socioeconomic groups in a number of high-income countries. The review also showed evidence of widening socioeconomic inequalities between 1990 and 2015. The longitudinal mediation analysis demonstrated two important findings. Firstly, socioeconomic differences in the consumption of unhealthy food and drinks emerge in the first year of life and persist throughout childhood. Secondly, discretionary food and drink consumption during childhood prospectively contributes to the development of socioeconomic inequalities in excess weight among Australian children. The focus group study found that parents perceived children's sweet drink consumption to be influenced by multiple factors. These factors were observed across all domains of the socioecological model. Many factors appeared to be beyond individual control. The critical policy analysis identified inequalities in childhood obesity to be predominantly represented as an issue of individual responsibility in Australian public health and obesity prevention policy documents. A political preference for policy action that addresses individual behaviour over and above the structural determinants of health was identified. Finally, the analysis found that equity was positioned as a principle of policy documents but was seldom mentioned in policy actions.

CONCLUSION

Collectively, the findings from this thesis make several contributions to the current literature on socioeconomic inequalities in childhood obesity. This thesis advances the evidence on the research methods, trends, determinants and current approaches to address socioeconomic inequalities in childhood obesity in Australia. The challenge for governments therefore is twofold; to develop and implement prevention policy that reduces childhood obesity and at the same time improves health equity. This will require a range of complementary policies that address the individual, social, and structural determinants of childhood obesity. These findings will be useful to public health nutrition advocates, researchers, and policymakers in the development and prioritization of policy action to reduce socioeconomic inequalities in obesity among Australian children.

PUBLICATIONS DURING ENROLMENT

PUBLICATIONS DURING ENROLMENT RELEVANT TO THE THESIS

Peer-reviewed publications

Chung A, Backholer K, Zorbas C, Hanna L, Peeters A. Factors influencing sweet drink consumption among preschool-age children: A qualitative analysis. *Health Promotion Journal of Australia*. 2021; 32(1):96-106.

Chung A, Peeters A, Gearon E, Backholer K. Contribution of discretionary food and drink consumption to socioeconomic inequalities in children's weight: Prospective study of Australian children. *International Journal of Epidemiology*. 2018; 47:820-828.

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Chung A, Zorbas C, Peeters A, Backholer K, Browne J. A critical analysis of representations of inequalities in childhood obesity in Australian health policy documents. *International Journal of Health Policy and Management*. *Under review*.

Other publications

Chung A. Junk food in childhood contributes to socioeconomic inequalities in overweight and obesity. *International Journal of Epidemiology Blog*, 6 March 2018.

ADDITIONAL PUBLICATIONS DURING ENROLMENT

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Chung A, Tully L, Czernin S, Thompson R, Mansoor A, Gortmaker SL. Reducing childhood obesity risk in the wake of COVID-19. *BMJ*. 2021.

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PRESENTATIONS DURING ENROLMENT

Oral presentations

Chung A. A critical analysis of equity in childhood obesity prevention policy in Australia. Presentation for the World Public Health Nutrition Congress. Virtual event, April 2020.

Chung A. A socioecological model of factors influencing sweet drink consumption among preschool aged children. Presentation at the Food Governance Conference. Sydney, July 2019.

Chung A. Factors influencing sweet drink consumption among preschool aged children. Presentation at the 16th Dangerous Consumptions Colloquium. Melbourne, November 2018.

Chung A. Discretionary food and beverages and the relationship between socioeconomic position and obesity in Australian children. Presentation at the 15th World Congress on Public Health. Melbourne, April 2017.

Chung A. Trends in child and adolescent obesity prevalence according to socioeconomic position: a systematic review. Presentation at the Population Health Congress. Hobart, September 2015.

Chung A. Socioeconomic inequalities in childhood obesity. Presentation at the Central Clinical School Postgraduate Symposium. Melbourne, November 2014.

Poster presentations

Chung A. Trends in child and adolescent obesity prevalence according to socioeconomic position: a systematic review. Poster presentation at the Victorian Obesity Consortium Symposium. Melbourne, November 2014.

Chung A. Trends in childhood obesity prevalence according to socioeconomic position: a systematic review. Poster presentation at Alfred Health Week. Melbourne, October 2014.

Chung A. Trends in child and adolescent obesity prevalence according to socioeconomic position: a systematic review. Poster presentation at the Australian and New Zealand Obesity Society Annual Scientific Meeting. Sydney, October 2014.

PROFESSIONAL DEVELOPMENT DURING ENROLMENT

Qualitative Research: Design, Analysis and Representation 5-day course. Australian Consortium for Social and Political Research (2020)

Qualitative Research Methods Short Course. School of Public Health and Preventive Medicine, Monash University (2017)

Moderating Focus Groups 3-day course. Australian Consortium for Social and Political Research (2017)

Fundamentals of NVivo 11 for Windows Online Course (2017)

Moving on with NVivo 11 for Windows Online Course (2017)

Systems Thinking and Collective Impact 2-day course. Global Obesity Centre (GLOBE), Deakin University (2017)

Introduction to STATA Short Course. School of Public Health and Preventive Medicine, Monash University (2016)

Longitudinal Study of Australian Children (LSAC) data user workshop. Australian Institute of Family Studies (2016)

THESIS INCLUDING PUBLISHED WORKS DECLARATION

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

This thesis includes four original papers published in peer reviewed journals and one submitted publication. The core theme of the thesis is socioeconomic inequalities in childhood overweight and obesity. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the student, working within the School of Public Health and Preventive Medicine under the supervision of Anna Peeters and Kathryn Backholer.

The inclusion of co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges input into team-based research.

In the case of Chapters Four to Seven my contribution to the work involved the following:

Thesis Chapter	Publication Title	Status	Nature and % of student contribution	Co-author names, nature and % of contribution	Co-author Monash student
Four	Trends in child and adolescent obesity prevalence according to socioeconomic position: protocol for a systematic review	Published	80% Study design, writing first draft	1) Anna Peeters, study design and input into manuscript 5% 2) Kathryn Backholer study design and input into manuscript 5% 3) Evelyn Wong, input into manuscript 2.5% 4) Palermo C, input into manuscript 5% 5) Keating C, input into manuscript 2.5%	No No Yes No No
Four	Trends in child and adolescent obesity prevalence in economically advanced countries according to socioeconomic position: a systematic review	Published	70% Study design, data collection, data analysis, writing first draft	1) Anna Peeters, study design, analysis and input into manuscript 10% 2) Kathryn Backholer study selection, data extraction and input into manuscript 5% 3) Evelyn Wong, study selection, data	No No Yes

				extraction and input into manuscript 5% 4) Claire Palermo, study selection, data extraction and input into manuscript 5% 5) Catherine Keating, study selection, data extraction and input into manuscript 5%	No No
Five	Contribution of discretionary food and drink consumption to socioeconomic inequalities in children's weight: Prospective study of Australian children	Published	80% Study design, data preparation and analysis, writing first draft	1) Kathryn Backholer, study design, data analysis, input into manuscript, 10% 2) Anna Peeters, study design, input into manuscript 5% 3) Emma Gearon, study design, data analysis, input into manuscript 5%	No No Yes
Six	Factors influencing sweet drink consumption among preschool-age children: A qualitative analysis	Published	80% Study design, data collection and analysis, writing first draft	1) Anna Peeters, study design, data collection, input into manuscript 8% 2) Kathryn Backholer, data collection and analysis, input into manuscript 5% 3) Christina Zorbas, data collection and analysis, input into manuscript 5% 4) Lisa Hanna, study design, input into manuscript 2%	No No No No
Seven	Representations of inequalities in childhood obesity in Australian health policy documents	Under Review	75% Study design, data collection and analysis, writing first draft	1) Jennifer Browne, study design, data analysis, input into manuscript 7.5% 2) Christina Zorbas, study design, data analysis, input into manuscript 7.5% 3) Anna Peeters, study design, input into manuscript 5% 4) Kathryn Backholer, study design, input into manuscript 5%	No No No No

I have not renumbered the published papers presented in Chapters Four, Five and Six of this thesis.

Student name: Alexandra Chung

Student signature: Date: 6th February 2021

(signature removed for security)

I hereby certify that the above declaration correctly reflects the nature and extent of the student's and co-authors' contributions to this work. In instances where I am not the responsible author I have consulted with the responsible author to agree on the respective contributions of the authors.

Main Supervisor name: Anna Peeters

Main Supervisor signature: Date: 08/02/2021

(signature removed for security)

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ABBREVIATIONS

BMI	Body Mass Index
IRSD	Index of Relative Socioeconomic Disadvantage
LSAC	Longitudinal Study of Australian Children
PRISMA	Preferred Reporting Items for Systematic review and Meta-Analysis
PRISMA-P	Preferred Reporting Items for Systematic review and Meta-Analysis Protocols
PROSPERO	International Prospective Register of Systematic Reviews
SEP	Socioeconomic Position
SEIFA	Socioeconomic Index for Area
SDoH	Social Determinants of Health
SSBs	Sugar-Sweetened Beverages
UK	United Kingdom
UNICEF	United Nations Children's Fund
US	United States
WHO	World Health Organisation
WHO ECHO	World Health Organisation Commission on Ending Childhood Obesity
WPR	What's the Problem Represented to be?

GLOSSARY

Body mass index (BMI)	An indicator of adiposity, calculated as body weight in kilograms divided by height in meters squared
BMI percentile	Reference chart to compare a child's BMI to the BMI of other children the same age and sex
BMI z-score	Body mass index standardized for child's age and sex, to account for physiological growth during childhood and adolescence
Equity	A fair opportunity for all persons to attain their full health potential
Health inequalities	Differences in health status experienced by individuals or population groups
Health inequities	Differences in health status that are unnecessary, avoidable, unfair and unjust
Overweight	Excess body weight classified as either BMI 25.0 to <30kg/m ² or BMI 85th to <95th percentile for children and adolescents of the same age and sex
Obesity	Excess body weight classified as either BMI >30 kg/m ² or BMI >95th percentile for children and adolescents of the same age and sex
Social determinants of health (SDoH)	The material, social, political, and cultural conditions in which we are born, grow, work, live and age, and which influence health and wellbeing
Socioeconomic Position (SEP)	The position of an individual or group of people within society based on their access to social and economic resources such as education, occupation and income
What's the Problem Represented to be (WPR)	An analytic strategy based on problematization theory that can support critical interrogation of policy documents to reveal how issues become defined as "problems"

1 INTRODUCTION

1.1 OVERVIEW

This first chapter begins with an introduction to the central theme of the thesis - socioeconomic inequalities in overweight and obesity among children. This chapter then provides an introduction to the thesis aims and structure, followed by a summary of the contributions of this research to the evidence on socioeconomic inequalities in childhood obesity.

1.2 SOCIOECONOMIC INEQUALITIES IN OVERWEIGHT AND OBESITY AMONG CHILDREN

Childhood obesity is a significant public health issue with detrimental health and wellbeing effects that extend beyond the childhood years. Children with overweight and obesity are at risk of becoming adults with overweight or obesity (1, 2), with increased risk of morbidity and mortality (3). In this thesis, childhood is defined as the period up to age 18 years. In Australia, national data shows that one in four children aged two to 17 years live with overweight or obesity (4). This high prevalence of childhood overweight and obesity presents a significant health and economic burden to society (5). For example, non-hospital costs incurred by Medicare as a result of GP and specialist medical care for overweight and obesity among six to 13 year-olds was reported to be \$43.2 million in 2015 (6). Childhood obesity trends in Australia have accelerated rapidly since the 1970's (7) with observations of a doubling of combined overweight and obesity and a trebling of obesity prevalence between 1985 and 1997 among children aged seven to 15 years (8). The rising prevalence of childhood obesity in Australia coincides with worldwide trends which have seen an increase from around 0.8% among boys and girls in 1975 to 5.6% among girls and 7.8% in boys in 2016 (9). There have been reports that suggest trends in the prevalence of childhood obesity is slowing or stabilising, however there are signs that this is not being experienced equally by all groups of children. This thesis will examine whether recent reports of a plateau in childhood obesity prevalence had been experienced equally across socioeconomic groups.

In high-income countries including Australia, childhood obesity is socioeconomically patterned whereby obesity prevalence increases as socioeconomic disadvantage increases (10-12). Among Australian children aged two to 17 years, those living in the most disadvantaged neighbourhoods are one and a half times more likely to experience overweight and obesity

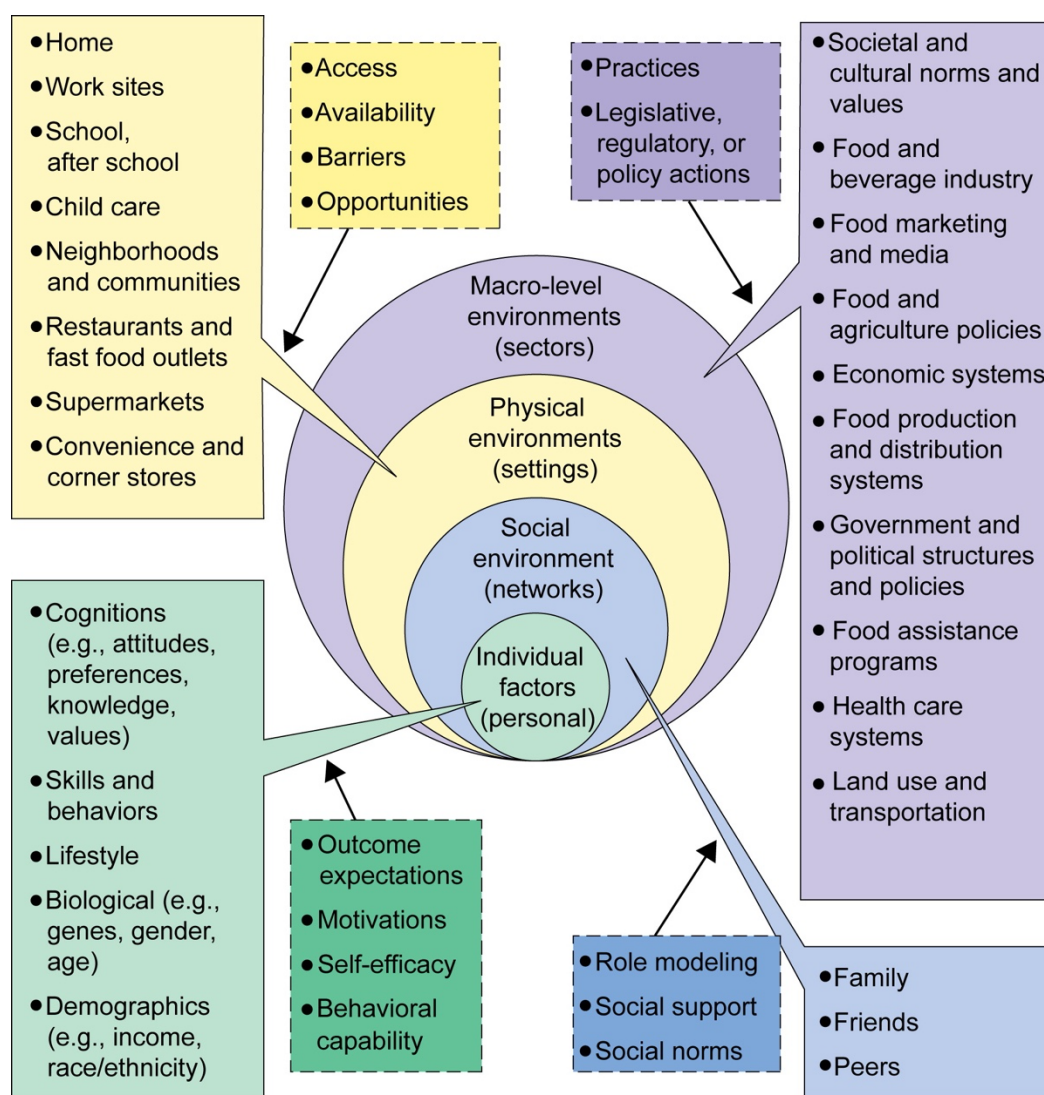
compared to children living in neighbourhoods of least disadvantage (4). These inequalities in obesity mean that children with lower socioeconomic position (SEP) are disproportionately burdened. Differences in obesity prevalence, or in health status more generally, are known as health inequalities. Health inequalities arise from the systemic, unequal access to social and economic resources and differential exposure to healthy or harmful conditions in the environments in which individuals are born, grow, live, learn, work, and age (13).

Unhealthy diets are a key modifiable risk factor for childhood obesity (14, 15). Australian children and adolescents consume up to 40% of their daily energy intake from unhealthy food and drinks, that is, food and drinks high in saturated fat, sodium, and/or added sugars (16). At the same time, a majority of Australian children do not meet recommended daily intakes for fruit and vegetables (16). These dietary patterns suggest that unhealthy diets are the norm for many children. In high income countries dietary behaviours are socioeconomically patterned whereby higher SEP is associated with healthier dietary patterns (17-19). For example, children with higher SEP are more likely to achieve recommended intakes of fruit and vegetables (20-25). On the other hand, children with lower SEP are more likely to consume discretionary food and drinks such as sugar-sweetened beverages (SSBs) (20, 24, 26-28), fruit juice (21), snack foods (28), and fast food (24, 29). Given the large influence that dietary intake has on weight gain, and that dietary behaviours are a modifiable risk factor, children's diets represent an ideal target for preventive health action (30). What is not well known is the age at which socioeconomic differences in children's diet emerge, and the impact of dietary behaviours in the development of excess weight. The second study in this thesis will focus on socioeconomic position, children's diets and weight, examining the mediating role of unhealthy in the development of socioeconomic differences in BMI z-score at age 10-years. The study will examine data from a cohort of Australian children, observed from birth, to identify the age at which socioeconomic differences in weight emerge.

The determinants of children's dietary behaviours are complex, acting across multiple contexts and settings. Conceptually, the socioecological model provides a useful framework for understanding the determinants of children's dietary behaviour. For example, the ecological model developed by Story et al (2008) (31) visually summarises many of the factors influencing individual diets (Figure 1.1). At the micro level, children's diets are influenced by individual factors including individual knowledge and skills, dietary behaviours, parenting practices, race and ethnicity (31-33). These individual factors are in turn shaped by social

factors such as grandparents and extended family, peer networks and role modelling (31, 33). Moving outward, the settings in which children live, grow and learn such as early childhood education and care and schools and the caregivers within these settings influence dietary behaviours (32). Local food retail environments including food availability, affordability also influence dietary behaviours (30, 31). At the macro level, food and beverage taxation and subsidies, food marketing policies, and urban planning laws shape the food environment (30, 31). These factors are not experienced equally across populations, giving rise to differential exposure to the opportunities required to achieve a healthy diet, and inequalities in children's dietary behaviour and obesity prevalence (34).

Understanding how these factors drive children's dietary behaviour is necessary for advocacy and action to improve children's diets and diet-related health. Drawing on the key finding from the second study within this thesis that the emergence of persistent socioeconomic differences in the consumption of sweet drinks occurs during the first year of life, the third study will examine parents' perceptions of the factors influencing sweet drink consumption, during the preschool period (up to age 5-years), a critical period for the development of dietary behaviours (35, 36).



AR Story M, et al. 2008.
Annu. Rev. Public Health. 29:253–72

FIGURE 1.1 ECOLOGICAL MODEL OF FACTORS INFLUENCING DIETS (31)

In order to progress action on childhood obesity, approaches will need to include policies and strategies that address the determinants of children's diets at the individual level and also across the social, physical, and environmental contexts (31). To improve health equity, evidence indicates that these approaches will need to prioritise actions that address the structural determinants with the aim to change the social, physical or macro-level environments in which dietary choices are made rather than focusing on individual behaviour change (5, 37).

Governments have a critical role to play in developing healthy public policy to protect and promote the health of its citizens (38). Action to address health issues is underpinned by the way in which such issues are represented in public policy (39). Analysis of how policy

problems are represented provides the opportunity to rethink policy, research and advocacy efforts (40) with a view to ensuring an equitable and effective policy response.

In Australia, national, state and territory governments have, over the years, proposed various childhood obesity prevention policies. However, these proposals appear to have been ad hoc and not necessarily part of comprehensive obesity prevention strategies, but instead included within general public health or health promotion strategies. This decentralized approach to childhood obesity prevention gives rise to an approach that lacks coordination and consistency across jurisdictions. Furthermore, the way in which Australian governments represent inequalities in childhood obesity is not well understood, leaving a gap in understanding of how Australian health policy is placed to address socioeconomic inequalities in childhood obesity.

1.3 RESEARCH AIM AND OBJECTIVES

The overall aim of this thesis is to generate evidence to inform the implementation of obesity prevention policies most likely to reduce socioeconomic inequalities in childhood obesity. To achieve this aim, four research objectives were identified. These objectives form the basis of each of the four studies presented in this thesis;

1. To identify and describe the extent to which trends in childhood overweight and obesity differ according to socioeconomic position;
2. To identify the role of dietary behaviours, particularly consumption of unhealthy food and drinks, on the development of socioeconomic inequalities in BMI z-score among Australian children;
3. To understand parents' perceptions of the factors influencing sweet drink consumption among preschool-age children;
4. To critically examine the representations of inequalities in childhood obesity in Australian health policy.

1.4 THESIS STRUCTURE

This thesis comprises eight chapters. Following this **Introduction**, **Chapter Two** provides a **Literature Review** of key evidence on childhood obesity and socioeconomic inequalities in childhood obesity and more broadly, in health. **Chapter Three** introduces the theoretical frameworks and methods that were applied to undertake the research presented in this thesis. The next four chapters comprise each of the studies undertaken to address the research objectives described above. **Chapter Four** describes the socioeconomic differences in trends in childhood obesity prevalence between 1990 and 2015 across 15 high-income countries. **Chapter Five** provides a quantitative assessment of the contribution of unhealthy dietary behaviour to the development of socioeconomic differences in childhood obesity (BMI z-score) among a nationally representative cohort of Australian children. Following the findings in **Chapter Five** that socioeconomic differences in unhealthy dietary behaviour are evident within the first year of life, **Chapter Six** explores parents' perspectives of the determinants of sweet drink consumption among preschool-age children. **Chapter Seven** marks the final study of the thesis with a critical analysis of 18 Australian national, state and territory health policy documents. This critical policy analysis provides insight into how Australian governments consider and propose to address inequalities in childhood obesity. **Chapter Eight** discusses the main findings of the thesis, considers limitations of the research, and concludes with recommendations for research and policy. **Chapter Nine**, the final chapter, presents an overall conclusion to the thesis.

1.5 CONTRIBUTIONS OF THIS THESIS

This thesis uses novel research methods to explore trends, drivers and current policy approaches to address socioeconomic inequalities in childhood overweight and obesity. The findings presented in this thesis make a number of key contributions to the evidence. To the best of my knowledge, this thesis includes the first systematic review of trends in childhood obesity in high-income countries according to socioeconomic position. Trends in childhood obesity prevalence, stratified by socioeconomic position, had not previously been systematically examined. This study therefore builds on previous reviews that have reported trends in childhood obesity prevalence by systematically examining studies that have reported data according to socioeconomic position. This was the first systematic study to show that the reported plateau in the prevalence of childhood obesity across high-income countries was

masking widening socioeconomic inequalities in childhood obesity. Trends showed a stabilization or decrease in overweight and obesity prevalence among children with high SEP and ongoing rising trends in overweight and obesity prevalence among children with lower SEP. This demonstrates the need for ongoing monitoring and fine-grained analysis of childhood obesity prevalence and associated risk factors across socioeconomic groups.

This thesis includes the first study to examine the role of Australian children's discretionary food and drink consumption in mediating socioeconomic differences in obesity. Using longitudinal mediation methods, the contribution of unhealthy food and drink consumption in the development of socioeconomic inequalities in obesity among a nationally representative cohort of Australian children was quantified. This study showed that 11% of the observed difference in children's BMI z-score at age 10 to 11 years was mediated by socioeconomic differences in unhealthy food and drink consumption throughout childhood.

The thesis also offers new insights into parents' perceptions of the factors influencing sweet drink consumption among preschool-age children. Findings demonstrated that factors exist across multiple contexts, with parents identifying a need for additional support to assist them with making healthy beverage choices for their children, including implementation of policy to reduce marketing of sugary drinks and increased availability and affordability of healthy beverage choices. Providing insight into the perspectives of parents of preschool-age children is an important contribution to the literature, where studies on factors influencing sweet drink consumption among school-age children have tended to predominate.

Finally, the critical policy analysis presented in this thesis is the first of its kind to examine representations of childhood obesity and associated inequalities in Australian health policies. The findings of the critical policy analysis are essential to improving our understanding of how childhood obesity and health inequalities are represented in Australian health policy, and how these representations are reflected in the solutions proposed to address inequalities in childhood obesity.

Collectively this thesis advances the evidence on the research methods, trends, determinants and current approaches to address socioeconomic inequalities in childhood obesity in Australia. Findings of this thesis highlight the need for ongoing monitoring and analysis of childhood obesity and its risk factors according to socioeconomic position. Findings also demonstrate the role of unhealthy food and drinks in the development of socioeconomic inequalities in

childhood obesity and the need to better support parents to make healthy dietary choices for their children. Combined with the existing evidence, these findings clearly demonstrate that implementation of a range of complementary policies and strategies that address the individual, social, and structural determinants of childhood obesity and health inequalities will be necessary to reduce socioeconomic inequalities in childhood obesity. This research is intended to be useful to public health nutrition advocates, researchers, and policymakers in the development and prioritization of policy action to reduce socioeconomic inequalities in obesity among Australian children.

1.6 CONCLUSION

Childhood obesity follows a socioeconomic gradient whereby children with lower socioeconomic position carry a disproportionate burden of excess weight leading to poorer health. This thesis reports on four key studies that, using novel research methods, examined trends, determinants and current approaches to address socioeconomic inequalities in childhood obesity. Findings demonstrate that socioeconomic inequalities in childhood obesity are the result of factors operating across multiple contexts. Addressing these inequalities requires the implementation of a range of equitable, equity-focused government-led policies. Findings presented in this thesis provide recommendations for obesity prevention policy most likely to achieve the equitable reduction of overweight and obesity among Australian children.

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2 LITERATURE REVIEW

2.1 INTRODUCTION

Childhood obesity is significant public health problem, affecting children and adolescents worldwide, with short- and long-term health consequences. In high-income countries including Australia, childhood obesity is socioeconomically patterned, with gradients in obesity prevalence observed across socioeconomic groups whereby children with lower socioeconomic position (SEP) are more likely to experience overweight or obesity compared to children with higher SEP (1, 2). For example, around 11% of children and adolescents aged two to 17 years living in the lowest socioeconomic areas of Australia experience obesity compared to 4.4% of children and adolescents living in the highest socioeconomic areas (3). This inequitable distribution of obesity means that children with lower SEP are disproportionately burdened by obesity and its health consequences.

Childhood obesity is complex, the result of multiple determinants that interact in a systems-like manner. Individual behaviours including diet, physical activity and sedentary behaviour play a role in the development of childhood obesity. At the most basic level, these behaviours determine the overall energy balance of the body. Children's behaviours are influenced by family and peers, whose behaviours are, in turn, shaped by the social determinants of health (SDoH), the daily living conditions in which they are born, grow, work, live, play and age (4, 5). These include early life experiences, education and employment opportunities, housing, and food environments.(4) The SDoH also include the economic, social, political and cultural contexts that shape these daily living conditions (6). Understanding the determinants of childhood obesity across these contexts is critical to the prioritisation of strategies that can promote and support health and prevent the development of obesity in childhood.

Like obesity, dietary behaviour is socioeconomically patterned such that children with higher SEP are more likely to consume healthy food and less likely to eat excess amounts of unhealthy food compared to children with lower SEP (7-10). Yet the extent to which socioeconomic differences in children's dietary behaviours contributes to socioeconomic differences in weight has not been tested. Understanding this will be important to guide action to address socioeconomic differences in childhood obesity towards the relevant drivers.

There is consensus that in order to improve children's diets, and therefore obesity risk, coordinated action, including government-led policies will be required to equitably support healthy dietary choices (11, 12). Yet there is no clear strategy for government action to address inequalities in childhood obesity. Indeed, there is no current obesity strategy in many countries, including Australia. This gives rise to the risk that inequalities in childhood obesity continue unchecked.

2.2 HEALTH EQUITY

Health is a fundamental human right, but it is not equally distributed across the population. Health status differs between population groups and these discrepancies are known as health inequalities. *Health inequalities* can be defined as differences in health status experienced by individuals or population groups (13). These differences can be observed when population data are stratified by age, sex, race and ethnicity or an indicator of SEP, determined on the basis of individual characteristics such as level of education, occupation, or income (14) or on the relative level of socioeconomic disadvantage within a geographical area (13).

Indicators of SEP can provide different insights into an individual's circumstances and are not necessarily interchangeable (15). The use of a single individual marker of SEP such as education or income provides some indication of an individual's access to social and material resources, but will not necessarily capture the total effect of SEP on health (16). Composite measures of SEP that combine two or more individual markers can be useful for describing patterns in health inequalities, but are less useful for determining the mechanisms leading to health inequalities (17). Area level SEP indicators are generated from aggregates of individual data and whilst they provide a useful proxy for SEP for people living in a particular geographical area, they may not necessarily reflect individual circumstances (17). For children, parent or household characteristics are commonly used as indicators of SEP, for example one or both parent's education or occupation, or the household income (16). Consistent across all indicators of SEP is a gradient in health. That is, poor health is not only concentrated among those at the most disadvantaged end of the spectrum but distributed along a gradient such that increased risk of avoidable ill health is associated with increasing levels of disadvantage (18). This means health inequalities are a problem across the whole of society.

Health *inequities* are differences in health that are socially produced and are avoidable. Because these differences can be avoided, they are considered unjust. Whitehead's (1990) widely used definition of health inequities states 'health inequities as differences in health that are unnecessary, avoidable, unfair

and unjust' (19). The injustice arises from unequal access or opportunities to benefit from the conditions required for good health such as employment opportunities or adequate health care (20). These opportunities are amenable to policy change through government action such as labour policy, tax policy, welfare and social support and health care funding (20). Health *equity* therefore can be described as the notion that everyone should have a fair opportunity to attain their full health potential (21).

Kawachi et al (2002) present the notion that inequality and equality are dimensional concepts, attributed to measurable differences, whereas inequity and equity are political concepts, indicating a moral commitment to social justice (8). In that context, the term *inequalities* is used in this thesis when describing measured differences between population groups. The term *equity* is used when describing aspirations and ideals for policies and other actions to improve health. Achieving health equity, will therefore require elimination of avoidable differences in health, social, and economic circumstances. To do this, there is a need to understand and act upon the social determinants of health.

2.3 THE SOCIAL DETERMINANTS OF HEALTH

Individual behaviour is shaped by the material, social, political, and cultural conditions in which people are born, grow, live, learn, work, and age (18). These are known as the social determinants of health (SDoH) and they have a profound impact on health and wellbeing. The SDoH include early life experiences; opportunities for education; housing; working conditions; unemployment; access to health care; social exclusion and discrimination; social support and stress (18). They also include the broader social, economic and political systems in which people live.

Drawing on the work of the World Health Organization (WHO) Global Commission on the Social Determinants of Health, Solar and Irwin's (2010) conceptual framework illustrates the impacts of the social determinants of health (14) (Figure 2.1). Moving from left to right, the framework depicts the way in which structural determinants including social, economic and political conditions give rise to socioeconomic position, whereby populations are stratified according to characteristics such as education, income, occupation, gender or race and ethnicity. These factors influence the SDoH, living and working conditions that shape our daily lives. Collectively these structural and social factors influence health and wellbeing. (14).

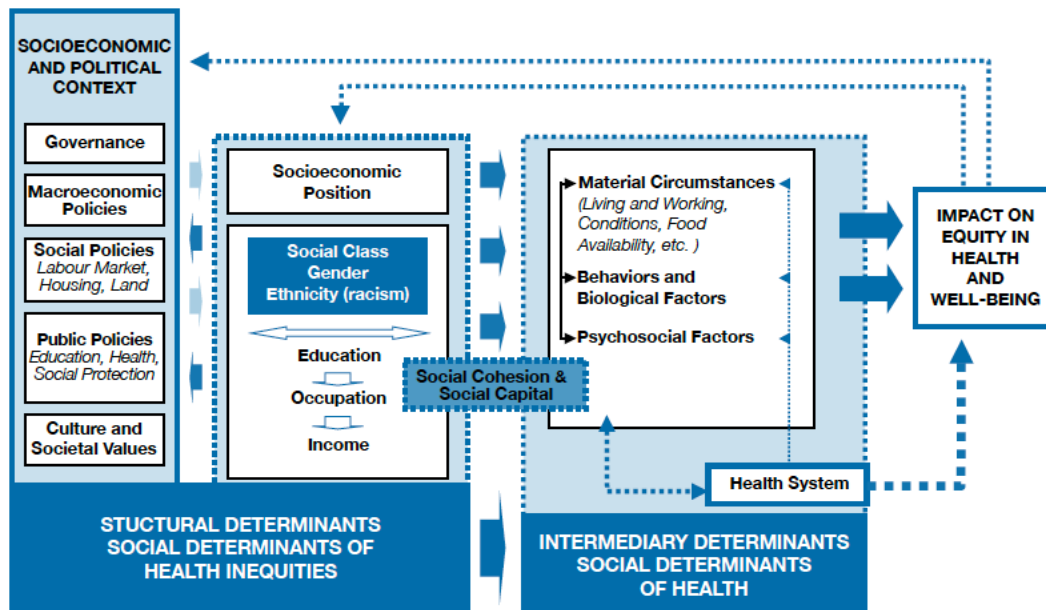


FIGURE 2.1 SOCIAL DETERMINANTS OF HEALTH CONCEPTUAL FRAMEWORK (14)

These structural and social determinants represent the underlying determinants of health. Inequalities in the structural and social conditions that shape daily life give rise to health inequalities (14). For example, those with less education, insecure work and poor living conditions are less likely to consume healthy diets and are at increased risk of diet-related disease (22). To reduce inequalities in childhood obesity, there is a need to understand and act upon these underlying determinants of health as well as the more frequently discussed proximal drivers such as knowledge, skills and health behaviour (23).

2.4 OVERWEIGHT AND OBESITY AMONG CHILDREN

2.4.1 *Childhood obesity definitions and prevalence*

Childhood overweight and obesity is a major public health challenge. Global estimates suggest that in 2016 more than 330 million children and adolescents aged five to 19 years and a further 40 million children under the age of five years were living with overweight or obesity (24, 25). Overweight and obesity is classified by the WHO as abnormal or excessive fat accumulation that presents a risk to health (25). Overweight and obesity are commonly measured using body mass index (BMI), calculated as a ratio of body weight in kilograms divided by height in metres squared (kg/m^2). To account for growth during the childhood period, classifications of overweight and obesity also consider age and sex. Widely accepted methods for classifying childhood obesity at a population level include age- and

sex-adjusted BMI centile curves, such as those available from the International Obesity Taskforce (26), the WHO (27), and the United States (US) Center for Disease Control and Prevention (28).

According to the most recent national data on Australian children and adolescents aged five to 17 years, 17.6% are overweight and 8.5% have obesity (29). These figures are similar for preschool children aged two to four years among whom 15.3% are overweight and 8.7% have obesity (29). However, the prevalence of childhood obesity is not distributed evenly across the population. In high-income countries, including Australia, overweight and obesity is socioeconomically patterned whereby those experiencing greater social and economic disadvantage are more likely to also experience obesity (2). Socioeconomic differences in childhood obesity have been observed across individual markers of socioeconomic position including parents' level of education, occupation and/or income, and neighbourhood indicators such as the level of disadvantage in a child's area of residence (1, 2, 30). Socioeconomic patterning in childhood obesity occurs along a gradient, whereby the risk of overweight and obesity increases as the level of socioeconomic disadvantage increases (Figure 2.2).

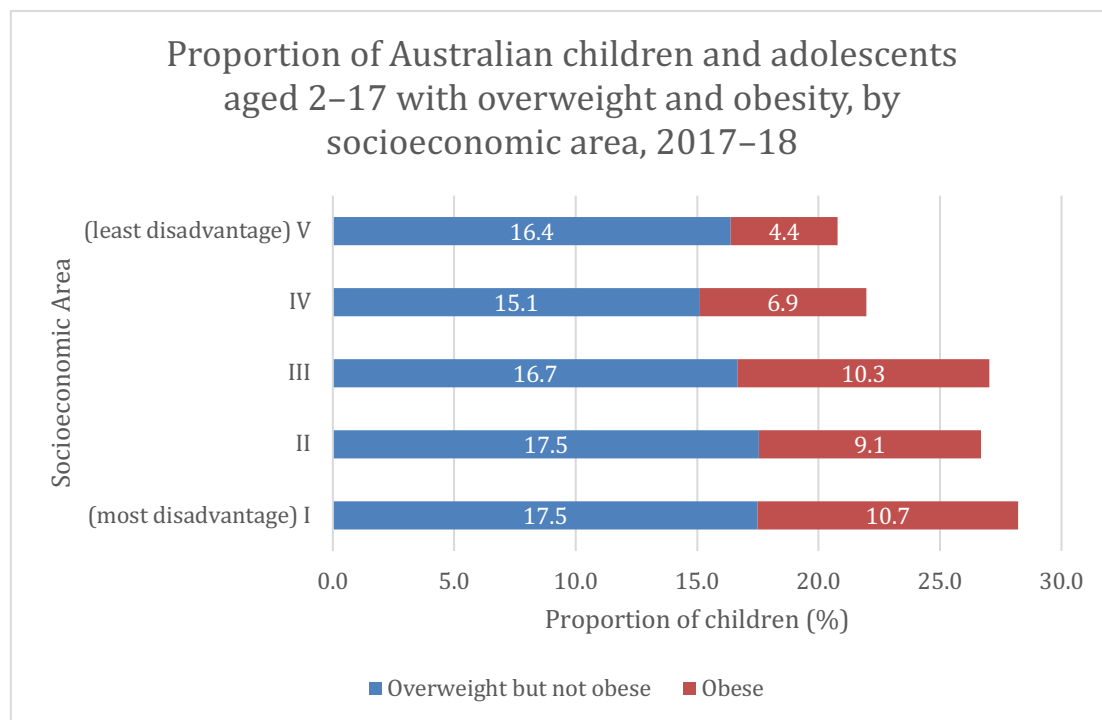


FIGURE 2.2 SOCIOECONOMIC PATTERNING IN OVERWEIGHT AND OBESITY AMONG AUSTRALIAN CHILDREN AGED 2-17 YEARS, 2017/18

2.4.2 Trends in overweight and obesity among children

The rising prevalence of childhood overweight and obesity is a global problem, described as a pandemic (31) and a public health crisis (32). Rapidly increasing trends in childhood overweight and obesity prevalence have emerged over the past fifty years. In the decades prior to 1970, rates of childhood overweight and obesity were consistently low in Australia, with fewer than 10% of children aged 5 to 15 years experiencing overweight or obesity (33). However, rapid increases in childhood overweight and obesity followed during the 1980's and 1990's (33-35) (Figure 2.3). By 2007, the prevalence of overweight and obesity among Australian children aged 2 to 17 years had reached 22% among boys and 24% among girls (36). Data from 2017/2018 indicates that among Australian children 2 to 17 years, 25% of boys and 24% of girls have overweight or obesity (29). Whilst this suggests that the rapid increases in weight have slowed, obesity prevalence remains unacceptably high among Australian children and adolescents.

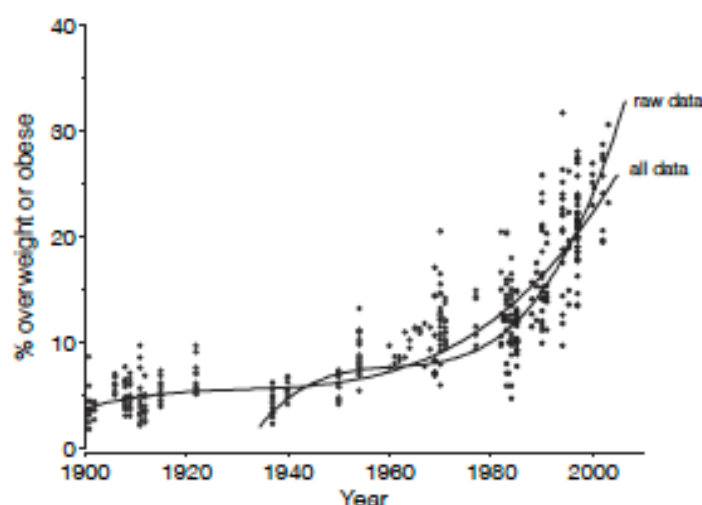


FIGURE 2.3 PREVALENCE OVERWEIGHT AND OBESITY AUSTRALIAN CHILDREN 5-15 YEARS, 1900 TO 2007 (33)

Across high-income countries more broadly, overweight and obesity prevalence among children and adolescents aged 2-19 years has risen from around 17% in boys and 16% among girls in 1980, to 24% in boys and 23% among girls in 2013 (37). In some high-income countries, overweight and obesity prevalence among children and adolescents aged 5 to 19 years has seen a doubling since the 1970s (38). For example, between the mid 1970's and 1980's to the early 2000's, overweight and obesity prevalence among children and adolescents aged 5 to 19 years increased by more than double in

countries including the United States, England, and Australia (31) (Figure 2.4). Similar patterns have been observed among preschool age children worldwide, with overweight and obesity almost doubling since the 1990s (39).

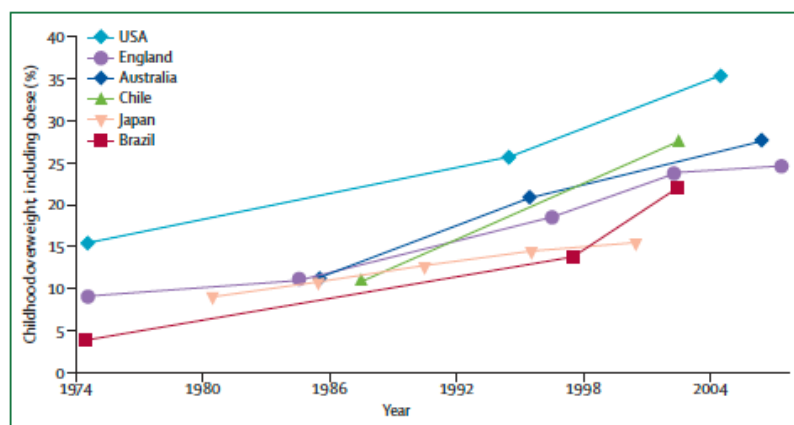


FIGURE 2.4 ESTIMATES OF PERCENTAGE OF CHILDHOOD POPULATION OVERWEIGHT, INCLUDING OBESE IN A SELECTION OF COUNTRIES (31).

Recent reviews demonstrate that the rising prevalence of childhood obesity has slowed across high-income countries including Australia (40, 41). These are signs of optimism, suggesting that at a population level, childhood obesity has reached a plateau, albeit at very high levels. However, there are also indications of differences in trends in child and adolescent obesity prevalence according to socioeconomic position (40, 41). For example, in Australia, between 2000 and 2006 more significant increases in obesity were observed among school children aged six to 18 years attending schools in areas with low SEP (from 5.8 to 8.6% ($P < 0.05$)) compared to children in areas with middle (5.5 to 6.3% ($P = 0.32$)) and high SEP (3.3 to 4.2% ($P = 0.92$)) (42). Increases in childhood overweight and obesity prevalence among children in the UK between 1974 and 2003 were greater among children from lower socioeconomic strata compared to children with higher SEP (43). More recently, between 2002/3 and 2006/7, overweight and obesity prevalence among school-age children in the UK has stabilized, but less so among children from lower socioeconomic strata, and socioeconomic inequalities in obesity were observed to have widened during that time. For example, compared to 1997/8, in 2006/7 the age and sex-adjusted odds ratio for overweight was 1.88 (95% CI 1.52 to 2.33) in low-SEP, 1.25 (95% CI 1.04 to 1.50) in middle-SEP, and 1.13 (95% CI 0.86 to 1.48) in high-SEP children (44). These studies provide evidence of socioeconomic differences in trends in childhood overweight and obesity prevalence within a selection of high-income countries.

Whilst there have been country-level studies examining socioeconomic differences in the prevalence of childhood overweight and obesity over time, there has been no systematic synthesis of this data to understand whether a slowing of childhood obesity trends is being experienced equally by children from all socioeconomic backgrounds.

2.4.3 *Childhood obesity burden*

Childhood obesity has significant and persistent impacts on the health of individuals and contributes to economic and social costs including increased health care costs and reduced economic productivity (45, 46). Prevention of childhood obesity is necessary to reduce the extensive burden attributed to obesity. In Australia, the direct costs of obesity were approximated to equal \$3.8 billion per year in 2014-2015. This figure, likely to be even higher, is made up of the health and medical costs of care for individuals living with obesity. The indirect costs of obesity, from reduced workforce participation and productivity, pose a further economic burden, estimated to be an additional \$4.8 billion each year (47). These costs contribute significantly to government expenditure in Australia where a majority of health care is government funded (48).

Whilst children make up only a proportion of the population, the burden of childhood obesity contributes to overall national health expenditure. For example, it has been estimated that the Australian government spends an additional \$43 million dollars on non-hospital health care (such as general practitioner and specialist doctor services) for children aged 6 to 13 years with overweight and obesity compared to non-overweight children (49). Whilst this lends support to the economic argument for prevention of childhood obesity, it is not the only reason for preventing childhood obesity.

Consequences of childhood obesity borne by individuals include detrimental health and wellbeing effects during childhood and throughout life. In the short term, overweight and obesity in childhood is associated with type 2 diabetes (50), cardiovascular disease including high blood pressure (51, 52) and dyslipidaemia (52, 53), asthma (54), and reduced physical functioning and musculoskeletal pain (55, 56). Children with obesity are also at increased risk of depression, anxiety, low self-esteem, emotional and behavioural disorders (57, 58). These consequences mean that children with obesity are likely to have poorer health compared to children with healthy weight. Furthermore, the socioeconomic patterning in the distribution of overweight and obesity means that children with lower SEP carry a disproportionate burden.

Obesity in childhood is also a risk factor for non-communicable disease in later life. Longer term consequences of excess weight in childhood include increased risk of diabetes, cardiovascular disease, and some cancers, contributing to disability and premature mortality (59-63). Furthermore, obesity in childhood is highly likely to persist throughout life. Cohort studies have shown that overweight and obesity persists throughout childhood (64, 65). While review studies have demonstrated that children with obesity are at increased risk of becoming adolescents with obesity (66) and adults with obesity (66, 67).

The burden of obesity is also exacerbated by weight stigma. Weight stigma includes bias and discrimination targeted to individuals because of their weight, shape and size. Individuals who experience weight stigma are subject to discrimination in many contexts, including healthcare, education and employment (68). Weight stigma leads to social and emotional distress with known negative health consequences, including depression and further weight gain, as well as social and economic consequences (69, 70). Media coverage commonly features stigmatising imagery and language (71) inviting damaging commentary about those carrying excess weight. This is likely to exacerbate existing mental health impacts of obesity and hinder efforts to address overweight and obesity (72). Overweight and obesity cannot be overcome without addressing stigma. To do this, action to address childhood obesity needs to acknowledge and address the complex factors that contribute to individual weight-related behaviours (73).

2.5 DEVELOPMENTAL DETERMINANTS OF OBESITY

Early life is a key determinant of health and a critical period for the development of childhood obesity. The conditions to which a child is exposed during pre-conception, pregnancy and early childhood influence a child's biology, pre-disposing some infants to more rapid weight gain and greater risk of obesity (74, 75). This period is known as the first thousand days of life, the time from conception to age 2 years (76). There are growing recommendations, including recently from an international expert collaboration, that this critical period be extended to encompass the first 2000 days of life, that is, from conception to age 5 years (74, 77). This demonstrates the profound importance of the early childhood period for the development of trajectories that continue into later life.

Risk factors for the development of childhood obesity during pre-conception and pregnancy period include higher maternal pre-pregnancy BMI (78, 79), maternal smoking during pregnancy (74, 78), gestational diabetes (74), excessive gestational weight gain (79), and low or high infant birthweight

(74, 76, 78). For example, maternal obesity was associated with increased risk of childhood overweight and obesity in early, mid, and late childhood, respectively: OR 2.43 (95% CI 2.24, 2.64), OR 3.12 (95% CI 2.98, 3.27), and OR 4.47 (95% CI 3.99, 5.23) (79). Maternal smoking was associated with a 47% increase in childhood overweight in one meta-analysis (adjusted odds ratio 1.47, 95% CI 1.26 to 1.73; n=7 studies) (78). In early life, infant nutrition including breastfeeding has been found to have protective effects against the development of obesity (74, 78, 80). One meta-analysis identified 15% decrease in the likelihood of childhood overweight among breastfed infants compared to non-breastfed infants (adjusted odds ratio 0.85 95% CI 0.74 to 0.99; n=10 studies) (78). On the other hand, rapid infant weight gain (74, 78, 81), the introduction of solids foods before 4 months of age (76, 78, 82), and prolonged use of infant formula (76) have been identified as risk factors for the development of obesity. During this period of early nutrition, children's dietary preferences and patterns begin to establish, setting the course for future dietary behaviours (83, 84).

Many of these early life risk factors for childhood obesity are socioeconomically patterned. Maternal risk factors including pre-pregnancy BMI, diabetes, and pre-pregnancy diet, and smoking during pregnancy are all associated with lower SEP (85). Low infant birth weight has also been associated with lower SEP (85). Associations between early life nutrition and SEP have also been identified. For example, higher SEP is associated with initiation and longer duration of breastfeeding, optimal timing of the introduction of solid foods, better maternal and infant diet quality, and a positive home food environment including parent modelling of healthy eating (85).

2.6 WHAT DRIVES OVERWEIGHT AND OBESITY?

The immediate determinants of obesity include diet, physical activity, sedentary behaviours and sleep. These behaviours determine the overall energy balance within the body. However, obesity is complex and cannot be simplified to an issue of energy in versus energy out. Energy balance is shaped by factors across the individual, social, settings and broader environmental contexts (31). It is now widely understood that these factors act as system to influence health across the lifecourse.

2.6.1 *An ecological perspective*

The complex and multifactorial nature of obesity may be best described with the use of a socioecological framework. Drawn from ecological systems theory (86), an ecological perspective

represents the factors influencing health as a series of layers. An ecological perspective can be utilised to explain the ecological impact of different factors on different health outcomes. In this section, I present three such models that have been applied to the 1) health (87); 2) dietary behaviour (5); and 3) childhood overweight (88). In Dahlgren and Whitehead's (1991) socioecological model of the determinants of health (87), the innermost layer of the ecological model represents individual biological factors. This includes fixed factors such as age, sex, ethnicity, and individual biology. The next layer represents individual behavioural or lifestyle factors. These include a child's diet, including breastfeeding, the introduction of first foods and transition to family foods. Other behavioural determinants of childhood obesity include physical activity (89, 90), sedentary behaviour (90) and sleep (91). Moving outwards are family, social and community networks. Then the conditions in which people live and work, shaped by sectors including housing, healthcare and education. Finally, the outermost layer represents the structural environment including socioeconomic, cultural and environmental conditions (87) (Figure 2.5).

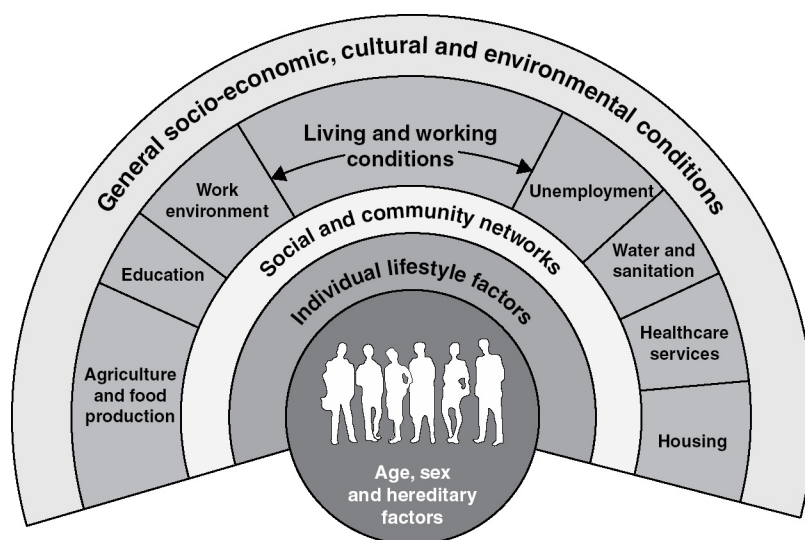


FIGURE 2.5 DETERMINANTS OF HEALTH MODEL (4)

Alongside their determinants of health model, Dahlgren and Whitehead (87) describe how each layer of health determinants can be translated into policy action in order to achieve a particular health goal. At the individual level, strategies could include providing health education to influence individual behaviour; at the social level, policy actions may seek to strengthen community capacity or improve opportunities for social connection; at the settings level, actions to improve living and working conditions might include employment and welfare policies, or implementing policies that improve the

access to and affordability of healthy foods; and finally at the macro-level, actions to achieve structural change could include national policies or international trade agreements. Two important considerations of these policy actions are 1) actions implemented across all levels are likely to have greater effect upon a policy goal compared to action that address only selected levels of determinants, and 2) strategies to promote equity in health are necessary across each policy level in order to reduce the risk of ill health and create fair opportunities for everyone to achieve their full health potential (87).

Ecological systems theory has also been used to conceptualise determinants of dietary behaviour (5) and the risk factors for the development childhood overweight (88). In their model, Story et al (2008) (5) present factors influencing dietary choice across the individual, social, physical, and the macro-level environments. At the individual level, knowledge and skills, preferences and also age, sex and race and ethnicity influence food choices. At the social level, family, friends and peers are shown to shape food choices through role modelling, parenting styles and the reinforcing of social norms. In the physical environment, conditions in the home, child-care and school, workplaces, as well as the food retail environment influence food choices. Finally at the macro level, food marketing, food production and distribution and agricultural and economic policies affect individual food choices (5). The way that an ecological approach illustrates the different contexts in which dietary determinants exist demonstrates the importance of structural factors and supportive environments in order for individuals to make healthy dietary choices (5).

In Davison and Birch's (2001) model of determinants of childhood overweight, the innermost layer represents a child's weight status (88) (Figure 2.6). Moving outwards, immediate determinants of child weight include diet, physical activity and sedentary behaviour. These individual factors are influenced by family characteristics such as parents' behaviours and knowledge, parenting styles, interactions between peers and siblings, and foods available within the home. Parenting and home factors are in turn shaped by factors including, but not limited to, parents' work demands and available free time, the nature of the local food environment, neighbourhood safety, school programs, and family socioeconomic position (88). Missing from this model, but shown in the previous two models, are factors in the macro-environment, such as political structures and commercial determinants.

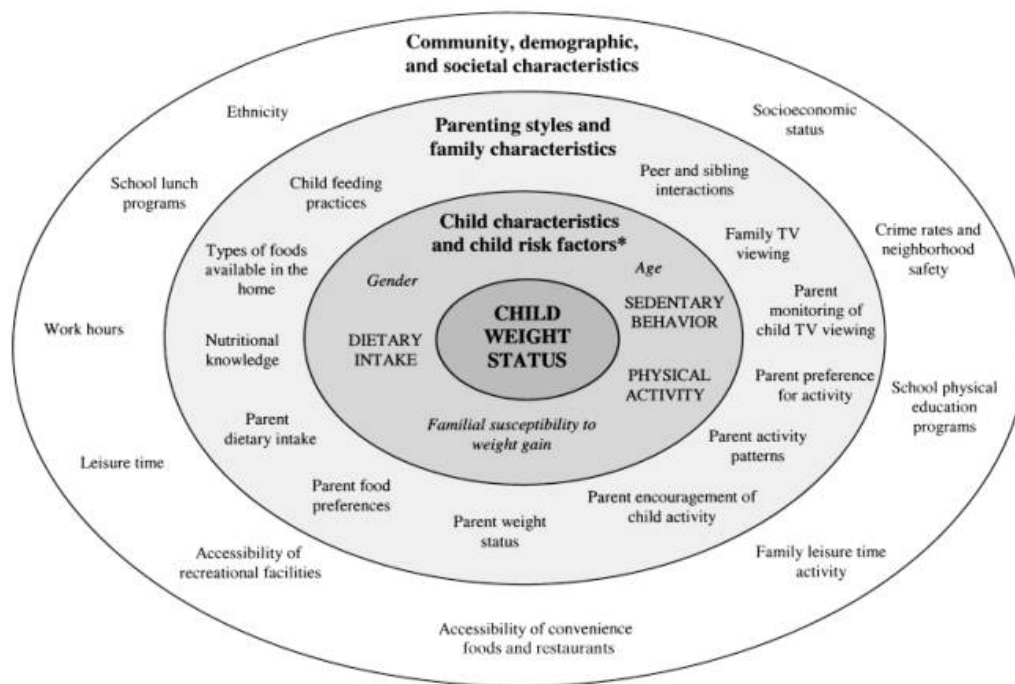


FIGURE 2.6 ECOLOGICAL MODEL OF PREDICTORS OF CHILDHOOD OVERWEIGHT (88)

2.6.2 Dietary determinants of obesity

Behavioural determinants of childhood obesity include diet, physical activity, sedentary behaviour and sleep (92, 93). This thesis will focus on the role of diets, in particular the role of unhealthy diets in the development of obesity among children. Whilst physical activity, sedentary behaviour and sleep are important determinants of childhood overweight and obesity, they are beyond the scope of this thesis.

Dietary behaviours contribute to overweight and obesity when energy intake exceeds energy expenditure (94, 95). Dietary risk factors for childhood overweight and obesity include the consumption of unhealthy or discretionary food and beverages. These can be defined as food and beverages high in energy, fat, and/or sugar, and contribute little to the diet by way of micronutrients (96). Unhealthy food and beverages are considered to be surplus to the requirements of a healthy diet (97).

The consumption of unhealthy food and beverages in childhood has been associated with increased weight. An ongoing longitudinal study of Australian children found higher BMI z-scores to be strongly associated with the consumption of SSBs and high fat foods in children aged four to 10 years (98). Similar associations between unhealthy food and beverages and excess weight have been reported in the international literature where a number of reviews have demonstrated that regular SSB

consumption in children is related to higher BMI z-scores (99-101). For example, a 2007 meta-analysis found positive associations between SSB consumption and children's body weight r value 0.03 (95% CI: 0.02, 0.04) ($P < .005$) (101). Several studies have also reported positive associations between children's consumption of high fat unhealthy food and increased body weight (102-104). On the other hand, some studies have reported no association between the consumption of unhealthy food and excess weight. For example, similarly high levels of unhealthy food and beverage consumption have been observed among Australian children and adolescents regardless of weight status. The authors of that study intimated that differential underreporting of unhealthy food and drink intake may have biased their findings (97). This is a plausible explanation, with evidence of associations between underreporting of dietary intake and higher body weight (105). The lack of association might also be explained by the cross-sectional design of the study and/or residual confounding from other energy-balance behaviours including physical activity and sedentary behaviour (97). However it also points to a key challenge in nutrition research more broadly, that is, obtaining accurate records of dietary intake.

Analysis of Australian children's diets have found them to be inconsistent with recommendations outlined in the Australian Dietary Guidelines (106). Unhealthy food including cakes, muffins and sweet biscuits, potato crisps, processed meats, and sugar-sweetened beverages have been found to contribute significantly to the energy, saturated fat, sugar and sodium intake of Australian children aged two to 18 years (107). Australian children and adolescents consume up to 40% of their daily energy intake from foods and drinks high in saturated fat, sodium, and/or added sugars (107). This is in excess of the recommended daily intake of 0 to 3 serves of these foods for children and adolescents, depending on age and activity level (106).

Dietary preferences are established in childhood and have been shown to track throughout childhood and into adolescence. An Australian study of children aged 9 months to 5 years found fruit, vegetable and discretionary food consumption patterns tracked throughout early childhood with tracking found to be strongest for unhealthy foods (108). Furthermore, dietary patterns have been found to cluster with other behavioural determinants of obesity whereby healthy or unhealthy behaviours tend to cluster together. This was observed among preschool aged children in Australia where two lifestyle patterns 'discretionary consumption and TV' and 'fruit, vegetables and outdoor' were identified. These lifestyle patterns remained consistent throughout early childhood, tracking from 18 months to five years of age (109). The role of unhealthy diets in the development of childhood obesity, and the evidence that

indicates dietary behaviours track throughout childhood demonstrate the importance of developing healthy dietary behaviours during early childhood.

A further reason to support the development of healthy diets in childhood is that children's diets are socioeconomically patterned. Different indicators of socioeconomic position have different impacts on the association between SEP and children's diets, with mother's education the strongest predictor of dietary intake among Australian children (10). Mechanisms through which parental SEP can influence children's diets include nutrition knowledge, parent role modelling, and availability and accessibility of food within the home (110). Children's dietary behaviours are socioeconomically patterned in such a way that higher SEP is associated with healthier dietary patterns (111-113). Children with higher SEP are more likely to consume and achieve recommended intakes of fruit and vegetables (8, 114-118). On the other hand, unhealthy dietary patterns are more likely to be observed among children with lower SEP (10). Children with lower SEP are more likely to consume discretionary food and drinks such as sugar-sweetened beverages (SSBs) (9, 114, 118-120), fruit juice (115), snack foods (9), and fast food (7, 118). Whilst the evidence is clear that children's dietary behaviours are socioeconomically patterned, the extent to which socioeconomic differences in children's diets contributes to differences in childhood obesity is not well understood. Understanding the relative importance of the different elements of children's diets in driving socioeconomic differences in excess weight gain will be important for the prioritisation of actions to effectively and equitably prevent obesity across the population.

2.6.3 Social determinants of obesity

Whilst dietary behaviours represent the downstream determinants of childhood obesity, they are influenced by upstream factors including a child's social networks. Within the social context, family and peers play a role in the development of children's dietary behaviours. Studies have demonstrated the influential role of family and peer behaviour, in shaping children's dietary preferences and behaviours (84, 121, 122).

Children's dietary behaviours develop in the context of the family environment (123) and parents play a key role (84, 124). During childhood, and early childhood in particular, parents tend to have a high degree of control over children's dietary intake (125). Parenting practices are important determinants of children's nutrition behaviours (126). For example, parental role modelling is thought to be influential in determining children's drink preferences (127). Importantly, positive parental role

modelling, rather than controlling techniques, have been shown to have a positive impact on the development of children's dietary behaviour (124). Interestingly, research has found maternal self-efficacy in limiting unhealthy food and drink consumption among children decreases across the early childhood period (128). This is likely as a result of children developing increased agency over their food choices as they grow up.

Exposure to and availability of food and drinks have been associated with building familiarity and subsequent preference for these items (84). Parents have identified food availability as an influence over what children consume (129). For example, the presence of sweet drinks in the home has been associated with children's sweet drink consumption (130, 131). Furthermore, mothers' own sweet drink consumption has been shown to influence intake of sweet drinks among very young children (132). Grandparents also appear to have influence over children's dietary behaviours through the food and drinks they offer to their grandchildren (133, 134).

Peer influence is also recognised as influential in shaping children's dietary behaviour. The food choices of siblings and peers influences the development of a child's eating behaviour and food preferences (84). Preschool aged children have been found to make food choices that mirror choices made by their peers (135) and a recent systematic review of factors influencing unhealthy food intake preschool aged children found peer influence to strongly influence dietary behaviour (136). This gives rise to the importance of creating healthy eating environments in settings where young children are likely to eat together.

2.6.4 Settings determinants of obesity

The settings in which children go about their daily lives influence their everyday behaviours. These settings include schools and early childhood education and care settings, out of school care programs and sport and recreation settings and local food environments. These physical environments have the potential to support the development of healthy dietary behaviours.

Recognising the role that settings can play in influencing health of children, the WHO Health Promoting Schools Framework, guides schools and early childhood education centres towards providing a holistic approach to health and wellbeing that includes the creation of healthy environments (137). Schools in particular have the potential to reach a large number of children and as

such have been recognised to be more effective, efficient and equitable in promoting health compared to other settings (138).

Aspects of the school and early childhood environments considered important in supporting healthy dietary behaviours among children include healthy school food policies, standards for meals provided onsite and the inclusion of healthy eating and physical activity in the curriculum (138). Healthy school food policies can nurture the development of healthy behaviours and reinforce healthy norms around healthy eating and physical activity. Importantly, evaluation of the uptake and implementation of school-based interventions show that they are likely to be equitable (139, 140).

Health services, local councils, and sports, recreation and aquatic centres are also ideal settings to enact policies that encourage healthy eating. Many of these settings are frequented by children and families for purposes such as receiving health care, visiting local libraries or attending swimming classes. These settings have population reach, are likely to already be engaged in other health-related activities, such as the promotion of physical activity, and may have influence over food retailers in their purview (141).

The local or neighbourhood food environment has been identified as an important determinant of obesity. For example, Canadian children living in neighbourhoods with good access to food outlets consumed more fruit and vegetables compared to children living in neighbourhoods with poor access to food outlets (142). An Australian study found that living close to fast food outlets was associated with children being less likely to consume fruit and vegetables compared to children who lived further away from fast food outlets (143). In a study from the UK, children living close to fast food outlets were found to be higher consumers of SSBs compared to children living in neighbourhoods with fewer fast food outlets (144). These studies demonstrate the need to create healthy local food environments, to enable convenient access to healthy foods.

2.6.5 Environmental determinants of obesity

Environmental factors constitute the macro-level determinants of childhood obesity. These factors include economic and political systems, cultural and societal norms, and commercial interests, shaping the conditions in which people live. Over time, our environmental conditions have become increasingly obesogenic. That is, the environments in which we live promote obesity by encouraging

excess consumption of unhealthy food and promoting sedentary activity ahead of physical activity (145).

A number of environmental factors that influence obesity can be found within the food environment (31). These include the location and accessibility of food outlets, food pricing, and food marketing and promotion (146). These aspects of the food environment are the interface between children and food systems, providing food and information about food to children and their families (147). Evidence demonstrates that the availability, accessibility, affordability and marketing of unhealthy foods, influences children's diets (148) and overweight and obesity (149).

Food access can mean a number of things. At a macro level, trade and agricultural policies determine the types of food available to consumers (150). At the local level, the physical location of retail markets and stores to purchase food affects food access. Interventions to increase access to healthy foods can include improving the locations of supermarkets, particularly in socially disadvantaged communities, and implementing standards that ensure the provision of healthy food in settings such as schools and public places (23).

Food price and the relative price of healthy and unhealthy foods are important determinants of dietary behaviour. For example, lower fruit and vegetable prices have been associated with higher frequency of fruit and vegetable consumption among children, while higher dairy prices have been associated with lower frequency of milk consumption (151). The price of unhealthy foods has also been shown to impact consumption, with cheaper fast food prices associated with greater fast food consumption among children and adolescents (152). Families with low-incomes or limited budgets are likely to be more sensitive to food prices as a result of needing to spend a greater proportion of their income on food compared to families with higher incomes. This has implications for health equity, because it means the affordability of healthy diets is not the same across socioeconomic groups.

Interventions that alter food prices, such as subsidies or taxes have the potential to shift population diets (153). A real-world example of this is the implementation of sugar-sweetened beverages (SSBs) taxes. There is a growing body of evidence that consistently demonstrates that the implementation of SSB taxes reduces both purchase and consumption of SSBs (154), and shift consumers towards lower sugar beverages (155). Further benefits of SSB taxation are that it is a cost-effective intervention (156, 157) and it incentivises the food industry to reduce the sugar content of its products through reformulation (158). Finally, evidence demonstrates that a sugar-sweetened beverage tax is an

equitable intervention with health benefits reported to be similar across socio-economic strata or greater for those experiencing socio-economic disadvantage (159).

Marketing techniques are used by the food and beverage industry to promote the sale and consumption of their products. Ever present, marketing shapes social norms around the consumption of unhealthy food and beverages. Unhealthy food and beverage marketing negatively influences dietary preferences and consumption among children and adolescents (160-163). The impacts of marketing include increased awareness of products and brands (164, 165), brand loyalty (164, 166) and the reinforcement of social and cultural norms around unhealthy foods (164, 167, 168). Unhealthy food marketing increases unhealthy food consumption (163), and increases children's total energy intake (164). The impact of excess energy intake over time ultimately leads to excess weight gain and obesity (169). Unhealthy food marketing may also play role in the development of socioeconomic inequalities in childhood obesity. Evidence demonstrates that children from socioeconomically disadvantaged backgrounds are more likely to be exposed to unhealthy food and beverage advertising, compared to children with higher SEP (170). There are also some indications that the impact of unhealthy food and beverage marketing may be greater among children with lower SEP (170). There is strong support for regulatory approaches to reduce children's exposure to unhealthy food marketing (171). Government regulation of unhealthy food marketing has been identified as feasible and supported by the general public (172, 173). However the food and beverage industry maintains strong opposition to regulatory action, preferring industry-led codes of governance (174), that have been found to have limited impact on reducing children's exposure to unhealthy food marketing (175, 176).

Many factors within the food environment are driven by commercial interests. The Commercial Determinants of Health, defined by Kickbush et al. (2016) are "strategies and approaches used by the private sector to promote products and choices that are detrimental to health" (177). These actions promote business interests, in particular profits, ahead of public health (178). As part of a comprehensive approach to obesity prevention, there is clearly a need for governments to hold corporate actors to account and curtail their harmful influence on public health (179).

In the current obesogenic environment, equitable reduction of childhood obesity will require a range of government-led strategies. There are a number of reasons for this. Firstly, changes to the environment are necessary in order to reduce availability and promotion of unhealthy food and drinks and enable improved access, affordability, and promotion of healthy food and drink choices (180). Secondly, equitable reductions in childhood obesity are likely to require the implementation of actions that alter the structural determinants of childhood obesity, in addition to actions that focus on

individual behaviours (181). Finally, strategies that aim to bring about structural change are likely to reach the whole population and have the potential to make it easier for individuals to make healthy choices (31).

2.7 ACTION TO EQUITABLY REDUCE CHILDHOOD OBESITY

There is no shortage of recommendations for action to address childhood obesity. In response to the growing problem of obesity, in 2016 the World Health Organization Commission on Ending Childhood Obesity (WHO ECHO) provided a set of recommendations for policy across six areas to prevent the development of obesity among infants, children and adolescents;

1. Promote intake of healthy foods
2. Promote physical activity
3. Pregnancy and preconception care
4. Early childhood diet and physical activity
5. Health, nutrition and physical activity for school-age children
6. Weight management

Within each of these areas, actions have been recommended to address the multiple determinants of childhood obesity, from individual behaviour change, strengthening action in schools, and developing policies to improve food environments. Efforts to support action on childhood obesity have also been made by other leading organizations. The World Cancer Research Fund' Building Momentum series aims to inform the design and implementation of nutrition policies (182). The United Nation Children's Fund (UNICEF) advocates for protecting children's rights to a healthy diet in the context of sustainable food systems (183). In Australia, the Tipping the Scales National Obesity Prevention Consensus outlines evidence-based action for the Australian Government to address childhood obesity (11).

Common to each of these is the call for political leadership and government action. Implementation of comprehensive government policies has been identified as necessary to create and support healthy and equitable food and physical activity environments (184, 185). Reducing and preventing overweight and obesity in children and adolescents has been identified as an important priority for Australian policymakers in order to improve the health of the population (3), yet progress remains slow.

At the same time there is growing consensus that policies that act upon environmental determinants are necessary to achieve equity in obesity prevention and access to healthy diets (23, 31, 147). A

number of useful frameworks and principles have been developed, proposing policy action to reduce obesity, improve children's diets and achieve health equity.

Kumanyika (2019) provides a framework to prioritise equity in obesity prevention policy (23). Central to this is action to address the social determinants of health in order to achieve the conditions required for healthy eating and physical activity (23). Kumanyika's framework considers a number of structural determinants, proposing policy action to increase access to healthy options through school settings and food retail environments, and to reduce deterrents to healthy diets by restricting unhealthy food marketing (23). This framework demonstrates a systems-oriented approach to advancing population health and improving health equity by identifying multiple points for intervention across different contexts.

Hawkes (2020) also takes a systems approach to healthy diets, proposing a child-centred reorientation of food systems (147). This reorientation seeks to improve children's diets by making healthy foods more available, affordable, appealing and aspirational in the context of children's lives (147). To achieve this, Hawkes outlines a number of steps to identify the nutritional needs of the population of concern, understand how current food environments influence child diets and in that context, identify a package of actions to create healthier food environments (147).

These frameworks provide important guidance for the development of policies to equitably reduce childhood obesity. Of particular relevance to health equity, the obesity prevention frameworks propose actions to address behavioural and structural determinants – the latter being more likely to give rise to equitable outcomes (181). But the extent to which this has been translated into action is arguable. At present, there is no current obesity strategy in Australia, although a National Obesity Strategy has been proposed and is currently under consideration by the National Obesity Strategy Working Group following public consultation (186). In the absence of a national obesity strategy, policy actions to address childhood obesity are, sometimes, included within national, state and territory health policies. These policies reflect policymakers' ideologies and values and are shaped by political, institutional and interest group pressures (187). They carry implicit or explicit problem representations that influence and are influenced by public discourse and opinion, and can further shape the political agenda (188).

Analysis of how policy problems are conceptualized provides the opportunity to rethink policy, research and advocacy efforts (189). For example, Bastian (2011) employed a problem representation analysis to examine representations of public health nutrition in Australia's Agenda for Action for

Public Health Nutrition 2000-2010 (190). The analysis found public health nutrition to be represented as a problem of individual, social, structural and economic circumstances. Responsibility for action was seen to be shared among individuals, governments and private industries. Absent from the agenda however was consideration of the impact of proposed actions on health inequalities (190). Whilst Bastian's work looked at nutrition policy, there has been no critical analysis of how governments in Australia have responded to socioeconomic inequalities in childhood obesity. Critical analysis of the representations of inequalities in childhood obesity in Australian health policy would be useful provide an understanding of current government responses. These findings could inform the development of future public health policies.

2.8 SUMMARY OF KEY EVIDENCE GAPS

There are a number of gaps in our understanding of the trends, determinants of and current course of action to address socioeconomic inequalities in obesity among children. This thesis proposes to address the following gaps in the evidence:

1. Whilst recent evidence suggests a plateau in childhood obesity prevalence, there is a need for further evidence to demonstrate whether a plateau has been experienced equally across all socioeconomic groups.
2. Childhood obesity and its key determinants including dietary behaviours are understood to be socioeconomically patterned. However, the extent to which different dietary factors contribute to socioeconomic differences in weight is not well understood.
3. Dietary behaviours are understood to be influenced by a range of factors. However, factors influencing unhealthy dietary behaviour, particularly among preschool-age children are less well understood.
4. There is consensus that a government-led policy approach is required to reduce childhood obesity, and to reduce health inequalities. But the ways in which the Australian federal, state and territory governments consider and propose to address the issue of inequalities in childhood obesity are largely unknown.

2.9 CONCLUSION

Childhood obesity is a significant public health issue with detrimental health and wellbeing effects that extend beyond the childhood years. In Australia, one in four of children aged two to 17 years has overweight or obesity. The burden of excess weight is disproportionately carried by children from lower socioeconomic backgrounds, giving rise to the need to identify policies that can address socioeconomic inequalities in childhood obesity. Despite evidence and consensus on action, the prevalence of childhood overweight and obesity remains high, and a strong socioeconomic gradient in childhood obesity persists. The challenge for governments is twofold; to develop and implement prevention policy that both reduces obesity and improves health equity, thereby reducing socioeconomic inequalities in overweight and obesity among Australian children.

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3 METHODOLOGY

3.1 OVERVIEW

The aim of this chapter is to provide an introduction to the research methodologies used in this thesis including data sources, analytical methods, and the theoretical frameworks that underpin the analysis.

3.2 RESEARCH METHODOLOGY AND METHODS

The overall aim of this thesis is to generate evidence to support the implementation of obesity prevention policies most likely to decrease socioeconomic inequalities in childhood overweight and obesity. To achieve this aim, four research objectives were identified;

- 1 Identify and describe the extent to which trends in childhood overweight and obesity differ according to socioeconomic position;
- 2 Identify the role of dietary behaviours, particularly consumption of unhealthy food and drinks, on the development of socioeconomic inequalities in obesity among Australian children;
- 3 Understand parents' perceptions of the factors influencing sweet drink consumption among preschool-age children;
- 4 Critically examine the representation of inequalities in childhood obesity in Australian health policy.

To achieve these objectives, four studies were planned, each drawing on different methodologies and research methods. These are summarised in Table 3.1 and discussed in detail in section 3.4 of this chapter. A pragmatic approach was taken, where different methods were intentionally combined to address the overall thesis aims (1, 2). Qualitative and quantitative approaches have been applied separately to the collection and analysis of data and reporting of results. Findings from each study are drawn together in the final chapter of the thesis to make conclusions and recommendations based on the overall body of research (3). Drawing on the strengths of qualitative and quantitative approaches allowed exploration of a

number of facets of inequalities in childhood obesity, leading to recommendations that consider the multiple determinants of, and current policy approaches towards, addressing inequalities in childhood obesity.

TABLE 3.1 RESEARCH OBJECTIVES, METHODOLOGY, METHODS & DATA SOURCES USED IN THIS THESIS

Thesis Chapter	Research objective	Methodology	Research Methods	Data Source
Chapter 4	Identify and describe the extent to which trends in childhood overweight and obesity differ according to socioeconomic position	Systematic literature review	Systematic review and analysis	Peer-reviewed, published literature reporting trends (at least 2 timepoints since 1990) in child and adolescent overweight and obesity according to socioeconomic position
Chapter 5	Identify the role of dietary behaviours on the development of socioeconomic inequalities in obesity among Australian children	Longitudinal mediation analysis	Product of coefficients mediation method	Longitudinal Study of Australian children (LSAC) cohort study
Chapter 6	Understand parents' perceptions of the factors influencing sweet drink consumption among preschool-age children	Qualitative data collection and analysis	Focus groups and semi-structured interviews, thematic data analysis	Primary data collection using focus groups and interviews with 25 primary caregivers of children aged 6 months to 5 years
Chapter 7	Critically examine the representation of inequalities in childhood obesity in	Critical policy analysis	Critical document analysis informed by What's the problem represented	Publicly available Australian national, state and

	Australian health policy		to be (WPR) approach (4)	territory health policy documents
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3.3 THEORETICAL FRAMEWORKS

The social determinants of health (5) and the socioecological model of health (6) are the key theoretical frameworks informing the conceptual orientation of this thesis. The selection and application of these theories underpins the view that health is influenced by multiple factors that exist across individual, social and broader environmental contexts.

3.3.1 *The Social determinants of health*

A social determinants of health view considers individual behaviour to be shaped by the material, social, political, and cultural conditions in which we are born, grow, work, live and age (7). These conditions have a profound impact on health and wellbeing. The structural social, economic and political conditions in society give rise to socioeconomic position, whereby individuals or groups of people are stratified according to their level of income, education or occupation. The social conditions of daily life such as early life experiences; working conditions; unemployment; social exclusion and discrimination; social support; stress; and access to a nutritious, affordable, sustainable food supply represent the underlying determinants of health (7). Inequalities in these structural and social conditions give rise to health inequalities. The pathways by which this occurs includes differential exposure to conditions that contribute to ill health and differential resources and opportunities to achieve good health (8).

The role of the social determinants of health in shaping children's health outcomes provides the motivation for this thesis - to better understand the determinants of socioeconomic inequalities in childhood obesity and identify policy options to ameliorate these inequalities. Recognising that socioeconomic inequalities in childhood obesity stem from underlying determinants, this thesis has been written from a point of view that considers addressing the underlying social determinants of health to be central to the equitable reduction of childhood overweight and obesity.

3.3.2 Socioecological model of health

The socioecological model provides a conceptual model of the factors that influence health behaviour. The socioecological model is derived from ecological systems theory, originating from the work of Urie Bronfenbrenner (6). Bronfenbrenner proposed that individual behaviour is best understood in the context of the ecology within which a person exists, recognising that the interplay between individual and environmental determinants shapes human behaviour. For example, a child exists within the ecological context of their family, who go about their lives within a neighbourhood, that is embedded in society more broadly (6). Since its development, ecological systems theory has been applied in numerous ways to illustrate the influence of environmental factors on health outcomes.

Dahlgren and Whitehead (1991) utilised ecological systems theory to illustrate the determinants of health (9) (Figure 3.1). In their model, the innermost layer represents fixed factors that influence health, such as age, sex, ethnicity. Moving outward, individual level determinants of health include dietary and physical activity behaviours. These are in turn influenced by family, peers and community networks. The next layer comprises the conditions in which people live and work, across sectors including housing, healthcare and education. And finally, the outermost layer represents the macro environment including socioeconomic, cultural and environmental conditions.

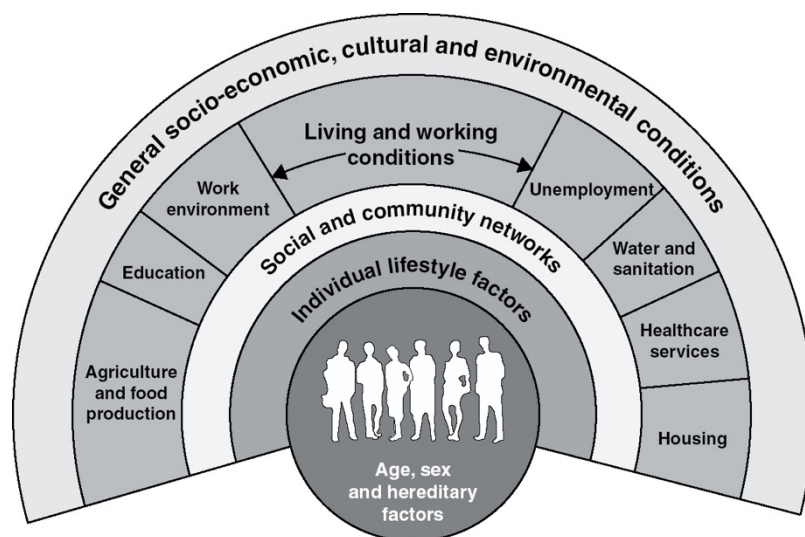


FIGURE 3.1 DETERMINANTS OF HEALTH MODEL (9)

The socioecological model has been used many times over to demonstrate the multiple factors that influence individual health and wellbeing. For example, ecological systems theory has been used to conceptualise risk factors in the development of childhood overweight. Davison and Birch (2001) present a model in which children's behaviour is shown to be shaped by determinants at the family-level and the community-level (10). In this model, immediate determinants of child weight, including diet, physical activity and sedentary behaviour are influenced by family characteristics including parents' own behaviours and knowledge, parenting styles and interactions between peers and siblings, as well as foods available within the home. This is in turn shaped by parents' work demands, and available free time, the nature of the local food environment and neighbourhood safety, school programs, and the family's socioeconomic position (10).

Recognising the key role of diets as a determinant of obesity and other non-communicable disease, an ecological approach has also been used by Story and her colleagues (2008) to argue that supportive environments are essential if individuals are to make healthy dietary choices (11). This particular model also acknowledges inequalities in access to healthy food for people experiencing poverty, and discusses the benefits of improving local food environments to increase the availability and affordability of healthy food in low-income neighbourhoods (11).

Whilst there are some differences in the way ecological systems theory has been applied by researchers, the implications remain constant. That is, that health is influenced by the interaction between a range of factors that exist across multiple settings and contexts. Ecological systems theory has been applied in three of the studies presented in this thesis.

In **Chapter Five**, the research centres on the inner determinants of the socioecological model, individual dietary behaviours. The study presented quantifies the role of dietary behaviours, specifically childhood consumption of unhealthy food and beverages, on the development of socioeconomic differences in childhood obesity. The findings of this study highlight the role of individual behaviour in the development of socioeconomic inequalities in childhood obesity, but importantly also recognises the importance of the wider determinants of these behaviours. In particular, the finding that the emergence of persistent socioeconomic differences in the consumption of sweet drinks occurs during the first year of life, informs the subsequent study of the thesis that aims to better understand the determinants of sweet drink consumption among young children.

In **Chapter Six**, the socioecological model of health was applied as a framework to understand factors influencing unhealthy dietary consumption among preschool-age children. In this study a socioecological approach was used to create a framework within which themes generated from the analysis of focus group and interview data were arranged. The framework comprised three layers; individual factors, social factors and environmental factors. The themes generated from analysis of focus group and interview transcripts were mapped to corresponding levels of the socioecological framework to provide a conceptual model of factors perceived by parents to influence drink choices among young children.

Finally, **Chapter Seven** moves further upstream to examine the policy representations of inequalities in childhood overweight and obesity. In this study, the socioecological model informed an analysis of the representations of inequalities in childhood obesity in Australian health policy documents. Ecological systems theory was used to create a theoretical framework that comprised questions to guide the coding and subsequent analysis of policy documents. Text-based thematic maps were constructed to explore relationships between coded data and the key questions from the analytic framework, giving rise to higher-order themes that demonstrated how governments perceive and propose to address inequalities in childhood obesity. Taking a socioecological approach was considered essential to building an understanding of the extent to which policies addressed the multiple layers of influence of inequalities in childhood obesity.

3.4 METHODS AND DATA SOURCES

This section includes an overview of the methods used in each of the four research studies and presents the rationale for why each approach was chosen. Descriptions of the methods for each study can also be found in the corresponding study chapters.

3.4.1 *Systematic literature review*

A systematic review of published literature reporting trends in child and adolescent obesity prevalence according to socioeconomic position between 1990 and 2015 across high income countries was conducted to determine whether trends in child and adolescent overweight and obesity differed across socioeconomic groups and ascertain whether recent reports of a plateau

in childhood obesity prevalence had been observed among children across all socioeconomic groups.

3.4.1.1 RATIONALE

At the time this study was conceived, emergent evidence suggested overweight and obesity among children in high-income countries had started to plateau from around the year 2000. For example a review of data from nine countries demonstrated flattening trends in the prevalence of childhood overweight and obesity between 1995 and 2008 (12). This review reported that differences in trends were observed according to socioeconomic position among children in England, France and Sweden (12). Another review of obesity trends found evidence of a plateau in child and adolescent obesity in Australia, Japan, Europe and the USA (13). This review also identified socioeconomic differences in trends in child and adolescent obesity, in data from Australia and England (13).

To further explore indications that the observed plateau in childhood overweight and obesity was not being experienced equally by children across all socioeconomic groups, a study was designed to examine data specifically reporting trends in child and adolescent obesity prevalence according to socioeconomic position. A systematic review was chosen for its robust and rigorous approach to collating and analysing an existing body of evidence (14). A prevalence review, to identify trends over time and allow for the description of variations between subgroups, was identified as the most suitable type of systematic review (14, 15).

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic review and Meta-Analysis statements (16). A protocol for the systematic review was developed, protocol guided by the Preferred Reporting Items for Systematic review and Meta-Analysis Protocols (PRISMA-P) guidelines (17). The protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) (18). Reporting of the findings of the systematic review was also in accordance with the checklist and flow chart provided in the PRISMA statement (16).

3.4.1.2 DATA SOURCE

A search strategy was developed to identify published literature reporting overweight and obesity prevalence, stratified by SEP, for children and/or adolescents aged two to 18 years, for at least two timepoints between 1990 and 2015. The study was limited to reports of trends among children and adolescents age two to 18 years living in high-income countries because

of the known inverse association between socioeconomic position and excess weight in these countries. A total of 6057 studies were identified in the database search, with 30 studies from 15 countries eligible for inclusion in the review.

3.4.1.3 DATA ANALYSIS AND QUALITY

The primary analysis was an assessment of socioeconomic differences in the prevalence of overweight and obesity over time, within each study. Thirty studies, representing 15 countries met the inclusion criteria of reporting overweight and obesity prevalence in children and or adolescents age two to 18 years for at least two time points since 1990, stratified by SEP. Where included studies reported statistical analyses of differences in trends between SEP groups, those findings were used as the assessment of differential trends. Where these statistical tests were not available, the magnitude of absolute change in overweight and obesity over time between the low and high SEP groups was calculated. Age- and sex-specific sub-group analyses to examine differences in trends between SEP groups for these subgroups were also conducted. Finally, sub-group analyses were conducted for studies that reported trends since 2000, to test the hypothesis that the plateau in child and adolescent overweight and obesity was not being experienced equally by children across all socioeconomic groups. Due to the heterogeneity in definitions of overweight and obesity and in the SEP indicators used across included studies, it was not possible to conduct subgroup analysis by obesity measure or SEP indicator.

In this review, the EPHPP tool was applied to assess internal and external validity of included studies with questions on selection bias, study design, confounders, data collection and data analysis (19).

3.4.2 *Longitudinal mediation analysis*

A longitudinal mediation analyses was conducted to quantify the relative contribution of different types of unhealthy food and drink consumption on the development of socioeconomic inequalities in weight among a nationally representative cohort of Australian children.

3.4.2.1 RATIONALE

While diets and weight are known to be socioeconomically patterned, the contribution of unhealthy food consumption in childhood to the relationship between socioeconomic position and weight gain among Australian children has not previously been examined. The aim of this

study therefore was to longitudinally examine the role of unhealthy food and drink consumption throughout childhood (from the first year of life to age eight to nine years) on the relationship between SEP at birth, and the child's BMI z-score at age 10 to 11 years.

Mediation analysis was chosen as the method for this study for its ability to explain the mechanisms by which socioeconomic position affects childhood weight. Mediation analysis provides a means to test whether the relationship between two variables is explained by an additional, intermediate variable (20). An intermediate variable or *mediating factor* lies along the causal pathway between an exposure and an outcome and can explain some, or all, of the effect between an exposure and outcome.

3.4.2.2 DATA SOURCE

Data for this study was obtained from the nationally representative cohort Longitudinal Study of Australian Children (LSAC). The LSAC study began in 2003 with a representative sample of 10,000 children from urban and rural areas of all states and territories in Australia. The study comprises two cohorts with data collected across three domains (health and physical development, social and emotional functioning, and learning and cognitive ability) collected from the two cohorts every two years. The first cohort, B (birth) cohort, was aged zero to one year in 2003–04, and the second cohort, K (kindergarten) cohort, was aged four to five years in 2003–04. To examine the mediating role of dietary behaviours from birth, this study used data from B cohort.

Key data variables used in this study included:

- Socioeconomic position (SEP), as a composite score provided in the LSAC dataset, comprising parents' combined annual income, educational attainment, and occupational status, adjusted for the number of parents in the home. (For detailed description of the construction of the composite SEP score see Blakemore et al (2009) Measuring family socioeconomic position (21))
- Child's BMI z-score, calculated by converting the child's body mass index (weight in kilograms divided by height in meters squared) into an age and sex-specific score.
- Frequency of consumption of discretionary (unhealthy) food and drinks across Waves One to Five. Parents used a diary to report frequency of consumption (not at all, once, twice, three times, four or more times) over a 24-hour period of groups of food such as fresh fruit; cooked vegetables; meat pie/hamburger/hot dog sausage roll; hot chips;

potato chips or snacks such as twisties; biscuits/doughnuts/cake/chocolate. For this study, frequency of consumption was determined by calculating the summed consumption of sweet drinks, discretionary hot food (meat pie/hamburger/hot dog sausage roll), savoury snacks (potato chips/twisties), sweet snacks (biscuits/doughnuts/cake/chocolate) respectively for each wave, so that each child was classified as an overall high consumer (consumed discretionary food at ≥ 2 waves or sweet drinks at ≥ 3 or waves) or low consumer (consumed discretionary food at ≤ 1 wave or sweet drinks at ≤ 2 waves) for each of sweet drinks, discretionary hot food, savoury snacks, and sweet snacks.

Participants with complete data for SEP at Wave One, BMI at Wave Six and dietary variables of interest at each of Waves One to Five were included in the study (Figure 3.2).

	0-1 years	2-3 years	4-5 years	6-7 years	8-9 years	10-11 years
Dependent variable	SEP					
Mediating variables		Cumulative consumption <u>sweet drinks</u> (cordial, soft drink, fruit juice)				
		Cumulative consumption <u>discretionary hot food</u> (pies, hot dogs, hot chips)				
		Cumulative consumption <u>savoury snacks</u> (potato crisps, twisties)				
		Cumulative consumption <u>sweet snacks</u> (cakes, donuts, biscuits)				
Independent variable						BMI z-score
Confounding variables	Maternal age ATSI LOTE Child age & sex Birth weight					
		Child's preference for physical activity / sedentary activity				

SEP: Socioeconomic Position BMI: Body Mass Index ATSI: Aboriginal and Torres Strait Islander LOTE: Language other than English

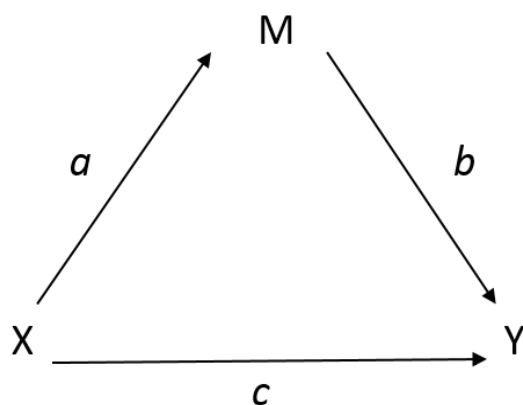
FIGURE 3.2 DATA ITEMS AND CORRESPONDING SURVEY WAVES USED TO GENERATE DEPENDENT, INDEPENDENT, MEDIATING AND CONFOUNDING VARIABLES FOR LONGITUDINAL MEDIATION ANALYSIS (22)

3.4.2.3 DATA ANALYSIS

The products of coefficients mediation method was applied for this analysis. This method fits a series of regression models to estimate the total effect of an exposure on an outcome, the indirect effects of exposure on outcomes through each of a number of potential mediators, and the total indirect effect of exposure on outcome through all significant mediators, adjusted for

potential confounders (20, 23). To be considered as a mediating variable, a variable must be i) independently related to the exposure, ii) independently related to the outcome and iii) plausibly lie within the causal pathway between the exposure and outcome.

In this study, the exposure (X) was socioeconomic position (at Wave One when children were aged zero to one year), the outcome (Y) was child's BMI z-score at age 10 to 11 years, and the potential mediating variables included parent report of child's consumption of discretionary food and drink items, grouped into four categories (sweet drinks, discretionary hot food, savoury snacks, sweet snacks) and cumulatively counted from age zero to one year, to eight to nine years old (Figure 3.3). Evidence of associations between unhealthy diets among children and socioeconomic position and unhealthy diets and excess body weight has been demonstrated in the literature, as described in **Chapter Two**.



X = socioeconomic position at Wave 1 (age 0-1 years)

Y = change in BMI z-score at Wave 6 (age 10-11 years)

M = consumption of sweet drinks from Waves 1 to 5 (age 0-1 to 8-9 years)

and discretionary hot food; savoury snacks; sweet snacks from Waves 2 to 5 (age 2-3 to 8-9 years)

FIGURE 3.3 LONGITUDINAL MEDIATION ANALYSIS MODEL (22)

Potential confounding factors of the associations between exposure and outcome, exposure and mediators and mediators and outcome, were identified from existing literature and included child's sex, weight at birth, age in months, physical activity, as well as mother's age in years, main language spoken at home and if the child was an Aboriginal and/or Torres Strait Islander.

To test the robustness of these analyses, a series of sensitivity tests were conducted. Separate models were created to test the effects of 1) using mother's level of education as an alternate

indicator of socioeconomic position, 2) using overweight and obesity as an alternative indicator of excess weight among children and, 3) applying LSAC sample weights to account for bias arising from non-response and attrition throughout the study period. In each of these analyses, results were not appreciably different to the findings of the primary analysis.

3.4.3 Qualitative data collection and analysis

Focus groups and semi-structured interviews were conducted to collect data from parents and primary caregivers (referred to as *parents* throughout the thesis) of children aged six months to five years. This data was thematically analysed to explore parents' perceptions of factors influencing sweet drink consumption among preschool-age children.

3.4.3.1 RATIONALE

The mediation analysis conducted previously identified that unhealthy diets, including sweet drink consumption, begins at an early age among Australian children and mediate part of the relationship between socioeconomic position and children's weight. To build on this finding and understand the drivers of sweet drink consumption among such young children, a focus group study was designed to explore parents' perceptions of factors influencing sweet drink consumption among young children.

Focus groups were chosen as the primary method for data collection for this study as they are an ideal method to gain an in-depth understanding of views from a purposely selected group of participants (24). Focus groups originated in sociology and psychology, but are now frequently used across a number of disciplines including health (25). In this particular study, individual interviews were also conducted. These were arranged when potential participants expressed interest to participate but were unable to attend scheduled focus groups. Using focus groups and interviews allowed discussions to be moderated, including the use of follow-up questions to build an understanding of participants' experiences, beliefs, and perceptions (24).

3.4.3.2 DATA COLLECTION

Prior to conducting this study, I attended training in the design and conduct of focus groups and in qualitative data analysis. These training programs provided me with knowledge and skills to develop the study protocol and carry out the data collection and analysis.

With a view to obtaining a socioeconomically diverse sample, a purposive sample of four Australian Local Government Areas (LGAs) in metropolitan Melbourne and regional Victoria across low, middle, and high area-level socioeconomic disadvantage was identified (26). To obtain the perspectives of parents of preschool-age children, eligible participants included parents of children aged six months to five years, living in the geographic areas sampled. Eight focus group sessions were planned, two in each selected LGA. Recruitment for the focus groups was facilitated by local Councils with invitations to participate displayed in maternal and child health (MCH) centres, emailed via Local Council Child and Family Service email networks and handed out by MCH nurses and playgroup facilitators. This was important to provide participants with a familiar contact person and enabled the use of venues familiar to participants for focus group sessions.

Focus group and interviews were moderated using a topic guide piloted in the preliminary phase of the study. In the focus groups, the researcher role was a peripheral one, moderating conversations between participants in focus groups, while in interviews, this role required more active dialogue with each participant (24). All focus groups and interviews were audio recorded, with prior consent obtained from participants, and transcribed following the sessions. All transcripts were reviewed for accuracy.

3.4.3.3 DATA ANALYSIS

Thematic analysis of focus group and interview data was undertaken manually. Field notes and transcripts were initially read and subsequently re-read through an iterative process of data analysis, inductive coding, and creating and interpreting themes (27). The socioecological model was used to create a framework within which themes generated from the analysis of focus group and interview data were arranged with consideration of the research objectives of the study (28). Table 3.2 provides an illustrative example of how coded data were mapped against the socioecological model during analysis.

TABLE 3.2 OVERVIEW OF THEMATIC ANALYSIS PROCESS, MAPPING CODED DATA TO DOMAINS OF THE SOCIOECOLOGICAL MODEL

Research Objective: Explore parents' perceptions of the factors that influence drink choices for preschool-age children in various contexts			
Socioecological Domain	Theme	Codes	Quotes
Individual Domain	1.1 Health and nutrition knowledge	Obesity; dental decay; soft drink is unhealthy; juice as preferred alternative; sugar free; eczema and allergies; constipation	<i>He likes soft drink but they are unhealthy so we don't give them to him.</i>
	1.2 Health beliefs	Lemonade when sick; treats in moderation	<i>Most of the time just water, because I don't buy him soft drinks, no cordial and none of those. I mean, I will have honey; just sometimes when he has sore throat then he has honey with a bit of lemon juice.</i>
	1.3 Habits	Family habit; hard to break habits	<i>Maybe they know it's not healthy, but it's just what they do and they really enjoy it and it's part of what they buy at the supermarket and what goes in their fridge. How do you break that habit?</i>
	1.4 Parenting skills and confidence	Doing better than other parents; strict; hard to say no; nagging; judgement from others; easy at home	<i>It's either that or death stares by fellow shoppers thinking you can't handle your kids. They just want it. And you don't want a death stare so you just buy them.</i>
Social Domain	2.1 Peer and family influence	Grandparents; friend's house; conflict mothers' group	<i>Like I said, if they've seen someone in the house drink soft drink, then they'll ask for it.</i>
	2.2 Social and cultural norms	Birthday parties; cafes; restaurants; treats; same as own upbringing;	<i>Because I grew up in a household where we didn't drink water. We drank</i>

		different to own upbringing	<i>mostly soft drink. And I didn't want my kids – to want that to be normal for them.</i>
Environmental Domain	3.1 Sweet drink availability	Exposure; supermarkets; shopping centres; swimming lessons	<i>At the supermarket sometimes I'll give in. Just easy access and if it's there, in their line of sight.</i>
	3.3 Unhealthy and misleading marketing	Advertising on tv; food packaging; characters on labels; product placement; implied healthiness; baby aisle	<i>I don't think that unhealthy choices should be specifically marketed towards children.</i>
	3.2 Relative price of healthy and unhealthy drinks	Soft drink is cheap; Water is expensive; penalized for healthy choice;	<i>And the cost of soft drink is so cheap, I think it's the same price as water in a bottle.</i>
	3.4 Policies that encourage and discourage healthy drink choices	Child care; school; fast food restaurants; kids meals	<i>At day care, they're really strict. It's just milk and water.</i>

3.4.3.4 RESEARCHER REFLEXIVITY

It is important to recognize the lens through which I have approached this qualitative study. With a background in nutrition and dietetics and public health I am of the belief that individual health behaviour is determined by multiple layers of influence, as demonstrated by the socioecological model. As a parent of young children, I also have my own experiences in parenting and making dietary choices for my children. In conducting the focus groups and interviews I was conscious of remaining neutral to the conversations so as not to influence participant responses. Throughout the data analysis I constantly referred to theory and existing evidence. To reduce subjectivity in the analysis phase, all final themes and conclusions were cross-checked against data transcripts and with members of the extended research team.

3.4.4 Critical policy analysis

A critical analysis of representations of inequalities in childhood obesity within 18 Australian health policy documents was undertaken to investigate how inequalities in childhood overweight and obesity are represented as problems in Australian health policy.

3.4.4.1 RATIONALE

A critical policy analysis was chosen to provide a nuanced understanding of how governments in Australia represents inequalities in childhood obesity as a problem. Action to address health issues is underpinned by the ways in which they are represented as ‘problems’ in public policy. Policy analysis is a useful tool to examine how and why certain policy actions are proposed (29). Policy analysis also helps to understand the successes and failures of past policies and plan for the implementation of future policy (30). In this study, critical examination of problem representations uncovers how and why governments propose to address inequities in childhood obesity and supports advocacy for and prioritization of policies likely to equitably improve childhood obesity.

3.4.4.2 DATA SOURCE

Australia’s nine national, state and territory government health department websites were systematically searched for potentially relevant health policy documents. The study sought to examine 1) national or state or territory healthy eating / obesity prevention policy documents, 2) national or state or territory public health policy documents that proposed objectives or strategies for childhood obesity prevention. From a total of 30 retrieved documents, 18 were identified as eligible for inclusion in the analysis.

3.4.4.3 DATA ANALYSIS AND THEORETICAL FRAMEWORK

Document analysis offers qualitative researchers access to a rich data source (31). Critical analysis of policy documents allows examination of a government’s course of action towards a particular issue and thereby provides insights to the values and dominant views of that government (32, 33). In this study, critical policy analysis was underpinned by a theoretical framework that considered problematization theory applied according to Bacchi’s *What’s the Problem Represented to be?* (WPR) approach (4), ecological systems theory (6), and evidence-based principles for promoting equity in health policy (34, 35) (Table 3.3). Bacchi’s WPR approach has previously been used to explore problematizations in nutrition policy in Australia (36) and internationally (37). To embed an equity perspective, the analysis drew upon

ecological systems theory (6) and Whitehead and colleagues' (2001) evidence-based principles for promoting equity in health policy (35). Collectively these theories and principles demonstrate the role of structural influences on individual health outcomes and underscore the need for action at the environmental and the individual level if policies are to address underlying causes of health inequalities and promote and achieve health equity.

TABLE 3.3 THEORETICAL FRAMEWORK FOR CRITICAL POLICY ANALYSIS

Theoretical Perspective	Description	Guiding questions for data coding and analysis
Problematization theory (applied as <i>What's the problem represented to be?</i> (WPR)) (4)	The WPR approach comprises critical analysis questions to interrogate policy recommendations or actions, ultimately identifying how problems are implicitly or explicitly represented within these.	<ol style="list-style-type: none"> 1. What's the problem represented to be in a specific policy or policies? 2. How has this representation of the "problem" come about? 3. What is left unproblematic in this problem representation? Where are the silences? 4. What effects are produced by this representation of the "problem"?
Ecological systems theory (38)	According to ecological systems theory, health is influenced by multiple factors operating across several levels. Dahlgren and Whitehead align 4 levels of policy action to the corresponding determinants of health.	<ol style="list-style-type: none"> 1. How are the determinants represented across (i) individual (ii) community (iii) settings (iv) macro levels? 2. How do proposed policy actions align across (i) individual, (ii) community, (iii) settings and (iv) macro levels?
Key concepts and principles for equity promoting health policy (34, 35)	Evidence-based features of a policy response to promote equity or reduce health inequities.	<ol style="list-style-type: none"> 1. How have equity objectives and targets been stated in the policy? 2. To what extent are actions to prevent childhood obesity targeting the social determinants of health? 3. How does the policy report on or plan for measurement of inequalities and outcomes for different socioeconomic groups?

Problematization theory suggests that policies contain implicit representations of problems within the strategies they propose (4). This study was informed by the WPR analytic approach, underpinned by Foucault's problematization theory (39). The WPR approach provides an analytic strategy, comprising a series of questions that, as a whole, or in part, can support critical interrogation of policy documents to reveal how complex issues become defined as political problems (39).

Guided by the analytic framework, all sections of each document relating to the prevention of childhood overweight and obesity were coded. Guiding principles and overarching statements made in policy documents were assumed to apply to all strategies (including those proposed to address childhood overweight and obesity) within the documents and were coded for the analysis. Codes were subsequently aggregated to generate higher-order themes illustrating the representations of inequalities in childhood obesity (28). To do this, text-based thematic maps were constructed to iteratively explore relationships between codes and the theory. The themes generated through the mapping process were verified through the use of the analytic framework, by revisiting the data ,and through discussion with other researchers involved in the study (40).

3.4.4.4 RESEARCHER REFLEXIVITY

In undertaking this critical analysis, it was important to acknowledge my public health experience and my fundamental belief that childhood obesity is a health equity issue and is structurally determined. To ensure this position did not bias my interpretation of the data, I referred to the theory and evidence throughout the analytical process. Final themes and research findings were cross-checked against the policy documents for validity and with the extended research team, who have expertise in nutrition policy.

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4 SOCIOECONOMIC DIFFERENCES IN TRENDS IN CHILD AND ADOLESCENT OVERWEIGHT AND OBESITY PREVALENCE

4.1 SUMMARY

This chapter presents a systematic review of trends in the prevalence of child and adolescent overweight and obesity according to socioeconomic position in economically advanced countries. Prior to the commencement of this thesis, emerging evidence indicated a plateau in childhood obesity prevalence in high-income countries from around the year 2000. However, it remained unclear as to whether overweight and obesity trends had reached a plateau for children across all socioeconomic groups. This study therefore aimed to examine trends in the prevalence of child and adolescent overweight and obesity according to socioeconomic position and ascertain whether recent reports of a plateau in childhood obesity prevalence had been experienced equally across socioeconomic groups.

This study demonstrated that trends in the prevalence of child and adolescent overweight and obesity differ between socioeconomic groups. A majority of included studies indicated differential trends in child and adolescent obesity prevalence according to SEP across the period 1990 to 2015 and around half of the studies demonstrated widening socioeconomic inequalities. Examining a subset of 14 studies reporting trends since the year 2000, a majority of studies demonstrated stable or a decreasing obesity prevalence among both high and low SEP groups. However, this improvement in trends was not experienced equally across socioeconomic groups with 40% of studies indicating widening socioeconomic inequalities in overweight and obesity post-2000. These findings indicate persistent and widening socioeconomic inequalities in child and adolescent overweight and obesity.

This chapter includes two published papers. A protocol, published in *Systematic Reviews* in May 2014; and a systematic review, accepted for publication by *Obesity Reviews* in October 2015.

4.2 PUBLICATION: TRENDS IN CHILD AND ADOLESCENT OBESITY PREVALENCE ACCORDING TO SOCIOECONOMIC POSITION: PROTOCOL FOR A SYSTEMATIC REVIEW

PROTOCOL

Open Access

Trends in child and adolescent obesity prevalence according to socioeconomic position: protocol for a systematic review

Alexandra Chung^{1,2}, Kathryn Backholer¹, Evelyn Wong¹, Claire Palermo³, Catherine Keating¹ and Anna Peeters^{1*}

Abstract

Background: Obesity is a significant public health issue and is socially patterned, with greater prevalence of obesity observed in the most socioeconomically disadvantaged groups. Recent evidence suggests that the prevalence of childhood obesity is levelling off in some countries. However, this may not be the case across all socioeconomic strata. The aim of this review is to examine whether trends in child and adolescent obesity prevalence since 1990 differ according to socioeconomic position in developed countries.

Methods: An electronic search will be conducted via Ovid Medline, Embase, Cumulative Index to Nursing and Allied Health Literature, Scopus and Cochrane Collaboration to identify articles that report trends in obesity prevalence in children and adolescents according to socioeconomic position. We will also search grey literature databases including the Virtual Library for Public Health and the System for Information on Grey Literature, as well as websites from relevant organisations. Articles that report on a series of cross sectional studies; describe one or more measure of obesity with data recorded at two or more time points since 1990; and report trends by at least one indicator of socioeconomic position will be included. Quality of included studies will be evaluated according to criteria that consider both internal and external validity. Descriptive analysis will be performed to examine trends since 1990 in childhood obesity prevalence according to socioeconomic position.

Discussion: The review will provide a picture of change over time in developed countries of childhood obesity prevalence across socioeconomic strata and identify whether changes in childhood obesity prevalence are experienced equally across socioeconomic groups.

Systematic review registration: PROSPERO CRD42014007625.

Keywords: Trends, Socioeconomic position, Childhood, Adolescence, Obesity

Background

It is well recognised that childhood obesity is a significant public health issue, with adverse physical and psychological effects that persist beyond childhood into the adult years [1]. After decades of rapid increase [2], it appears that childhood obesity prevalence in developed countries is starting to plateau. Reviews of international evidence have shown that the prevalence of obesity in children and adolescents is stabilising in countries including Australia, Japan, France, the UK and US [3,4]. However, evidence

also suggests that such progress may not have been shared among children across all socioeconomic groups [4,5].

An international systematic review published in 2010 [4] examined obesity prevalence trends and reported levelling off of the obesity epidemic in recent years. Heterogeneity in obesity trends were reported across socioeconomic strata, with levelling of obesity prevalence less apparent for more disadvantaged socioeconomic groups [4]. However, the authors noted that trends by socioeconomic strata were only explored in a small number of their included studies [4]. Individual studies reporting the impact of socioeconomic position (SEP) on obesity prevalence provided mixed results. Studies from Australia [5] and England [6] reported socioeconomic differences in obesity

* Correspondence: anna.peeters@bakeridi.edu.au

¹Obesity and Population Health, Baker IDI Heart and Diabetes Institute, Level 4, 99 Commercial Road, Melbourne VIC 3004, Australia

Full list of author information is available at the end of the article

trends among children and adolescents, while evidence from France [7,8] did not show a difference. With a specific focus on SEP and childhood obesity, this review will capture additional data, including papers published since 2010, to allow greater understanding of trends in the prevalence of obesity by SEP.

Further investigation is warranted, particularly because of the existing excess burden of obesity in children in a lower SEP. Given the health risks associated with excess weight, and the observed socioeconomic patterning in chronic diseases, if trends in obesity prevalence are not improving at the same rate across socioeconomic groups, this will likely lead to further inequalities across a range of health and wellbeing outcomes. Understanding the differences between subgroups of the population is critical to ensuring policy makers can make informed decisions as to where preventive efforts should be focused. This is particularly important in light of evidence that demonstrates differential effectiveness of a number of obesity prevention interventions according to SEP [9].

The aim of this review is to examine whether trends in child and adolescent obesity prevalence since 1990 differ according to socioeconomic position in developed countries.

Methods

Literature search strategy

The search strategy will include searches of the following electronic databases: Ovid Medline, Embase, Cumulative Index to Nursing and Allied Health Literature, Scopus and Cochrane Collaboration. Databases will be searched for articles published between January 1990 and February 2014. We will also search grey literature databases including the Virtual Library for Public Health and the System for Information on Grey Literature, as well as websites from relevant organisations. Finally, we will hand-search reference lists of all included articles. As a proxy for developed countries, we will focus the search on literature from countries that are members of the

Organisation for Economic Co-operation and Development (OECD).

Search terms

Search terms will include relevant medical subject headings (MeSH) and keywords in the title, abstract and text for terms including overweight, obesity, socioeconomic position, children and OECD member countries (see Table 1). The search will be limited to studies published in English since 1990.

Inclusion criteria

Articles will be included if they report socioeconomic trends in the prevalence of obesity in children and/or adolescents aged 2 to 18 years from at least two time points since 1990. Socioeconomic markers could include one or more family- (parent education, parent occupation, family income) or area-level (household postcode, school or neighbourhood socioeconomic index) indicator. Obesity markers will include at least one measured or self reported anthropometric measure (weight and height, body mass index (BMI), BMI z-scores, height and weight plotted on growth charts/percentile charts, waist circumference, waist to hip ratio, percentage body fat, skinfold thickness). Only studies from OECD member countries (chosen as a proxy for developed countries) will be included.

Exclusion criteria

Cohort studies that report time trends not independent of aging will be excluded. Clinical studies, obesity intervention or treatment studies and studies conducted among single or high-risk groups such as low socioeconomic populations or ethnic minorities will be excluded.

Study selection

The initial screening of titles and abstracts will be completed independently by two authors. Full text articles will then be retrieved and assessment against inclusion

Table 1 Search terms

Concept	Search terms
Overweight, obesity	<i>MeSH terms:</i> overweight/obesity/body mass index/ <i>Free-text terms:</i> overweight, obesity, body mass index, BMI, body weight, waist circumference, waist hip ratio, adiposity, anthropometric
Socioeconomic position	<i>MeSH term:</i> Socioeconomic factors/ <i>Free-text terms:</i> socioeconomic factors, socioeconomic, socio-economic, socioeconomic status, socioeconomic gradient, social class, social gradient, social inequality*, inequality*, disparity*, disadvantage*, poverty, income, employment status, education* status, educational attainment, deprivation, health inequality*
Childhood	<i>MeSH terms:</i> child/child, preschool/adolescent/ <i>Free text terms:</i> child*, adolesc*, school
OECD countries	<i>MeSH term:</i> developed countries/ <i>MeSH exp & Free-text for each OECD member country</i> (America, Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, England, Estonia, Finland, France, Germany, Great Britain, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, new Zealand, Norway, Poland, Portugal, Slovak Republic, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States)
OECD, Organisation for Economic Co-operation and Development.	

criteria and data extraction will be conducted independently by two authors, using an electronic spreadsheet. Any discrepancies will be resolved through discussion with a third author.

Data extraction

From the included publications we will extract, where available: author; journal; year of publication; location of study (country/state/city); survey years and time points of data collection; sample population (national survey/community survey/school); sample size; response rate or participation rate; age of population; measure of overweight and/or obesity and whether this is measured or self reported; indicator of SEP and whether this is a family- or area-level marker; any other stratification of results; descriptive results including time trends and obesity prevalence according to SEP; results of significance testing for differences in trends.

Quality assessment

The quality of included studies will be evaluated independently by two authors, according to criteria adapted from an existing quality assessment tool for quantitative studies from the Effective Public Health Practice Project [10]. We will descriptively assess internal and external validity of included studies with questions on selection

bias, study design, confounders, data collection and data analysis (see Table 2). We will perform a sensitivity analysis to evaluate the potential effect of study quality on our conclusions by repeating our analysis on only those studies with high quality ratings for all components.

Data synthesis

We will report on trends in child and adolescent obesity prevalence according to SEP and discuss whether trends are homogenous across the socioeconomic strata. Where trends have been reported by more than one marker of SEP we will preferentially select the marker of SEP that is found to be most common among included articles for our primary analysis. Secondary analysis will consider other reported SEP measures to examine any differences in findings according to SEP measure used. Secondary analysis will also be undertaken to explore any additional available obesity-related outcome data (for example, BMI) to examine the continuous relationship between SEP and excess weight.

We will generate summary tables, firstly using crude data on prevalence from all articles and then, where data are available, we will table results of studies that have undertaken significance testing of differences in trends. Analyses will be conducted to examine overall trends as well as trends over specific time periods. We will also

Table 2 Quality assessment

Component	Questions	Assessment	Ratings
Selection bias	Are the individuals selected to participate likely to be representative of the national population?	<ul style="list-style-type: none"> • Very likely • Somewhat likely • Not likely • Cannot tell 	Studies that are very likely to be representative and have greater than 80% participation will be rated as strong.
	What percentage of selected individuals agreed to participate?	<ul style="list-style-type: none"> • 80 to 100% • 60 to 79% • Less than 60% • Can't tell 	
Study design	Were study methods comparable over time?	<ul style="list-style-type: none"> • Yes • No • Cannot tell 	Studies with comparable methods over time will be rated as strong.
Confounders	Were confounders (age, sex, race/ethnicity) controlled for in study design or analysis?	<ul style="list-style-type: none"> • Yes • No • Cannot tell 	Studies that control for confounding will be rated as strong.
Data collection methods	Was anthropometry measured (as opposed to self reported)?	<ul style="list-style-type: none"> • Yes • No • Cannot tell 	Studies where anthropometry was measured will be rated as strong.
Analyses	Are the statistical analyses appropriate to detect differences by SEP?	<ul style="list-style-type: none"> • Yes • No • Cannot tell 	Studies that have performed analyses to detect differences by SEP will be rated as strong.
SEP, socioeconomic position.			

analyse variations in findings according to country, age group (childhood, adolescence) and sex, and will discuss trends in terms of both absolute and relative inequalities where possible.

Discussion

In this review we will examine studies of child and adolescent obesity prevalence published since 1990 in order to analyse and compare trends across different socioeconomic strata. The findings will provide a comprehensive picture of recent trends in child and adolescent obesity prevalence in developed countries according to SEP, contributing to a greater understanding of the relationship between SEP and childhood obesity. Further, the review will provide evidence to help understand any socioeconomic disparities in childhood obesity trends and reveal if current reporting of the recent plateau in obesity prevalence masks important differences across the socioeconomic strata. In so doing the findings of this review will contribute to evidence-based policy making including policy decisions to reduce obesity-related inequalities.

Abbreviations

BMI: body mass index; OECD: Organisation for Economic Co-operation and Development; SEP: socioeconomic position.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

AC shared responsibility for the development of the research question and the research approach and drafted the article. KB, EW, CP and CK contributed to the development of the protocol and manuscript. AP shared responsibility for the development of the research question and the research approach, and contributed to the development of the protocol and manuscript. All authors read and approved the final manuscript.

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Author details

¹Obesity and Population Health, Baker IDI Heart and Diabetes Institute, Level 4, 99 Commercial Road, Melbourne VIC 3004, Australia. ²Department of Epidemiology and Preventive Medicine, Monash University, Level 6, 99 Commercial Road, Melbourne VIC 3004, Australia. ³Department of Nutrition and Dietetics, Monash University, Level 1, 264 Ferntree Gully Road, Notting Hill VIC 3168, Australia.

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4.3 PUBLICATION: TRENDS IN CHILD AND ADOLESCENT OBESITY PREVALENCE IN ECONOMICALLY ADVANCED COUNTRIES ACCORDING TO SOCIOECONOMIC POSITION: A SYSTEMATIC REVIEW

Pediatric Obesity/Public Health

Trends in child and adolescent obesity prevalence in economically advanced countries according to socioeconomic position: a systematic review

A. Chung,¹ K. Backholer,¹ E. Wong,¹ C. Palermo,² C. Keating³ and A. Peeters^{4,5}

¹Baker IDI Heart and Diabetes Institute, School of Public Health and Preventive Medicine, Monash University, Melbourne, Australia,

²Department of Nutrition and Dietetics, Monash University, Australia, ³Baker IDI Heart and Diabetes Institute, Population Health, Deakin University, Melbourne, Australia, ⁴Baker IDI Heart and Diabetes Institute, School of Public Health and Preventive Medicine, Deakin University, Burwood, Australia, and ⁵Monash University, Melbourne, Australia

Received 5 June 2015; revised 29 October 2015; accepted 30 October 2015

Address for correspondence: A Peeters, Head, Obesity and Population Health, Deakin University, Burwood Hwy, Burwood 3125, Australia.

E-mail: anna.peeters@deakin.edu.au

Summary

Recent obesity trends in children and adolescents suggest a plateau. However, it is unclear whether such trends have been experienced across socioeconomic groups. We analysed whether recent trends in child and adolescent overweight and obesity differ by socioeconomic position (SEP) across economically advanced countries. Eligible studies reported overweight and obesity prevalence in children and/or adolescents (2–18 years), for at least two time points since 1990, stratified by SEP. Socioeconomic differences in trends in child and adolescent overweight and obesity over time were analysed. Differences in trends between SEP groups were observed across a majority of studies. Over half the studies indicated increasing prevalence among low SEP children and adolescents compared to a third of studies among children and adolescents with a high SEP. Around half the studies indicated widening socioeconomic inequalities in overweight and obesity. Since 2000 a majority of studies demonstrated no change or a decrease in prevalence among both high and low SEP groups. However around 40% of studies indicated widening of socioeconomic inequalities post-2000. While our study provides grounds for optimism, socioeconomic inequalities in overweight and obesity continue to widen. These findings highlight the need for greater consideration of different population groups when implementing obesity interventions. © 2015 World Obesity

Keywords: Adolescent, child, obesity, socio-economic position, trends.

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Introduction

Childhood obesity rates have increased rapidly in recent decades, particularly, but not only, in developed countries (1–3). Globally the prevalence of childhood overweight and obesity is high,(4,5) and the health consequences are significant. Obese children are likely to remain obese as adults,(6) and the consequences of overweight and obesity in childhood, including adverse physical and psychological effects, are likely to persist into adulthood (7,8).

In economically advanced countries obesity is socially patterned whereby individuals with a lower socioeconomic position (SEP) are more likely to be overweight and obese

than individuals with a higher SEP (2,9). Such inequalities in the prevalence of obesity are likely to contribute to socioeconomic inequalities in health more broadly (10,11).

Emerging evidence indicates a plateau in childhood obesity prevalence (4,12,13); however, it remains to be understood whether such a plateau in obesity is experienced by children from all socioeconomic backgrounds. To date, analysis of socioeconomic differences in trends in child and adolescent obesity has been limited. Conclusions based on total population data can be quite different to those made from analyses according to SEP (11) and may mask important differences between subgroups (13,14).

The aim of this review was to systematically examine published literature to identify whether trends in overweight and obesity prevalence differ according to SEP among children and adolescents in economically advanced countries.

Methods

Protocol

A protocol for this review has been published (15) and registered with PROSPERO (16).

Search methodology and study eligibility

Electronic searches of five databases (OVID Medline, Embase, CINAHL, Scopus and Cochrane Library) were conducted through to February 2015.

Search terms included relevant medical subject headings (MeSH) and keywords in the title, abstract and text for terms including overweight, obesity, SEP, children and Organisation for Economic Co-operation and Development (OECD) member countries (used as a proxy for economically advanced countries). The search was limited to retrieve studies published since 1990 and only in English. The Medline search strategy is presented in Table 1. This was adapted as required for each database.

Eligible studies included those that reported overweight and/or obesity prevalence in children and/or adolescents aged 2–18 years for at least two time points since 1990 stratified by SEP. Studies that pooled data over a period of time just prior to but including 1990 were also eligible (for example the United States National Health and Nutrition Examination Survey [NHANES] time point of 1988–2004 was included). Studies reporting socioeconomic differences in trends over time in child and/or adolescent obesity prevalence since 1990 were also eligible for inclusion.

Obesity markers included measured or self-reported anthropometrics (weight and height, BMI, BMI z-scores, height and weight plotted on growth charts/percentile charts, waist circumference, waist to hip ratio, percentage body fat, skinfold thickness). Socioeconomic markers included one or more family- (parent education, parent occupation, family income) or area-level (household postcode, school or neighbourhood socioeconomic index) indicator. Only studies reporting on economically advanced countries were eligible.

Cohort studies reporting time trends within a study population were ineligible. Clinical studies, obesity intervention or treatment studies and studies conducted among single or high risk groups such as low socioeconomic populations or ethnic minorities were also ineligible.

Table 1 Medline search strategy

1. overweight.mp. or Overweight/
2. obesity.mp. or Obesity/
3. body mass index.mp. or Body Mass Index/
4. Pediatric Obesity/
5. Body Weight/
6. Waist Circumference/
7. Waist-Hip Ratio/
8. Adiposity/
9. Anthropometry/
10. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9
11. Socioeconomic Factors/
12. Social Class/
13. Poverty/
14. Income/
15. Employment/
16. Educational Status/
17. socioeconomic status.mp.
18. socioeconomic gradient.mp.
19. social gradient.mp.
20. inequalit*.mp.
21. 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20
22. Child/
23. Child, Preschool/
24. Adolescent/
25. child*.mp.
26. adolesc*.mp.
27. 22 or 23 or 24 or 25 or 26
28. Developed Countries/
29. Australia.mp. or exp Australia/
30. Austria.mp. or exp Austria/
31. Belgium.mp. or exp Belgium/
32. Canada.mp. or exp Canada/
33. Chile.mp. or exp Chile/
34. Czech Republic.mp. or exp Czech Republic/
35. Denmark.mp. or exp Denmark/
36. Estonia.mp. or exp Estonia/
37. Finland.mp. or exp Finland/
38. France.mp. or exp France/
39. Germany.mp. or exp Germany/
40. Greece.mp. or exp Greece/
41. Hungary.mp. or exp Hungary/
42. Iceland.mp. or exp Iceland/
43. Ireland.mp. or exp Ireland/
44. Israel.mp. or exp Israel/
45. Italy.mp. or exp Italy/
46. Japan.mp. or exp Japan/
47. Korea.mp. or exp Korea/
48. Luxembourg.mp. or exp Luxembourg/
49. Mexico.mp. or exp Mexico/
50. Netherlands.mp. or exp Netherlands/
51. New Zealand.mp. or exp New Zealand/
52. Norway.mp. or exp Norway/
53. Poland.mp. or exp Poland/
54. Portugal.mp. or exp Portugal/
55. Slovak Republic.mp. or exp Slovakia/
56. Slovenia.mp. or exp Slovenia/
57. Spain.mp. or exp Spain/
58. Sweden.mp. or exp Sweden/
59. Switzerland.mp. or exp Switzerland/
60. Turkey.mp. or exp Turkey/
61. United States.mp. or exp United States/

Table 1 (Continued)

62. 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60 or 61
63. 10 and 21 and 27 and 62
64. limit 63 to yr = '1990–2014'
65. limit 64 to English language

Study selection, data extraction and quality appraisal

The initial screening of titles and abstracts for eligibility and subsequent assessment of full text articles against eligibility criteria was conducted independently by two authors, with any discrepancies resolved through discussion with a third author. Reference lists of full text articles were hand searched for further relevant studies. Data extraction from eligible studies was conducted in duplicate using a standard form. Data items recorded included author; journal; year of publication; location of study; survey years and data collection time points; sample size; response rate; age of population; measure of obesity and whether this was measured or self reported; indicator of SEP; any other stratification of results (e.g. age, sex, ethnicity, rural/urban); descriptive results including obesity prevalence according to SEP and associated time trends; results of statistical testing for differences in trends between SEP groups. The authors of three studies were contacted with requests for additional data, and all provided the requested data for inclusion in our analyses.

Where more than one article reported on a particular dataset (for example the NHANES data) we preferentially included the article that presented data up to the most recent timepoint; for the largest age range; for overweight and obese combined; and that reported statistical tests for differences in trends between SEP groups.

The quality of studies was assessed independently by two authors, according to criteria adapted from an existing quality assessment tool for quantitative studies from the Effective Public Health Practice Project (EPHPP) (17). We carried out descriptive assessment of internal and external validity of included studies with questions on selection bias, study design and data collection methods. Because of the heterogeneity in the exposures and outcomes reported across studies, we did not examine risk of publication bias.

Data analysis

We analysed socioeconomic differences in overweight and obesity trends over time. Where study authors conducted statistical analyses to determine differences in trends over

time between SEP groups, we report on conclusions from those analyses. Our first preference was to make conclusions from interaction tests for differences in trends by SEP. In the absence of interaction tests we looked for other statistical tests that enabled detection of differences in trends according to SEP (such as significance testing of trends within SEP groups).

Where authors did not perform statistical analyses for differences in trends by SEP, we referred to point prevalence data where available, and calculated the magnitude of absolute change in overweight and obesity prevalence over time between the highest and lowest SEP groups to examine whether trends differed according to SEP. If the absolute difference in change over time was 2% or greater, we classified this as a between group difference. For those studies where we calculated absolute change over time, we tested both 1% and 2% absolute differences as cut-offs for difference in trends. In the final analyses we elected to apply the more conservative cut-off of a 2% absolute difference.

Neither statistical analyses of trends, nor point prevalence data were available for two studies. In these instances, we have reported on data presented in graphs and/or conclusions made by study authors.

Where studies reported on overweight and obesity combined, and obesity, we preferentially analysed data on overweight and obesity combined. Where studies reported on overweight excluding obesity, and obesity, we analysed data on obesity.

Subgroup analyses

We conducted subgroup analyses to examine socioeconomic differences by SEP across age and sex subgroups where stratification allowed. We also conducted subgroup analyses for those studies that reported trends post-2000 to examine socioeconomic differences in overweight and obesity prevalence in recent years. Methods were as for our primary analysis.

Sensitivity analyses

We performed sensitivity analyses to assess the robustness of our findings by analysing results for studies that conducted interaction tests for differences in trends by SEP, and for studies that received a strong or moderate quality assessment rating.

Results

Study selection

The database search identified 6057 potentially relevant titles of which 42 were identified as eligible for inclusion in this review. However, several studies utilized common national datasets, resulting in multiple reports of the same study populations. For this reason, 12 of the 42 eligible studies were excluded (18–29), and trends in child and

adolescent obesity were analysed and reported for 30 unique study populations. The process for study selection is outlined in Fig. 1.

Study characteristics

Key characteristics of all included studies are displayed in Table 2.

Descriptive results of all included studies are provided in Appendix 1.

Our review included 30 studies, representing 15 countries. Fourteen studies reported on national data, and 16 reported on state or local level data. Thirteen studies reported trends in overweight and obesity among children and adolescents, nine reported on children only and eight on adolescents only. The mean period of time for which trends were analysed was 9.7 years. However time periods varied greatly across studies, with 5 years the shortest time period studied and 17 years the longest. The earliest time point included in the analysis was 1988, and the most recent was 2011. Of the 30 included studies, five were rated as strong, 18 as moderate and seven as weak according to our quality assessment.

There was limited consistency in the key adiposity and SEP indicators described in included studies. Obesity was most commonly determined using either measured or self

reported height and weight to calculate BMI and then categorized as overweight or obese according to one of a number of reference cut offs. Continuous measures, including BMI, waist circumference and skinfolds, were reported in a small number of studies. SEP was measured in several different ways, at both the family (parent education, income or occupation), and area-level (school or neighbourhood socioeconomic status). A small number of studies reported overweight and obesity by both family- and area-level indicators of SEP. For consistency we preferentially analysed data reported by family-level SEP.

Inverse associations between SEP and overweight and obesity were observed among 72% of studies across all time points. That is, lower SEP was associated with a higher prevalence of overweight or obesity. A further 14% of studies reported associations that shifted from positive to inverse over time. A further 7% of studies reported positive associations between SEP and obesity, and 7% reported no clear associations between SEP and obesity.

Ten studies reported statistical tests that assessed socioeconomic differences in obesity trends between SEP groups; seven studies reported statistical tests within SEP groups that enabled a conclusion on socioeconomic differences in obesity trends between SEP groups; 11 reported point prevalence data that we analysed to determine absolute difference in trends between the lowest and highest SEP groups;

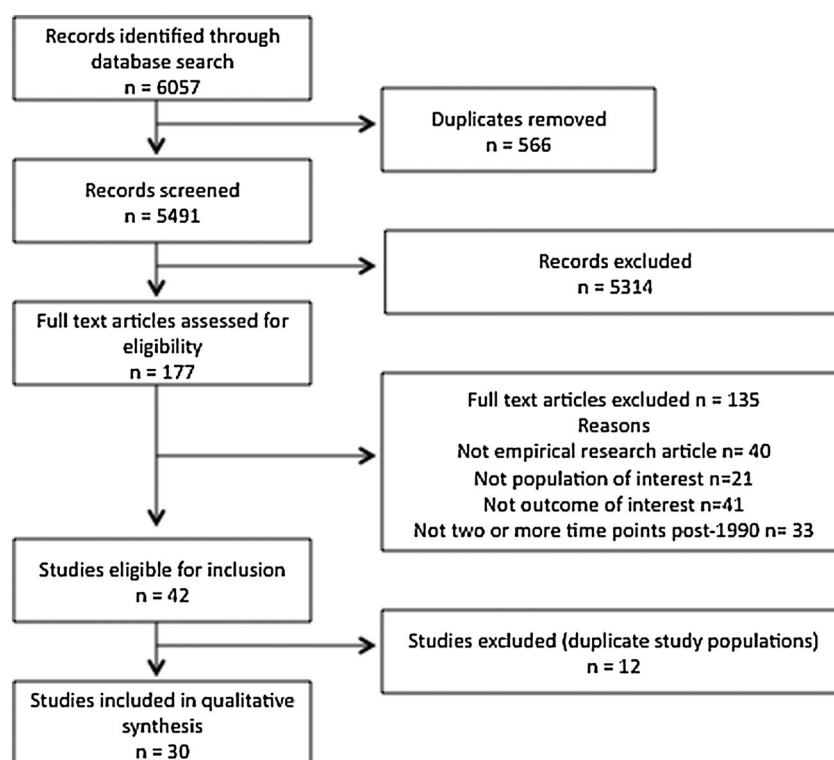


Figure 1 Study selection flow chart.

Table 2 Description of included studies

Study	Country	Time period ^a	Population characteristics	Sample size#	Obesity measure	SEP measure	Quality rating
Babey <i>et al.</i>	United States	2001–2007	12–17 year olds California	n = 17,535 2001: n = 5,858 2003: n = 4,010 2005: n = 4,029 2007: n = 3,638 n = 947,765	Overweight and obesity (sr)	Family (family income)	Weak
Berger <i>et al.</i>	United States	2006–2011	5 to 14 year olds New York City	n = 152,803 2003: n = 16,909 2004: n = 17,506 2005: n = 17,607 2006: n = 18,813 2007: n = 20,202 2008: n = 20,407 2009: n = 20,481 2010: n = 20,878	Obesity (m)	Area (school neighbourhood poverty)	Moderate
Boles <i>et al.</i>	United States	2003–2011	School grades K, 1, 3, 5, 7 Anchorage, Alaska	n = 16,909 2003: n = 16,909 2004: n = 17,506 2005: n = 17,607 2006: n = 18,813 2007: n = 20,202 2008: n = 20,407 2009: n = 20,481 2010: n = 20,878	Obesity (m)	Area (proportion students enrolled in school lunch program)	Weak
Bonvecchio <i>et al.</i>	Mexico	1988–2006	2 to 18 year olds National survey	n = 62,494 1999: n = 19,353 2006: n = 33,459	Overweight and obesity (m)	Family (living conditions index [household characteristics])	Moderate
Brunt <i>et al.</i>	South Wales	1995–2005	3 year olds South Wales	n = 35,560 1995: n = 2,846 1996: n = 3,840 1997: n = 3,497 1998: n = 3,396 1999: n = 3,094 2000: n = 3,339 2001: n = 3,345 2002: n = 2,996 2003: n = 2,999 2004: n = 3,097 2005: n = 3,111 n = 162,162	Overweight and obesity (m)	Area (Townsend Material Deprivation Index)	Moderate
Delva <i>et al.</i>	United States	1993–2003	School grades 8, 10, 12 National data	n = 162,162	Overweight (sr)	Family (parent education)	Moderate
Dollman & Pilgrim	Australia	1997–2002	11 year olds South Australia	n = 2,415 1997: n = 1,423 2002: n = 992	BMI, waist circumference, skinfold (m)	Area (school SEP)	Moderate
Frederick <i>et al.</i>	United States	1988–2011	12 to 17 year olds National data	n = 105,524	Obese (m & sr)	Family (parent education)	Moderate
Gross <i>et al.</i>	Israel	1967–2003	17-year-old males National data	n = 1,140,937	Obese (m)	Area (SEP of residence)	Strong
Hardy <i>et al.</i>	Australia	1985–2010	6 to 16 year olds New South Wales	1997: n = 5,518 2004: n = 5,402 2010: n = 8,058	Obese (m)	Area (SEIFA – SEP of postcode of residence)	Weak

Table 2. (Continued)

Study	Country	Time period ^a	Population characteristics	Sample size ^b	Obesity measure	SEP measure	Quality rating
Kautiainen <i>et al.</i>	Finland	1979–2005	12 to 18 year olds National survey	1993: <i>n</i> = 8,189 1995: <i>n</i> = 8,382 2005: <i>n</i> = 6,503	Overweight and obesity (sr)	Family (mother's education level)	Moderate
Kirchengast <i>et al.</i>	Austria	1985–2000	18-year-old men National data	<i>n</i> = 130,235 1990: <i>n</i> = 47,459 1995: <i>n</i> = 39,272 2000: <i>n</i> = 43,504 <i>n</i> = 1,030	Overweight and obesity (m)	Family (education level of individual)	Strong
Lioret <i>et al.</i>	France	1998–2007	3 to 14 years old National survey	1999–2002: <i>n</i> = 6,081 to 7,293 2003–2006: <i>n</i> = 6,081 to 7,293 2007–2010: <i>n</i> = 6,081 to 7,293	Overweight and obesity (sr)	Family (occupation of head of household)	Weak
May <i>et al.</i>	United States	1999–2010	2 to 17 year olds National survey	1999–2002: <i>n</i> = 6,081 to 7,293 2003–2006: <i>n</i> = 6,081 to 7,293 2007–2010: <i>n</i> = 6,081 to 7,293	Obesity (m)	Family (education level of head of household)	Moderate
Moller <i>et al.</i>	Denmark	1997–2004	8 to 10 year olds Odense	<i>n</i> = 982 1997–1998: <i>n</i> = 559 2003–2004: <i>n</i> = 423 <i>n</i> = 225,430 1999: <i>n</i> = 9,310 2000: <i>n</i> = 13,612 2001: <i>n</i> = 18,506 2002: <i>n</i> = 22,821 2003: <i>n</i> = 26,333 2004: <i>n</i> = 29,764 2005: <i>n</i> = 32,955 2006: <i>n</i> = 34,772 2007: <i>n</i> = 37,357 <i>n</i> = 9,343 2000: <i>n</i> = 3,819 2006: <i>n</i> = 5,524 <i>n</i> = 1,088 2004: <i>n</i> = 590 2009: <i>n</i> = 498 <i>n</i> = 477,725 2006–2007: <i>n</i> = 114,721 2007–2008: <i>n</i> = 119,793 2008–2009: <i>n</i> = 121,413 2009–2010: <i>n</i> = 121,798 <i>n</i> = 2,596 2000: <i>n</i> = 1,582 2007: <i>n</i> = 1,014	Overweight (including obesity) (m)	Family (parent occupation)	Moderate
Nichols <i>et al.</i>	Australia	1999–2007	2 and 3.5 year olds Victoria		Overweight and obesity (m)	Area (SEIFA – SEP of postcode of residence)	Weak
O'Dea & Dibley	Australia	2000–2006	6 to 18 year olds National survey		Overweight and obese (m)	Area (school SES)	Strong
O'Dea <i>et al.</i>	Australia	2004–2009	9 to 12 year olds New South Wales		Overweight and obesity (m)	Area (school SES)	Moderate
Robbins <i>et al.</i>	United States	2006–2010	5 to 18 year olds Philadelphia, Pennsylvania		Obesity (m)	Area (eligibility for free/reduced price school meals)	Moderate
Salanave <i>et al.</i>	France	2000–2007	7 to 9 year olds National survey		Overweight and obesity (m)	Family (parent occupation)	Moderate

(Continues)

Table 2. (Continued)

Study	Country	Time period [^]	Population characteristics	Sample size#	Obesity measure	SEP measure	Quality rating
Salcedo <i>et al.</i>	Spain	1987–2007	5 to 15 year olds National survey	<i>n</i> = 9,535 1995–1997: <i>n</i> = 2,013 2001: <i>n</i> = 2,638 2006–2007: <i>n</i> = 4,884	Overweight and obesity (sr)	Family (education of the head of household)	Moderate
Sjöberg <i>et al.</i>	Sweden	2000–2005	10 year olds Goteborg	<i>n</i> = 8,079 2000: <i>n</i> = 4,188 2004: <i>n</i> = 3,891 <i>n</i> = 6,168	Overweight and obesity (m)	Area (socioeconomic area index)	Moderate
Skelton <i>et al.</i>	United States	1988–2004	2 to 19 year olds National Survey	<i>n</i> = 81,206 1990–1999: <i>n</i> = 48,579 2000–2006: <i>n</i> = 32,627	Obesity (m)	Family (poverty income ratio)	Moderate
Smith <i>et al.</i>	Scotland	1970–2006	5 and 6 year olds Grampians Region	<i>n</i> = 5,164 1999: <i>n</i> = 2,145 2006: <i>n</i> = 3,019	Obesity (m)	Area (SIMD – measure of neighbourhood deprivation)	Moderate
Stamatakis <i>et al.</i>	England	1995–2007	2 to 18 year olds National survey	<i>n</i> = 4,599 1999: <i>n</i> = 2,416 2003: <i>n</i> = 2,183	Obesity (m)	Family (occupation head of household)	Moderate
Sundblom <i>et al.</i>	Sweden	1999–2003	10 year olds Stockholm County	<i>n</i> = 5,164 1999: <i>n</i> = 2,145 2006: <i>n</i> = 3,019	Overweight and obese (m)	Area (area SES)	Weak
Sweeting <i>et al.</i>	Scotland	1987–2006	15 year olds Central Clydeside	<i>n</i> = 14,235 2004: <i>n</i> = 2,005 2005: <i>n</i> = 2,100 2006: <i>n</i> = 2,010 2007: <i>n</i> = 1,952 2008: <i>n</i> = 2,040 2009: <i>n</i> = 2,017 2010: <i>n</i> = 2,111	Obesity (m)	Family (occupation of head of household)	Moderate
Thibault <i>et al.</i>	France	2004–2011	5 to 6 year olds Bordeaux City	<i>n</i> = 5,132 1996: <i>n</i> = 2,484 2007: <i>n</i> = 2,648 <i>n</i> = 6,371 1992: <i>n</i> = 2,982 2002: <i>n</i> = 3,389	Overweight, including obesity (m)	Area (school SEP)	Strong
	Northern Ireland	1996–2007	12 to 15 year olds National survey		Overweight and obese (m)	Family (occupation – highest in household)	Strong
Zadzinska <i>et al.</i>	Poland	1977–2004	7 to 18 year olds Lodz		Overweight and obesity (m)	Family (parent education)	Weak

[^]Time period described here includes entire time period reported in study, our analysis included only data points post-1990.

[#]Where available we have specified the sample size for each of the time points included in our analysis.

m, measured height and weight; nr, not reported; SEIFA, socioeconomic indexes for areas; SES, socioeconomic status; SIMD, Scottish index of multiple deprivation; sr, self reported height and weight.

two presented graphed results or described changes in trends that were interpreted to determine socioeconomic differences in obesity trends.

Socioeconomic differences in child and adolescent overweight and obesity over time

Of the 30 included studies, 12 indicated no socioeconomic differences in overweight and obesity trends over time, across all age and sex subgroups. Eighteen of the 30 studies demonstrated differential trends in overweight and obesity by SEP. Fifteen of these reported trends that demonstrated some widening in the difference in overweight and obesity prevalence between SEP groups over time, of which five demonstrated a mix of widening and no change to the difference between SEP groups, depending on the age and sex of subgroups examined. One study reported trends that indicated some narrowing of the difference in overweight and obesity prevalence between SEP groups over time, and a further two reported trends that demonstrated a combination of narrowing and no change to the difference between SEP, depending on the age and sex of subgroups examined (Table 3).

Of the studies reporting findings stratified by age, analysis of socioeconomic differences in overweight and obesity trends over time indicates widening of the socioeconomic difference among children (in some or all sex subgroups) in 39% of studies, narrowing (in some or all sex subgroups) in 15% of studies and no change to the difference between SEP groups (in all sex subgroups) in 46% of studies. While among adolescents, results indicate widening (in some or all sex subgroups) in 70% of studies and no change to the difference between SEP groups (in all sex subgroups) in 30% of studies. Figure 2 shows the proportion of studies (of those where results were stratified by age) indicating widening (in some or all sex subgroups), narrowing (in some or all sex subgroups) and no change (in all sex subgroups) to the socioeconomic differences in trends in overweight and obesity among children and adolescents.

Among children and adolescents with a high SEP 10 studies demonstrated increases in overweight and obesity prevalence across some or all age and sex subgroups. Eleven studies reported a stabilization of prevalence across all subgroups, and eight demonstrated decreasing prevalence in some or all age and sex subgroups. Among children and adolescents with a low SEP 17 studies demonstrated increases in overweight and obesity prevalence across some or all age and sex subgroups. Eight studies reported a stabilization of prevalence across all subgroups, and four demonstrated decreasing prevalence in some or all age and sex subgroups (Table 3).

Subgroup analyses

Time period

The time period sub-analysis included the 11 studies where all the point prevalence estimates were reported post-2000 and an additional three studies where trends post-2000 could be interpreted from a larger dataset that included data prior to the year 2000 (Table 4).

Eight of the 14 studies demonstrated differential trends according to SEP. Of these studies, six studies indicated widening of socioeconomic differences over time, including four that demonstrated overall widening and two that demonstrated a mix of widening and no change to the difference between SEP across subgroups by sex. Two studies demonstrated narrowing of socioeconomic differences in overweight and obesity trends, including one that demonstrated a mix of narrowing and no change to the difference according to sex subgroups.

Among children and adolescents with a high SEP one study demonstrated increases in overweight and obesity prevalence across some or all age and sex subgroups. Seven studies reported a stabilization of prevalence across all subgroups, and six demonstrated decreasing prevalence in some or all age and sex subgroups. Among children and adolescents with a low SEP five studies demonstrated increases in overweight and obesity prevalence across some or all age and sex subgroups. Six studies reported a stabilization of prevalence across all subgroups, and three demonstrated decreasing prevalence in some or all age and sex subgroups.

Figure 3 shows the proportion of studies indicating increases (in some or all age and sex subgroups), stabilization (in all age or sex subgroups) and decreases (in some or all age and sex subgroups) in overweight and obesity trends according to SEP for all included studies, and for those studies reporting only post-2000 data.

Age group

Where study results were stratified by age, we examined socioeconomic differences in overweight and obesity trends by age group.

Three studies presented results for preschool-aged children. In one study, socioeconomic differences in overweight and obesity trends were observed among pre-school aged children. This study showed a mix of narrowing and no change to the socioeconomic difference across age subgroups.

Ten studies reported on socioeconomic differences in overweight and obesity trends among primary school-aged children. In six studies, socioeconomic differences in overweight and obesity trends were observed. This included widening of the difference between socioeconomic groups in five studies, of which two indicated a mix of widening

Table 3 Trends in overweight and obesity by socioeconomic position

			Preschool		Primary school		Secondary school		Children and adolescents	
			Boys	Girls	All children	Boys	Girls	All children	Males	Females
Australia	Dollman and Pilgrim 2005	Obesity prevalence trends	Low SEP			nr	nr			
		Differences between SEP groups	High SEP			nr	nr			
	O'Dea and Dibley 2010	Obesity prevalence trends ⁺	Low SEP			w	nc			↑
		Differences between SEP groups ⁺⁺	High SEP							↔
	Nichols <i>et al.</i> 2011	Overweight (incl obesity) prevalence trends (2 year olds & 3.5 year olds) ⁺	Low SEP	↔	↓					w
		Differences between SEP groups	high SEP	↔	↓					
	O'Dea <i>et al.</i> 2011	Obesity prevalence trends	Low SEP	nc	n					
		Differences between SEP groups	High SEP			↓	↔			
	Hardy <i>et al.</i> 2012	Differences between SEP groups	Low SEP				n		↔	↔
		Obesity prevalence trends ⁺	High SEP						↔	nc
	Kirchengast <i>et al.</i> 2004	Differences between SEP groups ⁺⁺	Low SEP					↑		
		Obesity prevalence trends	High SEP					↔	↔	nc
Austria	Moller <i>et al.</i> 2007	Differences between SEP groups	Low SEP			↔	↔			
		Obesity prevalence trends ⁺	High SEP			↔	↔	nc		
Denmark	Stamatakis, Zaninotto <i>et al.</i> 2010	Differences between SEP groups [*]	Low SEP			nc	nc			
		Obesity prevalence trends	High SEP			↑	↑	↑	↑	↑
England	Kautiainen <i>et al.</i> 2009	Differences between SEP groups	Low SEP			↑	↔	w	w	w
		Obesity prevalence trends	High SEP			w	w	↑	↑	↑
Finland	Lioret <i>et al.</i> 2009	Differences between SEP groups [*]	Low SEP					↑	↑	nc
		Obesity prevalence trends ⁺	High SEP					w		
France	Salanave <i>et al.</i> 2009	Differences between SEP groups ⁺⁺	Low SEP							↔
		Obesity prevalence trends ⁺	High SEP							↔
	Thibault <i>et al.</i> 2013	Differences between SEP groups	Low SEP			↔	↔			nc
		Obesity prevalence trends ⁺	High SEP			nc	nc			
Israel	Gross <i>et al.</i> 2009	Differences between SEP groups ⁺⁺	Low SEP			↔	↓			
		Obesity prevalence trends	High SEP			w	w	↑	↑	↑
Mexico	Bonvecchio <i>et al.</i> 2009	Differences between SEP groups	Low SEP							
		Obesity prevalence trends	High SEP	↔	↔	↑	↑	w	↑	↑

Table 3. (Continued)

		Preschool	Primary school	Secondary school	Children and adolescents
Northern Ireland	Whittle <i>et al.</i> 2013	Low SEP	nc	nc	
		High SEP		↑	↑
Poland	Zadzinska <i>et al.</i> 2012	Low SEP		↑	↑
		High SEP		w	nc
Scotland	Smith <i>et al.</i> 2013	Low SEP	↑		↑
		High SEP	↑		nc
	Sweeting <i>et al.</i> 2008	Low SEP	w		nc
		High SEP			
Spain	Salcedo <i>et al.</i> 2010	Low SEP	↑	↑	↑
		High SEP	nc	nc	nc
Sweden	Sundblom <i>et al.</i> 2008	Low SEP	↑		↑
		High SEP			nc
	Sjöberg <i>et al.</i> 2008	Low SEP	↑		↑
		High SEP	nc		nc
United States	Delva <i>et al.</i> 2006	Low SEP	↑	↑	↑
		High SEP	↑	↑	nc
	Skelton <i>et al.</i> 2009	Low SEP	w	w	↑
		High SEP			↑
	May <i>et al.</i> 2013	Low SEP			nc
		High SEP			w
	Babey <i>et al.</i> 2010	Low SEP			↑
		High SEP			nc
	Berger <i>et al.</i> 2011	Low SEP	↑	↑	nc
		High SEP	↓	↓	w
	Robbins <i>et al.</i> 2012	Low SEP			nc
		High SEP			nc
	Boles <i>et al.</i> 2013	Low SEP			nc
		High SEP			nc

(Continues)

Table 3. (Continued)

		Preschool	Primary school	Secondary school	Children and adolescents
	Differences between SEP groups ⁺⁺				w
Frederick <i>et al.</i> 2014	Obesity prevalence trends	Low SEP High SEP		↑ ↔ w	
	Differences between SEP groups*				
Wales	Obesity prevalence trends [†]	Low SEP High SEP	↑ ↔ nc		
Brunt <i>et al.</i> 2008	Differences between SEP groups*				

*Significance testing for differences in trends between SEP groups.

[†]Test for significance of trends within SEP groups.⁺⁺Test for trends that allows conclusions on differences in trends between SEP groups.[†]Increase in overweight and obesity prevalence over time.⁺⁺No change in overweight and obesity prevalence over time.[†]Increase in overweight and obesity prevalence over time.

nr, not reported.

w, widening of the difference in overweight and obesity prevalence between SEP groups over time.

nc, no change in the difference in overweight and obesity prevalence between SEP groups over time.

n, narrowing of the difference in overweight and obesity prevalence between SEP groups over time.

and no change to socioeconomic differences in trends; and one study that indicated a narrowing of the difference between socioeconomic groups.

Ten studies presented results for secondary school-aged children. Socioeconomic differences in overweight and obesity trends were observed among secondary-school aged children in seven studies. All of these demonstrated widening of the difference between socioeconomic subgroups, including two studies that showed a mix of widening and no change to the difference between socioeconomic groups across sex subgroups.

Ten studies presented results for children and adolescents combined. Socioeconomic differences in overweight and obesity trends were observed in five of those studies. Four studies indicated a widening of the socioeconomic differences over time, including one study that demonstrated a mix of widening and no change to the difference; one study demonstrated a mix of narrowing and no change to the difference between socioeconomic subgroups.

Sex

Seventeen studies presented results stratified by sex, allowing us to examine socioeconomic differences in child and adolescent overweight and obesity by sex in almost two thirds of included studies. In eight studies socioeconomic differences in overweight and obesity did not differ by sex. Four studies demonstrated a widening of the socioeconomic difference among boys, but not among girls, and one study demonstrated a widening of the socioeconomic difference among girls, but not among boys. One study demonstrated a narrowing of the socioeconomic difference among boys but no change to the socioeconomic difference in overweight and obesity trends among girls. Two studies reported on boys only, one of which demonstrated a widening of socioeconomic differences in trends, while the other demonstrated no change to the socioeconomic differences in trends. One study reported on adolescent girls, but not adolescent boys, and demonstrated no change to the socioeconomic differences in overweight and obesity trends over time.

Sensitivity analyses

To examine the robustness of the findings of this review, sensitivity analyses were performed using those studies reporting statistical analyses to detect differences in trends between SEP groups over time, those studies determined to be strong or moderate quality and without studies from the USA to test whether the high number of studies reporting on data from the USA impacted our findings.

Ten studies reported statistical tests for differences in trends between SEP groups in the time period since 1990. Six of these studies (60%) found statistically significant

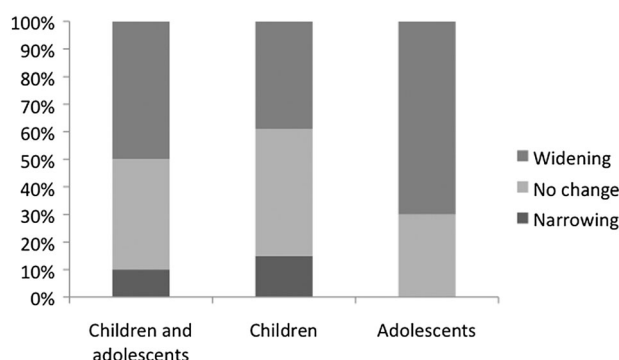


Figure 2 Socioeconomic differences in trends in overweight and obesity in children and adolescents. (Note, Fig. 2 shows the proportion of studies [grouped according to whether results were stratified by age] indicating widening [in some or all sex subgroups], narrowing [in some or all sex subgroups] and no change [in all sex subgroups] to the socioeconomic differences in trends in overweight and obesity among children and adolescents).

differences in trends between low and high SEP groups. In all cases, these studies indicated a widening of the difference in overweight and obesity prevalence between socioeconomic groups across some or all sex subgroups. The remaining four studies (40%) reported no statistically significant differences in trends between socioeconomic groups over time.

Twenty three studies were rated as strong or moderate according to quality assessment. Of these, 15 (65%) demonstrated differences in overweight and obesity trends according to SEP. Thirteen studies indicated some widening, including nine studies where widening was observed across all subgroups and four studies where results showed a mix of widening and no difference between SEP groups across age and sex subgroups. One study indicated a narrowing of the difference between socioeconomic groups, and one indicated a mix of narrowing and no difference across sex subgroups. Eight studies (35%) indicated no difference in trends between socioeconomic groups.

Of the 30 included studies, eight were from the USA. We conducted sensitivity analysis to determine whether this clustering of studies may have impacted our overall findings and found that when excluding the eight studies from the USA the overall conclusions of the review were unaffected.

Discussion

The overall finding of this review is that differences in overweight and obesity between socioeconomic groups widened for half of the populations that were examined. We also found, for the first time, evidence of improvements in overweight and obesity prevalence among high and low SEP groups of children and adolescents since the year 2000. However, while fewer than 10% of post-2000 studies indicate continued increases in overweight and obesity among high SEP children and adolescents, almost one third of studies demonstrate increases in overweight and obesity prevalence among children and adolescents with a low SEP.

Current literature on trends in overweight and obesity among children and adolescents includes mixed reports, with some evidence suggesting rates continue to rise, while other evidence suggests that overweight and obesity prevalence has levelled off (4,12,13). Our review found evidence of levelling off or improved overweight and obesity prevalence among children and adolescents from high SEP groups in two thirds of included studies but this was observed in fewer than half of the studies for low SEP children and adolescents, across a number of economically advanced countries. There are a number of likely reasons why some studies demonstrate differential trends in overweight and obesity, including the stage of economical and epidemiological development in each country at the time data was collected and individual country responses to the childhood obesity. The reasons for such differences should be teased out further in future research.

Our analyses of trends post-2000 found evidence of levelling off or improved overweight and obesity prevalence in children and adolescents with a high SEP in almost all studies, while this was seen in around two thirds of studies for children and adolescents with a low SEP. In each case, levelling or improvements in overweight and obesity prevalence were less apparent among low SEP children and adolescents compared to children and adolescents with a high SEP. This may be an indication of diffusion of innovations whereby individuals with a higher SEP respond to interventions sooner than individuals with a lower SEP (30). What we can be sure of is that socioeconomic differences in trends exist, and importantly, they may be masked in studies where trends are reported for whole populations without stratification by SEP. Two important systematic reviews that examined the association between SEP and overweight and obesity illustrate the strengthening association between low SEP and overweight and obesity in developed countries (31,32). Our review findings add more recent data to this literature, also showing strong inverse associations between SEP and overweight and obesity among children and adolescents in a number of developed countries.

Table 4 Post-2000 analysis

				Preschool			Primary school			Secondary school			Children and adolescents		
				Boys	Girls	All children	Boys	Girls	All children	Males	Females	All children	Males	Females	All children
Australia	O'Dea and Dibley 2010	Obesity prevalence trends ⁺	Low SEP												↑
		Differences between SEP groups ⁺⁺	High SEP												↔
		Obesity prevalence trends				↓									W
	O'Dea <i>et al.</i> 2011	Obesity prevalence trends	Low SEP			↔									
		Differences between SEP groups	High SEP			n									
		Obesity prevalence trends ⁺													
France	Hardy <i>et al.</i> 2012	Obesity prevalence trends ⁺	Low SEP										↔	↔	
		Differences between SEP groups ⁺⁺	High SEP										↔	↔	
		Obesity prevalence trends ⁺											nc	nc	
	Salanave <i>et al.</i> 2009	Obesity prevalence trends ⁺	Low SEP			↔									
		Differences between SEP groups ⁺⁺	High SEP			↔									
		Obesity prevalence trends ⁺				nc									
	Thibault <i>et al.</i> 2013	Obesity prevalence trends ⁺	Low SEP			↔									
		Differences between SEP groups ⁺⁺	High SEP			↓									
		Obesity prevalence trends				W									
Spain	Salcedo <i>et al.</i> 2010	Obesity prevalence trends	Low SEP							↑	↑		↑	↑	
		Differences between SEP groups	High SEP							↑	↑		↑	↑	
		Obesity prevalence trends								n	nc		n	nc	
Sweden	Sjöberg <i>et al.</i> 2008	Obesity prevalence trends	Low SEP				↔	↓							
		Differences between SEP groups	High SEP				↔	↓							
		Obesity prevalence trends					nc	nc							
United States	May <i>et al.</i> 2013	Obesity prevalence trends	Low SEP							↑	↑		↑	↑	
		Differences between SEP groups ⁺	High SEP							↔	↔		↔	↔	
		Obesity prevalence trends								nc	nc		nc	nc	
	Babey <i>et al.</i> 2010	Obesity prevalence trends	Low SEP							↑	↔		↑	↓	
		Differences between SEP groups	High SEP							↓	↔		↓	↓	
		Obesity prevalence trends ⁺								W	nc		W	W	
	Berger <i>et al.</i> 2011	Obesity prevalence trends ⁺	Low SEP												↓
		Differences between SEP groups ⁺⁺	High SEP												↓
		Obesity prevalence trends ⁺													nc
	Robbins <i>et al.</i> 2012	Obesity prevalence trends ⁺	Low SEP												↔
		Differences between SEP groups	High SEP												↔
		Obesity prevalence trends ⁺													nc
	Boles <i>et al.</i> 2013	Obesity prevalence trends ⁺	Low SEP												↔
		Differences between SEP groups ⁺⁺	High SEP												↓
		Obesity prevalence trends ⁺													W

Table 4. (Continued)

		Preschool	Primary school	Secondary school	Children and adolescents
Wales	Frederick <i>et al.</i> 2014	Low SEP High SEP		† ‡ w	
		Differences between SEP groups*			
	Brunt <i>et al.</i> 2008	Obesity prevalence trends [†]	† ‡ nc		
		Differences between SEP groups*			

*Significance testing for differences in trends between SEP groups.
†Test for significance of trends within SEP groups.
‡Test for trends that allows conclusions on differences in trends between SEP groups.
†Increase in overweight and obesity prevalence over time.
‡No change in overweight and obesity prevalence over time.
‡Increase in overweight and obesity prevalence over time.
nr, not reported.
w, widening of the difference in overweight and obesity prevalence between SEP groups over time.
nc, no change in the difference in overweight and obesity prevalence between SEP groups over time.
n, narrowing of the difference in overweight and obesity prevalence between SEP groups over time.

Strengths and limitations

Strengths of this review include clearly defined eligibility criteria and a rigorous process for article searching, study selection and data extraction. Our review identified and examined a large number of studies, with representation from a wide range of countries, and analysed overweight and obesity trends among children and adolescents of all ages. Importantly, sensitivity analyses corroborate the overall findings of the review.

Heterogeneity in definitions of obesity and choice of SEP indicator across included studies poses a potential limitation to our research. Differences in choice of obesity measure and definitions of overweight and obesity were apparent across the studies included in this review. The choice of SEP indicator also varied across included studies, and a small number of studies reported findings by more than one indicator. This wide heterogeneity precluded subgroup analyses by obesity measure or SEP indicator; as such we were unable to explore the extent to which these differences impacted the review findings.

Various methods of reporting socioeconomic differences in trends, and trends in prevalence, were evident in the studies examined for this review. For example, one third of the included studies used statistical testing to determine a significant change in overweight and obesity trends over time within each SEP group or to determine differences in these trends between SEP groups. The majority of other studies reported point prevalence data that we used to calculate absolute differences in obesity prevalence within and between SEP groups. For these studies we considered an arbitrary 2% absolute difference in the point prevalence of overweight and obesity over time, or between SEP groups, as meaningful, which may have been conservative as the majority of these conclusions tended towards no difference. Unsurprisingly, when using a 1% cut-off many more studies revealed a widening of overweight and obesity trends between high and low SEP children and adolescents over time. Sensitivity analyses of those studies that conducted significance testing for socioeconomic differences in trends did not alter our conclusions.

In this review we report absolute differences in overweight and obesity prevalence (that is, the difference in prevalence between two groups rather than the percentage, or relative, difference). Whilst the choice of inequality measure can result in different conclusions (33,34), we have focussed on absolute measures of inequality as these are most relevant for issues and decisions pertaining to health policy (35,36). Finally, like others reporting findings by SEP, we recognize that our analysis of absolute differences between the least and most disadvantaged groups did not allow for reporting of difference across the socio-economic gradient, but rather only differences between the extremes of SEP (32).

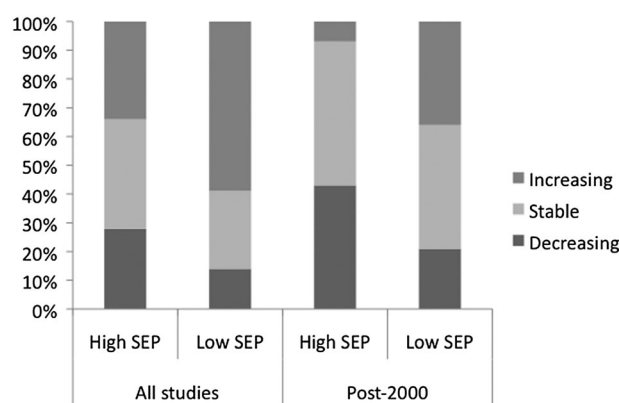


Figure 3 Overweight and obesity prevalence trends by socioeconomic position for all included studies and for those studies only reporting on post-2000 data. (Note, Fig. 3 shows the proportion of studies indicating increases [in some or all age and sex subgroups], stabilization and decreases [in some or all age and sex subgroups] in overweight and obesity trends according to socioeconomic position for all included studies, and for those studies reporting only post-2000 data).

Implications and future research

Children from lower socioeconomic groups disproportionately carry the excess burden of obesity. While there is some evidence of improvements in overweight and obesity, among both low and high SEP populations, it is now important to understand what has contributed to these improvements, to enable action to reduce overweight and obesity for children and adolescents in all SEP groups. If trends in obesity prevalence do not improve at the same rate across socioeconomic groups, this is likely to lead to further inequalities across a range of health and wellbeing outcomes. Efforts to reduce overweight and obesity must seek to reduce, or at the very least not widen, socioeconomic inequalities in weight and health. Future research has a role to play in ensuring that monitoring of overweight and obesity prevalence and trends and evaluation of the response to interventions to address overweight and obesity includes collection and reporting of findings by SEP, else important disparities may be masked.

Conclusion

Child and adolescent overweight and obesity remains an issue in economically advanced countries. Socioeconomic differences in child and adolescent overweight and obesity trends are evident, and while there are some signs of improvement in overweight and obesity prevalence for children and adolescents from both low and high SEP groups, in a number of countries inequalities between socioeconomic groups appear to be widening.

Conflict of interest statement

None

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Appendix 1: Findings by country

Australia

O'Dea and Dibley(37) used national data to report on overweight (not including obesity) and obesity among 6 to 18 year olds from 2000 to 2006. Authors performed logistic regression analyses of overweight and obesity prevalence according to SEP, with survey year included in the analyses. They reported significant increases in obesity over time among low SEP children, and no significant increases among high SEP children.

Dollman and Pilgrim(38) reported on trends in BMI, waist girth and skinfolds among 11-year-old children in South Australia from 1997 to 2002. Their results indicate increasing adiposity among boys and girls over the study period; however, this was not reported for SEP subgroups. The authors performed interaction tests to test associations between survey year, SEP and rates of change in adiposity. Among girls, results were significant with skinfolds increasing significantly over time among low, but not high SEP girls. No significant interactions were seen in BMI or waist circumference among girls. Among boys, no interactions between survey year and SEP were observed for any adiposity measure.

Nichols *et al.* (39) reported on overweight and obesity among preschool-aged children from Victoria for the period 1999 to 2007. The authors calculated odds ratios for overweight and obesity per year and tested for significance. Among 2-year-old children, decreases in overweight (including obesity) prevalence were not statistically significant for low or high SEP children. Among 3.5-year-old children, decreases in overweight (including obesity) were statistically significant in low and high SEP children. Our analysis of point prevalence data presented by the authors indicates a narrowing of socioeconomic differences in overweight (including obesity) trends among 3.5 year olds, but no changes to the differences between SEP subgroups among 2 year olds.

Hardy *et al.* (40) examined trends in obesity among children and adolescents from New South Wales for the period 1985 to 2010. The authors reported no significant increases in the prevalence of obesity among boys or girls

for the period 1997 to 2010. None of the interactions in the prevalence of obesity between SEP groups and survey year were significant.

O'Dea *et al.* (41) also reported on data from New South Wales, examining overweight and obesity among nine to 12 year olds from 2004 to 2009. Our analyses of their reported point prevalence data indicated decreasing prevalence of obesity among low SEP children, but no change among high SEP children.

Austria

Kirchengast *et al.* (42) used conscript data to describe overweight and obesity trends among 18-year-old men across three regions of Austria from 1985 to 2000. They found associations between lower socioeconomic status and overweight and obesity in each region. According to analysis of point prevalence data, obesity prevalence increased in low SEP males in Eastern and Central Austria, but did not change among high SEP males in the same regions. In Western Austria, obesity prevalence did not change over time in either SEP subgroup.

Denmark

Moller *et al.* (43) reported trends in overweight (including obesity) among Danish children for the period 1997 to 2004. Overweight trends showed little change over time within both low and high SEP groups. The authors conducted tests for polarization of trends between low and high SEP boys and girls over time; these were not significant after post-hoc Bonferroni's correction.

England

Stamatidis *et al.* (44) utilized data from the Health Surveys for England to report on obesity among children and adolescents aged 2 to 18 years from 1995 to 2007. Analysis of their graphed results indicated increasing obesity prevalence among primary school children in high and low SEP groups, with the exception of high SEP girls, for whom obesity trends appear to flatten. Among adolescents, it appears that obesity prevalence trends are increasing for both males and females in low and high SEP groups. It appears that among both children and adolescents, the socioeconomic differences in obesity are widening over time.

Finland

In Finland, Kautiainen *et al.* (45) examined trends in adolescent overweight and obesity from 1979 to 2005. Their findings indicated increasing prevalence of overweight and obesity among both low and high SEP groups. Our analysis of the point prevalence data presented by the authors indicates socioeconomic differences in trends among adolescent girls, where differences have widened over time, and no differences in trends among boys.

France

Lioret *et al.* (46) examined overweight and obesity among French children and young adolescents aged 3 to 14 years over the period 1998 to 2007. Chi-square tests performed by the authors indicated no significant changes in overweight and obesity prevalence over time for high or low SEP groups.

Salanave *et al.* (47) examined overweight among 7–9 year olds in France between 2000 and 2007. Chi-square analyses showed that the changes in overweight (including obesity) over time were not significant for any SEP group. Interactions between survey year and SEP were also not significant.

Thibault *et al.* (48) reported on overweight among 5- and 6-year-old children in Bordeaux City from 2004 to 2011. Their results showed statistically significant decreases in overweight prevalence among high SEP children, but no change over time among low SEP children.

Israel

Gross *et al.* (49) used conscript data to describe trends in obesity among 17-year-old males in Israel from 1967 to 2003. We examined graphed data from 1991 onwards which illustrated increasing prevalence of overweight among high and low SEP males over time. The authors reported that since the mid-1990s, growth in obesity rates was higher among lower socioeconomic males, leading to increased socioeconomic differences between high and low SEP groups.

Mexico

Bonvecchio *et al.* (50) reported on overweight (not including obesity) and obesity trends among children aged 2 to 18 years in Mexico for the period 1988 to 2006. Analysis of their findings showed no changes in obesity prevalence among both low and high SEP children aged 2–4 years, increasing obesity among both low and high SEP children aged 5–11 years, and increasing obesity among low and high SEP girls aged 12–18 years. No socioeconomic differences in obesity trends were observed among children aged 2–11 or among girls aged 12 to 18 years. Overweight and obesity prevalence for boys aged 12 to 18 years were not reported according to SEP.

Northern Ireland

Whittle *et al.* (51) reported trends in underweight, overweight and obesity among young adolescents in Northern Ireland for the period 1996 to 2007. Their data illustrated rising rates of overweight and obesity among low and high

SEP children. Our analysis of point prevalence data from this study found socioeconomic differences in trends in overweight (including obesity) between SEP groups have widened over time among both girls and boys.

Poland

Zadzinska *et al.* (52) described underweight, overweight and obesity among children and adolescents in Poland from 1977 to 2004. Their findings indicated increasing prevalence of overweight and obesity among high and low SEP boys, and decreasing prevalence among low SEP girls with little change among high SEP girls. Analysis of the point prevalence data presented by the authors indicated no socioeconomic differences in trends in overweight and obesity. Of note is that the authors of the study reported increasing incidence of underweight in children and adolescents, and describe positive associations between low SEP and underweight.

Scotland

Smith *et al.* (53) reported trends in overweight and obesity among 5- and 6-year-old Scottish children from 1970 to 2006. Graphed trends showed that obesity prevalence increased among low and high SEP children over time. Interaction tests for socioeconomic differences in trends were significant for overweight and obesity.

Sweeting *et al.* (54) examined obesity prevalence among 15-year-old Scottish adolescents from 1987 to 2006. Their findings showed increasing overweight and obesity prevalence among low and high SEP groups. Our analysis of obesity prevalence data stratified by parent occupation indicated no socioeconomic differences in obesity trends over time.

Spain

Salcedo *et al.* (55) reported point prevalence data for overweight and obesity by SEP among children and adolescents from the Spanish National Health Surveys from 1987 to 2007. Their data indicated increasing prevalence of overweight and obesity among low and high SEP children. Analysis of the point prevalence data from this study indicated socioeconomic differences in trends in overweight (including obesity) among boys aged 5 to 15 years but no differences in trends among girls of the same age.

Sweden

Sundblom *et al.* (56) examined overweight and obesity among 10 year olds in Stockholm County from 1999 to 2003. Point prevalence data presented by authors indicated increasing obesity prevalence among low SEP boys, and decreasing prevalence among high SEP boys. Among girls, no changes in prevalence were observed over time for either SEP subgroup.

Sjoberg *et al.* (57) reported on overweight and obesity among 10 year olds in Gothenburg for the period 2000 to 2005. Their data indicated no changes in overweight (including obesity) trends among low and high SEP boys, and decreasing trends among low and high SEP girls. The authors performed interaction tests and found no significant interactions between linear trends in overweight and obesity prevalence between socioeconomic groups.

United States

May *et al.* (58) used NHANES data to report on national obesity prevalence from 1999 to 2010 for young people aged 2 to 17 years. Their data showed increasing prevalence of obesity among low SEP males and females, accompanied by little change in obesity prevalence among high SEP males and a decrease in prevalence among high SEP females. Authors performed interaction tests that showed a widening of socioeconomic differences in obesity trends among females, but no changes to the differences between low and high SEP males over time.

Frederick *et al.* (59) also reported national trends in adolescent obesity, from the National Survey of Children's Health (NSCH) for the period 2003 to 2011. The NSCH data indicated increasing prevalence of obesity among low SEP adolescents, accompanied by a stabilization among high SEP adolescents. Authors performed interaction tests to examine the differences in obesity trends between SEP groups and found these to be significant.

Delva *et al.* (60) reported on overweight (including obesity) among 8th, 10th and 12th grade boys and girls across the United States from 1993 to 2003. Their results indicated increasing prevalence of overweight over time for both low and high SEP populations. Analysis of point prevalence data found a widening of socioeconomic differences in trends in overweight for most subgroups examined. Exceptions to this were seen among 8th grade girls, where no changes to the differences between low and high SEP subgroups were seen over time, and among 12th grade boys for whom socioeconomic differences between low and high SEP groups narrowed over the study period.

Skelton *et al.* (61) reported trends in severe obesity among children and adolescents across the United States from 1988 to 2004. Their findings showed significant increases in the prevalence of severe obesity among low SEP children and adolescents, but not among high SEP children and adolescents.

Babey *et al.* (62) reported on overweight and obesity among Californian adolescents for the period 2001 to 2007. Results indicated increasing obesity prevalence among low SEP adolescents, and a stabilization in prevalence among high SEP adolescents. Interaction tests performed by the authors showed significant widening of socioeconomic differences in overweight and obesity among

boys, but no statistically significant changes in to the differences between SEP groups over time among girls.

Berger *et al.* (63) examined obesity among 5 to 14 year olds in New York City from 2006 to 2011. The authors reported decreasing obesity prevalence across the study period for children in high and low SEP subgroups. Our analysis of obesity prevalence data stratified by SEP found no changes to the socioeconomic differences in obesity between low and high SEP groups.

Boles *et al.* (64) examined obesity among children and young adolescents living in Anchorage, Alaska from 2003 to 2011. The data showed a decrease in obesity prevalence over time among high SEP children accompanied by an increase in obesity prevalence over time among lower SEP children. Analysis of point prevalence data found that socioeconomic differences in obesity trends between low and high SEP groups have widened from 2003 to 2011.

Robbins *et al.* (65) reported on obesity among children and adolescents in Philadelphia, Pennsylvania for the period 2006 to 2010. Their findings indicated small

decreases in the prevalence of obesity and severe obesity for low and high SEP groups. Analysis of point prevalence data indicated no socioeconomic differences in obesity prevalence between low and high SEP groups.

Wales

Brunt *et al.* (66) reported trends in overweight and obesity among 3-year-old children in South Wales for the period 1995 to 2005. While the study authors' analysis of overweight and obesity trends groups suggested a greater rate of increase of overweight/obesity in children from most deprived areas compared to least deprived areas, this was not statistically significant. Linear regression lines were plotted to show trends in prevalence of overweight and obesity in lowest and highest SEP groups between 1995 and 2005. The difference in the slopes of the two regression lines was also not statistically significant.

5 THE CONTRIBUTION OF UNHEALTHY FOOD AND DRINK CONSUMPTION TO THE DEVELOPMENT OF SOCIOECONOMIC INEQUALITIES IN CHILDREN'S BMI Z-SCORE

5.1 SUMMARY

The findings presented in the previous chapter demonstrated differences in trends in child and adolescent obesity prevalence across socioeconomic groups. In order to better understand the factors driving those differences in trends, this chapter now focuses on the role of dietary behaviours on the development of socioeconomic inequalities in overweight and obesity in a cohort of children followed from birth to age 10 to 11 years of age. Dietary behaviours are known to be socioeconomically patterned and unhealthy diets are a leading risk factor for obesity. The aim of this study was to explore the relationship between unhealthy diets across childhood and the development socioeconomic inequalities in BMI z-score among Australian children.

This study found that socioeconomic differences in unhealthy food and drink consumption emerged during the first year of life and persisted throughout childhood. This study also demonstrated that inequalities in the consumption of unhealthy food and drinks throughout childhood contributed to the development of socioeconomic inequalities in BMI z-score in children at the age of 10 to 11 years.

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**5.2 PUBLICATION: CONTRIBUTION OF DISCRETIONARY FOOD AND DRINK
CONSUMPTION TO SOCIOECONOMIC INEQUALITIES IN CHILDREN'S WEIGHT:
PROSPECTIVE STUDY OF AUSTRALIAN CHILDREN**



Social Inequality

Contribution of discretionary food and drink consumption to socio-economic inequalities in children's weight: prospective study of Australian children

Alexandra Chung,^{1,2} Anna Peeters,² Emma Gearon^{1,2} and Kathryn Backholer²

¹School of Public Health & Preventive Medicine, Monash University, Melbourne, VIC 3004, Australia and ²Global Obesity Centre (GLOBE), World Health Organization Collaborating Centre for Obesity Prevention, Centre for Population Health Research, School of Health & Social Development, Deakin University, Geelong VIC 3220, Australia

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Abstract

Background: In high-income countries, children with a lower socio-economic position (SEP) are more likely to gain excess weight compared with children with a higher SEP. The extent to which children's consumption of discretionary food and drinks contributes to the development of these inequalities over childhood has not been examined.

Methods: The study sample comprised 3190 children from the nationally representative Longitudinal Study of Australian Children. Linear and logistic regression models were fitted in accordance with the product of coefficients mediation method to determine the contribution of cumulative consumption of sweet drinks, discretionary hot foods, savoury snacks and sweet snacks from the first year of life, over a period of 10 years, on the relationship between SEP and children's body mass index (BMI) z-score at age 10–11 years.

Results: At age 10–11, mean BMI z-score was 0.17 in the highest SEP tertile, 0.33 in the middle and 0.47 in the lowest tertile. Corresponding values for overweight and obesity prevalence were 16.6%, 25.7% and 32.7%, respectively. Eleven per cent [95% confidence interval (CI) 4.77%, 19.84%] of the observed difference in BMI z-score at age 10–11 years was mediated by socio-economic differences in consumption of sweet drinks and discretionary hot foods including pies and hot chips throughout childhood.

Conclusions: Findings indicate that consumption of sweet drinks and discretionary hot food, from the first year of life, is likely to contribute to the development of inequalities in excess weight among children. Poor dietary intake is a key risk factor for excess weight gain among children and a reduction in discretionary food and drinks is likely to contribute to the dual goal of improving overall weight and reducing socio-economic inequalities in weight gain across childhood. To maximally reduce inequalities in weight gain across childhood, additional determinants must also be identified and targeted.

Key words: child, overweight, obesity, health inequalities, mediation

Key Messages

- Weight gain among children in Australia follows a socio-economic gradient whereby those with lower socio-economic position (SEP) have higher BMI z-scores at age 10–11 years compared with children with higher SEP.
- Socio-economic differences in the consumption of discretionary food and drinks emerge at a young age and persist throughout childhood.
- Discretionary food and drink consumption from the first year of life appears to contribute to the development of inequalities in excess weight among Australian children.

Introduction

In high-income countries, children from lower socio-economic backgrounds are more likely to be overweight or obese compared with children with greater social and economic resources.¹ In Australia, 33% of children living in the most disadvantaged areas are overweight or obese, compared with 19% of children living in the least disadvantaged neighbourhoods.²

Dietary behaviours follow similar socio-economic gradients. Among children and adolescents, higher socio-economic position (SEP) is associated with healthier dietary patterns^{3,4} and better diet quality.⁵ In particular, children with higher SEP are more likely to consume and achieve recommended intakes of fruit and vegetables.^{6–11}

Discretionary food and drinks can be defined as food and drinks containing added fat, sugar and/or salt and are considered not necessary for a healthy diet.¹² Despite recommendations to limit consumption,¹² they have been found to contribute up to 40% of Australian children’s total daily energy intake.^{2,13} Children with lower SEP are more likely to consume discretionary food and drinks such as sugar-sweetened beverages (SSBs),^{6,10,11,13,14} fruit juice,⁷ snack foods¹¹ and fast food.^{10,15} This is concerning because poor diet quality, including consumption of sweet drinks and unhealthy snack foods in childhood, is considered a key risk factor for overweight and obesity.^{16–18} Whilst many aspects of diet are important, given their lack of nutritional value and high contribution to children’s daily energy intake, discretionary food and drinks are an important policy target.

Whilst there is evidence of socio-economic differences both in children’s weight and diet quality, there has been no formal examination of the mediating role of discretionary food and beverages in the development of socio-economic inequalities in children’s weight from birth. Identifying the mechanisms by which socio-economic inequalities in weight gain develop across the life course

can highlight leverage points for intervention that are both effective and equitable. This is critical, as inequalities in weight translate into inequalities in health.¹⁹

Using data from the Longitudinal Study of Australian Children (LSAC), this study explored the mediating role of cumulative discretionary food drink consumption during childhood (from age 0–1 year, collected every 2 years) on the development of socio-economic inequalities in weight gain from birth to age 10–11 years.

Methods

Ethics

The LSAC study protocol was approved by the Australian Institute of Family Studies Ethics Committee. Written consent was provided for each participant. This analysis was approved by Deakin University Human Research Ethics Committee (Reference 2016–161) and Monash University Human Research Ethics Committee (Project Number CF14/2574–2014001384).

Study design and sample

LSAC is a nationally representative prospective study following two cohorts of Australian children since 2004²⁰ (Table 1). Our study comprised participants from the B cohort of LSAC into which 5107 participants were recruited. Our eligible sample included the 3764 children in the B

Table 1. Longitudinal Study of Australian Children (LSAC) study waves

Year	2004	2006	2008	2010	2012	2014
Study wave	1	2	3	4	5	6
B cohort (age in years)	0–1	2–3	4–5	6–7	8–9	10–11
K cohort (age in years)	4–5	6–7	8–9	10–11	12–13	14–15

cohort present at Wave 6 (74%). We excluded participants with missing data for SEP at Wave 1 ($n = 8$), BMI z-score at Wave 6 ($n = 201$), dietary variables of interest at Waves 1, 2, 3, 4 or 5 ($n = 337$) and relevant confounding variables ($n = 28$), resulting in a final analytical sample of 3190 participants. The proportion of participants with missing data was less than 10% for variables included in our analysis. (Further study design details are provided in Supplement A, available as [Supplementary Data](#) at *IJE* online.)

Data collection

Data were collected via structured interviews conducted by trained professionals and written questionnaires completed by the child's primary caregiver (typically the child's mother).

Socio-economic position (exposure)

A composite measure of SEP was generated for the LSAC cohort to provide a continuous relative SEP score. The score comprised measures of parents' annual income; years of education of each parent; and the occupational status of each parent, accounting for the number of parents in the home.²¹ To capture SEP around the time when discretionary food and drinks are first introduced, we used the SEP score generated at the first wave of data collection to create deciles of SEP, which were used as a continuous measure of SEP in our mediation analysis. From the composite SEP score, we also generated tertiles of SEP, which were used to describe population characteristics according to higher, middle and lower SEP.

Anthropometry (outcome)

Trained professionals measured children's weight to the nearest 50 grams and height to the nearest 0.1 centimetre. From this, BMI (kg/m^2) was calculated and converted into continuous age- and sex-specific BMI z-scores.²² Overweight and obesity were classified according to International Obesity Taskforce cutoffs.²³

Diet (mediators)

In face-to-face interviews, parents were asked about their child's consumption of specific food items in the previous 24-hour period. The interviewer asked: 'In the last 24 hours how often did child have (*specified food or drink*)' and response options were 'not at all' (0); 'once' (1); 'more than once' (2). Questions on consumption of sweet drinks were asked from Wave 1 (age 0–1 year) onwards and questions about discretionary foods were asked from Wave 2 (age 2–3 years) onwards. Our analysis examined all available discretionary food and drink variables that we grouped into four categories: sweet drinks, discretionary hot food, savoury snacks and sweet snacks ([Table 2](#)).

For our descriptive analysis, participants were identified as 'non-consumers' (answered 'not at all') or 'consumers' (answered 'once' or 'more than once') for consumption in the past 24 hours of any of the food or drink items listed within each discretionary food and drink category, for each survey wave. For mediation analyses, these dichotomous responses were summed across each survey wave, for each discretionary food and drink category, so that each participant was classified as an overall high consumer (consumed discretionary food at ≥ 2 waves or sweet drinks at ≥ 3 or waves) or low consumer (consumed discretionary food at ≤ 1 wave or sweet drinks at ≤ 2 waves) ([Table 2](#)).

Covariates

Covariates were identified based on prior evidence of their influence on the relationships examined in our analyses. At the first survey wave, parents reported their child's sex, weight at birth and age in months. Parents reported their child's preference for active or inactive use of free time at each survey wave from age 2–3 years onwards by responding to the question: 'What does Child usually do when she/he has a choice about how to spend free time? Usually chooses inactive pastimes like TV, computer, drawing or reading; just as likely to choose active as inactive pastimes; usually chooses active pastimes like bike riding, dancing, games or sports.' Mother's age in years was self-reported. Parents reported whether their child was of Aboriginal or Torres Strait Islander (ATSI) origin. Mother's main language was determined by the question: 'Does Mother speak a language other than English at home?'

Descriptive analysis

Descriptive statistics examined key demographic (Wave 1) and behavioural characteristics (Waves 1–6) of our analytical population, according to tertile of SEP (Wave 1). Logistic regression models were fitted to examine socio-economic differences in the prevalence of overweight and obesity at Wave 6 (age 10–11 years), adjusted for child's age, sex, birthweight, mother's age, English as main language and ATSI origin.

Longitudinal mediation analysis

To determine the mediating effect of cumulative discretionary food and drink consumption throughout childhood on the relationship between SEP and BMI z-score at age 10–11 years, we fitted a series of regression models in accordance with the product of coefficients mediation method. A mediator must be associated with SEP (a-relationship) and be associated with BMI z-score at age 10–11 years independently of each other mediator, SEP and

Table 2. Classification of discretionary food and drink categories for mediation analysis

Discretionary food or drink category	Constituents	Data waves used	Low/high consumer cut-points
Sweet drinks	Fruit juice Soft drink Cordial	1, 2, 3, 4, 5	≤ 2 waves = low consumer ≥ 3 waves = high consumer
Discretionary hot food	Meat pies Hamburgers Sausage rolls Hot dogs Sausages Hot chips French fries	2, 3, 4, 5	≤ 1 wave = low consumer ≥ 2 waves = high consumer
Savoury snacks	Potato chips Savoury snacks, i.e. Twisties etc.	2, 3, 4, 5	≤ 1 wave = low consumer ≥ 2 waves = high consumer
Sweet snacks	Biscuits Doughnuts Cake Pie Chocolate	2, 3, 4, 5	≤ 1 waves = low consumer ≥ 2 waves = high consumer

potential confounders (b-relationship). The proportion mediated (for each individual mediator and for all significant mediators combined) was determined by dividing the indirect effect by the total effect coefficients. We used a bootstrap with 5000 replications to obtain 95% confidence intervals (CIs) for all coefficients and mediated proportions. All models were adjusted for Wave 1 covariates including child's age, sex, birth weight, mother's age, English as main language, ATSI origin and child's preference for active or inactive pastimes at Waves 2–5. A heuristic model of the longitudinal mediation analysis is depicted in Figure 1. (The multiple steps undertaken are outlined in Supplement B, available as [Supplementary Data](#) at *IJE* online.)

Sensitivity analysis

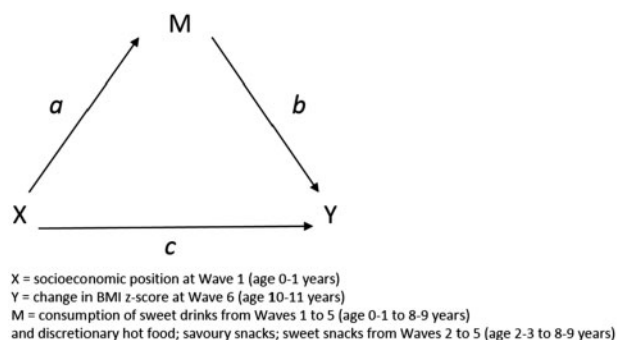
We tested whether our analyses were sensitive to non-response and attrition by applying LSAC sample weights to our descriptive analyses and regression models.²⁴ We also tested sensitivity of our exposure and outcome indicators in separate models using mother's education at Wave 1 and SEP at Wave 6 as exposures and overweight and obesity at Wave 6 as the outcome.

All analyses were conducted using Stata version 14.²⁵

Results

Descriptive analysis

Socio-economic patterning was observed for a number of key characteristics. Weight at birth, birthweight z-score and maternal age increased with increasing SEP. The

**Figure 1.** Heuristic model for longitudinal mediation analysis.

proportion of ATSI children and child's BMI z-score at age 10–11 years decreased as SEP increased. The proportion of families with mothers who spoke a language other than English was higher among those in the low and high SEP tertiles (Table 3). The proportion of overweight and obesity was lower for each increase in tertile of SEP at each study wave (Figure 2). The consumption of sweet drinks, discretionary hot food and savoury snacks was greater among children with lower SEP across all study waves (Figure 3).

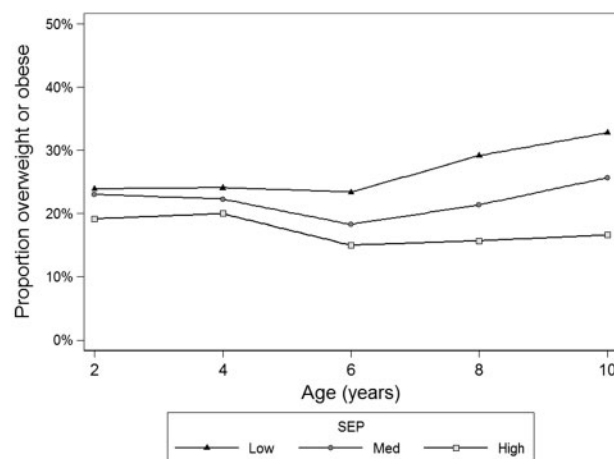
Longitudinal mediation analysis

Of the four potential mediating categories of discretionary food and drinks examined in our study, sweet drinks and discretionary hot food were associated with both exposure (SEP) and outcome (BMI z-score at age 10–11 years). Consumption of sweet drinks from age 0–1 to 8–9 years mediated 5.9% of the relationship between SEP and BMI z-score at age 10–11 years, and consumption of

Table 3. Population characteristics according to tertile of socio-economic position

<i>n</i> =	Lower SEP 808 (25.3%)	Middle SEP 1096 (34.4%)	Higher SEP 1286 (40.3%)
Baseline			
Sex (% male)	49.9%	50.6%	52.9%
Age (months)	8.6 (2.5)	8.6 (2.6)	8.9 (2.5)
Weight at birth (grams)	3387.1 (638)	3413.4 (583.9)	3475.5 (546.7)
Birth weight z-score	−0.05 (1.1)	−0.03 (1.0)	0.07 (1.0)
Maternal age (years)	29.9 (5.8)	31.6 (4.7)	33.2 (4.0)
Aboriginal or Torres Strait Islander	5.2%	2.3%	0.6%
English as Mother's main language spoken at home	88.6%	90.1%	88.1%
Wave 6			
BMI z-score (age 10–11 years)	0.47 (1.1)	0.33 (1.0)	0.17 (0.9)

Figures in table are means and standard deviations or proportions. SEP, socio-economic position; BMI, body mass index.

**Figure 2.** Prevalence of overweight and obesity according to tertile of socioeconomic position (SEP) at each LSAC survey wave.

discretionary hot food between ages 2–3 and 8–9 years mediated 5.4% of the relationship between SEP and BMI z-score at age 10–11 years. Collectively, the intake of these discretionary items across childhood mediated 11.31% (95% CI 4.77%, 19.84%) of the socio-economic differences in BMI z-score at age 10–11 years (Table 4).

Sensitivity analysis

The relationships between SEP and all mediators and between mediators and BMI z-score did not appreciably differ after applying LSAC sample weights (Supplement C, available as [Supplementary Data](#) at *IJE* online). Using mother's education (Supplement D, available as [Supplementary Data](#) at *IJE* online) and SEP at Wave 6 (Supplement E, available as [Supplementary Data](#) at *IJE* online) as the exposures and overweight and obesity as the outcome (Supplement F, available as [Supplementary Data](#) at *IJE* online), results were not appreciably different to the primary analysis.

Discussion

This is the first study, to our knowledge, to estimate the mediating effect of specific discretionary food and drink items on the development of socio-economic inequalities in children's weight. Using a contemporary sample of Australian children, followed up every 2 years between birth and age 10–11 years, we found distinct socio-economic differences in the development of overweight and obesity, which increased as SEP decreased. Similar socio-economic differences in the consumption of discretionary food and drinks emerged at a young age and persisted throughout childhood. Childhood consumption of sweet drinks and discretionary hot food was associated with a greater gain in BMI z-score from birth to age 10–11 years. Cumulative consumption of sweet drinks from age 0–1 year and discretionary hot food from age 2–3 years mediated just over 11% (95% CI 4.77%, 19.84%) of the longitudinal relationship between SEP and BMI z-score from birth to age 10–11 years.

Our analysis found that SEP was positively associated with birthweight z-scores, but this association shifted to an inverse association by age 2–3 years, which remained throughout childhood. Other research has also identified this shift in socio-economic patterning from a positive SEP-weight relationship at birth to an inverse relationship in later childhood, commonly reported to occur around the ages of 5–7 years.^{24,26}

Our findings of socio-economic differences in adiposity among children are comparable to the observed socio-economic differences in weight among children in LSAC's kindergarten cohort.²⁷ Similar socio-economic inequalities in children's weight have been reported in a number of high-income countries in recent years.^{28,29}

Consumption of discretionary foods appears to begin at an early age, with sweet drink consumption evident among almost half of 0- to 1-year-old children in the lowest tertile

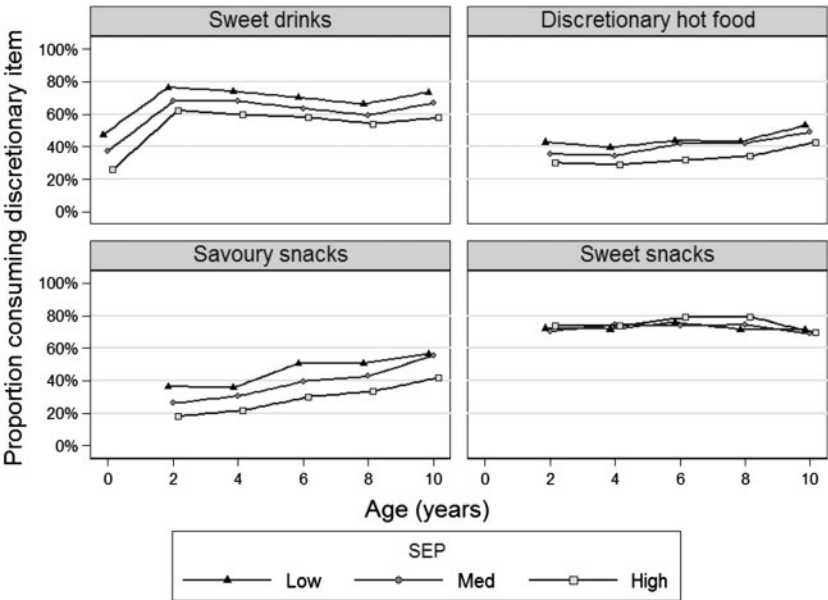


Figure 3. Consumption (once or more) of discretionary food and drinks in the 24-hours prior to survey. Results presented for each LSAC survey wave according to tertile of socioeconomic position (SEP).

Table 4. Results from mediation analysis examining the contribution of discretionary food and drink consumption across childhood on the development of socio-economic differences in BMI z-score from birth to age 10–11 years

	Association between SEP and mediator		Association between mediator and BMI z-score		Mediated effect ^b		Proportion mediated	
	a ^a	95% CI	b ^a	95% CI	ab	95% CI	%	95% CI
Sweet drinks	−0.14	(−0.17, −0.11)	0.09	(0.01, 0.16)	−0.008	(−0.016, −0.001)	5.94%	(0.89%, 12.45%)
Discretionary hot food	−0.12	(−0.15, −0.09)	0.09	(0.01, 0.16)	−0.007	(−0.014, −0.001)	5.37%	(0.77%, 10.96%)
Savoury snacks	−0.15	(−0.18, −0.12)	−0.05	(−0.12, 0.03)	0.005	(−0.003, 0.013)		
Sweet snacks	0.02	(−0.02, 0.07)	0.06	(−0.06, 0.17)	0.001	(−0.001, 0.003)		
Sum of significant mediators					−0.016	(−0.025, −0.007)	11.31%	(4.77%, 19.84%)

^aa coefficient adjusted for all confounders (child’s age, sex and birth weight, mother’s age, ATSI origin and English as mother’s main language at home and child’s preference for active or inactive pastimes as reported by parents at each wave from age 2–3 to 8–9 years); b coefficient adjusted for all confounders, the exposure (SEP), and all other mediating variables.

^bStandardized ab coefficients.

of SEP in our sample. We identified socio-economic gradients in the cumulative intake of discretionary food and drink items including sweet drinks, discretionary hot food and savoury snacks throughout childhood. Similar socio-economic patterning in the consumption of sweet drinks and high-sugar, high-fat foods has been observed among children in a number of other high-income countries.^{30,31}

We observed a positive association between childhood consumption of sweet drinks and BMI z-score at age 10–11 years. This is consistent with international findings from cross-sectional and longitudinal research indicating that consumption of sweet drinks, including fruit juice, in early childhood is associated with excess weight gain.^{32–34} We also observed associations between consumption of discretionary hot food across childhood and higher BMI

z-score, but found no association between consumption of sweet and savoury snacks and BMI z-score. The lack of association between consumption of sweet snacks and BMI z-score may be due to the limited variability in consumption, with high prevalence observed among all children. For savoury snacks, the lack of association with BMI z-score may be due to differential reporting bias according to children’s weight status; the relatively crude manner in which these items were reported, with little detail regarding quantities consumed; or a true lack of effect.

Our findings showed that cumulative consumption of sweet drinks and discretionary hot foods throughout childhood mediates around 11% of the socio-economic differences in children’s BMI z-score at age 10–11 years. Sweet drinks and discretionary hot foods were related to both

children's weight gain and to inequalities in the development of BMI from birth to age 10–11 years. Thus, interventions that reduce intake of these items may contribute to the dual outcome of reduced population weight for children and reduced inequalities in excess weight gain across childhood. Whilst sweet snacks was not identified as a mediator, it was consumed in high quantities by all children, regardless of SEP, and should be considered a target in interventions to improve children's diets across the socio-economic gradient. Our analysis also highlights the critical need to identify and target additional determinants of inequalities in weight gain across childhood.

Additional determinants that may contribute to the development of socio-economic inequalities in children's BMI z-scores include perinatal factors, including maternal weight and diet during pregnancy, commencement and duration of breastfeeding and complementary feeding;³⁵ behavioural factors in childhood such as overall diet and total energy intake, physical activity, sedentary behaviour and sleep; and more upstream determinants including neighbourhood environments³⁶ and social and cultural norms.^{37,38} A reduction in children's consumption of discretionary food and drinks is therefore an important target for preventive health policy alongside complementary actions to address the range of determinants of socio-economic inequalities in children's weight.

Strengths of this study include six waves of data collected over 10 years, allowing examination of the role of cumulative discretionary food intake on socio-economic inequalities in weight gain from birth to age 10–11. Our study utilized a robust measure of SEP measured at Wave 1, which tracked across study waves with 70% of participants remaining in the same SEP tertile at Wave 6. Our study was further strengthened by objectively measured anthropometric data.

The study also has a number of limitations to note. First, whereas the initial study population was representative of Australian children, non-response across LSAC waves was higher for children whose parents were low-income earners, of ATSI origin or spoke a language other than English as the main language at home. However, sensitivity analyses accounting for LSAC non-response yielded similar results. Second, discretionary food intake was self-reported. Self-reported dietary data can be imprecise and susceptible to underreporting.³⁹ The extent of differential underreporting according to SEP, e.g. due to social desirability bias, is unclear. Third, information for many discretionary food and drink items were not captured and, of those that were, we had information on frequency of consumption only. Ideally, dietary data would be obtained using data-collection methods validated for use in children⁴⁰ and provide greater detail on total dietary intake,

including quantities consumed. Fourth, whilst the data used in our study were the most contemporary data available for this age group, earlier waves of data were collected prior to the mounting public awareness of the harms of SSBs and may not fully reflect current perceptions or consumption of sweet drinks. Finally, the measure of physical activity in LSAC is relatively crude, reporting children's preferences for time spent in active or inactive pastimes. The differential attrition, self-reported dietary data and limited dietary detail may mean that the results in this study are underestimates of the true effect of impact of discretionary food and drink consumption on the development of inequalities in children's weight. Our findings demonstrate that intake of discretionary hot foods and sweet drinks throughout childhood contributes to the development of socio-economic differences in childhood weight gain. These findings may be generalizable across high-income countries where similar socio-economic gradients in overweight and obesity are evident. Reducing inequalities in discretionary food and drink consumption among children in high-income countries will require a combination of interventions, which act across the gradient of socio-economic disadvantage. This will likely include interventions that change the structural drivers of unhealthy food and drink intake and a combination of population level and targeted interventions towards more socio-economically disadvantaged groups.^{41,42} Evaluation of interventions and ongoing population health monitoring will be critical to our understanding of the impacts of population level and targeted interventions across the socio-economic gradient. Further research is also required to improve understanding of the role of other important modifiable obesity-related risk factors on socio-economic differences in children's weight.

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5.3 APPENDIX ONE: SUPPLEMENTARY MATERIAL

Supplement A: Longitudinal Study of Australian Children (LSAC) study design and sample

LSAC employed a two-stage cluster weights design. Australian postcodes were used as the primary sampling unit, stratified by state and by urban or rural status. All children born in the selected postcode areas between March 2003 and February 2004 (B Cohort, aged 0-1 years at wave 1) and between March 1999 and February 2000 (K Cohort, aged 4-5 years at wave 1), and enrolled on the Australian Medicare database were eligible and a random sample was invited to participate. Of the families contacted during recruitment 64.2% (B cohort) and 59.4% (K cohort) agreed to participate. Data collection has been conducted every two years since baseline (2004) and is ongoing.

Supplement B: Stepwise description of longitudinal mediation analysis methods

1) a linear regression model was used to determine the total relationship between SEP (wave 1) and BMI Z-score (wave 6) adjusted for all confounders (c coefficient); 2) separate logistic regression models were used to determine the independent relationship between SEP (wave 1) and each mediator (waves 1-5) adjusted for all confounders (a coefficient); 3) a single linear regression model was used to determine the relationship between each mediator (waves 1-5) and BMI z-score (wave 6) adjusted for all confounders, the exposure (SEP), and all other mediating variables (b coefficient); 4) the Stata code `binary_mediation` was used to generate standardized coefficients for the linear and logistic regression models described above, providing the indirect effect of SEP (wave 1) on BMI z-score (wave 6) through each of the individual mediating variables (waves 1-5). The sum of all indirect effects (sum of ab for all significant individual mediators) yielded the total indirect effect through all mediators; 5) the proportion mediated (for each individual mediator and for all significant mediators combined) was determined by dividing the indirect effect (standardized ab coefficient) by the total effect (standardized c coefficient). We used a bootstrap with 5000 replications to obtain the standardized c- and ab-coefficients and their respective 95% confidence intervals (CIs) and the 95% CIs for the mediated proportions.

The assumptions of the product of coefficients method were tested and upheld, including: linear relationships between exposure and outcome, and each mediator and outcome; no correlations between the predictor and residuals for the linear relationships tested; no exposure-mediator interactions; and normal distribution of continuous variables. We did not identify any SEP-sex interactions, thus our analyses were not stratified by sex.

Supplement C: Sensitivity analysis results with LSAC sample weights applied

Associations between SEP and BMI Z-score (c coefficient) with sample weights applied

	c coefficient (95% CI)
SEP to BMI z-score	-0.4 (-0.06, -0.03)

Associations between SEP and each mediator (a coefficient) and associations between each mediator and BMI Z-score (b coefficient) with sample weights applied

	Association between SEP and mediator		Association between mediator and BMI z-score	
	<i>a</i> *	95% CI	<i>b</i> *	95%CI
Sweet drinks	-0.16	(-0.19, -0.12)	0.08	(-0.008, 0.17)
Discretionary hot food	-0.11	(-0.14, -0.08)	0.11	(0.03, 0.19)
Savoury snacks	-0.15	(-0.18, -0.11)	-0.07	(-0.16, 0.03)
Sweet snacks	0.02	(-0.04, 0.07)	0.03	(-0.11, 0.16)

*a coefficient adjusted for all confounders (child's age, sex and birth weight, mother's age, ATSI origin and English as mother's main language at home and child's preference for active or inactive pastimes as reported by parents at each wave from age 2-3 to 8-9 years); b coefficient adjusted for all confounders, the exposure (SEP), and all other mediating variables.

Supplement D: Sensitivity analysis results using mother's education as exposure

Associations between mother's education and BMI Z-score (c coefficient)

	c coefficient (95% CI)
Mother's education to BMI z-score	-0.13 (-0.17, -0.08)

Associations between mother's education and each mediator (a coefficient) and associations between each mediator and BMI Z-score (b coefficient)

	Association between mother's education and mediator		Association between mediator and BMI z-score	
	<i>a</i> *	95% CI	<i>b</i> *	95%CI
Sweet drinks	-0.30	(-0.40, -0.21)	0.10	(0.03, 0.18)
Discretionary hot food	-0.30	(-0.39, -0.20)	0.10	(0.03, 0.17)
Savoury snacks	-0.40	(-0.50, -0.30)	-0.03	(-0.11, 0.04)
Sweet snacks	0.09	(-0.06, 0.24)	0.05	(-0.07, 0.17)

*a coefficient adjusted for all confounders (child's age, sex and birth weight, mother's age, ATSI origin and English as mother's main language at home and child's preference for active or inactive pastimes as reported by parents at each wave from age 2-3 to 8-9 years); b coefficient adjusted for all confounders, the exposure (mother's education), and all other mediating variables.

Supplement E: Sensitivity analysis results using SEP at wave 6 as exposure

Results from mediation analysis examining the contribution of discretionary food and drink consumption across childhood on the development of socioeconomic differences in bmi z-score from birth to age 10-11 years.

	Association between SEP and mediator		Association between mediator and bmi z-score		Mediated effect [^]		Proportion mediated	
	<i>a</i> *	95% CI	<i>b</i> *	95% CI	<i>ab</i>	95% CI	%	95% CI
Sweet drinks	-0.14	(-0.17, -0.11)	0.24	(0.05, 0.42)	-0.008	(-0.015, -0.001)	6.28%	(0.86%, 12.61%)
Discretionary hot food	-0.12	(-0.15, -0.09)	0.23	(0.06, 0.40)	-0.007	(-0.013, -0.001)	5.44%	(0.80%, 11.21%)
Savoury snacks	-0.15	(-0.18, -0.12)	-0.04	(-0.22, 0.13)	0.006	(-0.002, 0.015)		
Sweet snacks	0.02	(-0.02, 0.07)	0.03	(-0.25, 0.31)	0.001	(-0.001, 0.004)		
Sum of significant mediators					-0.023	(-0.041, -0.010)	11.72%	(4.80%, 20.17%)

*a coefficient adjusted for all confounders (child's age, sex and birth weight, mother's age, ATSI origin and English as mother's main language at home and child's preference for active or inactive pastimes as reported by parents at each wave from age 2-3 to 8-9 years); b coefficient adjusted for all confounders, the exposure (SEP), and all other mediating variables.

[^]Standardized ab coefficients.

Supplement F: Sensitivity analysis results using overweight and obese as outcome

Results from mediation analysis examining the contribution of discretionary food and drink consumption across childhood on the development of socioeconomic differences in overweight and obesity from birth to age 10-11 years.

	Association between SEP and mediator		Association between mediator and overweight and obesity		Mediated effect [^]		Proportion mediated	
	<i>a</i> *	95% CI	<i>b</i> *	95%CI	<i>ab</i>	95% CI	%	95% CI
Sweet drinks	-0.1	(-0.17, -0.11)	0.09	(0.01, 0.16)	-0.012	(-0.023, -0.005)	5.82%	(1.32%, 11.23%)
Discretionary hot food	-0.12	(-0.15, -0.09)	0.09	(0.02, 0.16)	-0.011	(-0.022, -0.001)	5.14%	(1.48%, 9.85%)
Savoury snacks	-0.15	(-0.18, -0.12)	-0.05	(-0.13, 0.02)	0.002	(-0.006, 0.012)		
Sweet snacks	0.02	(-0.02, 0.07)	0.06	(-0.06, 0.18)	0.000	(-0.002, 0.004)		
Sum of significant mediators					-0.023	(-0.041, -0.010)	10.96%	(5.35%, 18.14%)

*a coefficient adjusted for all confounders (child's age, sex and birth weight, mother's age, ATSI origin and English as mother's main language at home and child's preference for active or inactive pastimes as reported by parents at each wave from age 2-3 to 8-9 years); b coefficient adjusted for all confounders, the exposure (SEP), and all other mediating variables.

[^]Standardized ab coefficients.

6 FACTORS INFLUENCING SWEET DRINK CONSUMPTION AMONG PRESCHOOL-AGE CHILDREN

6.1 SUMMARY

In the previous chapter, it was identified that unhealthy dietary behaviours contribute to the development of socioeconomic inequalities in childhood obesity. The previous chapter also demonstrated that unhealthy dietary behaviours begin in the first year of life, and in concordance with existing literature, showed that these behaviours track throughout childhood. This chapter now takes an in-depth look at the drivers of dietary behaviour among young children, with a focus on sugar-sweetened beverages. Sweet drinks were chosen as the focus of this particular study for a number of reasons. First, there is clear evidence of associations between SSBs and poor health outcomes including excess weight. Second, there is also good evidence of high levels of consumption of sweet drinks among Australian children. Third, from a policy point of view sweet drinks are an ideal policy target, due to their definability and minimal nutritional benefit. The study presented here had the aim of exploring parents' perceptions of factors influencing sweet drink consumption among preschool-age children.

This study identified a range of factors perceived by parents to influence sweet drink consumption among young children. Factors were identified at the individual, social and environmental levels of the socioecological model, indicating that many factors influencing children's sweet drink consumption are beyond parental control.

The following paper was accepted for publication by the *Health Promotion Journal of Australia* in November 2019.

6.2 PUBLICATION: FACTORS INFLUENCING SWEET DRINK CONSUMPTION AMONG PRESCHOOL-AGE CHILDREN: A QUALITATIVE ANALYSIS

Factors influencing sweet drink consumption among preschool-age children: A qualitative analysis

Alexandra Chung BNutrDiet, MPH^{1,2}   | Kathryn Backholer PhD² |
Christina Zorbas BNutrDiet² | Lisa Hanna PhD³ | Anna Peeters PhD²

¹School of Public Health and Preventive Medicine, Monash University, Melbourne, Australia

²Global Obesity Centre, Institute for Health Transformation, School of Health and Social Development, Faculty of Health, Deakin University, Geelong, Australia

³School of Health and Social Development, Faculty of Health, Deakin University, Geelong, Australia

Correspondence

Alexandra Chung, School of Public Health and Preventive Medicine, Monash University, Melbourne, Australia.
Email: alexandra.chung@monash.edu

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Abstract

Issue addressed: Consumption of high sugar foods and drinks are key risk factors for childhood obesity and dental decay. Sweet drinks are the single greatest contributor to the free sugars consumed by Australian children. Little is known about the factors influencing consumption of sweet drinks, particularly among preschool-age children.

Methods: Focus groups and semi-structured interviews conducted with parents and grandparents (n = 25) residing in different socio-economic areas across metropolitan and regional Victoria, Australia. Thematic analysis identified the factors influencing sweet drink consumption, which were then aligned with the socio-ecological model.

Results: At an individual level, health knowledge, health beliefs, and parenting skills and confidence influenced drink choices. At the social level, peer and family influence, and social and cultural norms emerged as influential. At the environmental level, sweet drink availability, targeted marketing, drink prices and settings-based policies influenced drink choices. Strategies identified by participants to support healthier drink choices included health education at the individual level; positive role modelling at the social level; and restricting unhealthy marketing, improved access to water, decreased availability of sweet drinks and price modification at the environmental level.

Conclusion: Sweet drink consumption among preschool-age children is influenced by multiple factors across all domains of the socio-ecological model. Parents and grandparents are calling for education, healthy environments and supportive policies.

So what? In contrast to common rhetoric, children's sweet drink consumption is often influenced by factors beyond parental control. A multi-component strategy is required to support parents and grandparents in their efforts to make healthy choices for their children.

KEYWORDS

children, health behaviours, nutrition, obesity, qualitative methods

1 | INTRODUCTION

Childhood overweight and obesity is a global public health problem. Obese children are likely to remain obese as adults, and the adverse physical and psychological effects are likely to persist into

adulthood.¹ Dietary behaviours including consumption of high sugar foods and drinks are key risk factors for childhood overweight, obesity and dental decay.^{2,3} Furthermore, unhealthy food and drink consumption is socio-economically patterned, whereby those experiencing greater socio-economic disadvantage are more likely to

consume unhealthy food and drink more frequently and in larger amounts, with socio-economic differences in consumption observed from the first year of life, persisting throughout childhood.⁴

Foods consumed during early childhood are of particular importance as it is during this time that dietary preferences and habits are established.⁵ By 2 years of age, children's diets typically reflect the diets of their family members.⁶ Consumption of sweet drinks (those containing free sugars including soft drink, cordial, fruit juice, fruit drinks and flavoured milk) begins at an early age and is the single greatest contributor of added sugars consumed by Australian children.⁷

Dietary behaviour is influenced by multiple factors including individual and environmental conditions.⁸ Parents play a key role in shaping children's dietary behaviours.^{9,10} However, at present, little is known about the factors influencing the consumption of sweet drinks, particularly among preschool-age children.

This study examines the contexts in which sweet drink consumption occurs among preschool-age children and explores parents' and grandparents' perceptions of factors that influence sweet drink consumption. The study uses data from focus groups conducted with parents and grandparents residing in different socio-economic areas across metropolitan Melbourne and regional Victoria, Australia. Findings improve our understanding of contextual factors that influence drink choices for preschool-age children and identify opportunities to improve the nutritional quality of drinks consumed by children in their early life.

2 | METHODOLOGY

This study employed qualitative methods to generate an in-depth understanding of perceived factors influencing drink choices for preschool-age children. Semi-structured focus groups and interviews were conducted with parents and grandparents of children aged 6 months to 5 years, from diverse socio-economic backgrounds. Parents were chosen because of their key role in shaping the food environments to which young children are exposed.^{9,10} Focus groups were selected to enable group dynamics to prompt an in-depth discussion among participants. These were supplemented by individual interviews to allow participation by parents and grandparents who expressed interest to participate but were unable to attend scheduled focus group sessions.

2.1 | Theoretical perspective

The socio-ecological model of health informed this study.¹¹ An ecological perspective illustrates the ways in which multiple factors influence behaviour, across individual, social and environmental domains.^{8,11} The applicability of a socio-ecological framework to understand factors influencing food choices among young children has previously been demonstrated.¹² In this study, a socio-ecological approach has been used to create a framework within which emergent themes have been arranged, illustrating the contexts in which particular factors influence drink choices for children.

2.2 | Sampling and recruitment

We purposely sampled four Australian Local Government Areas (LGAs) in metropolitan Melbourne and regional Victoria across low, middle and high area-level socio-economic disadvantage¹³ (Table 1). The areas sampled reflect diverse childhood overweight and obesity rates¹⁴ and population sweet drink consumption patterns among adults.¹⁵ There are limited data reporting children's sweet drink consumption at the LGA level; however, the most recent National Nutrition Survey indicates that sweet drink consumption is higher among children aged 2-18 years than it is among adults.¹⁶

Eligible participants included parents or primary carers of children aged 6 months to 5 years, living in the geographic areas sampled, aged 18 years or above. Eight focus group sessions were planned, two in each selected LGA. Invitations to participate were displayed in maternal and child health (MCH) centres, emailed via Local Council Child and Family Service email networks and handed out by MCH nurses and playgroup facilitators. Invitations were distributed 2 weeks prior to each focus group and interested participants contacted the research team. Where participants were interested, but unable to attend the focus group sessions, interviews were arranged.

2.3 | Data collection

Focus groups were conducted on weekdays, mid-morning or early afternoon, in informal settings familiar to participants, including MCH clinics and playgroup venues. Interviews were conducted in person in MCH clinics and by telephone, at times convenient to study participants. Demographic data and a short survey of participants' drink behaviours (frequency of water consumption, tea and coffee, milk, fruit juice, soft drink, sports drinks, vitamin waters

TABLE 1 Geographic profile three metropolitan areas and one regional local government area

Region	Overweight and obesity prevalence, 2-17 year olds ^a	Proportion adults consuming sweet drinks daily ^b	SEIFA score and ranking ^c
Metropolitan			
City of Boroondara	24.4%	5.2%	79 (10)
Wyndham City	31.9%	15%	55 (7)
Melton City	30.4%	14.3%	50 (7)
Regional			
Colac Otway Shire	29.1%	22.5%	21 (3)

Abbreviation: SEIFA, Socio-Economic Index for Area.
^a2014-2015 Health Tracker data.¹⁴
^b2014 Victorian Population Health Survey.¹⁵
^cSocio-Economic Index for Area (SEIFA) State Rank and decile¹³ (Lower SEIFA score and ranking means greater socio-economic disadvantage).

and energy drinks) were collected via written questionnaire prior to commencement of the focus group. Interviews and focus groups were moderated by a member of the research team, using a semi-structured topic guide (Table 2). For the purpose of this study, water and plain milk were considered as healthy drinks for children, and sweet drinks, namely fruit juice, fruit drinks, flavoured milk, cordial and soft drink were considered as unhealthy drinks for children. These definitions were discussed with participants during the interviews once participants raised the concept of healthy and unhealthy drinks, and only after participants had shared their accounts of their children's typical drinking habits. A second investigator attended each focus group to take notes and observe the discussions. A semi-structured approach was chosen to facilitate data collection and enable responsiveness to participants' accounts and emergent themes. Immediately following each focus group, the moderator and note-taker discussed their observations and impressions of key themes arising from the session. The topic guide was piloted with a sample focus group. These data were included in the analysis. Focus group sessions lasted between 60 and 75 minutes, interviews lasted between 25 and 40 minutes. All were audio-recorded, transcribed verbatim and reviewed for accuracy. All participants were allocated an identification number.

2.4 | Data analysis

Transcripts were imported into NVivo data management software. An inductive approach to data analysis was taken and the process did not seek to establish evidence for any particular factors influencing drink choices. Two researchers immersed themselves in the data, independently reviewing the field notes and transcripts while moving between the key stages of data analysis; applying codes to the transcript texts; grouping similar codes into categories; and interpreting emerging themes.¹⁷ The two researchers then worked together to review and agree upon theme names and select supporting quotations. The socio-ecological model was used as a framework to inform the organisation of themes.

The researchers reviewed the data through multiple lenses, including socio-economic position (SEP), gender, parent/grandparent role, age of child(ren) and cultural background, in order to identify

any themes unique to particular cohorts within the participant sample. All members of the research team reviewed the final themes and verified that the themes were adequately supported by selected quotations. Demographic data and participants' drink consumption questionnaire data were analysed using descriptive statistics.

3 | RESULTS

Four focus groups, comprising two to seven participants per group, and eight individual interviews were conducted across four geographic areas across a range of levels of socio-economic disadvantage. Participants ($n = 25$, 92% female) included parents (88%) and grandparents (12%) of at least one child aged between 6 months and 5 years. Characteristics of study participants are presented in Table 3.

Drinks consumed by preschool-age children at home were typically different to what was consumed outside home. Water, milk and 100% fruit juice were the main drinks reportedly offered within the home. Drinks consumed at other people's homes typically included 100% fruit juice and soft drink. Drinks purchased outside the home (in restaurants, cafés and at the shops) included 100% fruit juice, fruit drinks and smoothies, soft drinks, milkshakes and baby-cinos (steamed milk topped with chocolate powder). Most participants perceived water and milk to be healthy, and sweet drinks such as fruit drinks, cordial, flavoured milk and soft drink as unhealthy. Some, but not all participants held the view that 100% fruit juice was healthy. Thematic analysis identified a multitude of factors across the domains of the socio-ecological model influenced these drink choices for preschool-age children. Similarly, thematic analysis identified various strategies proposed by participants as likely to support healthy drink consumption among preschool-age children (Table 4).

3.1 | Factors influencing drink choices: individual domain

3.1.1 | Health and nutrition knowledge

Health and nutrition knowledge played an important role in parents' and grandparents' intentions regarding drink choices for their

TABLE 2 Focus group topic guide

Objective	Key questions
Identify and describe parents' views about the contexts in which preschool-age children consume different drinks (specifically water, plain milk and sweet drinks including soft drink, cordial, fruit juice, fruit drinks and flavoured milk).	What types of drinks do your children most commonly consume, and in what settings?
Explore parents' perceptions of the factors that influence drink choices for preschool-age children in various contexts.	Can you tell me about the things that influence the drink choices in each of the settings that we have talked about?
Explore parents' suggestions of strategies to encourage healthy drink choices for preschool-age children.	Thinking about all the different settings where you offer your children something to drink, what do you think could be done to improve the healthiness of those drinks?

TABLE 3 Participant characteristics

Participant characteristics	
Total number	25
Parenting role	
Parent	88%
Grandparent	12%
Age (mean age of parent participants)	34.5 years
Age (mean age of grandparent participants)	67 years
Female (%)	92%
Education level	
Year 12 or less, graduate diploma or certificate	40%
Bachelor or postgraduate degree	60%
Occupation	
Full-time home duties	54.2%
Part-time or casual work	33.3%
Full-time work	12.5%
Country of birth	
Australia	36%
Main language spoken at home	
English	56%
Postcode of residence	
SEIFA IRSD decile 1-3 (most disadvantaged postcodes) ^a	24%
SEIFA IRSD decile 4-7	20%
SEIFA IRSD decile 8-10 (least disadvantaged postcodes)	56%
Parent/grandparent sweet drink consumption frequency	
Daily consumption	12%
Weekly consumption	20%
Monthly or less consumption	68%
Child characteristics	
Child age (mean)	3.5 years
% children breastfed at 3 months	84%
% children breastfed at 6 months	71%

Abbreviation: SEIFA, Socio-Economic Index for Area.

^aSEIFA decile based on Victorian State rankings.

children. In particular, participants spoke of choosing water because it is healthy. Among most families, water was the preferred drink offered at home and made available to children throughout the day, usually in children's own water bottles. On the other hand, participants labelled drinks such as soft drinks as unhealthy, with most demonstrating knowledge of the high sugar content of soft drink. There was consensus that sugar is unhealthy, reflected in participants' expressed intentions to limit their children's sweet drink consumption.

I want them drinking water as their main choice for that, because that's the healthiest thing to be drinking.

(Focus Group Participant 1)

TABLE 4 Themes from focus groups and interviews showing perceived factors and strategies to influence drink choices among preschool-age children

Socio-ecological domain	Factors influencing drink choices	Strategies to support healthy drink choices
Individual domain	Health and nutrition knowledge	Improved health education for parents and children
	Health beliefs	
	Habits	
	Parenting skills and confidence	
Social domain	Peer and family influence	Positive role modelling by parents, family and peers
	Social and cultural norms	
Environmental domain	Sweet drink availability	Improve access to water and decrease sweet drink availability
	Unhealthy and misleading marketing	Restricting unhealthy marketing
	Relative price of healthy and unhealthy drinks	Pricing strategies to make healthy drinks more affordable and unhealthy drinks less affordable
	Policies that encourage and discourage healthy drink choices	

He likes soft drink but they are unhealthy so we don't give them to him.

(Interview Participant 1)

Participants demonstrated nutrition knowledge in their accounts of a sweet drink hierarchy. Certain drinks were perceived to be more or less healthy relative to others, based upon the presence of healthy (eg vitamins) and unhealthy (eg sugar) ingredients. In general, the hierarchy reported by participants was nutritionally accurate, with water seen as most healthy and sweet drinks including cordial and soft drink understood to be least healthy. Fruit juice was considered a healthier alternative to cordial and soft drink with some participants reporting that fruit juice was offered regularly. There were inconsistencies in participants' views of whether or not fruit juice was suitable for daily consumption by children.

Participants demonstrated knowledge of the importance of hydration and the benefit of nutrients available in drinks such as milk. Some participants subsequently justified providing sweet drinks such as flavoured milk as a means to encourage children to drink or to ensure calcium intake. Health conditions such as eczema, constipation and food allergies motivated drink choices for some families. It was unclear whether these decisions were based on professional advice, or participants' own knowledge or beliefs.

I have a problem with encouraging my daughter to drink enough water and milk, so sometimes I'm really struggling. I have to give her flavoured milk or put some sugar in the bottle, just a bit, to make her drink more.

(FG 4)

3.1.2 | Health beliefs

Participants expressed the belief that sweet drinks are treats. The label “treat” was used to justify children's sweet drink consumption and frequently coupled this with the notion of occasional consumption. However, there was little consistency as to how frequent “occasional” might be. In many cases, the belief that “treats are okay sometimes” was applied to particular settings. For example the consumption of sweet drinks in restaurants or cafes and at special events like parties was generally acceptable. There were also discrepancies in the definition of a treat; for some parents, fruit juice and flavoured milk were treats, while for others, soft drink was considered a treat.

So we don't often go out for lunch or out for tea much, it's not a common occurrence. Like I think now the last time we went out and they had fizzy would have been a few months ago. But I do get them –you get meals, the drink and the meal with the ice-cream. And I'll often do that as a bit of a treat. And they will get lemonade.

(Int 6)

So I explain to him how this is a special occasion so that's why you're allowed a special treat. It's only this time. But when we're home, we don't have the special treat.

(Int 2)

Participants reported using sweet drinks to encourage or reward particular behaviours, such as eating dinner. This emerged as a competing health belief, with the perceived importance of eating dinner overriding the desire to limit their children's sweet drink consumption. Some participants held the view that sweet drinks are a suitable choice for children when they are sick, and this was seen as an acceptable exception to the belief that sweet drinks are unhealthy.

Sometimes if we want to manage that, to do something which she is not doing, sometimes we offer if you do this, or if you eat this meal, then after that we'll give some soft drink like coca cola.

(FG 8)

3.1.3 | Habits

Participants were conscious of fostering “good” or “healthy” habits among their children. They acknowledged that their own habits are likely

to be passed on to their children, and that once established, habits can be difficult to change. Some participants likened the habit of soft drink consumption to cigarette smoking, with one parent suggesting that the purchase and consumption of sweet drinks may be a habit that is enjoyed, and despite health knowledge to the contrary is hard to break.

I don't know if it's harder for people to break a habit, like smoking? Maybe they know it's not the right choice. Maybe they know it's not healthy, but it's just what they do and they really enjoy it and it's part of what they buy at the supermarket and what goes in their fridge. How do you break that habit?

(Int 7)

3.1.4 | Parenting skills and confidence

Parenting competence strongly influenced sweet drink consumption among preschool-age children. Participants acknowledged that parenting can be challenging, and their own skills and confidence in parenting during challenging situations emerged as an important influence of drink choices. Despite intentions to make healthy drink choices, many participants conceded that they often succumbed to their children's pestering for sweet drinks, particularly outside the home environment. This was driven by a strong desire to avoid tantrums, especially in public places. The power struggle between parents and children was reinforced with participants talking about the need to be “strong” when making drink choices, and at times feeling like they had “given in” to their children.

I just find it quite difficult to stand out and say, 'Actually, no, I don't want him to have that.' It's just easier to go with the flow. ... I'm saying I'd prefer he didn't want the lemonade, but I'd also prefer if I was stronger enough to just hold the ground, I suppose, and not give into that.

(FG 2)

I think it's a matter of being strong as well and just sticking to 'no'. But that's easier said than done. ... At the supermarket sometimes I'll give in. ... It's either that or death stares by fellow shoppers thinking you can't handle your kids. And you don't want a death stare so you just buy them [soft drinks].

(FG 7)

3.2 | Factors influencing drink choices: social domain

3.2.1 | Peer and family influence

The social contexts in which families spend their time was a strong influence on drink choices for children. Children want to drink whatever others around them are drinking. Coupled with participants' expressed

desires to avoid conflict around drink choices, sweet drink consumption by others – for example grandparents and peers – emerged a strong determinant of children's consumption of these drinks.

I mean, like with everything with kids, they see someone doing it, then they want to do that. They see a kid drinking juice, they want juice. If they see their grandmother drinking juice, that's what they want.

(FG 1)

Participants reported making conscious decisions to drink water in front of their children to model desired behaviours and encourage healthy habits. In contrast, some parents in particular reflected upon examples of unhealthy role modelling and unhealthy social influences. For example some parents spoke of fruit juice and soft drink being regularly offered by grandparents. In some instances this was seen as a treat, and therefore considered acceptable. However, some parents spoke of conflict where parents and grandparents held different views about suitable drink options. Of note, the grandparents who participated in this study reported being strict with their grandchildren in not allowing regular sweet drink consumption.

I think of course the adults in the family have to set the example. You can't say, 'I can drink coke but you are not.' And they're thinking, 'Why? Why can you do it and I can't do it?'

(Int 2)

3.2.2 | Social and cultural norms

Social norms and expectations were important factors in participants' decisions to allow sweet drinks for their children. This included expected behaviours among peers, for example the suitability of drinks at certain ages, and settings-specific norms. Sweet drinks were the norm at children's birthday parties and parents highlighted that it was difficult to make decisions against the norm. Most participants reported that they would allow their children to consume sweet drinks at parties, acknowledging that others were doing the same and it was a special occasion. A minority said they would only allow their child to drink water at parties, despite other children being allowed sweet drinks.

But we can't sit there at a party and just yell at him and say don't have that, don't have that. We tried, but then we just looked ridiculous.

(Int 7)

Participants' reflections upon their own upbringings influenced drink choices made for children. Those who felt they had healthy upbringings endeavoured to bring up their children in the same way. While others who had frequently consumed sweet drinks as children expressed a desire to encourage more healthy behaviours among their own children.

I think kids are happy with what you give them. And that's how it was when I was growing up. We never really had soft drink, or we did at birthday parties; it was a treat.

(Int 4)

I think just for health reasons... Because I grew up in a household where we didn't drink water. We drank mostly soft drink and other flavoured drinks. And I didn't want my kids, I don't want that to be normal for them.

(FG 3)

3.3 | Factors influencing drink choices: environmental domain

3.3.1 | Sweet drink availability

At the environmental level, a number of factors influencing children's drink behaviours emerged. The physical availability of sweet drinks was a key factor leading to consumption. This included availability within the home, in other people's homes and in places where drinks could be purchased. Among children familiar with sweet drinks, the presence of sweet drinks in the immediate environment was a trigger for children to ask for them. In these instances, participants explained that their children sought out sweet drinks within the home, or pestered for these drinks to be purchased. On the other hand, participants whose children had not previously tried sweet drinks did not share the view that the presence of sweet drinks posed a challenge. For these parents, delaying the introduction of sweet drinks was believed to be a key influence over their children's behaviour.

They won't ask me for juice always but if they open the fridge and they see it's there then they want it.

(FG 5)

I guess my kids are exposed to (soft drink) in the supermarket, but they don't know what it is, so it's not an issue. How powerful is that, not knowing, holding off.

(Int 8)

3.3.2 | Marketing

The marketing and promotion of sweet drinks emerged as a powerful influence over preschool-age children's drink behaviours, with targeted marketing towards children a major concern. Participants spoke of product placement and popular cartoon characters being used to market sweet drinks to children, leading children to easily identify and repeatedly request these products. Some participants drew parallels with cigarette advertising, suggesting that marketing, including product placement, of soft drink should be restricted, as it is with cigarettes.

Why is the first thing that we see when we walk into one of those stores is soft drinks? Why isn't it the water?

(FG 10)

Participants reported concern around food and drink marketing including claims made on product labels, citing these to be confusing and misleading. Product placement of certain foods and drinks in the baby aisle in the supermarket was also identified by participants as an example of misleading marketing.

Fruit juice is a great example. Like, it's portrayed that, they'll put the whole – on the front they'll put it's organic and it's got Vitamin C, but they don't show that it's basically just sugar and it's got all the fibre stripped out of it...

(Int 5)

3.3.3 | Price

The relative price of water and sweet drinks influenced participants' decisions around drink purchases. The low price of tap water was viewed as an incentive to consume water, but lack of availability of places to refill water bottles and the inconvenience when water bottles were forgotten were mentioned. When making drink purchase decisions, the low price of soft drink, compared to water, made it difficult for participants to justify paying for water. Price discounts on soft drinks in the supermarket and low priced soft drinks at fast food outlets were perceived to lure parents towards making unhealthy choices and punish those wanting to make healthy decisions.

It gets me a bit with the cost side of things where you go to McDonalds and you can get one of those crazy big frozen cokes for \$1.00. Like, the large one is a \$1.00. Whereas a lot of the water at Maccas might cost you \$3.00 or something like that. Like, it's people getting penalised for wanting to be healthier.

(Int 5)

3.3.4 | Policy

Policies including settings-based policies in childcare, kindergartens and schools were perceived to exert a positive influence. These settings were seen to be supporting healthy drink choices through role modelling and implementation of water-only (or water and milk in the case of childcare) policies. This aligned with participants' expectation that children's settings should support healthy drink choices. Importantly for some, the positive effect of these policies extended beyond the setting and into the home environment, making it easier to encourage the consumption of water and milk and limit sweet drinks.

Because I remember before (my daughter) started day care she had two or three juices a day, every day. And when she started going to day care she started with the water thing.

(FG 5)

3.4 | Strategies to support healthy drink choices: individual domain

3.4.1 | Health education

Education was the dominant factor underpinning participants' suggestions for ways to improve children's drink behaviours. Most apparent was the view that more education is necessary to teach parents and grandparents about healthy drink choices. Participants also suggested providing nutrition education to children to teach them to make healthy drink choices and develop healthy habits from an early age. Health professionals (including MCH nurses and General Practitioners) and settings such as schools were highlighted as important avenues for providing education to parents and children. There was some concern however that parents who do not regularly access health and care services may miss out on education, with further concern expressed that these parents may be those most in need.

I think maybe some more education really early on, from maternal child health, doctors. I can't really recall what was done back then (when my child was younger), but I guess getting in really early so it's more normal.

(Int 3)

3.5 | Strategies to support healthy drink choices: social domain

3.5.1 | Positive role modelling

To a lesser degree, participants talked about the potential impact of peer and family influences in improving children's drink choices. While participants reflected upon the influential nature of role modelling, they did not identify ways to encourage or facilitate positive role modelling. Participants spoke about the positive influence that organisations such as child care centres and schools can have over children's drink behaviours.

And role modeling in other places where the kids are, if not at home, at day care centres, making sure that it's milk and water as the options.

(Int 7)

3.6 | Strategies to support healthy drink choices: environmental domain

3.6.1 | Water and sweet drink availability

Increasing the availability of water and limiting the availability of sweet drinks were identified by participants as likely to improve drink behaviours among preschool-age children. In particular,

participants focused on limiting the availability and promotion of sweet drinks in supermarkets. The practice of regularly carrying water bottles was highlighted for the dual benefit of encouraging water consumption, and reducing the likelihood that sweet drinks would be purchased.

I like the idea of having the healthy aisles in the supermarket where I guess for the older kids you can have the lolly-free, soft drink-free checkouts, sorry not the aisles. That they are far and few between. There's actually probably not enough of them.

(FG 10)

3.6.2 | Restricting unhealthy marketing

Participants unanimously agreed that restricting unhealthy marketing would have a positive impact on children's drink behaviours. Participants called for greater accountability on the part of food industry to ensure consumers are not misled by food and drink packaging, labelling and promotion. Participants also suggested utilising healthy marketing strategies to encourage consumption of water, with the view that this would be a simple and effective strategy.

I think them not being able to market unhealthy food to children. So the fruit drinks that are not 100% juice shouldn't be allowed to have the children's characters and marketing on them.

(FG 3)

3.6.3 | Price

Price modifications to reduce the price of water and increase the price of sweet drinks were suggested by participants. This led to discussion of the potential impact of applying a tax to drinks with added sugar. Parents expressed views both for and against the implementation of such a tax as an effective strategy to improve children's drink behaviours.

Even the cost of buying water when you're out. If water was so much cheaper to buy, then it'd be an easier option than when soft drink or juice is the same cost, or even cheaper sometimes.

(FG 3)

And the cost of soft drink is so cheap, I think it's the same price as water in a bottle. Yeah. You know a tax on that. I think it's a shame that it has to come to that, but I think it would be effective.

(Int 3)

I think about things like – water is free! It comes out of the tap. I really don't know that price is going to make a

huge difference, or putting a tax on sugar beverages. ... I really don't think price would do it.

(Int 7)

4 | DISCUSSION

This qualitative study of parents' and grandparents' perceptions of factors influencing drink consumption among preschool-age children identified a number of influential factors across the domains of the socio-ecological model.

Within the individual domain, health knowledge and beliefs emerged as important influences over drink choices for preschool-age children. Other qualitative research has shown knowledge and beliefs to be central factors influencing food choices made by mothers.¹² In our study, participants demonstrated health knowledge through discussion of a hierarchy of drinks. Despite many participants correctly identifying sweet drinks as unhealthy, there was some confusion among some participants regarding whether fruit juice was healthy, and how often it ought to be consumed by children. In our study, the label "treat" was often applied to sweet drinks, particularly in the context of a special occasion. This seemed to justify sweet drink consumption as an exception to usual behaviour. The term "treat" is widely used by parents and the practice of sweet drinks being offered to children as treats is common.^{18,19} However, we found that participants in our study were neither clear nor consistent in their definition of a treat. We also found that participants used sweet drinks as a reward, or bribe to encourage children to consume more healthy foods. While not necessarily recommended, this notion of using food as a tool to motivate children to eat is not uncommon.^{19,20}

Parenting skills and confidence were identified as factors influencing children's drink choices in this study. Parenting practices, both in general and with regard to food choices, are understood to be important determinants of children's nutrition behaviours.²¹ In our study, participants acknowledged that it was easier to surrender to children's requests for sweet drinks in order to avoid negotiations or tantrums. Other research has found maternal self-efficacy in limiting unhealthy food and drink consumption among children decreases across the early childhood period, likely as a result of children's increased desire and capacity to exercise choice over what they consume.²² These findings reinforce the need for environments that support parents to make healthy food choices for their children.

Within the social domain, peer and family influence, including role modelling and norms were identified as factors influencing children's sweet drink consumption. In particular, our study found children's drink preferences were strongly influenced by observing what others around them were consuming. Previous research has reported on the influential role of family and peer behaviour, as well as observations of others eating and drinking in social situations in influencing children's dietary preferences and behaviours.^{8,23,24} Role modelling is thought to be highly influential in children's drink preferences,¹⁸ with emphasis placed on positive parental role modelling,

rather than controlling techniques, as influential to the positive development of children's dietary behaviour.⁹

Social networks play a further role in children's dietary consumption through foods directly provided to children. Recent research suggests that grandparents have increasing influence over children's dietary behaviours through the food and drinks they offer.^{12,25} Some parents in our study spoke with frustration about grandparents providing sweet drinks. Interestingly, the small number of grandparents who participated in this study reported being strict with their grandchildren in not allowing sweet drink consumption. This may be due to social desirability bias, influencing grandparents' reporting in our study, or it may be related to the roles played by the grandparents we spoke with, all of whom cared for their grandchildren on multiple days each week, a role more akin to parenting.

We found that children were more likely to consume sweet drinks if these drinks were kept in the home. Exposure to and availability of particular food and drinks have been associated with building familiarity and subsequent preference for these items.⁸ Parents have previously identified food availability as an influence over what children consume,²⁰ and availability of sweet drinks in the home has been associated with their consumption among children.^{26,27}

Furthermore, mothers' own sweet drink consumption has been shown to influence the intake of sweet drinks among very young children.²⁸ This was reflected in our findings whereby mothers who consumed sweet drinks went on to discuss their children's requests for and consumption of sweet drinks. This behaviour conflicted with participants' views of the detrimental health effects of sweet drinks and their expressed intentions to limit their children's sweet drink consumption.

Our study identified unhealthy food and drink marketing as a factor influencing children's preferences for sweet drinks. This was clearly a frustration for participants, many of whom felt that marketing should not promote unhealthy drinks and should not be targeted towards children. Targeted marketing of foods towards children has repeatedly been shown to influence children's intake of, and preferences for unhealthy foods^{20,29} and there is increasing support for restrictions on the advertising of unhealthy food and drinks towards children.³⁰

As for strategies to improve the health of drinks provided to preschool-age children, participants in this study focused mostly on factors within the individual domain of the socio-ecological framework. Participants were quick to suggest education as a potential solution. This finding should be interpreted with caution because while education was a commonly mentioned strategy, participants did not report a knowledge deficit regarding the unhealthiness of sweet drinks and many expressed the view that too much sugar was unhealthy. This finding reinforces our understanding that knowledge alone does not influence behaviour.

Within the environmental domain, participants identified limiting availability and promotion of sweet drinks in supermarkets and restricting unhealthy food and drink marketing targeted towards children as strategies likely to help them to make healthy choices for their children. Participants also acknowledged existing strategies

such as water-only policies in children's education and care environments as helpful. Some parents referred to pricing strategies such as taxing drinks with added sugar. However, opinions regarding the likely success of taxation were mixed. Recent research has shown that applying a tax to drinks with added sugar is likely to lead to health improvements at the population level, with greatest benefits observed among those with lower SEP.³¹⁻³³

Factors that influence dietary behaviour are diverse, and inter-related in an often-complex manner.³⁴ This is demonstrated in the findings of this study, where participants described multiple factors acting across different contexts having influence over the types of drinks consumed by their children. No one labelled any one particular factor in isolation, rather discussions moved within and between determinants. Strategies to improve the health of children's diets will therefore require coordinated action across multiple levels of the socio-ecological domain. Strategies will need to counter the current obesogenic environment to better support healthy food and drink choices and reduce consumption of unhealthy food and drinks.³⁵ What this study adds is strong desire from parents and grandparents for education, environments and policies that support them in their intentions to make healthy choices for their children.

4.1 | Limitations

Selection bias is a limitation of this study. Those who self-selected to participate are more likely to be interested in food and drink choices for children and more health-aware. While we recruited participants from different geographic areas, the majority of participants in the study had completed tertiary education and resided in well-off neighbourhoods. Participants in this study were also less likely to consume sweet drinks on a daily basis compared to the general adult population in three of the four geographic areas in which we sampled. We were unable to test whether sweet drink consumption among children differed according to parents' SEP; however, other research in Australia has shown that parents with low SEP were more likely to offer sweet drinks to their preschool-age children.¹⁹

While this study aimed to investigate the views of all parents, the majority of participants were mothers and after that, grandmothers. This is a reflection of current society, where mothers typically hold the primary care-giving role²⁸ and, compared to fathers, spend more time caring for children aged 0-5 years.³⁶ In addition, focus group sessions were held during weekday hours, limiting participation for working parents. Finally, the data in our analysis relied upon self-report in an interview or group setting, and is therefore susceptible to social desirability bias, which may lead to underreporting of sweet drink consumption.³⁷

There are currently a range of clear policy actions open to governments and recommended by national and international bodies to improve population nutrition. These include restricting unhealthy food advertising targeted towards children and applying a 20% health levy to drinks with added sugar,^{35,38} both of which are likely to improve children's dietary intake equitably.^{39,40} Beyond this,

further research could focus on better understanding how the determinants of children's sweet drink consumption varies across the socio-economic gradient. Understanding these drivers will help prioritise solutions that can serve the dual goal of reducing sweet drink consumption among preschool-age children and reducing socio-economic inequalities in sweet drink consumption.

4.2 | Researcher roles in construction of the data

All authors of this study are female, with postgraduate education, working in health research. Several members of the team are parents, including some with preschool-age children. With an overall interest in identifying policies to reduce obesity, the authors have backgrounds in the fields of epidemiology, chronic disease prevention, health inequity, and nutrition and dietetics. All subscribe to the view that individual health behaviour is determined by multiple layers of influence, as demonstrated by the socio-ecological model.

5 | CONCLUSION

This study provides insights into factors influencing sweet drink consumption among preschool-age children. In contrast to common rhetoric, this study suggests children's sweet drink consumption is often influenced by factors beyond parental control. Parents and grandparents with primary caregiving roles are asking for education, environments and policies to support their intentions to make healthy choices for their children. Findings indicate opportunities for strategies across the socio-ecological domains to facilitate more nutritious drink behaviours among preschool-age children.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ORCID

Alexandra Chung  <https://orcid.org/0000-0001-7121-9534>

TWITTER

Alexandra Chung  @chung_alexandra

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6.3 APPENDIX ONE: INTERVIEW GUIDE

Interview Guide

Introduction: Brainstorm topic

Can you tell me what drinks you can think of that are commonly consumed by preschool-aged children?

Can anyone suggest any other drinks we might have missed?

Aim to include at least: diet and non-diet softdrinks, fruit juice, cordial, iced tea, flavoured milk, plain milk, energy drinks, sports drinks, water.

Key question 1

What drinks do your children most commonly drink at home? (breakfast / lunch / the dinner table/ watching tv / before bed)

- What are the reasons for each of these drink choices?

What drinks do your children drink when out of the house? (At the shops/ restaurants/ parties?)

- What are the reasons for each of these drink choices?

What drinks do your children drink with particular people (friends, grandparents)?

- What are the reasons for each of these drink choices?

Where else might your children have something to drink – what might that drink be?

- What are the reasons for those drink choices?

Key question 2

Do you have any concerns about what preschool-aged children are drinking these days?

- Prompt: On the other hand, what are you happy about? What is working well?

Key Question 3

Thinking about all the different settings where you offer your young children something to drink, what do you think could be done to improve the healthiness of those drinks?

- Prompt: What could help you make different / healthier drink choices for your children?

- Prompt: Are there changes to the food in places you visit each day (supermarkets, schools, service station etc) that could help?
- Prompt: Are there particular people who could help? Family? MCH nurses?

Close

****Review purpose of study****

Is there anything else you would like to say or any questions you'd like to ask?

****Summarise key points raised and check for accuracy****

Thank participants for coming and close.

7 REPRESENTATIONS OF INEQUALITIES IN CHILDHOOD OBESITY IN AUSTRALIAN HEALTH POLICY

7.1 SUMMARY

This chapter now turns to policy strategies and actions proposed by Australian national, state and territory governments to address inequalities in childhood obesity. In order to achieve the dual goal of reducing childhood obesity and reducing inequalities, a range of complementary approaches will be required. This will need to comprise actions that address the individual, social, and structural determinants of childhood obesity. To identify what these actions need to be, an understanding of current and recent policy approaches is first required. This study therefore aims to critically analyse the representations of inequalities in childhood overweight and obesity in a sample of Australian health policy documents.

This study identified that childhood obesity was predominantly represented as an issue of individual responsibility. Whilst structural drivers of childhood obesity were recognised, individual-level actions were dominant. The study also found that health inequalities were represented as an issue in principle, but not addressed by policy actions. This study concluded that current representations of childhood obesity and health inequalities in Australian health policy documents do not adequately address the underlying causes of inequalities in childhood obesity.

The following paper has been prepared and submitted for publication to the *International Journal of Health Policy and Management*.

7.2 A CRITICAL ANALYSIS OF REPRESENTATIONS OF INEQUALITIES IN CHILDHOOD OBESITY IN AUSTRALIAN HEALTH POLICY DOCUMENTS

Abstract

Background

In Australia, childhood obesity follows a socioeconomic gradient whereby children with lower socioeconomic position are disproportionately burdened. To reduce these inequalities in childhood obesity requires a multi-component policy-driven response. Action to address health issues is underpinned by the ways in which they are represented as ‘problems’ in public policy. This study critically examines representations of inequalities in childhood obesity within Australian health policy documents published between 2000-2019.

Methods

Australia’s federal, state and territory government health department websites were searched for health policy documents including healthy weight, obesity, healthy eating, food and nutrition strategies; child and youth health strategies; and broader health and wellbeing, prevention and health promotion policies that proposed objectives or strategies for childhood obesity prevention. Thematic analysis of eligible documents was guided by a theoretical framework informed by problematization theory, ecological systems theory, and theoretical principles for equity in health policy.

Results

Eighteen policy documents were eligible for inclusion. The dominant representation of inequalities in childhood obesity was one of individual responsibility. Whilst structural determinants of inequalities in childhood obesity were acknowledged, policy actions predominantly focused on individual determinants. Equity was positioned as a principle of policy documents but was seldom mentioned in policy actions.

Conclusions

Current representations of inequalities in childhood obesity in Australian health policy documents do not adequately address the underlying causes of health inequities. In order to reduce inequalities in childhood obesity future policies will need greater focus on health equity and the structural determinants of health.

Keywords

Child obesity

Health equity

Health policy

Obesity prevention

Problematization

Socioeconomic inequalities

Figures

Figure 1. Determinants of health model

Figure 2. Overview of thematic mapping process and final themes from critical analysis of health policy documents

Figure 3. Article selection flow diagram

Tables

Table 1. Theoretical analysis framework

Table 2: Policy documents eligible for inclusion in the analysis

Key Messages:

1. Implications for policy-makers

- The dominant representation of inequalities in childhood obesity in Australian health policy documents was one of individual responsibility with policy actions predominantly focused on individual determinants of health behaviour.
- Actions to address structural drivers are necessary to shape health-promoting environments that support, instead of undermine healthy behaviours, however this was not a focus of actions proposed in the Australian health policy documents analysed in this study.
- Current representations of inequalities in childhood obesity in Australian health policy documents do not adequately address the underlying causes of health inequities. In order to reduce inequalities in childhood obesity future policies will need greater focus on health equity and the structural determinants of health.

2. Implications for public

This critical analysis of a sample of 18 Australian national, state and territory health policy documents was the first of its kind to explore how governments consider socioeconomic inequalities in childhood obesity in public health policy documents. Findings indicated childhood obesity is predominantly represented as an issue of individual responsibility in Australian national, state and territory public health policy documents. Actions proposed in policy documents focused primarily on improving knowledge and skills and changing children's dietary behaviour. These actions alone are unlikely to address the underlying causes of childhood obesity and may widen inequalities in childhood obesity. To better promote fair opportunities for health, policies need a greater focus on health equity, necessitating action on the social determinants of health within and beyond the health system.

Background

Children with obesity have increased risk of adverse physical and psychological health, with excess weight gain and associated health consequences likely to persist into adolescence and adulthood (1-4). In Australia and other high-income countries, childhood obesity is socioeconomically patterned whereby children who live in socioeconomically disadvantaged neighbourhoods or whose parents have low income or education are more likely to experience obesity compared to children with a relatively higher socioeconomic position (SEP) (5, 6). In a number of countries including Australia, socioeconomic inequalities in childhood obesity are widening (7, 8).

The determinants of childhood obesity are complex, acting across multiple contexts and in multiple settings (9). Childhood overweight and obesity is influenced by individual factors including diet and physical activity, knowledge and skills, individual preferences, and parenting practices (10, 11). These individual factors are in turn shaped by the social determinants of health (SDoH), the daily living conditions in which we are born, grow, work, live, play and age (11, 12). They include early life experiences, education and employment opportunities, housing, and food environments (12). The SDoH also include the economic, social, political and cultural contexts that shape these daily living conditions (13). The SDoH are not experienced equally with some populations having less access to the social and economic resources and conditions necessary for good health (14). These differences in the SDoH give rise to unjust inequalities in health (15). Health *equity* therefore can be described as the notion that everyone should have a fair opportunity to attain their full health potential (16).

Implementation of comprehensive and multi-faceted government policies across all levels of influence is necessary to create and support healthy and equitable food and physical activity environments (14, 17, 18). Evidence shows that in order to be both effective and equitable, actions must address the structural barriers to good health and a healthy weight (19). Interventions that target structural barriers to health aim to change the circumstances in which individuals' decisions are made, in order to better support healthy choices (19). Unlike behavioural interventions, these do not require individual agency and are typically enacted through regulatory changes (19).

Central to equity-oriented health policy is its attention to ensuring less privileged groups have the same opportunities to attain the same level of health as those who are better off (20). Carefully designed policies that address the underlying drivers of obesity and create health promoting environments combined with targeted actions that are proportionate to need can bring about fairer opportunities for good health across societies (19).

It is widely recognised that there is a role for government policy in obesity prevention (21-23). Government policies reflect policymakers' ideologies and values and are shaped by political, institutional and interest groups (24). They carry implicit or explicit problem representations that both influence, and are influenced by, media and public discourse and opinion, and can further shape the political agenda (25). The way issues are represented as problems within policy documents can be considered alongside the way in which policy actors frame issues. Problem representation analysis begins with proposed solutions and examines the implicit problem(s) within those solutions (26). Framing, on the other hand examines how language is used by stakeholders to construct reality, through shaping perceptions of an issue it's causes and solutions (27). Problem representations and issue framing within policies can direct attention to, or shift the focus from, particular aspects of a problem, which in turn influences the actions that are available to address the problem (26). Analysis of how policy problems are conceptualized provides the opportunity to rethink current, or inform future, policy, research and advocacy efforts (28).

This study focuses on health policy documents as an indicator of a government's institutional commitment to act on inequalities in childhood obesity (29). To date there have been no previous analyses of representations of inequalities in childhood obesity in health policy. The aim of the study, therefore, is to understand how inequalities in childhood overweight and obesity are represented as a problem in Australian health policy documents.

Methods

Study setting

Australia has a federated governance system, comprising a federal (national) government and eight state/territory governments. Under this structure, both federal and state/territory governments are responsible for health and health promotion policy. As a consequence, obesity

prevention is addressed in different ways across jurisdictions with some governments implementing specific healthy weight or obesity strategies, while others address childhood obesity within healthy eating or food and nutrition strategies; child and youth health strategies; or broader health and wellbeing, prevention or health promotion policies.

Study design

Qualitative policy analysis was undertaken to critically analyse public health and obesity prevention policy documents published by Australia's national, state and territory governments. We adopted an interpretive approach to policy analysis which is particularly useful for interrogating the framing, representation and social construction of policy problems (28). We used a theory-informed approach to examine how 1) childhood obesity and 2) inequalities in childhood obesity have been represented as problems in policy actions to prevent childhood obesity proposed during the period 2000-2019.

Theoretical Perspective

Multiple theories and principles relevant to health policy analysis were used to inform specific components of our methodological approach. These included problematization theory, ecological systems theory, and theoretical principles for advancing equity in health policy. We combined these theoretical perspectives to develop a comprehensive analytic framework (Table 1).

Based on problematization theory, Bacchi's 'What's the Problem Represented to be' (WPR) framework was used as the overarching approach to guide the analysis (26, 30). WPR proposes that analysis of problem representations must begin with the policy actions – which implicitly or explicitly represent dominant ideas, values and priorities, and silences across these domains. For example, proposing nutrition education to address childhood obesity indicates that obesity arises from knowledge and skill deficits (26). Yet, this silences the remaining socioecological causes of obesity, risking the deflection of political action across these levels.

The WPR approach is underpinned by Foucault's theory of problematization, which suggests that policies contain implicit representations of problems within the strategies they propose (30). Bacchi observes that "we are governed through problematizations rather than policies" (30) (p.xi). The WPR approach thus provides an analytic strategy that can support critical

interrogation of policy documents to reveal how issues become defined as “problems” and the political values and assumptions underlying these problem representations (26).

Previous studies have demonstrated that WPR is a useful approach for interrogating how public health nutrition and childhood obesity are problematized in policy documents and media stories (31-34). For example, analysis of Australia’s now expired national public health nutrition agenda, *Eat Well Australia*, revealed public health nutrition was represented as an individual problem, and as a problem arising from social, political and economic circumstances (31). Analysis of media representations of childhood obesity in Australia revealed media coverage favoured the representation of childhood obesity as a problem of individuals, in direct contrast to the social representation observed in the academic literature (34).

To examine the representations of childhood obesity and consider the equity impacts of proposed actions, we were guided by ecological systems theory in developing our analytic framework. In particular, we drew upon Dahlgren and Whitehead’s application of ecological systems theory (20). In their model, the outermost layer represents the socioeconomic, cultural and environmental determinants of health (level 1); moving inward, the next layer represents the settings in which people live, work, and learn (level 2); the next layer represents family and social networks (level 3); and the innermost layer represents individual behaviours and biological factors (level 4) (Figure 1) (20). These four levels of influence translate into corresponding levels of policy action. Level one policy actions bring about structural change, such as taxation policies. Level two policy actions improve daily life conditions, for example through employment and protection policies, or food and nutrition policies that improve access to and affordability of healthy foods. Level three policy actions build community capacity through improving local skills, leadership and infrastructure to better enable implementation of tailored actions that improve health within the community. Finally, level four policy actions influence individual behaviour, such as nutrition labelling or providing health education (20).

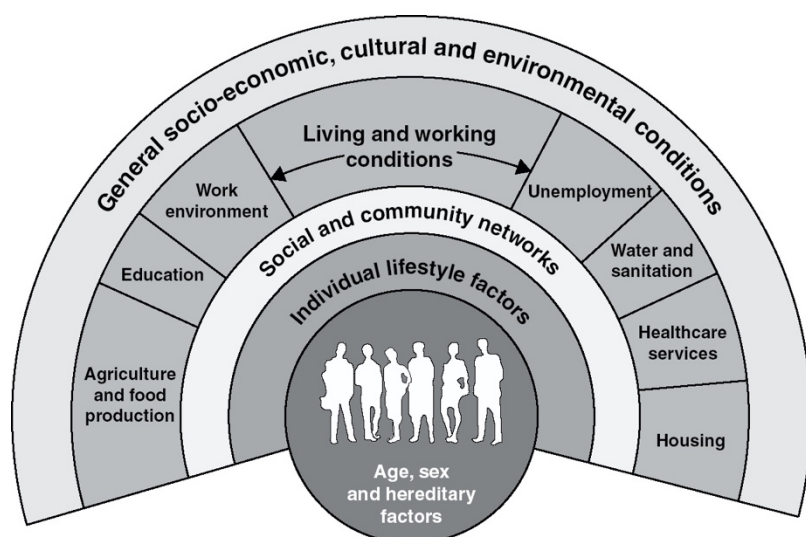


Figure 1. Determinants of Health Model. Source: Dahlgren and Whitehead (1991) (20)

To further interrogate the extent to which policy documents address equity, the analytic framework drew upon Whitehead and Dahlgren’s Ten principles for policy action (35) and Whitehead, Dahlgren and Gilson’s key action areas for robust policy response to health inequalities (36). Guiding questions for analysis were selected based on relevance to this particular critical analysis of policy documents from a single country. These documents outline key evidence-based policy features that are considered essential to promote equity in health policy (14, 37) and have previously been applied to understand inequities in children’s health including obesity, (38, 39) and in frameworks to examine health equity in child health policies (40).

TABLE 7.1 CODING AND THEORETICAL ANALYSIS FRAMEWORK

Theoretical Perspective	Description	Guiding questions for data coding and analysis	Codes
Problematization theory, applied as <i>What’s the problem represented to be?</i> (WPR) (30)	The WPR approach draws on problematization theory and comprises critical analysis questions to interrogate policy recommendations or actions, ultimately identifying how problems are implicitly or explicitly represented within these.	<ol style="list-style-type: none"> 1. What’s the problem represented to be in a specific policy or policies? 2. How has this representation of the “problem” come about? 3. What is left unproblematic in this problem representation? Where are the silences? 4. What effects are produced by this 	<p>Health burden</p> <p>Disease prevention</p> <p>Economic impacts</p> <p>Unhealthy behaviours</p> <p>Lifestyles</p> <p>Vulnerable populations</p>

		representation of the “problem”?	Individual responsibility
Ecological systems theory (41)	According to ecological systems theory, health is influenced by multiple factors operating across several levels. Dahlgren and Whitehead align four levels of policy action to the corresponding determinants of health.	<p>5. How are the determinants of childhood obesity represented across (i) macro (ii) settings (iii) community (iv) individual levels?</p> <p>6. How do proposed policy actions align across (i) macro, (ii) settings, (iii) community and (iv) individual levels?</p>	<p>Individual choice</p> <p>Behaviour not meeting guidelines</p> <p>Unhealthy food marketing</p> <p>Obesogenic environments</p> <p>Social determinants of health</p> <p>Unhealthy norms</p> <p>Individual responsibility</p> <p>Education and information</p> <p>Increase fruit and veg intake</p> <p>Social marketing</p> <p>School programs</p> <p>Sports and recreation policies</p> <p>Government responsibility</p> <p>Shared responsibility</p> <p>Partnerships</p>
Key concepts and principles for promoting equity in health policy (36) (35)	Evidence-based features of a policy response to promote equity or reduce health inequalities.	<p>7. How have equity objectives and targets been described in the policy?</p> <p>8. To what extent are actions to prevent childhood obesity targeting the social determinants of health inequalities?</p> <p>9. How does the policy report on or plan for measurement of inequalities and outcomes for different socioeconomic groups?</p>	<p>Equity in principle</p> <p>Equity objectives</p> <p>Equity targets</p> <p>Whole of populations</p> <p>Social determinants</p> <p>Targeted interventions</p> <p>Priority populations</p>

			Research and monitoring
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Reflexivity Statement

All researchers involved in this study are white, female and tertiary educated, with experience identifying and analysing policies to equitably reduce non-communicable diseases. Our professional backgrounds include the fields of nutrition and dietetics, chronic disease prevention, epidemiology, health equity, health policy, and Aboriginal and Torres Strait Islander health. In accordance with existing theories and evidence, we are of the view that health and health inequities are influenced by the social determinants that shape the conditions in which individual behaviours occur.

Document selection

For the purpose of this study we were interested in government health policy documents in order to analyse policy representations of inequalities in childhood overweight and obesity. Each of Australia's nine national, state and territory government health department websites were manually searched by one researcher (AC) between October 2019 and December 2019 for potentially relevant health policy documents. These included 1) national or state or territory healthy eating / obesity prevention policy documents, and 2) national or state or territory public health policy documents (including health and wellbeing, prevention, health promotion, and child and youth health policy documents) that proposed objectives or strategies for childhood obesity prevention, as an indication of governments' intentions. This range of document types was sought because of the observed inconsistencies in obesity prevention policy documents produced by national, state and territory governments. Keyword searches (for child, childhood, obesity, weight) were conducted to identify if a document was relevant to the study.

Inclusion and exclusion criteria

To be eligible for inclusion, documents had to be i) published by a government health department, ii) a policy, strategy, strategic framework, plan, strategic plan, or action plan, iii) published between 2000 and 2019 (to capture current or most recent childhood obesity prevention policy proposals), and iv) explicitly outline objectives or strategies for preventing

childhood obesity. Only health department policies were eligible because health departments are likely to take the lead/coordinating role for policies aiming to reduce childhood obesity. Documents were excluded if they did not outline actions specifically pertaining to the prevention of child obesity, or for which a more recent version of the same document was available.

Data extraction

The following details were entered into a data extraction matrix developed for this study in Microsoft Excel: the title of the policy; level of government (state/territory or national); the type of the policy (e.g. public health plan, healthy eating strategy); the timeframe of the policy; the overall goal of the policy.

Data analysis

The representations of childhood obesity and inequalities in childhood obesity in Australian health policy documents were examined through a theory-informed analysis. Policy documents were read in full and all sections relating to the prevention of childhood overweight and obesity were inductively coded, guided by the questions outlined in the analytical framework (Table 1). Guiding principles and overarching statements in each policy document were inductively coded in the same manner. Two authors (AC & CZ) independently coded a subset of three policy documents, before comparing, labelling and defining codes and developing a coding framework that was used to code the remaining documents by a single author (AC) (Table 1).

Codes were subsequently aggregated to generate higher-order themes illustrating the representations of inequalities in childhood obesity (42). To do this, text-based thematic maps were constructed to iteratively explore relationships between codes and the theory, using the guiding questions from the analytic framework.

Final themes were verified in three ways; 1) mapping the codes against the analytic framework; 2) revisiting the policy documents throughout the analytical process; and 2) through discussion with all members of the research team (43).

Results

A total of 30 documents were retrieved, of which 18 were eligible for inclusion in the analysis. Excluded documents either did not outline specific actions to address childhood obesity prevention, or a more recent version was identified. A flow chart illustrating the document selection process is shown in Figure 2. Nine policy documents focussed on healthy weight or obesity (n=4), healthy eating (n=4), food and nutrition (n=1) were included from national (n=2) and state and territory (n=7) governments. A further nine public health policy documents outlining strategies for health and wellbeing (n=4), prevention (n=1), health promotion (n=1), child and youth health (n=3) were included from national (n=2) and state and territory governments (n=7). Details including titles and jurisdictions of included documents is provided in Table 2.

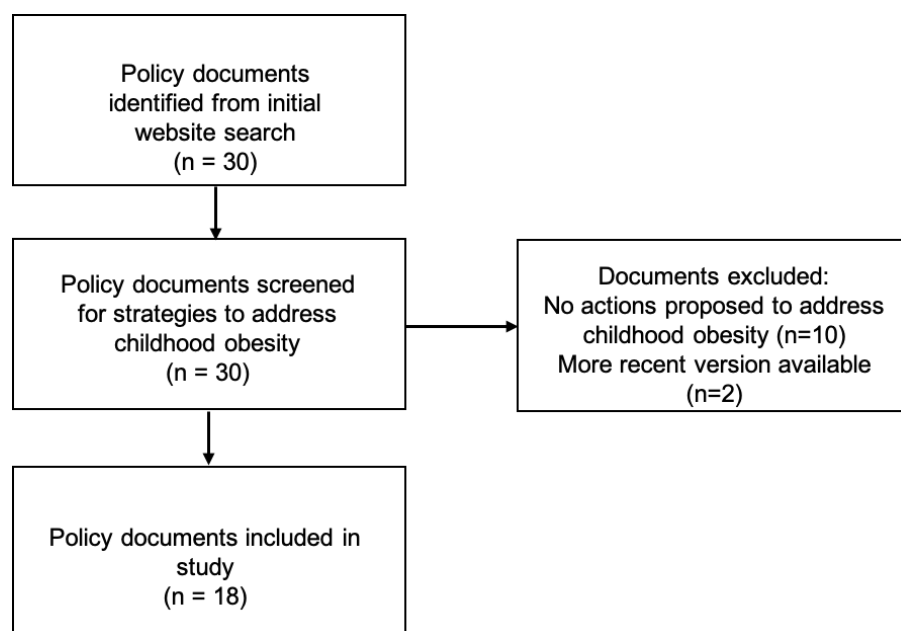


FIGURE 7.1 ARTICLE SELECTION FLOW DIAGRAM

TABLE 7.2 POLICY DOCUMENTS INCLUDED IN THE ANALYSIS

	Public Health Strategies	Obesity / Healthy Eating Strategies
Australia	National Preventative Health Strategy: Australia the healthiest country by 2020 <i>Published 2009, Australian Labor Party</i>	
	Healthy Safe and Thriving: National Strategic Framework for Child and Youth Health 2015 <i>Published 2010, Liberal-Nationals Coalition</i>	
		Eat Well Australia: An Agenda for Action for Public Health Nutrition 2000-2010 <i>Published 2001, Liberal-Nationals Coalition</i>
		Healthy Weight 2008: The National Action Agenda for Children and Young People and their Families <i>Published 2008, Australian Labor Party</i>
Victoria	Victorian Public Health and Wellbeing Plan 2019-2023 <i>Published 2019, Labor Party</i>	
New South Wales (NSW)	Healthy Safe and Well Strategic Health Plan for Children Young People and Families 2014-2024 <i>Published 2014, Liberal Party</i>	NSW Healthy Eating and Active Living Strategy: Preventing overweight and obesity in New South Wales 2013-2018 <i>Published 2013, Liberal Party</i>

		NSW Premier's Priority: Reduce Overweight and Obesity Rates of Children by 5% over 10 years <i>Published 2016, Liberal Party</i>
Australian Capital Territory (ACT)		ACT Towards Zero Growth Healthy Weight Action Plan <i>Published 2013, Labor Party</i>
Queensland (QLD)	Queensland Health and Wellbeing Strategic Framework 2017-2026 <i>Published 2018, Labor Party</i>	Queensland Health: Healthy Weight Strategy 2017-2020 <i>Published 2017, Labor Party</i>
Northern Territory (NT)	Northern Territory Child and Adolescent Health and Wellbeing Strategic Plan 2018-2028 <i>Published 2018, Labor Party</i>	Northern Territory Health Nutrition and Physical Activity Strategy 2015-2020
Western Australia (WA)	Western Australian Health Promotion Strategic Framework 2017-2021 <i>Published 2017, Labor Party</i>	
	Western Australian State Public Health Plan 2019-2024 <i>Published 2017, Labor Party</i>	
South Australia (SA)		The Eat Well Be Active Strategy for South Australia 2011-2016 <i>Published 2011, Labor Party</i>
Tasmania	Healthy Tasmania Five Year Strategic Plan 2016 <i>Published 2016, Liberal Party</i>	Tasmanian Food and Nutrition Policy 2004 <i>Published 2004, Labor Party</i>
Liberal party core values include individual freedom and minimal state involvement; Labor party core values include social security and a balance between market economy and state intervention.(44)		

A total of six themes were identified, illustrating representations of inequalities in childhood overweight and obesity in Australian health policy documents (Table 3). Policy documents dedicated to healthy eating and obesity prevention proposed actions to prevention childhood obesity in more detail compared to general public health policy documents (including health and wellbeing, prevention, health promotion, and child and youth health policy documents). An overview of each of the themes is provided below, using excerpts from policy documents to illustrate how data contributed to each theme.

TABLE 7.3 CODES AND FINAL THEMES

Codes	Themes
Health burden Disease prevention Economic impacts	Childhood obesity is a burden
Unhealthy behaviours Lifestyles Individual choice Behaviour not meeting guidelines Vulnerable populations Individual responsibility Unhealthy norms Education and information Increase fruit and veg intake Social marketing	Childhood overweight and obesity is a problem of individual responsibility
Unhealthy food marketing Obesogenic environments Social determinants of health School programs Sports and recreation policies	Social determinants contribute to childhood overweight and obesity
Individual responsibility Government responsibility Shared responsibility Partnerships	Shifting responsibility for childhood obesity prevention
Equity in principle Equity objectives Equity targets	Equity in principle but not in practice

Research and monitoring	
Whole of populations Social determinants Targeted interventions Priority populations	Priority populations for obesity prevention

1. Childhood obesity is a burden

Throughout policy documents childhood obesity was consistently represented as burdensome to the health system, the economy and to society. The burden of high rates of childhood obesity underscored the focus on childhood overweight and obesity. Objectives to reduce the burden of childhood overweight and obesity were made, and the health, economic and social burden of overweight and obesity was cited as a leading reason to act;

“Based on the available evidence, it is very likely that the impact of overweight and obesity on quality of life, primary health care and the ACT economy are growing. The ACT community cannot afford inaction.” ACT Towards Zero Growth Healthy Weight Action Plan (p.5)

Obesity was problematized as placing a higher burden on the health of particular population groups including people living in socioeconomically disadvantaged areas, regional and remote areas, and Aboriginal and Torres Strait Islander People. Policy documents included broad objectives to reduce childhood overweight and obesity (e.g. Healthy Weight 2008; NSW Premier’s Priority; ACT Towards Zero Growth Healthy Weight Action Plan) and a small number of policies set overall targets for obesity prevention or reduction (e.g. QLD Health Weight Strategy), however explicit targets for reducing childhood obesity among specific population subgroups were not identified. Furthermore, no targets were set for reducing inequalities in childhood obesity.

2. Equity in principle but not in practice

Equity was acknowledged in the majority of policy documents, commonly positioned as a guiding principle for the objectives and actions within. A number of equity-related concepts were theoretically discussed including health disparities, health inequalities, and social and economic disadvantage. Within these discussions, equity was more commonly represented as

an issue of health differences than as an issue of fairness. Only a minority of documents including the Northern Territory Health Nutrition and Physical Activity Strategy and Victorian Public Health and Wellbeing Plan spoke to the issue of fairness;

“This strategy acknowledges the need to address the multiple underlying social, economic and cultural determinants of health and aims to reduce health disparities seen in the NT, by focussing on those who experience the greatest disadvantage and are most at risk.” Northern Territory Health Nutrition and Physical Activity Strategy 2015-2020 (p.7)

“A fairer society is fundamental to improving the health of the whole population, yet we know that good health and wellbeing is not equally distributed across the population. Those who live with greater social and economic disadvantages are more likely to experience health inequalities.” Victorian Public Health and Wellbeing Plan 2019-2023 (p.15)

Most policy documents failed to report on the magnitude of inequalities in childhood overweight and obesity, with childhood obesity prevalence, trends and risk factor data predominantly reported in aggregate. Where childhood obesity data were reported by subgroup, this included reporting by age and/or sex, but not by indicators of socioeconomic position, silencing the health disparities within the population. One exception was seen in the NT Health Nutrition and Physical Activity Strategy which reported trends in overweight and obesity and health behaviours according to urban non-Aboriginal, urban Aboriginal and remote Aboriginal status. However, targets and actions to address the demonstrated differences were not proposed.

Very few policy documents explicitly proposed action to reduce inequalities in childhood overweight or obesity. This indicates that such inequalities were insufficiently problematized as an issue in the health policy documents examined in this study. Although specific actions were seldom articulated, broad intentions to reduce inequalities were stated such as in the National Strategic Framework for Child and Youth Health;

“Work collaboratively with other agencies and community health bodies to reduce disadvantage as a result of social determinants of health.” Healthy Safe and Thriving: National Strategic Framework for Child and Youth Health 2015 (p.30)

Equity objectives and targets were not articulated and consideration of equity impacts was lacking in actions proposed in policy documents. This leaves the impact of policies on different population groups largely unknown. A very small number of policies proposed monitoring of obesity, diet and physical activity indicators by sociodemographic characteristics as seen in the following example;

"Assess changes in prevalence of overweight and obesity, physical activity, healthy and unhealthy food consumption by sociodemographic groups (sex, age, SES, remoteness and HHS) for adults and children." Queensland Health: Healthy Weight Strategy 2017-2020 (p.8)

3. Childhood overweight and obesity is a problem of individual responsibility

The representation of childhood overweight and obesity as a problem of individual responsibility was the dominant theme throughout the policy documents analysed in this study. This representation was evident in all policy documents, particularly in the causes of childhood obesity and through the solutions proposed within policy documents

The focus on the individual was evident through an emphasis on policy actions targeting individual behaviour. The dominant message throughout all policy documents was that individuals and their inadequate dietary and activity behaviours are primarily responsible for the high prevalence of childhood overweight and obesity in Australia. A number of policy documents (e.g. Healthy Weight 2008; QLD Healthy Weight Strategy; NSW Healthy Eating Active Living Strategy; NSW Premier's Priority; Victorian Public Health and Wellbeing Plan; Tasmanian Food and Nutrition Policy; Eat Well Be Active SA; WA Health Promotion Strategic Framework; NT Health Nutrition and Physical Activity Strategy) reported discordance between national guidelines and children's behaviour such as consumption of unhealthy foods and sugar-sweetened beverages, and the proportion of children engaging in physical activity and sedentary behaviour, as illustrated by the following example;

"Non-observance with the Australian Dietary Guidelines was greatest in relation to vegetables, saturated fat and sugar for (children of) all age groups, as well as fruit and dairy intake for those 9 years and over." Northern Territory Health Nutrition and Physical Activity Strategy 2015-2020 (p.29)

Policy documents (e.g. QLD Healthy Weight Strategy; ACT Towards Zero Growth; Eat Well Be Active SA; WA Health Promotion Strategic Framework) also problematized “lifestyle choices” of individuals and families as responsible for childhood overweight and obesity;

“Compared to major cities, adult obesity rates are 22% higher in outer regional and 36% higher in remote and very remote areas. While disparities are not as evident among children, it is likely that family lifestyle choices over the longer term will put children at risk of weight gain.” QLD Healthy Weight Strategy 2017-2020 (p.2)

Maintaining a healthy lifestyle or preventing lifestyle-related ill health was commonly recommended as a strategy to prevent childhood obesity. All policy documents proposed objectives or actions at the individual level such as dietary and physical activity behaviour change, reinforcing the representation of childhood obesity as an individual problem. Actions such as information provision, education, and raising awareness were recommended in all policy documents. These actions problematize childhood obesity as an issue caused by individual choices, particularly parents’ choices, and as arising from a lack of knowledge or awareness;

“Develop and disseminate information resources for parents at different stages of their child’s development – starting with new parents – on healthy eating, active living and healthy weight for themselves as well as their child.” Healthy Weight 2008: The National Action Agenda for Children and Young People and their Families (p.11)

4. Social determinants contribute to childhood overweight and obesity

An alternative to the individual responsibility representation, is one that considers the underlying social determinants of childhood obesity. Compared to individual-level actions, policy documents were less likely to problematize childhood overweight and obesity as a problem to be addressed through structural interventions targeting the SDoH. It was common, however, for policy documents (e.g. National Preventive Health Strategy; NSW Healthy Eating Active Living Strategy; Victorian Public Health and Wellbeing Plan; Eat Well Be Active SA;

WA Health Promotion Strategic Framework) to rhetorically acknowledge the SDoH as drivers of childhood obesity;

“There is widespread consensus that the rise in overweight and obesity is mostly a result of social, environmental and technological changes over the last few decades. These changes have led to environments which encourage excess energy intake and reduced energy expenditure.” New South Wales Healthy Eating and Active Living Strategy 2013-2018 (p.27)

“We have recognised for some time that there is a broad range of social determinants that influence people’s wellbeing. How much you earn, the local environment, whether you have a job or are able to access the services you require will all have an impact on your diet, levels of physical activity, health, educational attainment, ability to secure and sustain housing, and risk of involvement with the criminal justice system.” The Eat Well Be Active Strategy for South Australia 2011-2016 (p.5)

Policy documents frequently problematised childhood overweight and obesity as a settings-based issue through a focus on actions within school or sport and recreation settings (e.g. NSW Healthy Safe and Well; NSW Premier’s Priority; ACT Towards Zero Growth Healthy Weight Action Plan; Victorian Public Health and Wellbeing Plan; Eat Well Be Active Strategy for SA; NT Child and Adolescent Health and Wellbeing Strategic Plan; NT Health Nutrition and Physical Activity Strategy). Although this suggests a shift away from individual responsibility, settings-based actions frequently included those which rely upon individual agency such as nutrition education in school curricula, reinforcing the problematization of individual behaviour. On the other hand, proposed actions at the settings level also included actions to change the environment within those settings such implementing healthy menus within sport and recreation centres and food and nutrition policies in schools;

“Develop and implement an ACT Government school food and drink policy with supporting guidelines that will mandate the implementation of the National Health School Canteen Guidelines in all ACT schools.” ACT Towards Zero Growth Healthy Weight Action Plan (p.16)

Proposed structural interventions included increasing availability and access to healthy food in communities, increasing the availability of free drinking water, and industry-led reductions in serving sizes and product reformulation. However, these actions were often loosely described leaving unclear the roles and responsibilities for implementation;

"Encourage the food service industry to limit size of servings and reduce energy content of less healthy meals and snacks, and support the food industry to develop less energy dense products." Healthy Weight 2008: The National Action Agenda for Children and Young People and their Families (p.14)

Children's exposure to unhealthy food marketing was commonly problematized as an issue, across a majority of policy documents. The National Preventive Health Strategy proposed detailed actions to address unhealthy food marketing;

"Reduce exposure of children and others to marketing, advertising, promotion and sponsorship of energy-dense nutrient-poor foods and beverages". Strategies include monitor and evaluate Industry self-regulation, identify shortfalls, introduce co-regulation, monitor, introduce legislation if self- and co-regulation are not demonstrated to be effective." National Preventive Health Strategy: Australia the healthiest country by 2020 (p.16)

5. Priority populations for obesity prevention

Priority populations were identified in all policy documents according to sociodemographic characteristics and included Aboriginal and Torres Strait Islander Peoples, culturally and linguistically diverse communities, socioeconomically disadvantaged communities and mothers and young children. The identification of priority groups was frequently seen in policy rhetoric and less commonly problematised through the proposal of actions targeted towards particular groups.

Policy documents commonly referred to population groups as "disadvantaged" (e.g. QLD Health and Wellbeing Strategic Framework; ACT Healthy Weight Action Plan; Eat Well Be Active SA; NT Health Nutrition and Physical Activity Strategy) or "vulnerable" (e.g. Eat Well Be Active SA; Tasmanian Food and Nutrition Policy; WA Health Promotion Strategic Framework) to poor health. Documents inconsistently elaborated which population groups experience disadvantage or vulnerability and infrequently attributed disadvantage to the socioeconomic circumstances which lead to increased risk of poor health. Instead, documents

more commonly attributed disadvantage and vulnerability to individual factors such as lifestyle behaviours;

“Within NSW there are sub-populations that warrant particular attention given their high prevalence of inadequate physical activity, unhealthy eating and higher than average rates of overweight and obesity.” NSW Healthy Eating Active Living Strategy 2013-2018 (p.20)

There were inconsistencies between policy documents in the proposal of actions for priority groups. This suggests that the rhetoric around priority groups was not always translated into policy action. Where documents did propose obesity prevention actions for priority populations, approaches were dominated by targeted education strategies. These representations reinforce the problematization of individual responsibility for overweight and obesity, suggesting that disparities within the population arise from a lack of knowledge and awareness. These representations also imply that the differences between population groups are due to the biology or behaviour of these groups rather than socially constructed as a result of unjust policies;

“By targeting better nutrition and physical health as part of its broader social equity agenda, the government will build on the wide range of programs already in place to assist those experiencing disadvantage. ... Improve awareness, skills and capability across the ACT in buying and preparing healthy food.” ACT Towards Zero Growth Healthy Weight Action Plan (p.15)

6. Shared responsibility for childhood obesity prevention

Childhood obesity was represented as the responsibility of multiple stakeholders. This was explicit in some documents which articulated a shared responsibility for health among individuals, society and governments, including a shared responsibility beyond the health sector;

“Health is a shared responsibility between those who will benefit from making healthy choices (for example individuals, families and communities) and those who provide the infrastructure, services and support (governments at all levels, professional associations, the non-government

sector, the research community, industry and business, and unions).” National Preventive Health Strategy: Australia the healthiest country by 2020 (p.41)

“... health is not merely a product of healthcare activities but is influenced by a wide range of social, economic, political, cultural and environmental factors, many outside the health sector.” The Eat Well Be Active Strategy for South Australia 2011-2016 (p.53)

One policy document from the ACT proposed to navigate the complexities of Australia’s federated system of government and identify opportunities for its government to regulate unhealthy food marketing.

“Australian experience suggests state or territory-based regulation of television advertising is problematic, however the ACT Government will examine its regulatory control across advertising mediums. There is a particular need to address marketing directed at children in close proximity to schools, playgrounds and child care centres.” ACT Towards Zero Growth Healthy Weight Action Plan (p.17)

On the other hand, some states and territories shifted all responsibility to the federal government, as seen in the NT Nutrition and Physical Activity Strategy, deferring to national action on unhealthy food marketing;

“Contribute to national initiatives seeking to reduce exposure to advertising of EDNP foods and drinks to children.” Northern Territory Health Nutrition and Physical Activity Strategy 2015-2020 (p.33)

The intent to work in partnership to address childhood obesity in Australia was evident throughout all policies, with partnership positioned as a guiding principle in a number of documents. Partnerships across levels of government, between government sectors and with external partners such as non-government organisations, academic institutions, industry and community were mentioned throughout policy documents, although roles and responsibilities of each partner were generally not articulated. The principle of working in partnership was supported by actions proposed to create and foster partnerships in order to achieve specific goals;

“Strengthen partnerships with the sport and recreation sector to increase regular participation in sports and active recreation across the lifespan, and improve the supply and promotion of healthy food and drinks at sporting clubs.” Queensland Healthy Weight Strategy 2017 to 2020 (p.8)

Discussion

This study presents the first critical analysis of how inequalities in childhood obesity are represented in Australian health policy. Our analysis examined the representations of inequalities in childhood obesity across a sample of 18 Australian health policy documents proposing action to prevent childhood overweight and obesity.

Childhood overweight and obesity was predominantly problematized as an issue of individual responsibility. Actions proposed in policy documents focused primarily on information provision and education to improve knowledge and skills and change children and parents’ behaviour with a focus on increasing fruit and vegetable intake and physical activity, and decreasing unhealthy food consumption and sedentary behaviour. The framing of nutrition and obesity as issues of individual responsibility has been identified in other policy analyses (27, 31, 33) and media studies (34, 45, 46). For example, Australian government healthy weight campaigns have frequently been built on the assumption that individuals are responsible for their own health and that behaviour change is a matter of individual choice (46). Governments have previously been observed to frame obesity as an issue of individual responsibility and to give preference to interventions targeted towards individuals (24, 47). The framing of obesity as the responsibility of individuals aligns with a neoliberal ideology characterised by behavioural approaches with a minimal role for government intervention or industry regulation (29).

The way childhood obesity is framed in policy and by media has widespread impacts. Framing childhood obesity as an issue of individual responsibility is likely to garner less public support for government action to address obesity compared to societal responsibility frames (48). Such emphasis on individual responsibility by governments, without also addressing the underlying drivers of weight gain, is likely to exacerbate health inequalities (19) as lifestyles are structurally determined, particularly among those with lower socioeconomic position (36). Actions that rely upon individual agency, such as behaviour change campaigns and promoting

healthy eating guidelines are less likely to be effective among those with fewer social and economic resources, unless the structural barriers that constrain healthy eating such as access and affordability to healthy diets are addressed (19).

Policy documents acknowledged the social determinants of inequalities in childhood obesity in their rhetoric but not in their solutions, thereby problematizing childhood obesity as an issue of individual responsibility. The representations of individual responsibility for childhood obesity stand in contrast to the representations made by public health and academic community which represent obesity as an issue arising from social determinants (27, 34).

In particular, we observed a focus on actions proposed in schools and other community settings. This settings-based problematization of childhood overweight and obesity could be interpreted to mean that settings are not doing enough to prevent childhood excess weight gain among children. On the other hand, it could be that governments are placing the onus on settings, such as schools to take responsibility for action to improve children's health. Indeed, schools play an influential role in the development of children's health behaviour and have been identified as highly capable of enacting policies to positively impact obesity (49). Community-based interventions are also increasingly being recognised for their role in improving childhood obesity outcomes (50). Whilst settings and community-based interventions have been shown to have positive outcomes across all socioeconomic groups (51) it is important that actions address the underlying determinants of inequalities in childhood overweight and obesity and are not limited to educational interventions that rely on individual agency for behaviour change (19).

Food access, food pricing and affordability, and unhealthy food marketing were acknowledged rhetorically in policy documents, but were not consistently committed to with proposed actions. These factors shape the environments in which food choices are made, and are arguably more influential than individual factors in the development of obesity (11, 19). Where objectives to address the SDoH were proposed in policy documents, actions tended to focus on changing behaviour, rather than environments. This has been observed previously (52) and has been described as 'lifestyle drift', where policies acknowledge a broad range of determinants, yet actions focus on behavioural interventions (53). Similar representations of obesity have also been observed within Canadian government documents (54). A lack of focus on the SDoH in government policy silences the broader determinants of obesity and instead emphasises individual behaviour which may perpetuate weight stigma (54).

Furthermore, a lack of proposed action to address the underlying determinants of childhood obesity allows the individual responsibility frame to predominate throughout the policy documents. This has been observed elsewhere, with proposed solutions to obesity targeted towards individuals through health promotion and children's education (47). In direct contrast, the public health sector frames the causes of and solutions to obesity in the context of the SDoH (27). This framing draws on evidence that indicates addressing underlying drivers of health is necessary to shape health-promoting environments which support, instead of undermine, healthy behaviours across populations (9). Creating environments that support fair opportunities for healthy behaviours for all will be necessary to achieving equitable reductions in childhood obesity (19, 36). To do this requires government regulation (18, 49). In this analysis, irrespective of the political party responsible for each policy document, we found very few documents that proposed regulatory action. This aligns with the findings of previous research that suggests regulatory action to address obesity has not been a political priority in Australia for a number of reasons including a neoliberal ideology that promotes individual responsibility (driven mainly by conservative governments), lack of political will to impose regulation (all governments), and food industry opposition (all governments) (21, 44).

Equity was positioned as a principle underpinning actions proposed within a majority of policy documents. However, references to equity were predominantly rhetorical. We observed limited reporting of inequalities in childhood obesity or inequalities in health more broadly. Instead, data were reported in aggregate, masking differences in health status within populations. This representation silences the disproportionate burden of obesity and associated ill health that is carried by groups experiencing greater socioeconomic disadvantage (18). Instead what is required is political commitment to ongoing monitoring and reporting of health status according to social group and action to address these disparities (36).

Limiting equity to an underlying principle of policy confines the discussion to a symbolic one (36). Without translation to more substantive policy commitments including clear actions and allocations of resources, this rhetoric is limited in its capacity to achieve equity (29). There is therefore a clear need to translate intentions around equity into action through higher levels of political commitment (18, 29). Explicit actions to address health inequalities and their underlying determinants are considered essential to equity-oriented health policy (18, 35, 36), however these were lacking in the policy documents examined in this study. In saying that, strategies to create healthy school food environments and policies that regulate unhealthy food

marketing targeting children were identified in this analysis. These actions have the potential to change the environmental conditions in which children live, learn and play (52) and are likely to have equitable impacts (19).

A number of priority populations were problematized throughout policy documents. Young children were represented as vulnerable to poor nutrition and the early childhood period was identified as a priority for action to address childhood obesity. Evidence demonstrates that conditions in early life are an important determinant of obesity (9), with early life a critical time for optimising healthy behaviours, through breastfeeding, the introduction of complementary foods, and the development of healthy eating, physical activity, and sleep patterns (55). The early childhood period is also critical in the development or avoidance of inequalities as the conditions to which children are exposed in early life will either promote or compromise health (16).

Aboriginal and Torres Strait Islander peoples, culturally and linguistically diverse communities and low-income families were also identified as priority populations in policy documents. These population groups were represented as experiencing overweight and obesity because of their poor lifestyle choices, rather than lacking privilege and adequate access to the resources required for good health (56). A similar representation was observed in Danish public health policy documents which represented poor health among populations experiencing disadvantage as caused by their own behaviour (57). This is in contrast to an equity-focused approach that identifies and names the conditions or circumstances that have led to individuals or groups of individuals being at greater risk of poor health (58). Representing vulnerable populations as a problem to be solved perpetuates a deficits-based perspective that may reinforce disadvantage (59). In the case of Aboriginal and Torres Strait Islander health and wellbeing evidence shows that a self-determination and a strengths based approach is fundamental (60).

Objectives and actions to improve health among priority populations were articulated with a dominant focus on targeted approaches such as tailored education campaigns and support programs. This reinforces the notion of individual responsibility and represents inequalities in childhood obesity as a dichotomy, where a particular group is seen to be at greater risk compared to the rest of the population (61). A targeted approach such as this may reduce the inequality gap, but ignores the social gradient in health (14). An alternative to a targeted approach is a universal approach. This includes strategies that are aimed at an entire population,

such as the promotion of dietary guidelines, or mandatory food and nutrition front-of-pack labelling. Although designed to reach the whole population, universal approaches may not necessarily have the same impact across population groups. For example, interventions that aim to provide information or education rely heavily on individual agency without addressing the underlying determinants of health inequalities (19). In between sits an approach known as proportionate universalism, where universal policies are designed and delivered at a scale and intensity relative to the level of need across populations (37). Ultimately, universal policies designed according to need, complemented by carefully designed targeted strategies, will be required to address childhood overweight and obesity across the entire socioeconomic gradient. Ongoing assessment of the impact of universal policies on socioeconomic inequalities will be necessary to ensure policies are having equitable impacts (49).

Policy documents emphasised that the health sector alone cannot resolve childhood obesity and partnerships were frequently mentioned. Yet the roles and responsibilities of other partners and the extent of their commitment were not described, and actions proposed within policy documents were confined to the health sector. This limits action to address the drivers of health outcomes that sit outside the health sector (37) and could be perceived as a political tactic to delay action. Partnerships between sectors are necessary for two key reasons. First, responsibility for the determinants of inequalities in childhood overweight and obesity extend beyond the health sector and include housing, education, employment and access to health and social services (9, 23). Second, food policy actions that address the upstream determinants of dietary behaviour require engagement from multi-sectoral partners. For example a health levy on sugar-sweetened beverages requires coordination between government health, finance, agriculture, trade and commerce ministries (62). In order to address inequalities in childhood obesity, health policies will need to actively engage stakeholders across sectors, and take stewardship of cross-sectoral actions that addresses the underlying social and commercial determinants (36, 63).

There are some limitations to consider. Our study sought to analyse how inequalities in childhood obesity are represented in policy documents. Findings do not reflect the extent to which proposed actions have been implemented or evaluated. Our focus was on health policy documents as an indicator of governments' rhetorical and institutional commitment to act on childhood obesity and its inequalities. The policy documents included in this study are the most recent of their type, however some have expired - such as Eat Well Australia: an agenda for

action in public health nutrition 2000-2010. This illustrates an urgent need for comprehensive government action. Of note, a National Obesity Strategy is under development, tabled for release in 2021. Although all documents included in this study were published by government health departments, we recognise that strategies proposed by other government departments will also impact the determinants of childhood obesity and are likely to impact the widening or narrowing of health inequalities (14). It is possible that documents from other portfolios (e.g. education) may have contained relevant actions but it is likely that these would have been cross-referenced in health policy documents. Analysis of representations of health equity in policy documents outside the health sector remains an important area for future research. Finally, it is important to note that the authors approached this analysis with a positionality stemmed in public health equity. To maintain rigour in our analysis, we used a theory-informed coding framework that was developed apriori and referred to the theory and evidence throughout the analytic process.

This study also has a number of strengths. To our knowledge, this study is the first of its kind. Its findings improve understanding of how childhood obesity and related inequalities are represented in Australian health policy, and how these representations potentially limit the possible solutions for addressing inequalities in childhood obesity. The analysis illuminates silences in these representations such as a silencing of the existence and social determinants of health inequalities within and between population groups. Our findings suggest a role for advocacy and political leadership to challenge current representations and reframe the issue of obesity in a way that puts equity and the SDoH equity at the forefront of the policy agenda. This requires a paradigm shift from individual responsibility towards action to address the SDoH, to ensure that future policies are aptly designed to achieve the goal of reducing inequalities in childhood obesity.

Conclusion

Australian health policy documents predominantly represent childhood obesity as an issue of individual behaviour, with SDoH recognised but not sufficiently targeted with proposed actions. Equity is positioned as a rhetorical guiding principle, but this is not translated into actions that seek to achieve equity. These representations set an agenda for public health policy that is unlikely to address the underlying causes of inequalities in childhood obesity. In order

to reduce inequalities in childhood obesity future health policies will require a greater focus on health equity and commitment to actions to address the SDoH. These findings highlight significant gaps in the current health policy landscape and can be used to inform the development of future policy and advocacy which aims to promote fairer opportunities for health across the population.

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8 DISCUSSION

8.1 OVERVIEW

This thesis began with the aim to generate evidence that informs the prioritisation of prevention policies most likely to reduce socioeconomic inequalities in childhood obesity. Four studies have been undertaken, the findings of which have advanced the evidence on the trends, drivers and current policy action in Australia to address socioeconomic inequalities in childhood obesity. Collectively, these findings demonstrate the need for a shift from the current approach to childhood obesity prevention to one that comprehensively addresses the immediate and underlying determinants of inequalities in child and adolescent overweight and obesity. My findings support the evidence indicating that the adoption and implementation of policies that have an explicit equity focus along with commitment to actions that address the behavioural and structural drivers of health will be necessary to reduce socioeconomic inequalities in childhood obesity. This final chapter discusses the key findings and strengths and limitations of the thesis and considers the implications for future research and policy development.

8.2 KEY FINDINGS

8.2.1 Socioeconomic inequalities in child and adolescent overweight and obesity are widening in high-income countries

Chapter Four presented a systematic literature review to identify and describe the extent to which trends in childhood overweight and obesity differ according to socioeconomic position. The systematic review found that trends in child and adolescent overweight and obesity differ across socioeconomic groups and furthermore, demonstrated evidence of a widening of socioeconomic inequalities in a number of high-income countries across the years 1990 to 2015.

These findings consolidate and expand existing evidence of socioeconomic inequalities in child and adolescent obesity (1). The study findings demonstrate for the first time that the widening socioeconomic inequalities in childhood obesity is made up of a stabilization or decrease in overweight and obesity among children with high SEP and concurrent rising trends in overweight and obesity among children with lower SEP. Findings suggest that recent gains in

preventing obesity are predominantly experienced by higher socioeconomic groups. In the context of evidence suggesting a plateau in childhood obesity trends in high-income countries (2-4), this study reinforces the need for improved and ongoing monitoring to allow SEP-specific sub-group analysis of childhood obesity and its risk factors (5). Ideally, population surveillance for monitoring childhood obesity would include regular monitoring and reporting of trends in overweight and obesity as well as obesity-related behaviours such as diet and activity, and conditions in the home, food, and macro environments, all according to indicators of socioeconomic position. This would improve understanding of trends and drivers of childhood obesity across socioeconomic groups and allow for evaluation of effects of interventions that aim to address childhood obesity.

Since this systematic review was completed, further evidence has emerged that substantiates the findings of differential and widening trends in child and adolescent overweight and obesity across socioeconomic groups. An Australian study examining 30 year trends in overweight and obesity by SEP among children and adolescents aged 4-18 years in the state of New South Wales (NSW) reported the emergence of socioeconomic inequalities in overweight from 2010 and the emergence of inequalities in obesity from 1997, with inequalities widening over time (6). Interestingly, the overall finding reported by the study's authors was that overweight and obesity remained stable among children between 1997-2015 (6). This demonstrates the way in which making conclusions based on population data can mask important socioeconomic differences.

Another study of more than 6000 children aged 11-12 years living in the Australian Capital Territory also demonstrated evidence of differential and widening socioeconomic inequalities in child and adolescent obesity prevalence in Australia over the period 2006 to 2018 (7). Children living in the most disadvantaged neighbourhoods were more likely to experience overweight or obesity compared to children living in relatively less disadvantaged areas. The observed widening of socioeconomic inequalities in weight were attributed to a stabilisation, albeit at a high level, in the prevalence of overweight and obesity among children with the lowest SEP, accompanied by a downward trend among children with the highest SEP (7).

In the systematic review presented in **Chapter Four**, some included studies indicated widening inequalities to be driven by a plateau in overweight and obesity among children and adolescents with high SEP and concurrent increasing trends among children and adolescents with low SEP. On the other hand, some studies reported downward trends among children and adolescents with high SEP and a concurrent plateau among children and adolescents with low SEP.

Observations that indicate either a plateau or downward trend in overweight and obesity among some groups of children and adolescents are promising, yet findings that inequalities are widening indicate an urgent unmet need. Given the significant efforts globally and within countries to prevent the rise in overweight and obesity (8), findings of persistent or worsening inequalities suggest that efforts to address childhood obesity are having at best a differential impact across socioeconomic groups or at worst, are failing to reach those most in need (9).

This study focused on the differences in obesity prevalence between low and high SEP, however an important consideration is that obesity prevalence exists across a socioeconomic gradient. Actions therefore will need to seek to improve childhood obesity across the entire socioeconomic gradient, not just among the most disadvantaged children. This will require a combination of interventions that are equitable across the population, as well as interventions targeted towards those at greatest risk. This approach is known as proportionate universalism, characterised by a response that is proportionate to need, such that resources and efforts are appropriately allocated to ensure all population groups have a fair opportunity to achieve optimal health irrespective of their position along the socioeconomic gradient (9). To effectively target responses requires a sound understanding of the drivers of obesity and in particular, the drivers of socioeconomic differences in obesity.

8.2.2 Unhealthy food and drink consumption mediates part of the relationship between socioeconomic position and childhood overweight and obesity

The aim of the study presented in **Chapter Five** was to identify the role of dietary behaviours, particularly the consumption of unhealthy food and drinks, in the relationship between socioeconomic inequalities and obesity among a nationally representative cohort of Australian children. This study made two important findings. First, discretionary food and drink consumption during childhood prospectively contributes to the development of socioeconomic inequalities in excess weight. Second, socioeconomic differences in the consumption of unhealthy food and drinks emerge during the first year of life and persist throughout childhood. This study also demonstrated the utility of longitudinal mediation analysis to quantify the role of dietary behaviour in the development of socioeconomic differences in childhood obesity.

Using longitudinal mediation methods, this study found that 11% of the observed difference in BMI z-score at age 10 to 11 years was mediated by socioeconomic differences in unhealthy food and drink consumption throughout childhood. The associations between unhealthy diets

and excess weight (10-12), SEP and excess weight (1, 7), and SEP and unhealthy diets (7, 13-17) among children have all been demonstrated separately. This study confirms these associations and extends our understanding of their relatedness by quantifying the contribution of unhealthy dietary factors to socioeconomic differences in childhood obesity.

Very few studies have examined the mediating role of diet in the association between SEP and obesity. A small number of studies have measured this association in adults, but to my knowledge, no studies have examined this association in children. Of the studies conducted in adults, unhealthy dietary factors have been found to mediate part of the association between socioeconomic position and excess weight. For example, a cross-sectional study of 30,630 participants from the Melbourne Collaborative Cohort Study, the consumption of savoury snack food and SSBs were found to contribute 13% to 15% of the association between educational attainment and BMI among men and women respectively (18). Similar findings were observed in a study of 1860 Swiss adults that found diet quality mediated 22% of the association between educational attainment and BMI (19). Together, these findings form the basis of a new body of evidence that demonstrates the role of unhealthy food and beverage consumption in the development of socioeconomic inequalities in excess weight throughout childhood.

This study also found that children consume SSBs from first year of life, with consumption more likely among children with lower SEP, and observed to track across childhood. The consumption of unhealthy food from the first year of life, and socioeconomic patterning of unhealthy food and SSB consumption among young children is supported by findings from other studies (14, 20-24). The finding in this thesis that dietary behaviours track throughout childhood has been observed previously, with a body of literature demonstrating that diet tracks throughout childhood (20, 21, 24, 25). There are also indications that unhealthy dietary behaviours in childhood are likely to track into adolescence and adulthood (26, 27).

Unhealthy dietary behaviour among children is not an intractable problem. Dietary behaviour is a modifiable determinant of health. The tendency of dietary behaviours to track, however, suggests that efforts to modify children's diets will need to focus on the development of dietary behaviours from the outset, before unhealthy dietary behaviours are established. The development of healthy diets in early childhood is likely to set children on a trajectory of healthy diets throughout childhood (20, 21), *and* have positive outcomes for early childhood development and health equity (28, 29).

This study demonstrated evidence of a socioeconomic gradient in childhood obesity, and also in the consumption of unhealthy food and SSBs. This socioeconomic patterning suggests that in order to be equitable, approaches to improve children's diets will require a response that is proportionate to need. A universally proportionate response to improve children's diets across the lifecourse and reduce health inequalities requires two complementary actions; 1) structural changes to the food environment to better support healthy population diets (30, 31); and 2) targeted support to improve dietary health among children and families experiencing socioeconomic disadvantage. The benefits of this approach are twofold. First, equitable changes to the food environment are likely to shift the entire population towards healthier diets, with the potential to also reduce the socioeconomic gradient by proportionately benefiting those with greater social and economic barriers to healthy eating (31). Second, targeted interventions for those most at need will address the gap between the most disadvantaged children and the rest of the population (32). An approach such as this is likely to improve the diets and subsequent diet-related health among all children, whilst at the same time reduce socioeconomic inequalities in childhood obesity.

8.2.3 Determinants of sweet drink consumption exist across multiple levels

Informed by key findings from the study presented in Chapter 5, the aim of the study presented in **Chapter Six** was to understand parents' perceptions of factors influencing sweet drink consumption among preschool-age children. This study identified a number of factors perceived to influence children's sweet drink consumption and using the socioecological model of health as a framework, illustrated the way in which these factors operate across different contexts.

At the individual level, health knowledge, health beliefs, and parenting skills and confidence were perceived by parents to influence the types of drinks consumed by preschool-age children. At the social level, peer and family role modelling, and social and cultural norms were seen as influential. At the environmental level, sweet drink availability in the home and other places, targeted marketing, drink prices and settings-based policies were perceived to influence drink choices. These factors were found to be important perceived drivers of children's drinking behaviours across a socioeconomically diverse sample of Victorian parents. Similar factors were identified in an international systematic review of determinants of SSB consumption among children aged 0-6 years that found factors including child's preference for SSBs, parent

consumption and home availability of SSBs to be associated with higher SSB consumption and positive role modelling and nutrition policies in preschool settings associated with lower SSB consumption (23).

This study provides insights into the multifactorial drivers of unhealthy diets among Australian children and adds to existing international evidence (23, 33, 34). Dietary behaviours, including SSB consumption are considered potentially modifiable risk factors for excess weight gain in children (23, 35). In order to modify dietary risk factors, the many factors that shape children's diets will need to be considered. These factors will likely differ according to family socioeconomic circumstances. For example, limited education may impact upon parents' capacity to access, interpret and apply health and nutrition information, while parents' occupations may determine the amount of time spent at work and therefore the time available to prepare and eat meals with their children, and income will likely determine the amount of money available for food (36). Action to modify children's diets will therefore need to address the range of drivers, from the individual to the social and environmental contexts. Findings from this study highlight the challenges faced by parents in navigating the daily environment to make healthy choices for their children. In order to improve their capacity to make healthy choices for their children, parents called for policy action to restrict the marketing and promotion of unhealthy food and drinks, improved access to free drinking water, and the adoption of pricing policies that encourage, rather than discourage healthy dietary choices. These findings suggest that, according to parents' perceptions, the current food environment overwhelms the efforts of individuals to choose healthy diets. The necessary action includes the implementation of policies that successfully change the food environment to increase the availability, affordability and appeal of healthy food thereby facilitating children's consumption of healthy diets (31).

8.2.4 Representations of inequalities in childhood obesity in Australian health policy documents

The aim of the study presented in **Chapter Seven** was to critically examine the representations of childhood obesity and health inequalities in a sample of 18 Australian health policy documents. This critical policy analysis was the first of its kind to explore how Australian governments consider socioeconomic inequalities in childhood obesity in health policy. Using Bacchi's WPR approach to problematisation (37), findings indicated childhood obesity is

predominantly represented as an issue of individual responsibility in Australian national, state and territory health policy documents. Actions proposed in policy documents focused primarily on improving knowledge and skills and changing children's behaviour, particularly increasing fruit and vegetable intake, decreasing unhealthy food consumption, increasing physical activity and reducing sedentary behaviour often through education and awareness raising strategies.

A dominant focus on individual behaviour has been observed in other critical analyses of obesity prevention and nutrition policies. A Canadian study employed the WPR approach to critically examine obesity prevention policies to identify underlying dominant narratives; with a view to consider the unintended consequences for people with obesity and the impact on weight bias (38). Among the key representations identified, obesity was represented as a problem for individuals with a dominant focus on the individual including healthy eating and physical activity behaviours (38). A critical analysis of UK public health nutrition policies found policies lacked recognition of the social and emotional factors that influence diet and nutrition, and did not fully consider the impact of structural influences on individual food choices (39).

Findings presented in this thesis indicated that policy documents also represented childhood obesity as a problem of structural determinants, but this was observed in policy principles more commonly than it was seen in policy actions. This demonstrates an understanding of the role of structural drivers, while at the same time highlights a lack of commitment to action to address these drivers. Policy actions instead focused on changing individual behaviour. This phenomenon, known as 'lifestyle drift', has been observed elsewhere (40), and is characterised by policies starting with an intention to address social determinants of health yet drifting or slipping towards actions that target individual behaviour (41, 42). The subsequent emphasis on lifestyle results in policies that overlook the significance of the social and structural factors that impact people's health and affects their capacity to adopt healthy lifestyles (43) and are unlikely to reduce inequalities (44, 45).

Actions to address structural drivers are necessary to shape health-promoting environments that support, instead of undermine, healthy behaviours across populations (46). Furthermore, creating environments that support fair opportunities for everyone to adopt and maintain healthy behaviours will be necessary to achieving equitable reductions in childhood obesity (44, 47). Yet we did not see this reflected in Australian health policy documents. There are a number of possible reasons for this. First, addressing health inequalities is inherently political because the social determinants that create conditions necessary for health are shaped by the

government's distribution of resources, money and power (48). Second, the complexity of addressing the social determinants of health inequalities is at odds with a political preference for simple solutions and actions focused on existing programs and structures (48). Third, the development of public health policy is influenced by commercial stakeholders with competing interests including the food and beverage industry whose business interests may be prioritised at the expense of population health (49).

This critical policy analysis makes an important contribution to the understanding of how inequalities in childhood obesity are represented in health policy documents. This study presents for the first time an analysis of the ways in which the Australian federal, state and territory governments have responded to the issue of inequalities in childhood obesity. Findings confirm and extend upon previous research that suggests a political preference for policy action that addresses individual behaviour over and above the structural determinants of health (45, 50, 51). These findings are likely to be useful to advocates seeking to influence decision makers to increase political priority for equity in future obesity prevention policies.

8.2.5 *Integrated findings*

The findings presented in this thesis collectively demonstrate the critical need for including regular monitoring and analysis of the prevalence of overweight and obesity throughout the childhood period and by various measures of SEP. This thesis also demonstrates the multifactorial nature of childhood obesity, providing evidence of the role of immediate and underlying determinants in shaping children's diets and in the development of inequalities in childhood obesity. Additionally, the thesis demonstrates the importance of early childhood, a time when children's dietary behaviours are established, and the time during which socioeconomic differences in children's dietary behaviours, and weight, emerge. The studies presented in this thesis highlight the utility of data collection and analysis using both quantitative and qualitative methods to examine the determinants of childhood overweight and obesity across socioeconomic groups. The findings also underscore the importance of an equity-focused approach to the prevention of childhood obesity, something found to be lacking in the current Australian policy response to childhood obesity, and previously noted as missing from obesity prevention efforts more generally (9).

There is already consensus and support for action to address childhood obesity. For example, the recommendations made by the WHO Commission on Ending Childhood Obesity include a

set of evidence-based actions for obesity prevention across six key themes that align with calls from the World Cancer research Fund, UNICEF, and a number of peak health and research agencies across Australia (8, 52-54). What this thesis adds, is evidence that emphasises the importance of a comprehensive approach to equitably reduce childhood obesity that addresses drivers across all levels. As this thesis demonstrates, this approach has not been applied to childhood obesity prevention in recent Australian health policies. To achieve an equitable response to childhood obesity requires two things. The first is political will and government commitment to adopt and implement a comprehensive suite of actions that equitably address factors across individual, social, physical, and structural environments (55). The second necessary requirement is the prioritisation of equity within obesity prevention policies (9).

Equity focused approaches are necessary if we are to reduce socioeconomic inequalities in childhood obesity. Policies need to be built upon a foundation of equity, but critically, also high-level political commitment is essential to ensure rhetoric is translated into action (9, 56). Actions to improve equity should strive to promote health by levelling up the health of children who are disproportionately affected by overweight and obesity (32). This requires equitable population approaches with their potential to reduce the socioeconomic gradient in obesity by proportionately benefiting those with greater social and economic barriers to healthy eating, combined with targeted approaches to meet the specific needs of children most at risk of obesity.

The development of equity targets provides a goal towards which policy action can strive (47). However thesis found equity targets be lacking in current approaches to obesity prevention in Australian health policy documents. Without targets for action, the rhetoric around equity remains symbolic. To know whether equity targets are being met, will require assessment of policy impacts against pre-determined equity targets (47). This will require data to be collected, reported and analysed according to population demographics, including age, sex, and socioeconomic position measured at the individual and neighbourhood levels (32). This statistical data provides part, but not all of the picture. Genuine community engagement is also necessary to complement quantitative assessments of inequalities and progress towards achieving equity. Efforts to include the voices of groups experiencing socioeconomic disadvantage ensures policy actions can be developed and their impacts understood from the perspective of those for whom they are designed (9, 32, 47).

8.3 STRENGTHS AND LIMITATIONS

This section includes an overview of the potential limitations of my research, with reflections of the implications of this for the thesis overall. I also reflect on the key strengths of the approaches undertaken to conduct the research presented in the thesis.

8.3.1 *Limitations*

8.3.1.1 HETEROGENEITY IN REPORTS OF CHILD AND ADOLESCENT OBESITY TRENDS

In **Chapter Four**, the systematic review of socioeconomic differences in trends in child and adolescent obesity examined data from 30 studies across 15 high-income countries. Heterogeneity was observed across the studies included in the review with different definitions of childhood and adolescence, obesity classification systems, and indicators of socioeconomic position. These findings are not unique to this study, with other research also limited by inconsistent classifications in reports of child and adolescent obesity according to socioeconomic position (57). The different classifications across the data precluded separate analyses according to overweight and obesity, or according to type of SEP indicator. This is an important area for future research given that different socioeconomic indicators have been shown to have differential associations with diet and obesity (58). Further, heterogeneity across included studies limited the ability to conduct more specific subgroup analyses. Population monitoring and surveillance of child and adolescent obesity, and obesity risk factors has been identified as a critical element of action to address childhood obesity (5). Standardised systems for classifying obesity and monitoring population data according to socioeconomic characteristics would be useful to allow comparison of prevalence and trends within and between countries.

8.3.1.2 SOURCES OF BIAS

Recall, social desirability and selection bias pose limitations to two studies presented in this thesis. Data from the Longitudinal Study of Australian Children (LSAC) cohort used in the mediation analysis in **Chapter Five**, including children's diet, physical activity and sleep were self-reported. The use of self-reported data presents the risk of recall bias where behaviours were incorrectly reported and the risk of social desirability bias such as underreporting unhealthy food consumption. Further, the dietary data was collected for a single 24-hour period at each survey wave. The implications of this for the mediation analysis presented in **Chapter Five** are that the reported data may not have necessarily reflected actual or usual dietary

consumption, and that unhealthy food consumption may have been differentially reported, with underreporting more likely among children with higher body weight (59).

Dietary behaviours discussed by parents in the focus group study presented in **Chapter Six** were also self-reported. The implications of this are slightly different. Whilst it is true that parents' reporting of dietary behaviours may have been affected by bias, the aim of the study was to ascertain parent's perceptions of factors children's sweet drink consumption, not the exact quantity of consumption, making it less likely that reporting biases impacted the overall findings of the study.

Selection bias also posed a potential limitation, due to non-response and attrition in the LSAC study in **Chapter Five**, and the self-selection of participants in the focus group study in **Chapter Six**. In the LSAC study, attrition was greater among children with parents earning low incomes, who speak a language other than English at home, and Aboriginal and Torres Strait Islander children. Sensitivity analyses using sample weights suggest that this differential loss to follow up did not significantly impact study findings.

The focus group study was designed to purposely select socioeconomically diverse neighbourhoods in order to recruit a sample of socioeconomically diverse participants. Whilst participants' home postcodes of residence were distributed across tertiles of relative disadvantage, the sample was highly educated, with 60% of participants having completed tertiary or post-graduate education. One implication of this was that focus group themes could not be examined for differences according to individual level socioeconomic position. This underscores the complexity of measuring SEP, including the need to select SEP indicators according to the specific research question, and devise a suitable strategy for participant recruitment (60). This also poses a limitation to the study, as research has shown lower SEP to be a key factor influencing higher SSB consumption among preschool age children (23), yet this study was unable to identify whether perceived determinants of sweet drink consumption differ according to individual SEP. Future studies will need to consider how better to engage with families with lower SEP, and conduct analyses in such a way that allows exploration of the determinants of unhealthy dietary behaviours across socioeconomic groups.

8.3.1.3 LIMITATIONS OF MEDIATION METHODS

The mediation analysis presented in **Chapter Five** was limited by the availability of dietary data that captured the frequency, but not quantity of a select number of discretionary food and drink items. This data may not fully reflect children's dietary consumption of unhealthy food

and drinks and may underestimate the role of unhealthy diets in the development of excess weight among children.

Secondly, residual confounding by unknown and unmeasured risk factors may influence the relationships tested in this study. We accounted for this as best as possible, including key confounders including child's age, sex, weight at birth, mother's age, Aboriginal and Torres Strait Islander identity, and main language spoken at home, as well as other possible mediators of the relationship between SEP and children's weight gain including physical activity. Covariates that were not measured include maternal pre-pregnancy weight, weight gain during pregnancy, breastfeeding duration and child's sleep behaviours. Future research will be necessary to further ascertain the role of factors likely to drive socioeconomic differences in weight gain among children. Findings of such research will help identify leverage points for action to reduce socioeconomic differences in child and adolescent obesity.

8.3.1.4 LIMITATIONS OF DOCUMENT ANALYSIS

The critical policy analysis sought to examine publicly available policy documents. Limitations of this approach include not knowing the extent to which these documents are representative of the views of all policy stakeholders and the inability to ascertain the extent or effectiveness of implementation of the policy actions outlined within the documents. Furthermore, this study focused on health policy documents and has therefore not examined representations of equity in proposed actions from other sectors such as education, housing, employment and social security. Future analysis should consider additional ways to capture the views of policy stakeholders, across multiple sectors, and evaluate the implementation and impact of policy actions across socioeconomic groups.

8.3.2 *Strengths*

This thesis has a number of important strengths including the novelty of the research projects, each rigorously undertaken, using carefully selected methods to reveal details of inequalities in childhood overweight and obesity. This thesis underscores the importance of monitoring and analysis of childhood obesity trends according to socioeconomic position. Such fine-grained analysis is necessary to reveal inequalities that can otherwise be masked by obesity prevalence reported in aggregate for the population. This thesis demonstrates the benefits of analysing data from multiple sources, quantitatively and qualitatively to better understand the drivers of inequalities in childhood obesity. Additionally, the thesis highlights the utility of critically

analysing government policy to gain insight into the way in which governments consider and propose to address socioeconomic inequalities in childhood obesity.

The range of study designs utilised acknowledges the complex nature of childhood obesity and socioeconomic inequalities in diet and weight. The thesis sought to answer critical questions to advance the evidence on action to address inequalities in childhood obesity and appropriate methods were carefully selected for each research objective. The comprehensive approach taken to explore the issue provides deeper insight into the necessary action to reduce socioeconomic inequalities in childhood obesity by highlighting drivers across different contexts and identifying gaps in the current Australian policy approach.

8.4 IMPLICATIONS

This thesis advances the evidence on the research methods, trends, determinants, and current policy response to address socioeconomic inequalities in childhood obesity in Australia. Collectively, these findings demonstrate the need to rethink the way inequalities in childhood obesity are addressed such that policy is designed with an explicit equity focus, proposing actions to address the determinants of childhood obesity across all ecological contexts. This is consistent with current global recommendations for the prevention of childhood obesity.

A clear need to address the risk factors of childhood obesity was demonstrated in this thesis by the findings of high and persistent levels of SSB consumption among preschool-age children. This highlights the importance of interventions to improve diets among preschool-age children, with benefits of established healthy diets likely to last throughout the childhood period and beyond. Interventions to support healthy diets in early childhood, such as the Australian INFANT program have demonstrated success in supporting first-time parents to establishment and maintain healthy behaviours among young children from birth to two years of age (61).

There is also a clear need, identified in this research and previously called for, for policy action that changes the food environment in order to support healthy diets among children (31, 34). For example the implementation of SSB taxes has been found to reduce the purchase and consumption of SSBs across a number of jurisdictions worldwide (62). Interventions that address structural health determinants of health are more likely to have equitable outcomes (44). Evaluation of SSB taxes have shown this to be true, with similar health benefits reported across the socio-economic gradient (63). Other interventions identified in this research and supported by existing evidence to reduce consumption of sweet drinks and unhealthy food

among children include removing unhealthy food and drink marketing, and implementing policies in schools and early childhood education and care settings that create healthy food environments (8, 64).

Findings of socioeconomic differences in the prevalence of childhood obesity and in dietary risk factors demonstrate the need to monitor population health data including prevalence and trends in obesity and its risk factors, by population demographics. This includes by age, sex, race or ethnicity and socioeconomic position to ensure important differences are not masked by population-level data.

The thesis identified a significant gap in the current approach to child obesity in Australia where the current approach emphasises individual responsibility and lacks an explicit equity focus. Understanding this gap in the current approach can inform the development of future policies that are more likely to address inequalities in child obesity. This will require healthy food policies that act across all ecological contexts to improve the availability, affordability and appeal of healthy food and ultimately the health of children's diets (30, 31). It will also require policies across other sectors in order to address breadth of underlying determinants of health and health inequalities (9, 31, 45).

These findings are likely to be relevant to other high-income countries where child and adolescent obesity is socioeconomically patterned. Public health researchers and advocates can use these findings and the resulting recommendations to inform future research and advocacy that drives an equitable policy response to reduce childhood overweight and obesity.

8.5 RECOMMENDATIONS

8.5.1 Research recommendations

The findings of this thesis inform four recommendations for further research to advance equity in child and adolescent overweight and obesity.

8.5.1.1 RESEARCH RECOMMENDATION ONE

Monitor, analyse and report population health data, including prevalence and trends in obesity and its risk factors, by population demographics. This includes by age, sex, race or ethnicity and socioeconomic position. Documenting these differences makes them visible and is a prerequisite for action to address inequalities.

8.5.1.2 RESEARCH RECOMMENDATION TWO

Further analysis of drivers of childhood obesity to better understand the causal relationships between various indicators of socioeconomic position, dietary, physical activity and sedentary behaviour, as well as more structural determinants, and the development of childhood obesity. This will help identify and prioritise leverage points for action at different stages of the life course and for different socioeconomic groups, to address the determinants of socioeconomic differences in childhood obesity.

8.5.1.3 RESEARCH RECOMMENDATION THREE

Exploration of the determinants of unhealthy dietary behaviour among children from socioeconomically disadvantaged backgrounds by capturing the lived experiences and perspectives of children and their families. A greater understanding of the drivers of unhealthy diets among children will be required to appropriately target action to address the underlying determinants of unhealthy diets among children with lower SEP.

8.5.1.4 RESEARCH RECOMMENDATION FOUR

Further examination of the perspectives of policy stakeholders with regards to socioeconomic inequalities in childhood obesity. Greater understanding the views of policy stakeholders will help inform advocacy efforts to ensure equity is a central consideration in the development and adoption of obesity prevention policy.

8.5.2 *Policy recommendations*

This thesis has identified three key components for a comprehensive policy approach to the equitable prevention of child and adolescent overweight and obesity.

8.5.2.1 POLICY RECOMMENDATION ONE

Prioritise equity in the development and implementation of health policy. This paradigm shift would see equity prioritised in principle and embedded within policy actions. Acknowledging inequalities, setting targets to reduce inequalities, and obesity targets for socioeconomically diverse population subgroups would all feature in obesity prevention policies that prioritise equity.

8.5.2.2 POLICY RECOMMENDATION TWO

Government commitment to and coordination of universal and targeted approaches that address individual behaviour, conditions in settings including schools and childcare, and the structural determinants of child and adolescent overweight and obesity. Again, this requires a shift away from a focus on individual responsibility and towards a focus on the role of society and the broader environment in influencing and being responsible for improving inequalities in childhood obesity.

8.5.2.3 POLICY RECOMMENDATION THREE

Implement systems to monitor and understand the short- and long-term impacts of policy on diets, weight and health across socioeconomic groups. This includes the prospective analyses of the equity impact of obesity prevention policies and ongoing evaluation to monitor whether equity targets are being achieved, and to identify any unintended consequences of policy implementation.

8.6 REFERENCES

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9 CONCLUSION

The primary aim of this thesis was to generate evidence to support the implementation of obesity prevention policies most likely to reduce socioeconomic inequalities in childhood obesity. Four research studies were undertaken, the findings of which demonstrated:

- i) Trends in child and adolescent overweight and obesity differ across socioeconomic groups and socioeconomic inequalities in overweight and obesity widened between 1990 and 2015 in a number of high-income countries;
- ii) Discretionary food and drink consumption during childhood prospectively contributes to the development of socioeconomic inequalities in BMI z-score among Australian children;
- iii) Parents perceive children's sweet drink consumption to be influenced by multiple factors operating across all domains of the socioecological model;
- iv) Inequalities in childhood obesity are predominantly represented as an issue of individual responsibility in Australian public health and obesity prevention policy documents, where the political preference is for policy action that addresses individual behaviour over and above the structural determinants of health.

These findings address the aim of the thesis and advance our understanding of the trends, determinants and current policy response in Australia to socioeconomic inequalities in childhood obesity. This research highlights the importance of ongoing research, monitoring and fine-grained analysis of the trends and drivers of socioeconomic inequalities in childhood overweight and obesity. Recommendations arising from this work point to the need for governments to develop and implement prevention policies that simultaneously reduce childhood obesity and improve health equity. This will require a range of complementary policies that explicitly consider equity and address the individual, social, and structural determinants of childhood obesity. Successful adoption and implementation of such a range of policies is necessary to reduce socioeconomic inequalities in obesity among Australian children.