Ultra-processed food intake, sources, and associations with sociodemographic factors in New Zealand adolescents.

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

Massey University, Albany
New Zealand

Jessie Dalton
2025

Abstract

Background

Adolescence is a critical period for establishing dietary patterns that can influence long term health outcomes. Ultra-processed foods (UPFs) are becoming increasingly prevalent within the modern diet, with research establishing the negative impacts of UPFs on several health markers and outcomes across populations. Understanding how UPF intake varies by sociodemographic characteristics is essential for informing policies and shaping food environments that support healthier choices. However, current data on UPF intake and sociodemographic factors amongst New Zealand (NZ) adolescents does not exist.

Aims and objectives

This research aimed to investigate UPF intake and sources of UPFs in NZ adolescents and associations with sociodemographic factors including sex, age, school region, school area, and school lunch programme eligibility.

Methods

The data for this research was obtained through the Te Rourou Kai o Ngā Rangatahi: Eating Patterns of Young People in NZ study. This cross-sectional study gathered data from 631 adolescents in Years 7-13 (aged between 11-19 years) in the Auckland, Waikato and Bay of Plenty (BOP) regions of NZ. Dietary data was collected through the Intake24 electronic software, using the multiple pass method, and demographic information was collected via an online questionnaire. Foods were linked to the NZ Food Composition Database and categorised according to NOVA, as either (1) whole or minimally processed foods, (2) processed culinary ingredients, (3) processed foods, or (4) ultra-processed foods. UPFs were further categorised into food groups to determine the top contributors to overall UPF intake. Differences in UPF (as a percentage of total daily energy intake (TDEI)) across sociodemographic variables were assessed using one-way ANOVA or independent t-tests. Tukey's Honest Significant Difference (HSD) test was used for post hoc comparisons.

Results

Participants (n=631) had a mean UPF intake of 892 ± 766 g/day, 5435 ± 3592 kJ/day, contributing to 62.5 ± 25.3% of TDEI. The top food group contributors to UPF energy were fast foods/takeaways (12.2 ± 19.9%), bread and bread products (7.9 ± 12.2%), and biscuits, cakes, desserts (7.5 ±12.2%). UPF intake (%TDEI) was higher among females compared to

males (64.4% vs. 58.1% of TDEI, p=0.01), participants in the Waikato region vs. Auckland (68.2% vs. 60.2%, p=0.008), and participants from medium and small areas compared to major and large urban areas (67.2% vs. 61.3%, p=0.0043). Those eligible for the school lunch programme consumed less energy from UPFs compared to those ineligible (60.0% vs. 65.6%, p=0.005).

Conclusion

UPFs contribute a high proportion of energy to adolescent's TDEI in NZ. Fast foods/takeaways; bread and bread products; and biscuits, cakes, and desserts are the largest food group contributors to total UPF intake. Our findings suggest that female adolescents, those living in the Waikato region, and residing in any size urban area consumed significantly greater energy from UPFs. Participants eligible for the school lunch programme consumed less energy from UPFs. Further research is required using multiple 24-hour recalls to account for habitual intake as well as investigating the influence of food environments, food marketing and regional access on UPF consumption in NZ adolescents.

Acknowledgements

I would firstly like to acknowledge my supervisors Professor Kathryn Beck, Professor Cath Conlon, and Dr. Jamie de Seymour. Thank you immensely for all your encouragement and feedback throughout this process as well as the opportunity to disseminate the results back into the community. I could not have made it here without your support.

This research was funded by a project grant from the New Zealand Heart Foundation. Thank you to the wider research team, Jasmin Jackson, Laurie Wharemata-Keung, Karen Mumme, and Kate Hammond, this work could not have happened without you all.

To my whānau, throughout my entire university journey you have been there behind the scenes pushing me gently along the way. Thank you for your endless love and support at each step, ngā mihi nui.

Table of contents

List of Tables

List of figures

List of abbreviations

BMI	Body mass index
CVD	Cardiovascular disease
CVH	Cardiovascular health
FFQ	Food frequency questionnaire
FSANZ	Food Standards Australia New Zealand
HDL	High-density lipoprotein
HFSS	High fat, sugar, salt
IBS	Irritable bowel syndrome
MS	Metabolic syndrome
NCD	Non-communicable disease
NDNS	National diet and nutrition survey
NHANES	National health and nutrition examination survey
NPSC	Nutrient profiling score
NZ	New Zealand
PF	Processed food
SEI	School equity index
SES	Socioeconomic status
T2DM	Type 2 diabetes mellitus
TDEI	Total daily energy intake
TG	Triglycerides
UK	United Kingdom
UPF	Ultra-processed food
USA	United States of America
WC	Waist circumference
WHO	World Health Organisation

Chapter 1: Introduction

1.1. Background

Adolescence, defined by the World Health Organization (WHO) as between 10-19 years of age, is a critical time of growth and development, where nutrition plays an integral role in the maturation of organs, skeletal bone, and physiological systems (Norris et al., 2022; Patton et al., 2016). Puberty can be affected by nutritional status throughout childhood and adolescence leading to consequences for body composition, linear growth, immune system development, and neurodevelopment. Throughout adolescence, nutrition and growth can have significant effects on an individual's health spanning into adulthood, and potentially impacting future offspring (Norris et al., 2022). Eating patterns and behaviours in adolescence are influenced by numerous factors such as peer and parental influences, food availability, preference, cost, convenience, as well as cultural and personal beliefs (Moreno et al., 2010).

Ultra-processed foods (UPFs) are foods that are manufactured almost entirely from industrial ingredients and undergo intense processing to produce convenient, palatable, ready-to-eat food items (Monteiro et al., 2013). Their nutrient profile is typically energy dense, containing a high glycaemic load paired with low dietary fibre and micronutrient content (Monteiro et al., 2013). The shift from a diet rich in whole foods to UPFs over recent years has been evident throughout the literature (Baker & Friel, 2016; Juul et al., 2022; Monteiro et al., 2013; Wang et al., 2021). In adults, UPF intake is associated with adverse health markers such as greater adiposity, including high body mass index (BMI), and waist circumference (WC), and with adverse health outcomes such as metabolic syndrome (MS), low high-density lipoprotein (HDL) cholesterol, cardiovascular disease (CVD), irritable bowel syndrome (IBS), type 2 diabetes (T2DM), cancer, and all-cause mortality (Elizabeth et al., 2020; Lane et al., 2024; Pagliai et al., 2021; Rauber et al., 2020; Srour et al., 2022; Vitale et al., 2024). Adverse health outcomes among children and adolescents associated with UPF consumption include cardio-metabolic disease, asthma, unfavourable lipid profiles, and markers of adiposity including increased BMI, and WC (Chang et al., 2021; Costa et al., 2019; Elizabeth et al., 2020; Leffa et al., 2020; Neri, Martínez-Steele, et al., 2022). UPF consumption is becoming increasingly prevalent within the modern diet and poses several health concerns across populations and age groups (Louzada et al., 2022).

The NOVA food classification system, of Brazilian origin, separates foods into groups, based on the extent and purpose of processing used in their production (Monteiro et al., 2010). Group 1 includes unprocessed or minimally processed foods, Group 2 is processed culinary ingredients (oils, fats, sugars, and salt), Group 3 is processed foods (PFs), and Group 4 is UPFs (Monteiro et al., 2018; Monteiro, 2019; Monteiro et al., 2010). Sugar sweetened and carbonated beverages, pre-packaged meals and breads, ice cream, sweetened yoghurts, and margarine and spreads are all food items belonging to the UPF category (Monteiro et al., 2016). These food items have little, if any, resemblance to Group 1 foods and are made almost entirely from substances extracted from foods, including fats, added sugars, starches, and proteins, as well as additives. The extensive processing methods are often used to increase shelf life, palatability, appeal, and convenience for consumers whilst minimising production costs for large scale manufacturers (Stuckler et al., 2012).

The contribution of UPFs to the adolescent diet varies between countries. UPF intake has been shown to contribute almost 50% of total daily energy intake (TDEI) amongst Brazilian adolescents (Bielemann et al., 2015; D'Avila & Kirsten, 2017; Enes et al., 2019), despite their national dietary guidelines highlighting the avoidance of UPFs (Monteiro et al., 2015). Similarly, in the United States of America (USA) UPFs contribute to 65% of TDEI in children (Neri et al., 2019). In contrast, Belgian adolescents consume a lower proportion of UPFs (approximately 29% of TDEI) (Vandevijvere, De Ridder, et al., 2019). A study in Brazil found adolescents with the highest level of UPF consumption had significantly higher BMI, and greater odds of obesity or excess body weight, in comparison to those with the lowest consumption (Louzada, Baraldi, et al., 2015).

UPF intakes have been associated with socio-demographic factors including age, income level, education status, ethnicity, sex, and living in rural versus urban areas (Baraldi et al., 2018; Bielemann et al., 2015; Chavez-Ugalde et al., 2024; Dicken et al., 2023; Marchese et al., 2022; Marrón-Ponce et al., 2018). A recent systematic review identified that UPF intake had a consistent inverse association with age, being highest among younger adults, adolescents, and children (Dicken et al., 2023). Low socioeconomic status (SES) is often associated with high UPF consumption due to affordability, accessibility, and marketing within deprived neighbourhoods (Almeida et al., 2018; Baraldi et al., 2018; Vandevijvere et al., 2014). Alternatively, individuals from high SES backgrounds may also exhibit high UPF consumption driven by busy lifestyles and reliance on convenience foods (Marrón-Ponce et al., 2018; Monteiro et al., 2019). Education and income have showed varying associations between countries (Dicken et al., 2023). Urbanisation and ethnicity too have been associated with UPF consumption. Evidence suggests urban residents are more exposed to UPF marketing (Baker et al., 2020), and ethnic minority groups may face systemic barriers that contribute to greater intake of UPFs (Wang et al., 2021). A single study from Brazil found adolescents at private schools had higher consumption of PFs and UPFs compared to adolescents attending public school (Ferreira et al., 2019). Research specific to the NZ context, regarding UPF intake amongst adolescents and associations with socio-demographic factors such as age, sex, geographical location, and school equity index, is an area that has not been widely researched.

Adolescents are particularly susceptible to UPF consumption due to their growing autonomy surrounding food choices, peer influences, and aggressively targeted food marketing (Vandevijvere et al., 2017; Viner et al., 2012; Ziegler et al., 2021). Adolescent obesity and T2DM prevalence is on the rise in NZ creating a drive for new public health policies to foster healthier food environments across the country (Ministry of Health, 2023; Sjardin et al., 2018). Understanding patterns of UPF consumption and associations with socio-demographic factors amongst NZ adolescents will form a crucial part of national public health policy and strategy development. Given the ever evolving landscape of food consumption in NZ, much has changed since the last National Children's Nutrition Survey was conducted over 20 years ago in 2002, which captured nutrient and energy intake of children aged between 5-14 years (Ministry of Health, 2003). Additionally, the most recent Adult Nutrition Survey was carried out in 2008/09, focussing on those aged over 15 years, and thus including older adolescents (University of Otago and Ministry of Health, 2011). Yet, there was no assessment of UPF intake from this data. The only New Zealand (NZ) based research surrounding UPF intake was a cohort study carried out on children from 12-60 months of age. The results concluded that UPFs contributed to 45, 42, and 51% of total daily energy intake in the children's diets at 12, 24, and 60 months of age, respectively (Fangupo et al., 2021). Additionally, a cross-sectional analysis exploring the supermarket food environment revealed that of packaged foods, 84% were classified as UPFs, with a poorer nutrient profile compared to culinary and minimally processed foods (Luiten et al., 2016). Despite these findings in young children, UPF intake in NZ adolescents remains an area underexplored.

With limited evidence on dietary intakes of adolescents in NZ and no studies which report UPF intake and its association with sociodemographic factors, further work is needed in this area. Analysing these factors within the context of NZ adolescents provides an opportunity to understand how sociodemographic factors are associated with UPF intake. This will enable the development of targeted public health policies and interventions to create healthier food environments in NZ.

1.2. Aim

This study aims to investigate UPF intake, sources of UPFs, and associations with sociodemographic factors including sex, age, school lunch programme eligibility, school region (Auckland, Waikato, Bay of Plenty) and urban or rural area in NZ adolescents.

1.3. Objectives

1. To describe UPF intake and sources of UPFs in NZ adolescents.

2. To describe the association between UPF intake and sociodemographic factors (sex, age, school lunch programme eligibility, school region and area).

1.4. Thesis Structure

This research study is divided into four chapters. Chapter one is the introduction consisting of the background, study purpose, research aims, objectives, hypotheses, and researcher contributions. Chapter two is a literature review comprised of relevant and recent literature surrounding UPF consumption and associations with health outcomes and socio-demographic factors, both internationally and in NZ, with a focus on adolescents. Chapter three is the research study manuscript including an abstract, introduction, methods, results, discussion, and conclusion of the study findings. Chapter four is the discussion including a summary of the main findings, strengths and limitations, and final recommendations based on the study findings. Following on are supplementary materials, reference list and appendices containing a list of all foods classified as UPFs as well as their attributed UPF food group.

1.5. Researcher contributions

Researcher	Contribution to thesis
Jessie Dalton	**MSc Nutrition and Dietetic Student** Author of the thesis. Responsible for classification of UPFs into subgroups, statistical analysis and interpretation. Responsible for dissemination of results back to participants and schools.
Professor Kathryn Beck	**MSc main academic supervisor** Principle investigator for the study. Conceptualisation of the study design. Acquisition of funding, ethical approval, and oversight of all parts of the study. Provided feedback on all aspects of the thesis.
Professor Cathryn Conlon	**MSc academic co-supervisor** Co-investigator. Provided feedback on all aspects of the thesis.
Dr Jamie de Seymour	**Academic co-supervisor** Co-investigator. Developed study protocol and led data collection and analysis. Provided feedback on the thesis.
Jasmin Jackson	Co-investigator. Assisted with the development of the study protocol and access to schools.
Laurie Wharemate-Keung	Co-investigator. Provided cultural advice and guidance for the study. Assisted with the development of the study protocol and access to schools.
Karen Mumme	Provided support with data analysis.
Kate Hammond	Assisted with classification of UPF.

Chapter 2: Literature Review

2.1. Introduction

This chapter focusses on the topic of UPFs, including their history, consumption patterns in adolescence, their impact on adolescent nutrition, and their relation to socio-demographic factors. Dietary assessment tools and the challenges of assessing dietary intake in adolescent populations will also be discussed.

Date searched: November 2024 – August 2025
Search criteria:
Ultra-processed food OR ultra processed food OR processed food OR fast food OR convenience food OR junk food
Adolescen* OR teen* OR youth* OR young people
Sociodemographic OR age OR sex OR gender OR ethnicity OR socioeconomic status OR equity OR geographical location OR rural/urban
New Zealand OR NZ OR Aotearoa
Filters: past 10 years, English language, peer-reviewed
Electronic databases: Massey Discover, Google Scholar, PubMed, Web of Science

Figure 1: Search strategy for literature review

2.1.1. Adolescent nutrition

The period of adolescence is a crucial time for establishing healthy dietary patterns and behaviours, with nutrition playing a key role in growth, development, and future disease prevention (Norris et al., 2022). To accommodate the rapid growth and maturation of organ and skeletal systems, energy and nutrient requirements are significantly elevated during this life phase (Das et al., 2017). However, dietary surveys have shown that the diet of adolescents across countries is often highly processed, with inadequate intake of fruits, vegetables, and wholegrains (Neri, Steele, et al., 2022). Poor nutrition in adolescence often lays the foundation for the development of non-communicable diseases (NCDs) such as CVD and T2DM later on in life (Dahm et al., 2016; Kaikkonen et al., 2014; Malik et al., 2011). Alongside physical development, this period of life involves cognitive, emotional, and social expansion which shape the skills and capabilities carried through to adulthood that promote health and well-being (Patton et al., 2016).

2.2. Ultra-processed foods

2.2.1. The history of food processing

Food processing is a practice that humans have developed and revolutionised over thousands of years. Processing has been used to increase food availability, storage life, digestability, safety, and transportability, all processes crucial to the sustainability of mankind (Ludwig, 2011). Some of the earliest methods of food processing include the use of fire and cooking to manipulate raw meat for safe consumption, as well as salt preserving, drying, and fermenting (Brown et al., 2009; Floros et al., 2010). With the turn of the 19th century and advances in technology, the industrial revolution allowed for large scale production of flour and sugars contributing towards the modern diet (Ludwig, 2011; Welch & Mitchell, 2000). Innovations such as canning, pasteurisation, and the transition from hand manufacturing to steam machines became significant enhancers to food processing practices (Huebbe & Rimbach, 2020). Technological advancements in food science in the 20th century produced ingredients such as refined starches, gums, and sweeteners (Welch & Mitchell, 2000), all of which are common occurences in modern day packaged foods. Processing has intensified and in recent times, the development of highly processed ready-to-eat foods has accelerated due to consumer demand for foods that are convenient and require minimal preparation for busy lifestyles (Huebbe & Rimbach, 2020).

2.2.2. What are ultra-processed foods?

UPFs are a growing component of the modern diet, ofen associated with poor dietary quality and health outcomes across populations (Neri, Steele, et al., 2022; Vitale et al., 2024). Typically, UPFs are hyper-palatable, convenient, and ready to eat products, consisting of ingredients often uncommon in household cooking (Monteiro et al., 2019). UPFs are generally described as being energy dense, containing a high glycaemic load, low in dietary fibre, micronutrients, and phytochemicals, alongside their low monetary cost (Gupta et al., 2019; Moodie et al., 2013). Their nutrient profile is typically characterised by a high sugar, sodium, and unhealthy dietary fat content (Moodie et al., 2013).

The greater purpose of ultra-processing is to create ready made, attractive, and profitable food products, made with low cost ingredients that are highly convenient to consumers. UPFs often displace all other food groups within the diet (Monteiro et al., 2018), including whole and minimally processed foods as well as meals and dishes made at home (Monteiro et al., 2018). UPFs include all fizzy drinks, sweet and savoury packaged foods, industrial bread products, reconstituted meat products, and pre-prepared frozen dishes. These foods have little to no resemblance to whole or natural foods, and are formulated almost entirely from substances derived from foods and additives (Monteiro et al., 2018; Petrus et al., 2021). The degree of food processing can contribute to differing levels of satiety. The poor nutritional profile of UPFs are typically less satiating than whole or minimally processed foods, which may lead to over consumption (Fardet, 2016) and addictive-like eating behaviours (Schulte et al., 2015).

2.2.3. The development of the NOVA classification system

The concept of ultra-processing was first coined by Brazilian researchers of the University of Sao Paulo. The initial public health nutrition commentary proposed that the issue is not the food or nutrients, but the level of processing in which health concerns arise (Monteiro, 2009). The original article proposed three categories: minimally processed foods, processed culinary ingredients, and ultra-processed foods (Monteiro, 2009). These groups established the basis of the NOVA classification system, that categorises all food items according to the level and purpose of industrial processing (Monteiro et al., 2019). Over time, NOVA has evolved to four groups of processing, separating PFs and UPFs.

The final revised categories include unprocessed or minimally processed, processed culinary ingredients, PFs, and UPFs (Monteiro et al., 2018) (Table 1). UPFs belong to Group 4 of the NOVA classification system. UPFs are extensively modified products composed primarily of ingredients derived from foods and additives, rather than whole or minimially processed foods (Monteiro et al., 2018). The processing begins with the fractioning of whole food ingredients into substances, including sugars, oils and fats, protein, starches and fibre, and chemical modifications of these substances (Monteiro et al., 2019). Further processing techniques to formulate UPFs include hydrogenation, hydrolysation, extrusion, moulding, and pre frying (Monteiro et al., 2018). An essential component of UPFs is the addition of colours, flavours, emulsifiers, thickeners and other additives to improve product palatability, appeal, shelf life, visual appearance and improve the desirability of the food items sensory properties (Monteiro et al., 2019).

The NOVA system is one of many food classification systems and is most widely used in research. Yet many controversies and arguements surrounding the system exist. Firstly, researchers argue that the NOVA systems use of the term ‘ultra-processed’ is misleading as it refers to food items containing more than five ingredients, despite these formulations being common within the food industry and within household recipes (Moubarac et al., 2014; Petrus et al., 2021). Furthermore, some studies highlight that the NOVA classification of food groups does not always accurately reflect a products nutritional profile or dietary quality, when considering foods fortified with micronutrients and other beneficial nutrients (Jones, 2019; Poti et al., 2017).

Misclassification of foods within the NOVA system, particularly the UPF category, is among another of the commonly discussed controversies. Many definitions of the term ‘ultra-processed’ exist, each showing variability and could be open to several interpretations (Gibney, 2019). Therefore, the lack of robustness and consensus over the definition of ‘ultra-processed’ may lead to missclassification of food items across studies (Gibney, 2019). Additionally, Poti et al. (2017) argue that previous studies cannot accurately conclude if the association between UPFs and disease is related to the processing itself or the energy and nutrient content of the selected foods. Lastly, residual confounding is often high in observational studies and further studies adopting prospective designs with adequate control for confounding are required to draw stronger conclusions on the link between UPF intake and adverse health consequences (Poti et al., 2017). Hall et al. (2019) undertook a randomised control trial, investigating whether UPFs affect energy intake compared to an unprocessed diet, offering insight into the causal relationship between food processing and obesity risk. Their findings revealed that the ultra-processed diet led to significantly higher energy intake and resulted in weight gain when compared to the unprocessed diet (Hall et al., 2019).

Table 1: NOVA classification system as adapted from (Monteiro et al., 2018, 2019).

Category	**Level of processing**	**Examples**
Group 1: Unprocessed or minimally processed foods	Unprocessed foods include any edible parts of plants (seeds, fruits, leaves, roots) or of animals (muscle, eggs, milk), and fungi, algae and water, after separation from nature. Minimally processed foods are whole foods modified by processes for the purpose of preservation, storage, or removing inedible or unwanted parts. Many unprocessed or minimally processed (Group 1) foods are prepared and cooked at home or in restaurant kitchens in combination with processed culinary ingredients (Group 2) as dishes or meals.	Fresh, chilled, frozen, vacuum packed or dried meats, poultry, fish, fruits, vegetables, roots and tubers, grains, cereals. Frozen or dried beans, legumes, spices, and fruits. 100% non-reconstituted and unsweetened fruit and vegetable juices. Fresh and pasteurised milk, fermented plain unsweetened yoghurts. Plain unsalted nuts, peanuts, and seeds.
Group 2: Processed culinary ingredients	Processed culinary ingredients include foods that derive from Group 1 foods or from nature by processing such as pressing, centrifuging, refining, grinding, and milling. These types of processing are intended to make food products more durable products suited to at home or restaurant use. They are often used in combination with Group 1 foods to increase palatability and appeal. They are not intended for individual consumption.	Oils, butters, lard, sugar, honey, syrup extracted from trees, general sweeteners, salt, starches, flour, 'raw' pasta and noodles made from flour and water.
Group 3: Processed foods	Processed foods include food products made by adding salt, sugar or other Group 2 ingredients through methods of processing and preservation such as canning, bottling and non-alcoholic fermentation. These foods may contain additives to prolong shelf life and durability whilst enhancing sensory qualities.	Canned and bottled vegetables and legumes in brine. Canned and preserved fruits in syrup, salted or sugared nuts and seeds; salted, cured, dried, or smoked meats, poultry, fish (additives may or may not be present). Freshly made breads and cheeses.
Group 4: Ultra-processed foods and drink products	Ultra-processed food and drink products are industrial formulations with little or no resemblance to Group 1 foods. They typically contain large ingredient lists. Additives include Group 2 foods, generally in combination, along with antioxidants, stabilisers and other ingredients that are rarely found in culinary preparations. The level of processing is used to formulate hyper-palatable, convenient products with ample shelf life.	Ice cream and frozen desserts, biscuits, cakes, confectionary, sugared fruit and milk drinks, sweetened yoghurts, chips, sauces and spreads, soft drinks, pre-prepared poultry and fish products, packaged breads and buns, 'instant' noodles, soups, pasta dishes, pizza, infant formula, distilled alcohol.

2.3. Dietary assessment

Accurately assessing dietary intake in individuals and populations proves crucial for determing the effects of food consumption on health outcomes. The four main types of dietary assessment methods include the 24-hour recall, food diaries/dietary records, food frequency questionnaires (FFQs), and the diet history (Thompson & Subar, 2017), each with their own strengths and limitations. Selection of a dietary assessment method is dependent on the populations characteristics and abilities, time, costs, labour, participant burden, and accuracy in representing the populations nutritional status (Brown, 2000; Livingstone & Robson, 2000; Shim et al., 2014). Without the assitance of parents, children over the age of 10-12 years can accurately report their dietary intake (Burrows et al., 2010; Foster & Bradley, 2018). However, underreporting is evident across all populations. Among adolescents, those who are female, or overweight or obese, may be likely to under report consumption of unhealthy or UPFs (Burrows et al., 2010). Additionally, during adolescence, increased energy demands, irregular and unstructured eating patterns, a high frequency of out-of-home eating, self-image concerns, and a tendency to rebel against authority figures may further contribute to poor compliance and inaccuracies in dietary reporting (Livingstone et al., 2004; Rankin et al., 2010). **Table 2** describes each method and its corresponding strengths and limitations. Many of these classical dietary assessment methods now have online versions available and are being enhanced with the use of different software, image based tools, and artificial intelligence (Phalle & Gokhale, 2025).

Table 2: Main Dietary Assessment Methods including their strengths and limitations

Method	**Description**	**Strengths**	**Limitations**
24-hour recall	• Respondents recall all food and drinks consumed within the previous 24 hour period. • Trained interviewers use open ended questions to gather the type, amount and cooking method of foods consumed. • The multiple pass method involves the interviewer gathering first a quick list from the respondent of all food and drink consumed. The interviewer then probes for commonly forgotten items, such as spreads, snacks, and sauces, portion size, brand names, and preparation method. • Information may also be gathered via online assistance, phone interviews, and self-administered computer forms.	• Can be used on participants with low literacy levels. • Low participant burden. • The retrospective nature of collection does not alter the participants usual consumption. • Relatively low in cost. • Less time consuming. • Online recalls reduce interviewer bias and judgement. • Captures detailed intake and prepartion methods, necessary for classifying foods according to NOVA.	• Is reliant on participants memory. • A single recall may not capture usual intake. • Participants may not accurately report snacks/UPFs due to fear of judgement by interviewer. • Interviewers are required to be highly trained.
Food diary/dietary record	• Participant records the type and amount of food consumed, over a specified period of time, ideally at the time of consumption. • Amounts are measured using calibrated scales, standard cups and spoons, or food pictures and models. • Information from multiple consecutive days is gathered to account for usual intake. • Participants may require training in methods of keeping accurate records.	• Less reliance on memory. • Relatively low participant burden. • If complete over multiple days, may capture usual dietary habits. • If using calibrated scales, can give quantitatively accurate data. • Can gather detail on food preparation and brands needed for NOVA classification.	• Bias in participants selection of foods and portion size. • High participant burden if using the weighed method. • Data can be burdensome to collate and code leading to high research costs. • Requires literacy and motivation to complete. • Under reporting in adolescents due to lack of interest or motivation.

Method	Description	Strengths	Limitations
Food frequency questionnaire (FFQ)	• Individuals retrospectively record their usual frequency of consumption of foods from a specific list, over a specified time period. • Gather information on types, frequency, and usual portion of foods consumed, disregarding preparation methods, and combination of foods in meals. • FFQs are designed to estimate nutrient intakes, dietary constituents, and food group proportions over a certain period of time.	• Represents usual intake over a long period of time. • Can be self-administered. • Relatively low costs for data collection and processing. • Low respondent burden due to retrospective nature. • The lists can be tailored to capture UPFs.	• May not capture all UPFs as limited by pre-defined food lists. • Dependent on participants memory over a long period of time. • Large amount of measurement error, as fine details are not measured. • Do not collect ingredient or brand detail needed to quantify UPFs. • May not be inclusive of cultural foods.
Diet history	• A comprehensive interview assessing usual dietary intake and eating patterns by a trained interviewer. • This method collects retrospective data concerning food type, amount, frequency of consumption, preparation method, and typical combinations of foods within meals. • Typically assesses intake over a relatively long period of time. • Commonly used in clincal practice rather than in research studies.	• Assesses usual consumption patterns, with detail, over a non-specified period of time. • Nutrient balance can be interpreted. • Food and nutrient interactions can be explored as foods consumed within a meal are collected. • Can be used for people with low literacy.	• High participant and interviewer burden due to long duration. • High cost due to extensive resourcing. • Respondents are required to make decisions in the moment about what is considered 'usual'. • Social desirability bias. • Not recommended for children under 14.

Abbreviations: UPF = ultra-processed food, FFQ = food frequency questionnaire.

Adapted from (Baranowski & Willett, 2012; Block, 1989; Castell et al., 2015; Fagúndez et al., 2015; Livingstone & Robson, 2000; Rebro et al., 1998; Shim et al., 2014; Thompson & Byers, 1994; Thompson & Subar, 2017; Willett, 2012a).

2.3.1. Estimating usual intake using 24-hour recalls

An individuals food consumption varies between seasons, months, and days as well as undergoing profound changes throughout each year. Often, a single 24-hour recall is not an accurate representation of an individuals usual dietary intake. Multiple recalls are required to reflect usual intake and account for day to day variation within the diet, usually 2 to 3 days of recall are sufficient (Castell et al., 2015). Best practice includes collecting dietary data from two week days and one weekend, accounting for weekly variability (Saravia et al., 2022). Two or more recalls are further recommended for statistical modelling to estimate usual dietary consumption of individuals (Saravia et al., 2022). Caution must be taken when carrying out multiple 24-hour recalls on participants as survey repetition can influence the respondents diet (Shim et al., 2014). However, when administered across a sufficiently large and diverse sample, a single recall can provide a valid estimate of mean dietary intake at the population level (National Cancer Institute, n.d.). Additionally, the 24-hour recall is considered the best option for adolescent populations as it has been shown to provide the least over and underestimation compared to other dietary assessment methods (Rankin et al., 2010).

2.3.2. The challenges of assessing dietary intake in adolescent populations

The diet of adolescents consists of sporadic eating patterns, meal skipping, grazing, and irregular meals, all of which present difficulties when assessing dietary intake (Lietz et al., 2002; Pérez-Rodrigo et al., 2015). Adolescents are prone to over and under-reporting dietary intake due to social desirability bias, lack of portion size awareness, and memory limitations (Livingstone & Robson, 2000). Under-reporting within this age group has been associated with lower SES, being overweight, and habitual meal skipping (Lioret et al., 2011). Female adolescents exhibit a greater tendency to under-report than their male counterparts and the omission of sugary food items is purposeful within under-reporting groups (Livingstone & Robson, 2000). Although adolescents are generally capable of self-reporting their dietary intake, low motivation or disinterest in the research purpose may lead to inaccuracies, particularly when using more burdensome methods such as weighed food records (Livingstone & Robson, 2000). Some dietary assessment methods, namely the 24-hour recall and diet records, are reliant on participants providing brand names and particulars about food products (Livingstone et al., 2004). This may pose challenges in the adolescent population, who are often not the sole purchasers of households food products.

Limitations in cognitive and developmental abilities present further challenges in dietary assessment within this population. Dietary assessment requires individuals to recall specific details about consumption patterns including quantities, frequencies, preparation method, eating occassion, and history of consumption up until the previous year for some methods. Inaccuracies in reporting may arise as literacy and numeracy skills may not yet be sufficient to accurately capture dietary intake (Livingstone & Robson, 2000; Pérez-Rodrigo et al., 2015). Younger adolescents may require parental assistance, whereas adolesence aged 14 years and above are likely able to provide accurate self-reports (Pérez-Rodrigo et al., 2015).

Cultural dietary practices significantly influence adolescent consumption behaviours and their ability to accurately report dietary intake. Practices such as consuming meals from a shared family plate, may not be accurately reflected in standardised dietary assessment methods and errors in consumption quantity may arise (Abera et al., 2021). Furthermore, traditional food items, meals specific to diverse cultures, and some UPF products may not be readily available in data bases or food lists utilised by assessment methods.

2.3.3. The challenges of assessing ultra-processed foods using dietary assessment methods

Many differing dietary assessment methods exist, yet not all are created equal when attempting to quantify UPF intake within a specified population. FFQs are often used innappropriately to assess UPF intake as they do not gather ingredient or brand level detail required for UPF quantification. Studies adopting this method may over or underestimate UPF intake due to limited predetermined food lists and lack of contextual processing information (Jung et al., 2022). The FFQ is best used to estimate the average long term usual intake for individuals, appropriate for epidemiological studies of diet disease associations. Thus it is necessary to consider the primary purpose of the dietary measure (Jung et al., 2022). Research undertaken by Fangupo et al. (2019), found that FFQs overestimated energy intake (kJ) of UPFs compared to weighed diet records in young children. Conversely, the open ended format of the 24-hour recall allows for greater coverage of foods and dishes compared to the predefined lists of the FFQ, and gathers sufficient detail on product brands which may help with identifying the NOVA group (Jung et al., 2022; Marino et al., 2021).

2.3.4. The challenges of classifying ultra-processed foods

Classifying foods and mixed dishes according to the NOVA system presents several methodological challenges. Assigning foods to NOVA categories can be complex due to varying detail in dietary assessment tools, variations in food preparation practices, nuanced definitions, and the difficulty of categorising multi-ingredient dishes (Gibney, 2019; Marino et al., 2021). For foods or dishes that lack agreement between those categorising foods, an expert consensus approach is often adopted without considering the reliability or validity of this method (Khandpur et al., 2021; Steele et al., 2016). Different studies may classify the same foods as UPFs or not based on the differing definitions proposed across Monteiro's work (Marino et al., 2021). Recent findings highlight the frequent disagreement in food assignment even when detailed ingredient information is available to researchers. This inconsistency challenges the validity of using expert consensus and suggests that NOVA may lack the clarity required to produce valid and reliable conclusions in population research (Braesco et al., 2022).

Composite dishes such as burgers, pizzas, and wraps, popular among adolescents, also pose difficulty when ingredients are not reported individually. Therefore, for mixed dishes to be accurately categorised, each ingredient must be disaggregated and placed into one of the four NOVA groups. Inaccurate disaggregation can lead to incorrect NOVA categorisation, over or underestimating UPF estimates (Cruz et al., 2025). Furthermore, foods that appear similar, such as plain yoghurt versus sweetened, flavoured yoghurt, may fall into different NOVA categories, yet adolescents may report them with the same descriptor, particularly if they have not purchased the food product, neglecting brand details (O'Connor et al., 2024). Lastly, adolescent targeted products, such as energy drinks and snacks, are reformulated often, altering processing classification over time. Therefore, longitudinal data may not reflect true UPF exposure patterns, limiting the accuracy of analysis of health outcomes in adolescents (Fanzo et al., 2023).

2.3.5. Intake 24

Intake24 is an online multiple pass 24-hour dietary recall software, developed by nutritionists and computer scientists from the University of Newcastle (Simpson et al., 2017). The tool was originally developed for Food Standards Scotland and is maintained through a partnership between Cambridge University, Monash University, and the University of

Newcastle. Development, refinement and evaluation took place throughout four rounds of user testing. Intake24 has been validated for use in participants aged 11 years and over, and has been adapted for use in NZ, Portugal, Denmark, the United Arab Emirates, and Australia (Foster et al., 2014).

The online system is self-administered and is designed to be simple and quick to use (Rowland et al., 2018), guiding and prompting participants throughout completion. The user begins by listing all food and drinks consumed in the previous 24-hour period, from midnight to midnight using free text entry. All entries are then matched to foods within the Intake24 database. Portion sizes are estimated using photos of food items, participants choose which photo is most representative of their consumed portion. The software probes with questions concerning quantity, preparation method, and condiments. Finally, participants then review all food and drink items, as well as adding any forgotten foods (Foster et al., 2014; Simpson et al., 2017).

Mean intakes of energy, macronutrients, and micronutrients reported using Intake24 have been found to be very close to that of interviewer administered 24-hour recalls, with the exception of alcohol (Bradley et al., 2016; Foster et al., 2014). Previously, Intake24 has provided energy estimates for individuals aged 11-16 years, that are just 3% lower on average than interviewer led recalls (Bradley et al., 2016). For individuals aged 17-24 years, estimates of energy intake are on average in agreement between both recall methods (Bradley et al., 2016). Overall, the underreporting of energy intake is comparable between online administered 24-hour recalls and interviewer led recalls (Foster et al., 2019).

The digital nature of Intake 24 has numerous advantages in comparison to the traditional interviewer led recall method. Interviewer bias and time and administration costs are reduced when utilising online software, as well as having the data collected and coded in real time (Castell et al., 2015). Social desirability bias and *whakama* (shame) are also reduced through the use of an online platform (Brassard et al., 2020). However, disadvantages exist in that those that are less technologically competent may be excluded from samples, there may be worries about data security, and coding of foods must take place manually as food composition databases do not usually contain data on processing levels of foods (Bonilla et al., 2015; GuneyCoskun et al., 2024).

The Intake24 software has been used most notably in the UK National Diet and Nutrition Survey (NDNS) from 2019, replacing the original 4-day food diary methodology (Public

Health England, 2021). The data from these surveys has been used to measured UPF intake according to NOVA within the UK adult popoulation (Dicken et al., 2025). Additionally, UPF intake was quantified among a sample of 700 Fijian adults where three 24-hour recalls were collected using the Intake24 software (Palu et al., 2025).

2.4. Ultra-processed foods and adolescent health

2.4.1. Obesity

UPFs have become an increasingly central focus of nutritional research due to their pervasive presence in modern diets coinciding with the displacement of whole and minimally processed foods. UPFs contain high amounts of fats, sugars, additives and salt whilst being low in dietary fibre and micronutrients (Monteiro et al., 2019). Therefore, the consumption of UPFs may contribute to weight gain and obesity due to their unfavourable nutritional profile (Askari et al., 2020). There is consistent evidence suggesting that UPF consumption is associated with higher BMI and excess weight amongst adolescents (Chang et al., 2021; da Costa Louzada et al., 2015; De Amicis et al., 2022; Neri, Martínez-Steele, et al., 2022).

Neri, Martínez-Steele et al. (2022) performed a cross-sectional analysis on adolescent data collected from the 2011-2016 National Health and Nutrition Examination Survey from the USA, which included 3,587 participants between 12-19 years of age. The study results revealed that the highest consumption of UPFs was associated with a 45, 52, and 63% higher odds of total, abdominal, and visceral overweight/obesity, respectively, compared with the lowest consumption (Neri, Martínez-Steele, et al., 2022). Furthermore, a 10% increase in the proportion of UPFs in the diet was associated with an increased risk of both abdominal overweight/obesity and visceral overweight/obesity (Neri, Martínez-Steele, et al., 2022). However, the cross-sectional nature of this study gives rise to several limitations including the inability to determine causality and the sequence of the association between UPF consumption and adiposity.

Petridi et al. (2023) conducted a systematic review analysing nine cross-sectional, seven cohort-longitudinal, and one study reporting both cross-sectional and longitudinal outcomes, investigating the impact of UPFs on child and adolescent obesity and cardiometabolic comorbidities. Fourteen out of 17 studies revealed that UPF consumption was associated with a higher prevalence of overweight/obesity and cardiometabolic comorbidities among children and adolescents (Petridi et al., 2023). In contrast, four of the studies found no association (three cross-sectional and one cohort) (Petridi et al., 2023). This discrepancy highlights the limitations of cross-sectional studies, which capture associations at a single time point and cannot determine causality. In contrast, longitudinal studies track changes over time, making these studies better suited to detect the cumulative impact of UPFs on adiposity and obesity.

2.4.2. Cardiovascular health

Beserra et al. (2020) conducted a systematic review analysing 14 studies to evalute the relationship between UPF intake and lipid profiles in children and adolescents. Of the studies, six reported that higher UPF intake was associated with increased LDL concentration, total cholesterol, triglycerides (TGs), and decreased HDL concentrations. However, findings were not consistent across all studies with one finding no association between UPF intake and lipid profiles in adolescents (Petridou et al., 1995) and two studies (Albertson et al., 2009; Gibson, 2003) found that greater consumption of ready-to-eat cereals (a subgroup of UPFs) was associated with lower total cholesterol and LDL concentration among adolescents. This systematic review included both cross-sectional and longitudinal studies; however, substantial variation existed in the dietary assessment methods employed, as well as in the measurement of UPF intake and lipid-related outcomes. Furthermore, some of the included studies did not adjust results considering the changing of participant characteristics with puberty. Despite limitations, the review highlights the adverse effect of UPF consumption on adolescent lipid profiles.

Similarly, Zhang et al. (2022) analysed data from 5,565 US adolescents aged 12–19 years using NHANES data from 2007–2018. They found that higher UPF intake was significantly associated with poorer cardiovascular health (CVH) scores. Adolescents in the highest quintile of UPF consumption had a 59% lower likelihood of achieving ideal CVH compared to those in the lowest quintile. The cross-sectional design limits causality but the study highlights a strong negative association between UPF intake and adolescent heart health. This research is consistent with findings from a survey of 210 Brazilian adolescents that found high UPF intake was associated with the prevalence of metabolic syndrome within this group (Tavares et al., 2012). Notably, this study was the first to explore UPF intake using the earlier version of NOVA which included three processing groups (unprocessed/minimally processed foods, processed culinary ingredients, UPFs) (Tavares et al., 2012). However not all research supports a consistent relationship. Melo et al (2017) found no association between UPF consumption and blood pressure or high WC in adolescents.

2.4.3. Diet quality and ultra-processed food consumption

Neri et al. (2022) conducted a multi-country study investigating the association between UPF intake and profiles of dietary nutrients linked with childhood and adolescent obesity. The study used data from nationally representative dietary surveys from Argentina, Australia, Brazil, Chile, Colombia, Mexico, the UK, and the US, collected between 2004-2014 (Neri, Steele, et al., 2022). Amongst most countries and age groups, increases in the dietary share of UPFs were associated with increases in energy density and free sugars and decreases in fibre (Neri, Steele, et al., 2022). In a Canadian study of adolescents, a higher dietary share of UPFs was significantly positively associated with carbohydrate, free sugar, total and saturated fat content, and overall energy density, and inversely associated with protein, fibre, calcium, and vitamins A, B6, B12, D, riboflavin, and niacin intakes (Moubarac et al., 2017).

Vandevijvere, De Ridder, et al. (2019) assessed associations between UPF intake and dietary quality amongst nationally representative samples from 2004 and 2014-2015, including children, adolescents, and adults. For all age groups, the dietary share of UPFs was much lower on days when participants met the WHO salt intake recommendation. Additionally, the dietary share of UPFs was significantly lower and the share of unprocessed/minimally processed foods was significantly higher during consumption days when saturated fat was ≤10% of energy intake ($p<0.001$, for all age groups). These findings confirm that UPFs contribute significantly to sodium and saturated fat intake within the diet.

A European study from 2013-2014, investigated UPF consumption and diet quality amongst children, adolescents, and adults. The sample included 3,061 adolescents aged between 10-20 years of age from Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain, and Sweden. Ultra-processed foods contributed more energy from sugars, saturated fat, and total carbohydrates, compared to foods categorised into other processing groups. Yet only the difference in sugar contribution was significantly different ($p<0.05$). Dietary quality was significantly lower in the fifth quintile of UPF intake and overall tended to decrease across quintiles. To assess dietary quality an FFQ was used, inclusive of only 43 Pan-European food items, which may have limited the ability to accurately capture the full range of UPFs consumed by adolescents and could lead to misclassification or underestimation of UPF intake. Furthermore, the studied sample is not representative of the whole European population (Lauria et al., 2021).

2.5. Intake of ultra-processed foods in adolescents

2.5.1. Globally

Adolescent consumption of UPFs abroad has been well documented in several countries with food environments similar to NZ, through nationally representative cross-sectional data, including Belgium (Vandevijvere, De Ridder, et al., 2019), Canada (Moubarac et al., 2017), the USA (Baraldi et al., 2018), and the UK (Rauber et al., 2018). These studies analysed UPF consumption across all age groups. Children and adolescents were found to be among the highest consumers of UPFs, with consumption within this age group ranging from 29-67% of TDEI (Baraldi et al., 2018; Machado et al., 2019; Moubarac et al., 2017; Rauber et al., 2019; Vandevijvere, De Ridder, et al., 2019). Among adolescents in the USA, UPF consumption contributed towards 67% of TDEI (Baraldi et al., 2018). Similarly, UPFs contributed substantially to TDEI in several other countries: 55% in Canada (Moubarac et al., 2017), 68% in the UK (Rauber et al., 2019), 29% in Belgium (Vandevijvere, De Ridder, et al., 2019).

Research conducted on a large sample of participants across European countries revealed participants aged between 10-20 years consumed 48.8% of daily energy from UPFs between the years of 2013-2014 (Lauria et al., 2021). This was comparable to the intake observed among children aged 6-10 years (49.0%) and notably higher than those aged 20 years and above (40.2%) (Lauria et al., 2021). Interestingly, UPF intake from two studies within the Belgian population reveal notable inconsistencies. Lauria et al. (2021) identified UPFs contribute to 48.9% of TDEI, however this estimate was derived from a mixed age population tha included adults. In contrast, Vandevijvere, De Ridder, et al. (2019) found that UPFs contributed to 29.2% of TDEI among Belgian adolescents specifically. The lower estimate from Vandevijvere, De Ridder, et al. (2019) may be explained by differences in population characteristics and susbstantial misreporting, with around one third of participants classified as mis reporters.

In Brazil, lower intakes of UPFs have been found. Amongst a nationally representative sample including 32,898 individuals aged 10 years and over, UPFs contributed towards only 21.5% of TDEI. This finding represents UPF intake across all participants, and was not stratified by age groups (Louzada, Martins, et al., 2015). Further findings suggest too that adolescent intakes of UPF have increased in recent years in Taiwan from 21% in 1990 to 25% of TDEI in 2011 (Chen et al., 2018). **Table 3** details UPF intake among adolescents from nationally representative cross-sectional studies globally.

Table 3: Ultra-processed food intake in adolescents from cross-sectional nationally representative studies globally.

Country, date of data collection, authors	**Study objectives**	**Population**	**Dietary assessment method**	**Method of classification**	**Results**	**Other findings/limitations**
Belgium, 2004, 2014-2015, (Vandevijvere, De Ridder, et al., 2019)	To assess the dietary share of UPFs among Belgian children, adolescents and adults and associations with diet quality.	Representative sample of the Belgian population (n= 3,083, individuals ≥ 15 years in 2004 and n= 3,146, individuals 3–64 years in 2014–2015) randomly selected from the National Population Register (multi- stage stratified sampling procedure).	Two computerised 24 hour recalls on non-consecutive days for participants between 10-64 years.	NOVA.	2014-2015: adolescents 10-17 years had a mean intake of 29.2% TDEI from UPF (in adults18-64 years UPFs contributed to 29.6% TDEI) For total population 3–64 years, processed meat products (14.3%), cakes, pies and pastries (8.9%) and dry cakes and sweet biscuits (7.7%) and carbonated soft drinks (6.7%) were the biggest contributors to UPF intake	For all age groups, dietary share of unprocessed/minimally processed foods were significantly higher on days when participants met the WHO salt and fruit and vegetable intake (≥ 400 g/day) recommendations (p<0.001). Almost one-third of participants were identified as mis reporters.
USA, 2007-2012, (Baraldi et al., 2018)	To compare UPF consumption across sociodemographic groups and over time (2007– 2008, 2009–2010, 2011–2012) in the USA.	Data from the National Health and Nutrition Examination Survey (NHANES) 2007–2012. Individuals >2 years with at least one 24 hour dietary recall (n=23,847).	Interviewer led 24 hour dietary recall. Follow up recalls were completed 3-10 days after visiting the mobile examination centre via telephone interview. Children aged 9-11 provided their own data, with adult assistance. For	NOVA.	UPFs contributed to 66.8% of TDEI in participants aged 10-19 years. Within UPFs most calories came from breads and frozen/shelf-stable meals (9.9% and 8.6% of total daily intake,	Both the crude and adjusted contribution of UPFs to the diet decreased with age, education and income. Consumption of UPFs decreased with age and income level, was higher for non-Hispanic whites or non-Hispanic blacks

Country, date of data collection, authors	Study objectives	Population	Dietary assessment method	Method of classification	Results	Other findings/limitations
			those <9 years, the interview was conducted with a proxy.		respectively), followed by confectionery (6.1%), fruit and milk drinks (5.8%), cakes, cookies and pies (5.7%), soft drinks (4.6%), salty snacks (4.1%) and breakfast cereals (3.0%).	than for other race/ethnicity groups and lower for people with college than for lower levels of education, all differences being statistically significant.
Canada, 2004, (Moubarac et al., 2017)	To estimate food consumption patterns according to the NOVA system. To investigate the association between the consumption of UPFs and the nutrient profile of the diet.	Participants aged 2 years and above from the 2004 Canadian Community Health Survey (n=33,694).	Two computer assisted interviewer led 24 hour recalls on non-consecutive days were collected.	NOVA.	The mean % of TDEI from UPFs for participants aged 2-18 years was 55.1%. Energy from UPFs came from soft drinks, fruit juices and fruit drinks (7.8% of TDEI), packaged breads (7.5%), confectionary (6.0%) and fast food dishes (5.3%).	A significant positive relationship was found between the dietary share of UPFs and the content of carbohydrates, free sugars, total and saturated fats, and overall energy density. A significant inverse relationship was found with the content of protein, fibre, calcium, and vitamins A, B6, B12, D, riboflavin, and niacin. The mean dietary share of UPFs ranged from 23.5% of total calories (1st quintile) to 76.2% of total calories (5th quintile). As the dietary share of UPFs increased across quintiles, the dietary share of all subgroups

Country, date of data collection, authors	Study objectives	Population	Dietary assessment method	Method of classification	Results	Other findings/limitations
						of unprocessed or minimally processed foods (except for fish and eggs), of culinary ingredients and of processed foods uniformly and significantly decreased. Dietary data was collected in 2004 and may not accurately reflect current intake patterns. No mention of how dietary data was collected for toddlers and young children.
Australia, 2011, (Machado et al., 2019)	To describe the consumption of UPFs in Australia and its association with the intake of nutrients linked to non-communicable diseases (NCDs).	Participants aged >2 years using the National Nutrition and Physical Activity Survey (n=12,153).	Two 24 hour dietary recalls administered by trained interviewers. The first recall was completed face to face (N=12 153), while the second recall was completed via telephone interview (N=7735) conducted at least 8 days after the first recall. For children under 15 years, parents/guardians were used as proxies.	NOVA.	UPFs contributed, on average, 42% of TDEI. Unprocessed or minimally processed, processed foods, and processed culinary ingredients contributed on average 35.4%, 15.8%, and 6.8% of TDEI, respectively.	The dietary fraction made up of exclusively UPFs contained significantly more free sugars, total fat, saturated fat, and sodium, whilst containing significantly less dietary fibre, potassium. The overall energy density of the UPF dietary fraction was significantly greater than the non-UPF dietary fraction, at 2.7kcal/g.

Country, date of data collection, authors	Study objectives	Population	Dietary assessment method	Method of classification	Results	Other findings/limitations
						Did not stratify by age group.
United Kingdom (UK), 2008-2014, (Rauber et al., 2019)	To describe dietary sources of free sugars in different age groups of the UK population considering food groups classified according to the NOVA system. To estimate the proportion of excessive free sugars that could potentially be avoided by reducing consumption of their main sources.	Participants from the National Diet and Nutrition Survey Rolling Programme aged 1.5 years and above (n=9,374)	Four day food diary, parents/caregivers completed diaries for younger children.	NOVA.	56.8% of TDEI came from UPFs. Among children (1.5-10y) and adolescents (11-18y), UPFs accounted for 63.5% and 68% of TDEI, respectively. UPFs contributed 78.9% of total energy intake from free sugars in adolescents.	On average, 17.4% of the total energy intake for adolescents in the highest UPF consumption quintile came from free sugars. Adolescents in the highest quintile of UPF consumption had a free sugar intake that was 58% higher than those in the lowest quintile of UPF intake.
Brazil, 2008-2009, (Louzada, Martins, et al., 2015)	To assess the impact of consuming UPFs on the nutritional dietary profile in Brazil.	Participants aged 10 years and over that completed the Brazilian Family Budgets Survey (n=32,898)	Two self-completed 24-hour food records on non-consecutive days. Food records were complemented by interview where a trained interviewer reviewed information.	Foods were classified into three food groups including natural or minimally processed, processed, and UPFs. Culinary preparations based on one or more natural or minimally processed food items were included in this first group.	On average, 21.5% of TDEI came from UPFs. Natural or minimally processed, and PFs contributed 69.5% and 9.0%, respectively. Among UPFs were cakes, pies and cookies (3.0% of daily calories), fast food dishes (2.9%), sugar-sweetened beverages (2.6%), sliced loafs, hamburger and hot dog breads (2.4%) and confectionary (2.2%). Second in energy contribution, are	When considered together, rice and beans were responsible for more than one quintile (22.9%) of the energy consumed throughout the day. The dietary fraction concerning UPF consumption had significantly less protein, potassium, and dietary fibre, whilst having significantly more energy, free sugar, total fat, saturated fat, and trans fat.

Country, date of data collection, authors	Study objectives	Population	Dietary assessment method	Method of classification	Results	Other findings/limitations
					crackers, chips, sausages, ready or semi-ready meals and sweetened dairy drinks.	Did not stratify by age group.
Europe, 2013-2014, (Lauria et al., 2021)	To provide a description of the consumption of UPFs among participants from eight European countries, and to investigate the association between UPFs intake and nutritional quality of the diet.	Participants apart of the I.Family Project in eight European countries (Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain, Sweden) (n=7,073).	At least one online 24-hour dietary recall. Recommended to complete a further two. Parents assisted in those aged <11 years.	NOVA	Those aged between 10-20 years consumed 48.8% energy from UPFs. Similar to those aged 6-10 years (49.0%), greater than those aged 20 years and above (40.2%).	UPFs had greater total fat, saturated fat, sugars compared to other food groups.

2.5.2. Intake of ultra-processed food groups globally

To date, limited research has examined the contribution of specific UPF food groups to overall intake among adolescents. Polsky et al. (2024) carried out a cross-sectional study in Canada with nutrition data from 2015, including 20,103 participants aged 2 years and above identifying commercial breads, fruit juices and drinks, chocolate and candies, and cakes, cookies and pastries as the leading contributors to UPF derived energy, contributing 9.5, 5.2, 4.3, and 3.9% of TDEI, respectively. Similarly, among adolescents in the USA, most energy came from breads and frozen/shelf-stable meals (9.9 and 8.6% TDEI, respectively), followed by confectionary (6.1%), fruit and milk drinks (5.8%), cakes, cookies and pies (5.7%), soft drinks (4.6%), salty snacks (4.1%) and breakfast cereals (3.0%) (Baraldi et al., 2018).

In Belgium, a similar study was conducted using data from the 2014-2015 National Food Consumption Survey, inclusive of 3,164 participants aged 3-64 years (Vandevijvere, De Ridder, et al., 2019). Processed meat products (13.5%), cakes, pies, pastries (10.8%), chocolate spreads (8.4%), and dry cakes and sweet biscuits (8.4%) were the top contributors to total energy intake for males between 10-13 years of age. As age increased these contributors differed slightly with processed meat products (14.1%), dry cakes and sweet biscuits (8.9%), and carbonated soft drinks (8.8%) leading UPF derived energy contributions. In females 10-13 years, processed meat products (11.9%), cakes, pies pastries (10.2%), dry cakes and sweet biscuits (9.5%) were dominant. Those between 14-17 years consumed the most UPF energy from dry cakes and sweet biscuits (11.2%), processed meat products (10.9%), and carbonated soft drinks (9.3%) (Vandevijvere, De Ridder, et al., 2019).

Gonçalves et al. (2023) undertook a cross-sectional survey, using data from 2019, to assess the prevalence of consumption of specific UPFs amongst Brazilian adolescents. The sample included 125,123 students from 4242 schools. Almost half of the participants reported having consumed crackers (49.6%) and cookies (46.7%), and slightly less than half reported having consumed bread (41.8%), soft drinks (40.5%), and margarine (40.1%) on the previous day. The studies use of prevalence data, which identifies whether adolescents consumed specific UPFs on the previous day, does not quantify the amount consumed or the proportion of total energy intake derived from each item. These findings provide insight into the most consumed UPF items among Brazilian adolescents.

2.5.3. New Zealand

There has been little research analysing UPF consumption patterns within NZ adolescents. Since 2018, the Ministry of Health have been monitoring childrens dietary habits, as part of the New Zealand Health Survey, encompassing the early years of adolescence between the ages of 2-14 years (Ministry of Health, 2022a). Adolescents aged 15 and above are covered in the Adult Health Survey (Ministry of Health, 2024a). UPFs monitored on an annual basis include fast food and fizzy drink intake. The prevalence of consuming fast food more than once a week, for adolescents aged between 10-14 years, has shown minimal change from 59.0% in 2018/19 to 59.8% in 2023/24 (Ministry of Health, 2024a). Additionally, the prevalence of consuming fast food more than three times a week has remained relatively stable for this age group from 7.9% in 2018/19 to 7.5% in 2023/24 (Ministry of Health, 2024a). As for fizzy drink consumption more than once a week, there has been an increase in prevalence from 44.3% in 2018/19 to 51.9% in 2023/24 (Ministry of Health, 2024a). Consuming fizzy drinks greater than three times a week has increased from 15.7% in 2018/19 to 20.2% in 2023/24 (Ministry of Health, 2024a).

The Ministry of Health's report on Children's Dietary Habits did not explicitly explore UPFs as classified by NOVA, however information surrounding processed meats, sweet baked items, and confectionary, all of which belong to the UPF category, were gathered (Ministry of Health, 2022a). The prevalence of consumption of processed meats, sweet baked items, and confectionary more than three times per week was 40.0, 75.1, and 42.0%, respectively for adolescents between 10-14 years of age (Ministry of Health, 2022a).

The only national survey exploring the diets of children in NZ is the 2002 National Children's Nutrition Survey, conducted on children between 5-14 years old, capturing the period of early adolescence (Ministry of Health, 2003). Although there was no reference made to the NOVA classification system, the collected data still holds importance for this review. **Table 4** details the commonly consumed convenience foods found within this study. Frequently consumed UPFs from this timeframe include potato crisps, tomato sauce or ketchup, and white bread (Ministry of Health, 2003).

Table 4: Commonly consumed convenience foods, snacks, and beverages amongst New Zealand children (5-14 years), based on the 2002 National Children's Nutrition Survey (Ministry of Health, 2003)

Category	**Food/drink item**	**% of children consuming at least once a week**
Convenience foods	Noodles	55
	Canned spaghetti	32
Breakfast cereals	Weetbix	62
	Cornflakes	50
	Rice bubbles	36
	Cocoapops	25
Breads	White	79
	Wholemeal	15
	Mixed grain	13
Spreads/condiments	Margarine or margarine blend	52
	Jam or honey	53
	Peanut butter	49
	Marmite or vegemite	47
	Nutella	30
	Mayonnaise or salad dressing	29
	Tomato sauce or ketchup	80
	Gravy	30
Snacks	Potato crisps, corn snacks or chips	83
	Popcorn	17
Confectionary	Moro bar	40
	Candy coated chocolate	25
	Other	48
Drinks	Soft drinks	45
	Coca-cola	43
	Mountain dew	9
	Juice	43
	Powdered fruit drink	54
	Cordial	32
	Sports drinks	8

The Adult Nutrition Survey 2008/09 provides the most recent data on national dietary intake in NZ individuals aged from 15 years, capturing the latter half of adolescence (University of Otago and Ministry of Health, 2011). Again, while UPF consumption was not explicitly explored nearly half (49.7%) of males and females (48.6%) between 15-18 years reported consuming white bread most commonly, with the proportion decreasing as age increased. In terms of processed meat consumption, 92.9% of males and 88.0% of females report consuming processed meats at least once a week. Other notable contributors were hot chips, with 52.5% of males and 39.6% of females reporting consuming at least 3 times a week (University of Otago and Ministry of Health, 2011). The most commonly used spread for this age group for both male and females was full fat margarine used by 42.3% and 44.9%, respectively, followed by reduced fat margarine, then butter (University of Otago and Ministry of Health, 2011). **Table 5** details the commonly consumed convenience foods in adolescents aged 15-18 years from the 2008/09 Adult Nutrition Survey. Hot chips and fast foods/takeaway were key UPFs consumed on a frequent basis for both males and females between the years of 2008/09 (University of Otago and Ministry of Health, 2011).

Table 5: Commonly consumed convenience foods, snacks, and beverages amongst New Zealand adolescents (15-18 years) based on the 2008/09 Adult Nutrition Survey (University of Otago and Ministry of Health, 2011)

Food item	**Frequency of consumption (times per week)**	**% males consuming**	**% females consuming**
Battered seafood	>1	15.1	12.6
Processed meat	≥1	92.9	88.0
Soft/energy drinks	≥3	42.3	44.9
Hot chips	≥3	52.5	39.6
Fast food/takeaways	≥3	25.4	-

One NZ based study analysed UPF intake among 669 Dunedin based children between 12-60 months of age. The cohort study involved a secondary analysis of data from the Prevention of Overweight in Infancy study, a 4-arm, randomised controlled trial. The research reported that UPFs contributed to 45, 42, and 51% of energy intake amongst children at 12, 24, and 60 months of age respectively (Fangupo et al., 2021). However, a limitation of this research is that the sample size is not representative of all NZ children (Fangupo et al., 2021).

Another study conducted a secondary analysis of cross-sectional data on packaged supermarket food availability in Auckland (Luiten et al., 2016). The study analysed 6,020 packaged food and beverage products from 2011, and 13,406 food and beverage products from 2013. Supermarket food products were classified according to their processing level (minimally, culinary, and UPFs) and their nutrient profiling score (NPSC). The NPSC was developed by Food Standards Australia New Zealand (FSANZ) to classify foods based on their nutrient content to help identify healthier foods. The higher the score the greater the levels of saturated fats, sugar, sodium, with lower levels of protein, fibre, vitamins and minerals (Food Standards Australia New Zealand, 2022b). The investigation revealed that in

2011 and 2013, 84% and 83% of packaged foods were classified as UPFs (Luiten et al., 2016). A positive association was found between the level of processing and NPSC, with UPFs having a worse nutrient profile score than culinary and minimally processed foods (Luiten et al., 2016).

2.6. Why adolescents are vulnerable – marketing, peer influence, food environments

Adolescents are particularly vulnerable to UPF consumption due to the routine interplay of individual, social, and environmental factors (Rodríguez-Barniol et al., 2024). Aggressive marketing techniques are utilised through platforms such as television advertisements, packaging, digital games, and the internet. To target children and adolescents, birght colours, gamified content, and youthful music are adopted to create brand loyalty in this population. Further tactics including the use of celebrities, influencers, and characters are often used by food brands to draw in a child and adolescent consumer base (Smith et al., 2019; World Health Organization, 2016). These platforms and methods significantly influence preference and attitude towards unhealthy advertised foods by increasing exposure and appeal, normalising the frequent consumption of UPFs (Smith et al., 2019).

Neurodevelopmental factors also play a role in increasing vulnerability to overconsumption of UPFs within adolescents. The prefrontal cortex, responsible for self-regulation and behavioural control, remains underdeveloped in adolescents. Coupled with this, the dopamine system, central to reward processing is highly abundant during this life stage (Reichelt, 2016). This ongoing maturation reduces adolescents capacity for impulse control and increases susceptibility to immediate rewards, making adolescents particularly prone to consuming high fat, sugar, salt (HFSS) foods (Reichelt, 2016). The highly palatable composition of UPF products, enhance the rewarding effects and activate parts of the brain involved in motivation and sensory processing, in which adolescents are especially responsive to these cues, contributing to greater intake of these foods (Calcaterra et al., 2023).

Within the broader food environment, adolescents are regularly exposed to UPFs around schools, neighbourhoods, recreational facilities, and retail outlets (Signal et al., 2017; Vandevijvere et al., 2014). Fast-food outlets and convenience stores are often concentrated around schools, creating environments that encourage routine consumption of UPFs. These outlets frequently use price promotions, ‘combo’ deals, and upsizing strategies that further encourage purchasing and intake of UPFs, compounding the risk of poor dietary quality (Andaluz et al., 2025). This high concentration of fast food outlets displaces fresh produce stores, and healthier food outlets creating low availability of healthy alternatives within many communities (Boskovic et al., 2025). In addition to marketing and local environments, peer influence also plays a role in adolescent food choices as mirroring peers and following social norms are common behaviours throughout adolescence (Montgomery et al., 2020; Neufeld et al., 2022).

2.7. Ultra-processed foods in national food and nutrition guidelines

2.7.1. Internationally

Recent research conducted by Koios et al. (2022) investigated the consumer-targeted key messages of 106 dietary guidelines globally. Their results found that nutrient based messages were more common than messages surrounding the level of food processing (Koios et al., 2022). The national nutrition guidelines in several countries make specific references to UPFs as defined by the NOVA classification, including Brazil, Belgium, Israel, Ecuador, Maldives, Peru, and Uruguay. The key messages within each of the guidelines discourage intake of UPFs, and emphasise including whole and minimally processed foods (Koios et al., 2022). **Table 6** details these guidelines below.

Table 6: Dietary guidelines with explicit mention of 'ultra-processing' according to NOVA.

Country	Guideline	Notes
Brazil	‘Avoid ultra-processed foods’	The guidelines give examples of how to distinguish PFs from UPFs and reasons to avoid these. Has an extensive section educating on UPFs. Their whole guidelines and 4 overarching recommendations are based on the NOVA food groups
Belgium	Their exclusion criteria for each food group references UPFs – although no specific guideline statement.	‘As regards to the classification of foods, the decision was made to take into account the degree of processing by using the NOVA classification system and distinguishing between three groups 1) Simply processed foods 2) Prepared or processed foods 3) Ultra-processed foods…’ Highlight the need to consider both processing and composition of foods
Israel	‘Foods for minimised consumption...ultra-processed products’	

Country	Guideline	Notes
Ecuador	'Let's protect our health: Avoid the consumption of UPFs, fast-food and sugar sweetened beverages'	
Maldives	'Limit intake of junk food and UPF'	
Peru	'Protect your health avoiding the consumption of UPFs'	

Notes: Adapted from Ministry of Health Brazil (2015), Superior Health Council (2019), Ministry of Health Israel (2020), Food and Agriculture Organization of the United Nations (2020), Ministry of Health Maldives (2019), Food and Agriculture Organization of the United Nations (2019).

In 2014, Brazil were the first country to explicitly reference the NOVA system in their national dietary guidelines. The guidelines outlines the groups of NOVA and advises individuals to reduce intake of PFs and avoid intake of UPFs as they are nutritionally unbalanced and displace whole and minimally processed foods within the diet (Ministry of Health Brazil, 2015). The guidelines also outline examples of UPFs, reasons to avoid consumption, how to identify UPFs using food labels, and their damaging impact on culture, social life, and the environment (Ministry of Health Brazil, 2015).

2.7.2. New Zealand

The Food and Nutrition Guidelines for Healthy Children and Young People (Aged 2-18 years) (Ministry of Health, 2012) make no specific reference to the NOVA classification system or UPFs. These guidelines discourage consumption of highly processed foods whilst encouraging consumption of less processed foods. The guidelines suggest 'Choosing a diet based on less refined or highly processed foods is likely to have many nutritional benefits, including gaining higher levels of fibre and micronutrients and phytonutrients found in 'whole foods', and reducing levels of sugar, fat and salt.'

The term UPF is not utilised within the guidelines however, the use of 'high fat, sugar, and salt' (HFSS) foods is frequently mentioned throughout. The guidelines state 'Limit HFSS foods and drinks to occasional (less than once a week) consumption only.' HFSS foods are described as having few micronutrients in relation to their energy content, making these foods energy dense with a low nutritional value (Ministry of Health, 2012). Examples of HFSS foods given within the guidelines include chocolate, confectionery, potato chips, chocolate or cream-filled biscuits, fast food and sugary drinks, all of which align with UPFs according to NOVA (Ministry of Health, 2012).

Emphasis is placed on choosing whole foods over highly processed convenience foods to decrease overall consumption of fat, sugar, and salt (Ministry of Health, 2012). The guidelines also suggest decreasing salt intake:

1. Choose whole or minimally processed foods instead of highly processed convenience and fast foods
2. Choose products with low (< 120 mg of sodium per 100 g) or medium (120–600 mg of sodium per 100 g) levels of sodium where possible
3. Use little or no salt in cooking and at the table (but if using salt, use iodised salt)
4. Limit intake of foods high in salt (sodium), such as savoury snacks and biscuits, fast food and takeaways, and processed meats and cheese (Ministry of Health, 2012).

In January of 2025, the Ministry of Health commenced a review of the above guidelines for children and young people, prior to this the guidelines were last updated in 2012. These guidelines will be updated to align with the Eating and Activity statements, included in the Eating and Activity Guidelines for NZ adults, infants and toddlers (Ministry of Health, 2025). These more recent guidelines reference limiting PFs but do not yet explicitly integrate the NOVA classification system or terminology around UPFs. The upcoming revision of the children and young people's guidelines provides an opportunity to align recommendations with emerging evidence on UPF consumption and health outcomes in adolescents.

2.8. Ultra-processed food intake and associations with socio-demographic factors in adolescents

Investigating associations between UPF intake and sociodemographic factors is pivotal as factors such as age, sex, ethnicity, geogrpahical location, and SES can shape access, affordability, preference, and marketing exposures to UPFs. These investigations also allow understanding into inequities in food environments and can guide targeted public health policies surrounding UPF consumption. **Table 7** details studies investigating UPF consumption and association with socio-demographic factors in adolescents globally.

2.8.1. Age

A few studies have described the association between age and UPF intake using cross-sectional study design (Baraldi et al., 2018; Chavez-Ugalde et al., 2024; Gonçalves et al., 2023; Khandpur et al., 2020; Marrón-Ponce et al., 2018; Polsky et al., 2024). Baraldi et al. (2018) conducted a cross-sectional study, using nationally representative data, comparing UPF intake across socio-demographic groups in the USA with data collected between 2007-2012. The study found that amongst all participants, the contribution of UPFs to TDEI was highest within the 10-19 year age category, contributing 66.8% of TDEI. As age increased, the dietary share of UPFs decreased with those ≥60 years consuming the lowest proportion of UPFs, although these findings were not statistically significant (Baraldi et al., 2018). A study in Mexico involving 10,087 nationally representative participants also identified an inverse association between age and UPF intake, where as age increased, consumption of UPFs decreased (Marrón-Ponce et al., 2018).

In Canada, children aged 6–12 years had the highest UPF energy intake (52.7%), followed by adolescents 13–18 years (51.0%) and young adults 19–30 years (44.7%), with lower values among older groups (Polsky et al., 2024). Children between 6–12 years, consumed 5.3 percentage points more UPF derived energy compared to those aged 2-5 years ($p<0.001$), while adolescents aged 13-18 years consumed 4.1 percentage points more (Polsky et al., 2024). Amongst a sample of UK adolescents, there was no association between UPF intake and age (Chavez-Ugalde et al., 2024).

Khandpur et al. (2020) analysed the consumption of UPFs in the Colombian population focusing on sociodemographic factors. The data was nationally representative, extracted from the 2005 National Survey of the Nutritional Status (Khandpur et al., 2020). They concluded that adolescents (10-19 years) exhibited the greatest % intake of energy from UPFs (18.6%), in comparison to all other age groups. However, there was no significant difference in consumption between those aged between 10-19 and 2-9 years (Khandpur et al., 2020). A limitation of this study is that participants only completed one 24-hour recall, which does not account for day-to-day variation in intake. Furthermore, the data was collected in 2005 and may not reflect the current food environment of Colombia. In contrast, cross-sectional findings from Brazil concluded that adolescents over 13 years of age were more likely to consume UPFs, specifically crackers, chocolate drinks, and flavoured yoghurts, compared to adolescents less than 13 years of age (Gonçalves et al., 2023).

Dicken et al. (2023) conducted a systematic review analysing 55 studies, covering 32 countries and 36 nationally representative surveys. The association of UPF intake and age was assessed across 17 countries. They found a consistent association of younger age within all age range categories (in adults, or in adults and children) having greater UPF intakes in all countries, with some studies showing the highest intakes in the adolescent population (Dicken et al., 2023).

2.8.2. Sex

Conflicting evidence has been documented when investigating the association between sex and UPF intake among adolescents. A cross-sectional study using data from 4-day food diaries from 2991 adolescents aged 11-18 years in the UK found no difference in UPF consumption between male and female adolescents (Chavez-Ugalde et al., 2024). Conversely, Polsky et al. (2024) found a statistically significant difference in UPF consumption between male and female participants, across all age groups, with females consuming 1.7 percentage points less than males (95% CI -2.7- -0.7, $p<0.001$). Further analysis concluded that females consumed less fast-food and frozen dishes, processed meat products, and soft-drinks when compared to their male counterparts (Polsky et al., 2024). However, the findings from Polsky et al. (2024) were not stratified by age group, and therefore reflect overall sex-based differences rather than those specific to adolescents. In agreement with this finding, mean UPF intake was higher among females than males in a cross-sectional analysis of adolescents in Costa Rica. Females consumed 37.2% TDEI from UPFs compared to 33.6% in males (p=0.001) (Mendoza et al., 2025).

Although some studies report sex-based differences in adolescent UPF intake, the direction and magnitude of these differences vary. A study conducted in China revealed male adolescents were significantly more likely to consume UPF more than 8 times per week than girls, indicating that boys are likely to have greater weekly UPF consumption (Yang et al., 2024). Similarly, amongst a sample of Spanish adolescents, males consumed a greater number of servings of UPF products within a 24-hour period compared to females (8.67 vs. 7.06, p=0.001). A key limitation of this study is the use of a self-administered questionnaire rather than a validated dietary assessment method. Furthermore, the questionnaire did not collect data on the quantity of UPF products consumed, limiting the ability to assess dose–response relationships. This may partly explain the observed sex differences, as it remains unclear whether associations seen in male adolescents reflect a higher prevalence or greater amounts of UPF intake (Reales-Moreno et al., 2022).

2.8.3. Ethnicity

Emerging research highlights that ethnicity is an important factor that may be associated with differences in UPF intake among adolescents. Analysis of nationally representative data, that included adolescents, from the US between 2007-2012 showed that UPF consumption was higher for non-Hispanic whites (60.2% of TDEI) or non-Hispanic blacks (60.6% of TDEI) compared to Mexican-Americans (54.8% of TDEI), other Hispanic (52% of TDEI) and other groups (49.6% of TDEI) (Baraldi et al., 2018). However, the difference was only significant ($p<0.05$) between the 'other' ethnicity group and the rest of the study population. While Baraldi et al (2018) provides robust data from a large nationally representative sample across ethnic groups, a limitation is the lack of age group specific analyses, making it challenging to determine differences in ethnic eating patterns among adolescents. More targeted evidence is provided by a recent UK study analysing adolescents aged 11–18 years from the National Diet and Nutrition Survey (2008/09–2018/19), which found that white adolescents had a lower proportion of UPF derived energy compared to their black counterparts (-7.95% (95%CI -9.8;-6.1)) (Chavez-Ugalde et al., 2024). A broader systematic review of nationally representative studies across multiple countries further supports these findings, showing that ethnicity is frequently associated with UPF intake, although the direction and strength of the association varies depending on the country (Dicken et al., 2023).

A cross-sectional study analysing 10 cycles of NHANES data (1999-2018) with 33,795 US youths (ages 2-19) found a significantly greater increase in the percentage of energy from UPFs among non-Hispanic Black and Mexican-American youths compared to non-Hispanic White youths between 1999-2000 and 2017-2018 cycles. For non-Hispanic Black youths, UPF intake increased from 62.2% to 72.5%, for Mexican-American youths from 55.8% to 63.5%, and for non-Hispanic White youths from 63.4% to 68.6%. These differences were statistically significant ($p=0.04$) (Wang et al., 2021).

2.8.4. Geographical location

Food environments in countries often differ between urban and rural areas, and there is conflicting evidence as to whether UPF intake is highest amongst rural or urban populations. One of few studies investigating geographical differences in UPF intake among adolescents took place in Latin America using data collected over the last 15 years. This cross-sectional study used data from national nutrition surveys across six countries including Argentina, Brazil, Chile, Colombia, Costa Rica, and Mexico, involving 19,601 adolescents. Dietary data was collected through either singular 24-hour recalls (Argentina), multiple non-consecutive 24-hour recalls (Brazil, Chile, Colombia, Mexico) or a 3-day food record (Costa Rica). Their findings concluded that adolescents residing in urban areas had greater energy intake from UPFs compared to rural adolescents (29.8% vs. 23.0%, $p<0.001$) (Vargas-Quesada et al., 2025). Although the data used was the most recent national nutrition data available, some surveys date back to 2009 and current dietary habits among adolescents may differ (Vargas-Quesada et al., 2025). Additionally, the classification of adolescents residential areas as urban or rural, was not standardised across studies, as each country applied its own national definitions (Vargas-Quesada et al., 2025).

Moubarac et al (2017), collected dietary data from 33,694 individuals aged >2 years from the 2004 Canadian Community Health Survey, using two 24-hour recalls on non-consecutive days. In contrast to studies in South America, the findings suggest that those living in urban areas had a significantly lower UPF consumption as %TDEI compared to those in rural areas (47.2% vs. 50%, $p<0.001$). However, the use of data from 2004 does not reflect recent changes in the reformulation of foods, the food environment, or changing dietary habits. A further limitation is that, although adolescents were included in data collection and analysis, the rural–urban differences in UPF intake were not stratified by age group, making it unclear whether the observed associations are consistent across different life stages.

Differences in urban vs. rural UPF intake between Canada and South America may exist for several reasons. In Latin America, UPFs are primarily sold in modern supermarkets concentrated in urban areas, while traditional rural retailers stock fewer UPFs (Pan American Health Organisation, 2015). In contrast, Canada has widespread access to modern retailers nationwide, contributing to higher per capita UPF sales (Pan American Health Organisation, 2015; Vandevijvere, Jaacks, et al., 2019). Additionally, traditional dietary patterns remain strong in many rural regions of Latin America. In Brazil, rice and beans, a traditional staple combination, contribute to over one-fifth (22.9%) of TDEI highlighting how such meals may displace UPFs from the diet in rural communities (Louzada, Martins, et al., 2015).

2.8.5. Socioeconomic status

SES is a key determinant of dietary quality and food choice during adolescence, influencing both the accessibility and affordability of UPFs and minimally processed alternatives.

However, the association between SES and UPF intake in adolescents is complex and appears to vary across settings. Chavez-Ugalde et al. (2024) explored UPF intake and associations with sociodemographic factors, including SES, among UK adolescents using dietary data from 2008-2019. Adolescents were placed into one of the following SES groups based on their parent's occupational social class: higher managerial, administrative, and professional, intermediate, or routine and manual. Linear regression analyses showed that adolescents whose parents held intermediate occupations consumed 2.0 percentage points (pp) more energy from UPFs (95%CI 0.38-3.55), and those with parents in routine and manual occupations consumed 4.7 pp more (95%CI 3.21-6.09), compared to adolescents whose parents worked higher managerial roles (Chavez-Ugalde et al., 2024).

Shim et al (2021) investigated the difference in UPF consumption across socioeconomic and subgroups in South Korea from the Korea National Health and Nutrition Examination Survey (KNHANES) between the years of 2010-2018. For each cycle year, approximately 10,000 individuals were included (Kweon et al., 2014). Household income was used as a measure of SES, and represented as low (Q1), middle (Q2-Q3), and high (Q4). Crude analyses showed that as household income level increased so did the mean dietary share of UPFs ($p<0.001$). Those from low, middle, and high income households consumed 21.0, 25.5, and 25.8% of TDEI from UPFs, respectively, however, after adjustment for other sociodemographic variables, there was no statistically significant difference between household income levels ($p=0.174$) (Shim et al., 2021).

Similarly, in Brazil, Bielemann et al (2015) found that individuals who had never experienced poverty reported significantly higher consumption of UPFs compared to those who had always been poor. After adjusting for other sociodemographic variables, the difference in UPF intake was estimated at 5.3 percentage points. These results came from a sample of 4,202 individuals who were a part of the 1982 Pelotas birth cohort, that were followed up in 2004-05. SES was derived using principal component analysis based on household and maternal characteristics (education, ethnicity, and health security at childbirth), and categorised into tertiles based on family income reported in minimum wages. This allowed the classification of participants into SES groups (always poor, never poor, poor → not poor, not poor → poor), reflecting changes in income between childhood and adulthood. Limitations of this study include that dietary data from 2004-05 may not be an accurate reflection of the food environment today. As dietary data was collected using an FFQ, there is a possibility that UPFs were under or overestimated due to lack of detail on food processing and reliance on pre-determined food lists (Bielemann et al., 2015).

Conversely, a large cross-sectional study from the US, utilised NHANES data from 23,847 individuals aged >2 years from 2007-2012 (Baraldi et al., 2018). The 24-hour recall method was used to collect one day of dietary data. Baraldi et al (2018) reported SES using income-to-poverty ratio defined as:

'*the ratio of family or unrelated individual income to their appropriate poverty threshold. Ratios below 1.00 is below the official definition of poverty, while a ratio of 1.00 or greater indicates income above the poverty level'* (U.S Census Bureau, n.d).

In adjusted analyses, individuals with the highest income-to-poverty ratio (>1.50) had a lower proportion of daily energy intake from UPFs (57.7%) compared to those with the lowest income-to-poverty ratio (≤1.30), whose UPF intake contributed 59.9% of daily energy intake. (Baraldi et al., 2018). The difference in intake between the groups was statistically significant ($p<0.05$). A limitation of the above findings is that although adolescents were included within each of the studies, the findings for SES were not stratified for different age groups. Measuring SES differs across studies, highlighting a further limitation of the above comparisons. Different measures included household income levels (Korea), parents' occupational social class (UK), income to poverty ratio (US), whilst in Brazil SES was measured inclusive of several variables and by changes in SES status. These varying definitions and proxies can influence how SES is associated with UPF intake and may partially explain inconsistencies in findings across populations.

Table 7: Studies investigating the association between UPF intake and sociodemographic factors in adolescents (age, sex, ethnicity, socioeconomic status, geographical location, urban/rural)[1]

Country, date of data collection, authors	**Study objectives**	**Population**	**Dietary assessment method**	**Results**	**Other findings/limitations**
Colombia, 2005, (Khandpur et al., 2020)	To analyse the consumption of UPFs in the Colombian population across sociodemographic factors.	National Survey of Nutritional status Colombia individuals aged 2-64 years (n=38,643).	24h recall	*Age* No significant difference in UPF consumption between adolescents (10-19 years) and children (2–9 years). *Sex* Significant difference in UPF consumption between males (15.5% TDEI) and females (16.2%) (p=0.007). *SES* Those with high SES consumed 10.1% more energy from UPFs compared to those with the lowest SES (p<0.001). *Urban/rural* Compared to urban areas those in rural areas consumed 6.1% less of TDEI from UPFs (p<0.001). *Regional differences* Individuals within the Bogota region derived 8.9% more energy from UPFs compared to those in the Atlantic region (p<0.001).	The study included adolescents, but did not stratify by age when investigating sociodemographic differences. Rural residents derived 1.4% of total energy from sugary drinks, compared to urban residents deriving 2.8% of total energy from sugary drinks (p<0.001). Urban residents derived 5.4% of UPF energy from industrialised breads compared to 3.5% in rural residents (p<0.001).
Brazil, 2019, (Gonçalves et al., 2023)	To evaluate the consumption of UPFs by Brazilian adolescents	Adolescents 13-17 years, using data from the Brazilian National	Self-administered online questionnaire.	*Age* Those aged 16-17 were significantly more likely to have consumed crackers (RP=1.055), cookies	Relies on self-administered data from a structured questionnaire.

Country, date of data collection, authors	Study objectives	Population	Dietary assessment method	Results	Other findings/limitations
	enrolled in public and private schools.	Adolescent School-based Health Survey (PeNSE) of 2019 (n=125,123).		(RP=1.020), desserts (RP=1.018), chocolate drinks (RP=1.042), flavoured yoghurts (RP=1.040) on the previous day compared to those less than 13 years (*p*<0.05). *Sex* Females were significantly more likely to consume cookies (RP=1.008), bread (RP=1.020), soft drinks (RP=1.019), chocolate drinks (RP=1.010), sausages (RP=1.010), flavoured yoghurts (RP=1.008) (p<0.05). *Ethnicity* Indigenous ethnicities were significantly more likely to consume industrialised desserts (RP=1.044), and significantly less likely to consume boxed/canned juices (RP=0.981) compared to those of white ethnicities (*p*<0.05). *Region* Those residing in Southern regions were significantly more likely to consume crackers (RP=1.073), margarine (RP=1.103), and less likely to consume sausages (RP=0.933) and industrialised sauces (RP=0.922) compared to those in Northern regions (*p*<0.05). *SES*	Did not measure the quantity of food consumed, but whether a particular UPF was consumed on the previous day. Attending public or private school was used as a proxy measure of SES.

Country, date of data collection, authors	Study objectives	Population	Dietary assessment method	Results	Other findings/limitations
				Students from private schools were significantly more likely to consume crackers (RP=1.044), cookies (RP=1.026), margarine (RP=1.047), and boxed/canned juices (RP=1.064) compared to private school students ($p<0.05$).	
UK, 2008/09-2018/19, (Chavez-Ugalde et al., 2024)	To quantify levels of UPF consumption and investigate consumption patterns in UK adolescents.	Adolescents 11-18y, from the UK National Diet and Nutrition Survey (n=2,991).	4-day food diary	*Age* No significant difference amongst age groups. *Sex* No significant difference. *Ethnicity* Non-white ethnicities consumed 8.0 pp less energy from UPFs compared to white ethnicities. *Region* Adolescents living in England South consumed 3.2 pp less energy from UPFs compared to England North. *SES* Adolescents with parents working routine and manual, and intermediate jobs consume 4.7, and 2.0 pp more energy from UPFs, respectively compared to adolescents with parents working higher managerial, administrative, and professional jobs.	Results from linear regression analysis. For SES, a measure of household income could not be used due to the way data was collected in waves 9-11. Instead, the proxy measure of parent's occupational social class was used instead. NDNS food diaries were not designed to capture UPFs.
USA, 2007-2012, (Baraldi et al., 2018)	To compare UPF consumption across sociodemographic groups	Individuals aged ≥2 years with at least one 24-hour	24h recall	*Age* As age increased, the % of energy from UPFs decreased. Those aged	Cannot conclude whether there is a statistically significant difference among adolescents only due to the lack of statistical

Country, date of data collection, authors	Study objectives	Population	Dietary assessment method	Results	Other findings/limitations
	and over time in the USA.	dietary recall were included (n=23,847). NHANES		>60 years had a significantly lower intake of UPFs (p<0.05). *Sex* No significant difference. *Ethnicity* Those within the 'other' category had a significantly lower intake of UPFs (49.6%, p<0.05) compared to other Hispanic (52.0%), Mexican-Americans (54.8%), non-Hispanic Blacks (60.6%), and non-Hispanic Whites (60.2%). *SES* Those with a higher income-to-poverty ratio (>1.50) consumed less UPFs (57.7%), compared to moderate income (58.7%), and low income (59.6%) (*p*<0.05).	comparison between adjacent age categories (e.g., 2–9 vs. 10–19 years). Cases of classification uncertainty were solved using a conservative approach, opting for the lesser degree of processing or assuming a homemade recipe, which could have led to underestimation of ultra-processed food consumption.
USA, 1999-2018, (Wang et al., 2021)	To characterise trends in the consumption of UPFs among US youths.	Individuals aged 2-19 years from 10 cycles of the National Health and Nutrition Examination Survey (NHANES) from 1999-2000 to 2017-2018 (n=33,795)	24h recall	*Age* UPF intake increased significantly across all age groups from 1999-2018 (*P-trend* < 0.05), with the largest increase in 12-19 year olds (6.89%). *Sex* Both boys and girls showed significant increases in UPF intake (*P-trend* < 0.001), with boys having a higher increase (6.29%) compared to girls (4.71%). *Ethnicity*	

Country, date of data collection, authors	Study objectives	Population	Dietary assessment method	Results	Other findings/limitations
				Significant increases in UPF intake were observed across all racial/ethnic groups (*P-trend* < 0.001), with the highest increase in Non-Hispanic Black children (10.3%). *SES* UPF intake increased significantly with higher family income levels. For families with a ratio <1.30, there was a 6.61% increase (P-trend < 0.001), while those with a ratio of 1.30-2.99 saw a 5.22% increase (P-trend < 0.001), and families with a ratio ≥3.00 showed a 4.18% increase (P-trend < 0.001).	
Mexico, 2012, (Marrón-Ponce et al., 2018)	To identify the energy contributions of NOVA food groups and the associations between sociodemographic characteristics and the energy contribution of UPFs.	Individuals ≥1 year of age, part of the Mexican National Health and Nutrition Survey 2012 (n=10,087).	24h recall	*Age* Adolescents consumed 3.0 pp less energy from UPFs compared to pre-school aged children. *Sex* No significant difference. *SES* Participants with high and middle SES consumed 4.5 pp more energy from UPFs compared to those in low SES. *Region* UPF intake was 8.4 pp higher in Northern and 2.7 pp higher in Central regions compared to Southern regions.	Adolescents classified as 12-19 years. For variables other than age, no stratification based on age groups so difficult to establish association between adolescent age group and sociodemographic variables.

Country, date of data collection, authors	Study objectives	Population	Dietary assessment method	Results	Other findings/limitations
				Urban/rural Compared to rural areas, urban participants consumed 5.6 pp more energy from UPFs.	
Canada, 2015, (Polsky et al., 2024)	To characterise consumption of UPFs and drinks across a range of socio-demographic characteristics.	Individuals aged >2 years, who completed the 2015 Canadian Community Health Survey–Nutrition (n=20,103)	Interviewer administered 24h recall, with 30% of participants completing a second recall 3-10 days later.	*Age* UPF intake was 4.1 pp higher in 13–18-year-olds, and 5.3 pp higher in 6–12-year-olds compared to 2–5-year-olds ($p<0.001$). *Sex* Females consumed 1.7pp less energy from UPFs compared to males ($p<0.001$). *SES* Participants within the highest quintile of income, consumed 5.8pp more energy from UPFs compared to those in the lowest quintile ($p<0.01$). *Region* Compared to the Atlantic region, UPF intake was lower by 6.1 pp in British Columbia, 4.1 pp in Ontario, 2.9 pp in the Prairie provinces, and 2.8 pp in Quebec ($p<0.001$).	The study included adolescents, but did not stratify by age when investigating sociodemographic differences.
Canada, 2004, (Moubarac et al., 2017)	To describe UPF food consumption patterns and investigate the association with the nutrient profile of the diet.	Individuals aged ≥2 years from the 2004 Canadian Community Health Survey (n=33,694).	24h recall	*Age* UPF intake decreased as age increased ($p<0.001$). *Sex*	Data collected in 2004, may not reflect the food environment today. It is possible that some ready to eat dishes not consumed in a fast-food place (eg. frozen lasagna) were treated as culinary

Country, date of data collection, authors	Study objectives	Population	Dietary assessment method	Results	Other findings/limitations
				Men consumed 48.6% TDEI from UPFs compared to 46.5% for women (p<0.001). *Rural/urban* Urban residents had a lower proportion of energy intake from UPFs (47.2%) compared to rural residents (50%) (p<0.001). *SES* No significant association.	preparations, with potential to underestimate UPF intake.
South Korea, 2010-2018, (Shim et al., 2021)	To investigate whether UPF consumption differed across socioeconomic subgroups and over time (2010–2018).	Data from the Korea National Health and Nutrition Examination Survey 2010–2018. Number of participants not specified.	Interviewer administered 24-h recall.	*Age* No significant association. *Sex* Males consumed 25.8% of energy from UPFs compared to 25% for females (p<0.05). *Urban/rural* Rural residents consumed 25% of energy from UPFs compared to 25.8% for urban residents (p<0.05). *SES* No significant association.	The study included adolescents, but did not stratify by age when investigating sociodemographic differences. Cannot conclude whether there is a statistically significant difference between groups due to the lack of statistical comparison between adjacent age categories (e.g., 2–9 vs. 10–19 years).
Chile, 2010, (Cediel et al., 2018)	To assess the consumption of UPFs and its association with the content of added sugars in the Chilean diet.	Individuals ≥2 years, studied in 2010 by a national dietary survey (Encuesta Nacional de Consumo	24-h recall	*Age* As age increased, dietary share of UPFs decreased (p<0.05 for linear trend). Highest consumption was observed in the children and adolescents' group 38.6% of TDEI. *Sex*	Child-adolescents group 2-19 years. The study included adolescents, but did not stratify by age when investigating sociodemographic differences.

Country, date of data collection, authors	Study objectives	Population	Dietary assessment method	Results	Other findings/limitations
		Alimentario) (n=4,920)		No significant difference. *SES* As the household number of minimum wages increased, the dietary share of UPFs increased (p<0.001 for linear trend). Intake increased from 25.8% in the lowest income to 30.1% in the highest income. *Rural/urban* Residents in urban areas consumed 29.3% of energy from UPFs compared to rural residents who consumed 23.7% (p<0.05). *Region* The highest UPF intake was in the Metropolitan region (30.2%) and lower intake in the South (26.7%), North (27.5%), Centre (28.5%), and South Austral (27.3%) regions (p < 0.05).	
Australia, 2010-2013 and 2018-2019, (Clark et al., 2025)	To describe school children's intake of UPF across sexes, age, geographic location and SES. To analyse associations between UPF intake and indicators of obesity.	Primary school children aged ≥8 years, part of the SONIC study in Victoria (n=682)	Interviewer administrated 24-h recall (2010-2013), web based 24-h recall (2018-2019)	*Age* No significant difference. *Sex* No significant difference. *Geographic location* No significant difference.	This study included children aged 8-9 years, prior to the adolescent age window. Children dervied 47.2% of TDEI from UPFs.

[1]All of these studies used the NOVA classification to identify UPFs. **Abbreviations:** TDEI = total daily energy intake, UPF = ultra-processed food, PP = percentage points, RP = prevalence ratio

2.9. Conclusion

In conclusion, this chapter has described that UPFs are foods that have undergone industrial processing, formulating products that are of low nutrient density, are convenient, palatable, and appealing to consumers. UPFs are characterised by their high fat, sugar, and salt profile and are readily available in markets globally. Research has shown that when consumed in high amounts, UPFs impact diet quality, cardiovascular health, and obesity in adolescent populations. Over time and across nations the dietary share of UPFs has increased, and the association between sociodemogrpahic factors and UPF intake has been investigated mostly in adult populations. UPF intake may be associated with sex, ethnicity, age, SES, and geographical location, yet mixed evidence exists. Although NOVA is the most widely used food processing categorisation system, limitations such as misclassification of foods, a lack of consenses surrounding 'ultra-processing', and whether the processing itself links UPFs and disease states across populations exists. Investigating UPF consumption and associations with sociodemographic factors in NZ adolescents will form an essential part of creating targeted public health policies surrounding food environments and regional access of UPFs in NZ.

Chapter 3: Research manuscript

Ultra-processed food intake, sources and associations with sociodemographic factors in New Zealand adolescents.

Abstract

Background

Adolescence is a critical period for establishing dietary patterns that can influence long term health outcomes. Ultra-processed foods (UPFs) are becoming increasingly prevalent within the modern diet, with research establishing the negative impacts of UPFs on several health markers and outcomes across populations. Understanding how UPF intake varies by sociodemographic characteristics is essential for informing policies and shaping food environments that support healthier choices. However, current data on UPF intake and sociodemographic factors amongst New Zealand (NZ) adolescents does not exist.

Aims and objectives

This research aimed to investigate UPF intake and sources of UPFs in NZ adolescents and associations with sociodemographic factors including sex, age, school region, school area, and school lunch programme eligibility.

Methods

The data for this research was obtained through the Te Rourou Kai o Ngā Rangatahi: Eating Patterns of Young People in NZ study. This cross-sectional study gathered data from 631 adolescents in Years 7-13 (aged between 11-19 years) in the Auckland, Waikato and Bay of Plenty (BOP) regions of NZ. Dietary data was collected through the Intake24 electronic software, using the multiple pass method, and demographic information was collected via an online questionnaire. Dietary outputs were linked to the NZ Food Composition Database and categorised into the four levels of NOVA processing groups. UPFs were further categorised into food groups to determine the top contributors to overall UPF intake. UPF intake results were expressed as mean ± standard deviation (SD), and as number (percentage) for food group contributors. Statistical significance was tested using independent samples t-tests, one

way ANOVA, and the Tukey’s post hoc test to determine associations between UPF intake as (%TDEI) and sociodemographic factors.

Results

Participants (n=631) had a mean UPF intake of 892 ± 766 g/day, 5435 ± 3592 kJ/day, contributing to 62.5 ± 25.3% of TDEI. The top food group contributors to UPF energy were fast foods/takeaways (12.2 ± 19.9%), bread and bread products (7.9 ± 12.2%), and biscuits, cakes, desserts (7.5 ±12.2%). UPF intake (%TDEI) was higher among females compared to males (64.4% vs. 58.1% of TDEI, p=0.01), participants in the Waikato region vs. Auckland (68.2% vs. 60.2%, p=0.008), and participants from medium and small areas compared to major and large urban areas (67.2% vs. 61.3%, p=0.0043). Those eligible for the school lunch programme consumed less energy from UPFs compared to those ineligible (60.0% vs. 65.6%, p=0.005).

Conclusion

UPFs contribute a high proportion of energy to adolescent’s TDEI in NZ. Fast foods/takeaways, bread and bread products, and biscuits, cakes, and desserts are the largest food group contributors to total UPF intake. Our findings suggest that female adolescents, those living in the Waikato region, and residing in any size urban area consumed significantly more energy from UPFs. Further research is required using multiple 24-hour recalls to account for habitual intake as well as investigating the influence of food environments, food marketing and regional access on UPF consumption in NZ adolescents.

3.1. Introduction

Rapid growth and development are critical markers during the period of adolescence, defined as the ages between 10-19 years (Norris et al., 2022; Patton et al., 2016). Dietary requirements during this time are heightened to facilitate the maturation of organs and physiological systems (Norris et al., 2022). Changes in linear growth, body composition, neurodevelopment, and cognitive ability all take place during this time (Norris et al., 2022). The establishment of healthy dietary and lifestyle behaviours are crucial during this phase as habits developed in adolescence can persist into adulthood (Viner et al., 2015). Despite the need for adequate nutrition, adolescents often exhibit poor dietary patterns, frequently characterised by low intakes of fruits, vegetables, and whole grains, and high intakes of energy-dense, nutrient-poor foods (Neri, Steele, et al., 2022; Rosi et al., 2019). Ensuring appropriate nutrition during this life stage is essential for supporting optimal growth and prevention of chronic diseases (Patton et al., 2016).

Food processing has long played a role in improving food safety and palatability (Welch & Mitchell, 2000). Processing practices have intensified over time giving rise to new food products created from industrial processing techniques and ingredients (Monteiro, 2009). Since its development in 2009, the food classification system NOVA, has been redefined to include four possible levels of processing for all food products (Monteiro, 2009; Monteiro et al., 2018). According to NOVA, UPFs can be defined as formulations of mostly exclusive industrial ingredients that have undergone extensive processing (Monteiro et al., 2019). Hydrogenated oils, corn syrups, hydrolysed proteins, sweeteners, and colours are a few of the ingredients often added throughout the stages of processing of UPFs (Monteiro et al., 2019). Examples of UPFs include sweet and savoury packaged snacks, carbonated drinks, packaged breads and pastries, sweets, reconstituted meat products, and ready-to-eat meals (Monteiro, 2019). Globally, UPF consumption has increased markedly, particularly among children and adolescents (Baraldi et al., 2018; Colombet et al., 2022; Smith et al., 2024). As these foods become increasingly available, affordable, and heavily marketed, they displace minimally processed, nutrient-rich foods in young people’s diets, contributing to excess energy, sodium, and free sugar intake, poor diet quality, obesity, and poor cardiovascular health (Neri, Martínez-Steele, et al., 2022; Neri et al., 2019; Neri, Steele, et al., 2022; Petridi et al., 2023).

International evidence suggests that UPF intake differs amongst sociodemographic groups. Sex, age, ethnicity, geographical location, and socioeconomic status are associated with differences in UPF consumption, although the strength and direction of association varies between countries (Dicken et al., 2023). Amongst adolescents, higher UPF intakes have been reported for those living in urban areas (Khandpur et al., 2020). However, findings for other variables are mixed. Some studies report higher consumption among boys, older adolescents, and certain ethnic groups, while others find minimal or inconsistent differences (Chavez-Ugalde et al., 2024; Gonçalves et al., 2023; Wang et al., 2021). These inconsistencies highlight the need for further investigations into UPF intake amongst adolescents in specific national contexts.

Previous child and adult nutrition surveys have assessed the intake of some UPFs in NZ adolescents. They revealed that children and adolescents frequently consume fast foods, carbonated drinks, processed meats, sweet and savoury baked items, confectionary, and convenience foods (Ministry of Health, 2003, 2022a; University of Otago and Ministry of Health, 2011). However, these surveys did not use the NOVA system to categorise UPFs, are outdated, and do not explore the contribution of UPFs towards energy intake or associations with sociodemographic factors. Additionally, a previous NZ supermarket analysis suggested that over 80% of packaged foods available on shelves nationwide were classified as UPFs (Luiten et al., 2016). These findings highlight the dominance of UPFs within the NZ food environment.

This study aims to describe UPF intake, food sources and associations with sociodemographic factors (age, sex, region, school area, school lunch programme eligibility) amongst adolescents in Years 7-13 (aged between 11-19 years) within the Auckland, Waikato, and BOP regions in NZ. The findings obtained from this study can be used to inform future public health and policy initiatives surrounding UPF consumption in NZ adolescents and the surrounding food environment.

3.2. Methods

3.2.1. Study design

The data for this study was collected through *Te Rourou Kai o Ngā Rangatahi* a study of the Eating Patterns of Young People in NZ. This study employed a cross sectional design, recruiting NZ adolescents, in Years 7-13 (aged between 11-19 years) from schools across the Auckland, Waikato, and BOP regions between April and September 2024. Data collected included all food and drink items consumed throughout a 24-hour period, and demographic information via an online questionnaire.

Ethical approval was granted by the Massey University Human Ethics Ohu Matatika 1, Application OM1 23/55. The funding for this research was provided by The New Zealand Heart Foundation.

3.3. Participants and recruitment process

3.3.1. School recruitment

Schools with students of Years 7-13 were recruited through convenience sampling in School Terms 2 and 3 of 2024. A total of 322 schools throughout the Auckland, Waikato, and BOP regions were contacted by phone and/or email to invite them into the study. A formal follow-up email was sent to those schools who were interested in further information, providing each school with an information sheet and invitation to join the study.

3.3.2. Participant recruitment

To be eligible for inclusion in the study, participants had to be between Years 7-13 at school and proficient in English. Participants over the age of 16 were recruited on the day of data collection. Those that were interested in being included in the study were asked to read and sign the electronic information sheet and consent forms. For participants under 16 years old, an information sheet and electronic consent form was emailed to their caregivers to complete prior to data collection. Once participants were recruited, they were allocated a unique number code that deidentified their personal information. This unique code was used to link answers from the demographic questionnaire and Intake24. As a *koha* (thank you), each school was offered a $300 voucher for participation.

3.4. Data collection

3.4.1. Sociodemographic information

To collect demographic data, an online survey was administered to gather participant information including sex, age, school year level, and ethnicity. The questionnaire was developed specifically for the NZ context using information from the national census (Stats NZ, 2022). For ethnicity and sex, if the preferred answer was not listed, an 'other' option with a free entry text box was provided for participants to specify.

Participants were able to identify with multiple ethnicities. Ethnic prioritisation was applied so each participant's main ethnicity could be reported. The ranking for the prioritised ethnicities were as follows Māori, Pacific, Asian, Middle Eastern, Latin American, African (MELAA), other ethnicity and NZ European (Education Counts, 2024). For this study, ethical approval was not granted to analyse UPF intake across ethnic groups.

School lunch programme eligibility was used as a proxy indicator of socioeconomic equity, as eligibility for the programme is determined by the NZ Ministry of Education's School Equity Index (SEI). SEI is a statistical model that estimates the extent to which students face socio-economic barriers to achievement at school, developed by Statistics NZ and the Ministry of Education (Ministry of Education, 2023). The SEI uses 37 variables, all uniquely weighted, to calculate an index value for each school. Each variable falls within one of the four broad categories: parental socio-economic indicators, child socio-economic indicators, national background, and transience. A higher SEI value indicates that a school is likely to have students that face greater socio-economic barriers relative to other schools. The number is used for funding purposes as well as school lunch programme eligibility (Ministry of Education, 2022, 2023).

School area was determined according to the Statistics NZ 2023 Urban Rural Geographic Data Service Category and schools were classified as either major and large urban; medium and small urban; or rural settlement (Statistics New Zealand, 2023). School region was also categorised as either Auckland, BOP, or Waikato according to the education regions provided by the Ministry of Education (Education Counts, 2025).

3.4.2. Dietary data

Dietary data was collected through electronic multiple-pass 24-hour recall surveys using the Intake24 software, adapted for use in NZ. Intake24 was initially developed in the United Kingdom (UK), and has since been used in various countries to collect dietary data (Bhagtani et al., 2025; Bradley et al., 2016; Rowland et al., 2018). Prior to use in this study, the Intake24 software was adapted to be more relevant for the NZ population (Ni Mhurchu et al., 2023). The final food list, containing 2,621 locally common food items and brands, including traditional Māori, Pacific, and Asian dishes was compiled from the NZ Food Composition Database (NZFCD) and international databases (Australia, UK, USA) (Ni Mhurchu et al., 2023). New nutrient lines were developed through analysis where no existing data were available (Ni Mhurchu et al., 2023). Each food entered is automatically linked to a nutrient line, providing the amount of 62 different core components of the food, including macronutrients, micronutrients, and additional components such as caffeine (Food Standards Australia New Zealand, 2022a; Ni Mhurchu et al., 2023; Plant and Food Research, 2024).

Researchers asked each participant to recall all the food and drink consumed in the previous 24 hours (from 12am to 12am) on iPads provided on-site within a classroom. Utilising the multiple pass method, the first pass prompted participants to enter all food and drink consumed in the previous day, as well as time of consumption using free text entry. For the second pass, their written answers were then matched to items in the database where the participant chose the closest match to the items they consumed from a list. Portion size was then estimated using visual guides and images of food items or serving utensils. Prompts were offered throughout completion of the recall to gather commonly missed information such as fluids, condiments, snacks between meals, or foods commonly paired with those already selected. In the final pass, participants were asked to review all food and drink entries for each meal and snack to ensure nothing was missed prior to submission. All participants were asked to complete the recall in one sitting, without a set time limit. Researchers were on site in the classroom to help participants use the software and to answer any questions.

3.4.3. Identification of ultra-processed foods, drinks and food groups

The NOVA food classification system (Monteiro, 2019) was used to classify all food items entered in Intake24 into one of the four levels of food processing. Two research members independently classified each food into one of the four processing groups. A third researcher conducted a 5% review of all classifications. For foods without consensus, a fourth researcher (Professor in Human Nutrition and Dietetics) made the final decision. For mixed meal dishes that were entered on Intake24 (e.g. Lasagne), each ingredient was categorised into one level of processing, ingredients were given a weighted share of each recipe. Recipes were sourced from the AUSNUT recipe files and New Zealand Food Composition files (Food Standards Australia New Zealand, 2014; Plant and Food Research, 2024). For some industrially prepared mixed dishes (e.g. store-bought family pies or ready-made pasta dishes), ingredient-level data were not available, and therefore disaggregation was not possible. The four possible categories included; 1. Unprocessed and minimally processed foods, 2. Processed culinary ingredients, 3. Processed foods, and 4. Ultra-processed foods. Foods belonging to the UPF category include, but are not limited to, fast foods, soft drinks, fruit juice, sweet and savoury packaged snacks, breakfast cereals, bread products, chocolates and sweets (Monteiro et al., 2019; Monteiro, 2019). All food items classified as UPFs were assigned into one of 18 specific food groups and analysed to determine which groups contributed the greatest proportion of TDEI.

3.5. Data handling

All foods entered on the Intake24 software were linked to excel spreadsheets which reported the level of processing for each food and ingredient item, the amount in grams of each food item/ingredient consumed (g), and energy contribution (kJ). For each participant the grams and energy of each UPF consumed were summed to give a total daily UPF consumption in grams per day (g/d) and kJ per day (kJ/d). UPF consumption as a percentage of total daily energy intake (%TDEI) was calculated by dividing each participants total energy intake from UPFs (kJ) by their total daily energy intake (kJ) and multiplying by 100 to express as a percentage.

24-hour dietary recalls that reported energy intakes below 2,100 kJ (500 kcal) or above 21,000 kJ (5000 kcal) were excluded from analysis (Banna et al., 2017; Willett, 2012b).

3.6. Statistical Analysis

Given the large sample size (n=631), the Central Limit Theorem was applied, and the mean was assumed to be normally distributed for all statistical tests (Field, 2024). Continuous data were expressed as mean and standard deviations. All categorical data were expressed as percentages. Per-capita intakes were calculated by including all participants, regardless of consumption on the recall day, and the proportion of consumers (% consumers) was also estimated for each UPF food group. Differences in mean UPF intake across sociodemographic factors were assessed using one-way ANOVA or independent t-tests. Tukey's Honest Significant Difference (HSD) test was used for post hoc comparisons. Statistical significance was set at $p<0.05$.

3.7. Results

3.8. Participant demographics

Prior to data analysis 67 participants were excluded from the sample due to implausible energy intakes. The final analysis included 631 participants from 16 schools aged 11–19 years, of which 394 were female, 170 were male (Table 1). Regionally, most participants attended school in Auckland (43.4%), with the remainder from BOP (33.1%) and Waikato (20.1%). Regarding school area, most participants attended schools located in major or large urban areas (71.3%), followed by medium urban and small urban areas (22.5%) then rural areas (2.9%). Over half (54.0%) attended schools eligible for the government-funded school lunch programme. Sociodemographic variables did contain some missing data due to some participant's non-response.

Table 1: Participant characteristics

Variable[3]	Total n (%)[1]	Male n (%)[1]	Female n (%)[1]
Sex			
Female	394 (62.5)		
Male	170 (26.9)	170 (26.9)	394 (62.5)
Age			
<16 years of age	128 (20.3)	23 (13.5)	105 (26.6)
≥16 years of age	437 (69.3)	147 (86.5)	289 (73.4)
Ethnicity			
Māori	179 (28.4)	59 (34.9)	119 (30.6)
Pacific	111 (17.6)	50 (29.6)	61 (15.7)
European	181 (28.8)	34 (20.1)	147 (37.8)
Asian	79 (12.6)	24 (14.2)	55 (14.1)
MELAA	9 (1.4)	2 (1.2)	7 (1.8)
Other	1 (0.2)	1 (0.1)	0 (0)
School region			
Auckland	274 (43.4)	88 (51.8)	161 (40.9)
Waikato	127 (20.1)	40 (23.5)	80 (20.3)
Bay of Plenty	209 (33.1)	42 (24.7)	153 (38.8)
School area			
Major and large urban	450 (71.3)	111 (65.3)	300 (76.1)
Medium and small urban	142 (22.5)	51 (30.0)	84 (21.3)
Rural	18 (2.9)	8 (4.7)	10 (2.5)
School lunch programme eligibility[2]			
Yes	339 (54.0)	147 (86.5)	161 (40.9)
No	271 (43.0)	23 (13.5)	233 (59.1)
Total participants	**631**	**170**	**394**

[1]Due to rounding, percentages may not total exactly 100%.
[2]Inclusion in the NZ school lunch programme (Ka Ora, Ka Ako) was used as a proxy indicator of socioeconomic equity. Schools eligible for this programme were identified as having higher levels of socioeconomic need, based on the NZ School Equity Index (SEI).
[3]Missing data as follows: Sex (n=67), Age (n=66), Ethnicity (n=71), School region (n=21), School area (n=21), School lunch programme eligibility (n=21)

Abbreviations: MELAA = Middle Eastern, Latin American and African

3.9. UPF intake among New Zealand adolescents

Table 2 provides an overview of the mean intake of each NOVA processing group, expressed as grams per day, kJ per day, and as a percentage of TDEI. Adolescents consumed the greatest quantity of food from unprocessed or minimally processed foods (Group 1), with a mean intake of 2279 ± 1715 g/d. This was followed by UPFs (Group 4), with a mean intake of 892 ± 766 g/d. Processed foods (Group 3) and processed culinary ingredients (Group 2) had a mean intake of 89 ± 120g/d and 10 ± 24g/d, respectively.

UPFs provided the greatest amount of energy, with a mean intake of 5435 ± 3592 kJ/d. Unprocessed or minimally processed foods contributed 2271 ± 2342 kJ/d, despite being consumed in greater quantities. Processed foods contributed 677 ± 931 kJ/d, and processed culinary ingredients provided 251 ± 474 kJ/d.

UPFs accounted for the majority of daily energy intake at 62.5 ± 25.3%. In contrast, unprocessed or minimally processed foods made up 26.3 ± 21.5% of daily energy intake, followed by processed foods at 8.2 ± 10.7%, and processed culinary ingredients at 3.0% ± 6.7%.

Table 2: Intake of NOVA food groups among adolescents

NOVA group[1]	Grams/day	kJ/day	% total daily energy intake
Group 1: Unprocessed or minimally processed foods	2279±1715	2271±2342	26.3±21.5
Group 2: Processed culinary ingredients	10+24	251±474	3.0±6.7
Group 3: Processed foods	89±120	677±931	8.2±10.7
Group 4: Ultra-processed foods	892±766	5435±3592	62.5±25.3

[1]Values are expressed as mean±SD

Abbreviations: kJ = kilojoules.

3.10. Sources of UPFs among New Zealand adolescents

Table 3 displays the intake of different UPF food groups amongst adolescents, presented as the number of consumers (%), grams per day, kilojoules per day, and expressed as a percentage of TDEI. All food sources included in the UPF subgroupings are listed in **Appendix A**. Fast foods and takeaways were the greatest contributor to TDEI, contributing a mean of 1058 ± 1814 kJ/day, accounting for 12.2 ± 19.9% of total energy intake. Other substantial contributors included breads and bread products (671 ± 1181 kJ/day; 7.9% ± 12.2%) and biscuits, cakes, pancakes, and desserts (690 ± 1271 kJ/day; 7.5% ± 12.2%).

Snack foods such as chips, crackers, nuts and other salty snacks contributed 5.2 ± 10.6% of total energy, while meat and meat products accounted for 4.3 ± 9.3% of energy intake. Carbonated drinks (3.5 ± 7.4%) and milk or milk-based drinks (3.0 ± 7.7%) contributed the greatest proportion of energy from beverages.

Table 3: Intake of UPF food groups among adolescents[1]

UPF food group[2]	Consumers n (%)	Grams/day	kJ/day	%TDEI
Biscuits, cakes, pancakes, desserts	277 (44)	53±94	690±1271	7.5±12.2
Breads and bread products	303 (48)	59±98	671±1181	7.9±12.2
Breakfast cereals	150 (24)	17±40	251±543	2.9±6.8
Carbonated drinks	183 (29)	226±482	299±673	3.5±7.4
Cheese and cheese products	25 (4)	1±5.6	11±63	0.14±0.84
Chips, crackers, nuts and other salty snacks	233 (37)	25±55	482±1071	5.2±10.6
Chocolate and confectionary	111 (18)	14±52	256±939	2.7±8.9
Fast foods/takeaways	251 (40)	102±177	1058±1814	12.2±19.9
Grains, pasta, noodles	67 (11)	28±95	181±604	2.3±7.7
Meat alternatives	2 (0.3)	0.4±7	3±63	0.06±1.2
Meat and meat products	177 (28)	40±93	364±934	4.3±9.3
Milk, milk alternatives, milk drinks	154 (24)	80±205	241±604	3.0±7.7
Mixed dishes[3]	250 (40)	41±111	234±731	2.7±8.1
Non-carbonated drinks	128 (20)	143±402	205±598	2.4±6.7
Other[4]	167 (27)	16±38	206±436	2.7±6.3
Spreads and sauces	292 (46)	20±47	160±364	1.8±3.5
Tea, coffee, hot chocolate	40 (6)	23±100	52±242	0.6±2.7
Vegetable products[5]	33 (5)	7±39	48±284	0.6±3.3

[1]Food groupings adapted from Khandpur N et al., 2019; Juul F et al., 2018; Wang L et al., 2021.
[2]Values are expressed as mean±SD
[3]Includes canned spaghetti, ready-made curry, sachet soup, ready-made roast meal, family size pie
[4]Includes alcohol, baking ingredients, canned, frozen, dried fruits, baked beans, muesli bars, bliss balls.
[5]Includes jarred olives, battered onion rings, frozen potato fries, hashbrowns

Abbreviations: UPF = ultra-processed food, kJ = kilojoules, TDEI = total daily energy intake.

3.11. UPF intake and sociodemographic factors

Table 4 presents the mean daily intake of UPFs amongst adolescents, stratified by sociodemographic factors, expressed in grams, kilojoules, and as %TDEI. Males consumed more UPFs by weight (1027 ± 933 g/d) and energy (5657 ± 3846 kJ/d), whereas females had a significantly higher proportion of total daily energy derived from UPFs (64.4 ± 24.2%) compared to males (58.1 ± 27.4%) (p=0.01). No significant differences in UPF intake were observed for age group (p=0.18).

UPF intake differed significantly by school region (p=0.01), with Waikato participants reporting the highest percentage of energy intake from UPFs (68.2%), followed by BOP (62.1%) and Auckland (60.2%). Differences were also observed by school area (p=0.03), with participants in medium and small urban areas reporting the highest UPF intake (67.2%). Those from major and large urban areas consumed 5.9 percentage points (pp) less energy from UPFs compared to those residing in medium and small urban areas (p=0.04). Participants attending schools eligible for the lunch programme consumed less energy from UPFs compared to participants from schools that were not eligible for the programme (60.0% vs. 65.6%) (p=0.005).

Table 4: UPF intake by sociodemographic characteristics of adolescents

Sociodemographic factor[1]	**UPF intake grams/day**	**UPF intake kJ/day**	**UPF intake % total energy**	**P-value**[4]
Sex				0.01*
Male	1027+933	5657±3846	58.1±27.4	
Female	818+644	5276±3326	64.4±24.2	
Age group				0.18
<16	748±546	5398±2997	64.9±22.2	
≥16	922±794	5388±3642	61.8±26.1	
School region				0.012*
Auckland	921±856	5189±3751	60.2±27.8	
Waikato[2]	984±820	5715±3741	68.2±23.0	
Bay of Plenty	807±604	5591±3263	62.1±25.4	
School area				0.03*
Major and large urban[3]	865±746	5427±3564	61.3±25.6	
Medium and small urban	977±822	5496±3667	67.2±23.6	
Rural	1009±978	5202±3821	55.9±30.1	
School lunch programme eligibility				0.005*
Yes	954±881	5151±3671	60.0±27.2	
No	822±605	5791±3461	65.6±22.5	

[1]All values expressed as mean±SD
[2]Participants from Waikato consumed significantly more energy from UPFs compared to Auckland participants ($p = 0.008$).
[3]Participants residing in major and large urban areas consumed significantly less energy from UPFs compared to those in medium and small urban areas (p=0.043).
[4]P-values correspond to UPF intake expressed as a % of total daily energy intake (%TDEI) only.

Notes: Differences between groups were tested using independent t-tests and one way ANOVA. Post hoc comparisons using Tukey's HSD adjustment after ANOVA.

Abbreviations: UPF = ultra-processed food, kJ = kilojoules.

3.12. UPF food group intake according to sociodemographic factors

Supplementary Table 1 presents the mean UPF food group intake stratified by sociodemographic factors, expressed as a percentage of total daily energy intake (TDEI), while **Table 5** displays the top 5 food group contributors to UPF intake. Food groups with significant differences between sociodemographic factors are displayed in **Supplementary Figure 2 (A-E).** Sex differences were observed for several food group contributors. Males had significantly lower contribution to UPF energy from consumption of biscuits, cakes, and desserts (5.8 vs. 8.8%, p=0.01) as well as chips, crackers, nuts, and other salty snacks (3.3 vs. 6.1%, p=0.02) compared to their female counterparts. Conversely, UPF energy contribution from carbonated drinks was higher among males than females (4.7 vs. 2.9%, p=0.01).

Participants <16 years consumed significantly more UPF energy from bread and bread products (12.0% vs 6.5%, p<0.001), and chips, crackers, nuts, and other salty snacks (8.2% vs. 4.4%, p=0.003) and less UPF energy from carbonated drinks (2.1% vs. 3.9%, p=0.002) in comparison to those aged 16 years and above.

Participants in the BOP consumed significantly more UPF energy from bread and bread products (10.7% vs. 5.7%, p<0.001), and other foods (3.7% vs. 2.3%, p=0.03), whilst consuming less from fast foods and takeaways (9.2% vs 14.2%, p=0.02) when compared to Auckland participants. Participants from the Waikato region had a significantly greater contribution to UPF energy from carbonated drinks (4.6% vs. 2.5%, p=0.03) and significantly lower contribution from other foods (1.7% vs. 3.7%, p=0.008) compared to those in the BOP region.

Participants residing in rural areas had a significantly greater UPF energy intake from bread and bread products compared to major and large urban areas (19.8 vs. 7.5%, p<0.001) and compared to small and medium urban areas (19.8 vs. 7.6%, p<0.001). Grains, pasta, and noodles also contributed to greater amounts of UPF energy in rural participants compared to major and large urban areas (8.3 vs. 2.2%, p=0.003) and compared to small and medium urban areas (8.3 vs. 2.0%, p=0.003).

Table 5: Top 5 food group contributors to UPF intake as a percentage of total daily energy intake

Indicators	Bread and bread products (%)	Biscuits, cakes, desserts (%)	Chips, crackers, nuts, salty snacks (%)	Fast foods/takeaways (%)	Carbonated drinks (%)
Sex					
Male	7.0±12.1	5.8±12.6[2]	3.3±9.1	11.3±20.5	4.7±9.0[1]
Female	8.1±12.0	8.8±12.5	6.1±11.0[1]	12.6±20.0	2.9±6.3
Age					
<16	12.0±14.0[2]	9.6±12.0	8.2±13.1[2]	9.6±18.8	2.1±4.7[1]
≥16	6.5±11.0	7.4±12.7	4.4±9.4	13.0±20.1	3.9±8.1
School region					
Auckland	5.7±10.4	7.0±12.8	5.1±10.6	14.2±22.0[1]	3.9±7.7
Waikato	7.8±11.4	7.3±10.7	4.6±11.0	13.5±21.0	4.6±8.2
Bay of Plenty[3]	10.7±14.2[1]	8.4±12.8	5.6±10.1	9.2±16.2	2.5±6.7[1]
School area					
Major and large urban	7.5±11.5	7.8±12.8	0.1±0.8	12.1±20.0	3.3±7.1
Medium and small urban	7.6±11.4	7.6±11.4	0.2±0.9	14.0±22.1	4.7±8.8
Rural[4]	19.8±22.2[1]	1.1±2.7	0.5±1.6	4.2±10.1	1.4±2.7
School lunch programme eligibility					
Yes	6.9±12.6	6.6±12.1	4.3±10.2	13.7±22.0	4.0±7.9
No	9.1±11.6	8.8±12.6	6.2±10.8	10.6±17.1	2.9±7.0

[1]($p \leq 0.05$). [2]($p \leq 0.01$).

[3]BOP participants consumed significantly more bread and bread products ($p<0.001$) to Auckland, and significantly less fast food/takeaways ($p=0.017$). BOP participants consumed significantly less carbonated drinks ($p=0.034$) compared to Waikato participants.

[4]Rural participants consumed significantly more bread and bread products than medium and small urban participants ($p<0.001$).

Notes: Values are expressed as mean±SD. Differences between groups were tested using independent t-tests and one way ANOVA. Post hoc comparisons using Tukeys HSD adjustment after ANOVA.

Abbreviations: UPF = ultra-processed food.

3.13. Discussion

3.14. Key findings

This study aimed to describe UPF intake, food sources and investigate associations with sociodemographic factors among adolescents in NZ. The mean UPF intake was 62.5% of TDEI, with the greatest subgroup contributors being fast foods and takeaways (12.2%), bread and bread products (7.9%), and biscuits, cakes, and desserts (7.5%). Participants that consumed significantly more UPFs were those that identified as female (64.4% of total daily energy intake), lived in the Waikato region (68.2%), resided in medium and small urban areas (67.2%), and those not eligible for the school lunch programme (65.6%). Differences also existed in UPF subgroup intake across sociodemographic variables.

3.15. UPF intake of adolescents

This study found that the mean UPF intake across the sample was 892±766 g/d, 5435±3592 kJ/d, amounting to 62.5±25.3% of TDEI. These findings align with international research from the UK, USA, Canada, and Mexico which has also shown that adolescents UPF intake typically exceeds 50% of TDEI (Baraldi et al., 2018; Chavez-Ugalde et al., 2024; Moubarac et al., 2017; Rauber et al., 2019). In the USA, Wang et al. (2021) investigated the trends in UPF consumption increased amongst adolescents from 61.4 to 67.0% between 1999-2018. However, not all countries have a contribution of UPFs within the adolescent diet of this magnitude. Findings from South America, Taiwan, and Belgium, suggest that UPFs account for less than 40% of TDEI, with some estimates as low as 18% (Chen et al., 2018; Khandpur et al., 2020; Vandevijvere, De Ridder, et al., 2019). These findings likely reflect differences in international food environments and availability of UPFs within these contexts.

While not investigated, several interrelated factors may be contributing to the high UPF intakes found within this study including accessibility, affordability, convenience, adolescent taste preferences and cooking skill. UPFs are often more affordable than unprocessed and minimally processed alternatives and are frequently used as a cost-effective means by families to meet energy requirements, despite their lower nutritional quality (Gupta et al., 2019). In NZ, the price of whole foods tends to fluctuate seasonally, whereas UPFs exhibit greater price stability. This relative consistency in cost may further incentivise the purchase and consumption of UPFs (Mackay et al., 2019). Additionally, NZ supermarkets are heavily dominated by packaged foods, of which a large proportion are classified as UPFs, suggesting that UPFs are highly accessible to NZ households (Luiten et al., 2016).

Convenience plays a pivotal role in shaping dietary patterns, particularly in the context of increasingly fast paced and demanding modern lifestyles. Previous qualitative research from international settings suggests that convenience and time constraints play into the decision making and consumption of UPFs for both adolescents and young adults (Busse et al., 2024; Rodríguez-Barniol et al., 2024; Sato et al., 2020). Further facilitating these purchase and consumption decisions for adolescents could be cooking skills and confidence within the kitchen. Adolescents with limited cooking abilities may be more reliant on foods that require little to no preparation. This is supported by findings from Hermosa-Bosano and López-Gil (2025) who reported that overall UPF intake showed a decreasing trend across cooking skill levels, with adolescents in the “very adequate” cooking skills group consuming significantly fewer UPF servings than those in the “very inadequate” group.

3.16. UPF food group intake of adolescents

The current study also analysed intake of UPF sub food groups amongst the adolescent population. Fast foods and takeaways; bread and bread products; and biscuits, cakes, and desserts, were among the top contributors to UPF intake. Similar studies from the USA, Brazil, Italy, and Belgium show top UPF food group contributors to be processed meats, biscuits, cakes and pastry type foods, and bread products and substitutes (Madalosso et al., 2023; Ruggiero et al., 2021; Vandevijvere, De Ridder, et al., 2019; Wang et al., 2021). Although fast foods were identified as the highest contributor in our findings, the above studies placed fast food items such as burgers and hot dogs within the processed meats category, explaining the slight discrepancy in findings. The inclusion of industrially produced breads and similar staples in the UPF category under NOVA has been debated, particularly in high-income countries where such products are dietary staples and often fortified (Monteiro et al., 2019; Petrus et al., 2021). Therefore, their regular consumption in the NZ diet may partly explain their substantial contribution to total UPF intake in our study. Future research should consider whether bread and bread products are associated with poor health outcomes in the same way as other foods categorised as UPF according to NOVA. However, with bread being a large staple in the NZ diet, it is also important to consider what foods may replace bread and bread products in the diet. Alternative choices could have differing nutritional implications, especially considering the mandatory fortification of breads with folic acid and iodine in NZ (Food Standards Australia New Zealand, 2025).

In the NZ context, while nationally representative data on UPF intake using the NOVA classification is limited, past surveys provide indirect support for our findings. The 2002 NZ National Children's Nutrition Survey reported high consumption of discretionary foods such as snack foods, bread products, confectionery, sugary beverages, and fast foods, many of which align with UPFs under NOVA (Ministry of Health, 2003). Similarly, the 2008/09 NZ Adult Nutrition Survey found that adults (those aged 15 years and above) were consuming large proportions of energy from nutrient-poor, highly processed foods (University of Otago and Ministry of Health, 2011). The types of foods reported to be frequently consumed correspond with major UPF subgroups identified in our analysis. These findings are particularly concerning given the increased nutritional needs of adolescents and the strong evidence linking UPF consumption to poor diet quality, excess body weight, and long term cardiometabolic risk (Das et al., 2017; Neri, Martínez-Steele, et al., 2022; Neri, Steele, et al., 2022).

Food retail stores including fast food outlets, convenience stores, and bakeries are highly concentrated around schools within urban areas in NZ (Brien et al., 2023). In addition to this high availability, unhealthy food and beverages are aggressively marketed to children and adolescents through various advertising channels (Brien et al., 2023). These marketing strategies significantly influence adolescents' food preferences and purchasing decisions (Tsochantaridou et al., 2023). Notably, peak exposure to such advertisements occurs on weekdays before and after school, further increasing the likelihood of consumption during these times (Liu et al., 2019). This environment likely contributes to the high intake of fast food and takeaway items, biscuits, cakes, and bread products identified in this study.

3.17. Associations between UPF intake and sociodemographic characteristics

Our findings suggest that UPF intake was associated with sociodemographic context. In this study, the highest UPF intakes were observed among females, students residing in the Waikato region, those attending schools in any size urban area, and those not participating in the school lunch programme.

Eligibility for the government-funded school lunch programme emerged as a protective factor against UPF intake in our study. Participants attending schools eligible for the scheme consumed a significantly lower amount of UPFs compared to their peers in ineligible schools. The Ka Ora, Ka Ako school lunch programme is a government initiative aimed to provide funded lunch meals at schools with high socioeconomic need to reduce food insecurity and boost child development and learning (Ministry of Education, 2025). Ka Ora, Ka Ako is guided by the Ministry of Education nutrition standards for menu design and development (Ministry of Health, 2022b). These structured nutrition standards likely reduce students' reliance on convenience foods typically brought from home or purchased from nearby outlets or school canteens. Comparable results have been observed in Brazil, where adolescents attending public schools have lower intake of UPFs compared to private schools due to participation in the Brazilian School Food Program (PNAE) (Boklis-Berer et al., 2021; Gonçalves et al., 2023; Noll et al., 2019). By increasing access to balanced, whole food-based meals during the school day, school lunch programmes may help displace more energy dense, nutrient poor processed alternatives.

Interestingly, females exhibited a significantly higher intake of UPF energy compared to male participants in our study. Previous findings regarding associations with UPF intake and sex have been inconclusive. Males have been found to consume significantly more energy from UPFs within some international contexts, including Colombia and Portugal (Khandpur et al., 2020; Magalhães et al., 2021), whereas no significant associations have been found in the UK, Belgium, Mexico, and the USA (Chavez-Ugalde et al., 2024; Dicken et al., 2023). Females comprised over half of our sample size (62.5%), with a large majority of the female participants attending schools outside of the school lunch programme, with lower socioeconomic deprivation, which is likely a contributing factor to the significant association found here.

Waikato based participants showed the highest intake of UPF energy, compared to Auckland and BOP participants. These findings align with the Waikato Regional Foodshed Analysis (2025) showing that despite agricultural abundance in the region, food insecurity is apparent. Although the region is a mass producer of fresh and minimally processed foods, these products are largely exported reducing availability and access within the region. Key food groups such as fruits, legumes and nuts, grain crops, and aquaculture are produced in insufficient quantities to meet local needs (Waikato Wellbeing Project, 2025). These deficits may be compensated by importing PFs and UPFs to meet dietary demands.

3.18. Associations between UPF food group intake and sociodemographic factors

Analysis of UPF food group intake revealed notable sociodemographic differences. Fast foods and takeaways were the largest contributors to UPF intake overall, particularly among males and participants residing in Auckland compared to other regions. Within this study, a greater proportion of students within the Auckland region (74%) were eligible for the school lunch programme compared to Waikato (67%) and BOP (24%), indicating that students in Auckland were from areas of greater deprivation. Previous NZ based literature has identified that food retailers and fast food chains are more accessible in areas of greater socioeconomic deprivation compared to areas of lower socioeconomic deprivation, which may partially explain the significant findings by regional fast food intake within this study (Sushil et al., 2017; Wiki et al., 2019).

Females consumed significantly more energy from biscuits, cakes, and desserts, a finding consistent with studies from Brazil and Belgium (Gonçalves et al., 2023; Vandevijvere, De Ridder, et al., 2019). Bread and bread products were consumed in significantly higher amounts in rural residing adolescents compared to any size urban area. The NZ Healthy Location Index shows that rural communities have poorer access to supermarkets, potentially reducing purchase options resulting in greater intake of bread and bread products within this group (Marek et al., 2021).

3.19. Strengths and limitations

One key strength of this study is the use of Intake24, a validated, self-administered online 24-hour dietary recall tool. Intake24 has been extensively field-tested and shown to provide comparable accuracy and precision to traditional interviewer-led multiple-pass recall methods, yielding similar estimates of energy intake (Bradley et al., 2016; Foster et al., 2014). Its interactive, user-friendly format and automated coding make it particularly well-suited for large-scale dietary assessments in adolescent populations (Rowland et al., 2018). This method of dietary data collection reduces interviewer bias, and social desirability effects, which play a large role when assessing intake of discretionary and processed foods in adolescents and children (Pérez-Rodrigo et al., 2015). Additionally, our study is among the first to use the Intake24 tool specifically adapted to the NZ food environment (Ni Mhurchu et al., 2023). The large, representative sample size of the study is a further strength. Dietary data was collected in 631 adolescents from diverse ethnic and socioeconomic backgrounds across the Auckland, Waikato, and BOP regions in NZ. The diverse sample enhances the generalisability of the findings to the broader NZ adolescent population.

There were also limitations within this study. Firstly, dietary intake was assessed using a single 24-hour recall, which may not accurately reflect an individual's usual intake, especially given the day-to-day variability in adolescent eating patterns (Baranowski & Willett, 2012). Secondly, the adolescent population is known to be prone to both under and over reporting of dietary intake often influenced by social desirability, recall ability, and levels of food literacy (Foster & Bradley, 2018; Livingstone & Robson, 2000). However, with the use of the Intake24 software mentioned above, it is likely these factors were mitigated to some extent. While the NOVA classification provides a useful framework for categorising foods based on level of processing, there is potential for misclassification of certain foods, which may lead to overestimation or underestimation of UPF intake (Jung et al., 2025; Petrus et al., 2021). Finally, convenience sampling is another important limitation to consider. More than 300 schools were contacted and only 16 were included in our final analysis. Whilst this sample provided a diverse range of socio-demographic contexts, this sample is not necessarily representative of the entire NZ adolescent population.

3.20. Conclusion

In this study, UPFs contributed a substantial proportion of total energy intake among NZ adolescents. Fast foods and takeaways, bread products, and biscuits, cakes and desserts were the leading contributors to UPF intake. The highest UPF intakes were observed among females, students residing in the Waikato region, those attending schools in any size urban area, and those not participating in the school lunch programme. These findings add to the body of literature on adolescent dietary patterns in NZ and provide important information regarding UPF intake using the NOVA classification system, enabling comparisons with international data. Results suggest that the dietary behaviours seen in NZ adolescents may reflect broader global trends in food processing and consumption. Future research should consider using multiple non-consecutive 24-hour dietary recalls to confirm these findings align with habitual intake, and further investigations should be conducted into the influence of food environments, food marketing, and regional food access on UPF consumption in NZ adolescents.

Chapter 4: Conclusions and recommendations

4.1. Achievement of aims and objectives

The aim of this research was to describe UPF intake and associations with sociodemographic factors among NZ adolescents. The specific objectives were to (1) describe UPF intake and sources of UPFs and (2) describe the association between UPF intake and sociodemographic factors (sex, age, region, urban/rural, school lunch programme eligibility) among NZ adolescents. This study found that UPFs contributed to 63% of TDEI among adolescents, with top sources including fast foods/takeaways; bread and bread products; and biscuits, cakes and desserts, contributing to 12.2, 7.9, and 7.5% of TDEI, respectively. The second objective revealed that females, students in the Waikato region, those living in small and medium urban areas, and students not eligible for the school lunch programme consumed significantly more energy from UPFs ($p<0.05$). Collectively, these findings fulfilled the overall aim by providing a comprehensive understanding of UPF contribution to adolescent diets in New Zealand and identifying key sociodemographic differences.

4.2. Research impact

This study provides the first detailed description of UPF intake among NZ adolescents, using the NOVA classification system. The findings from this study suggest that UPFs contribute substantially towards TDEI in NZ adolescents with significant variation across sociodemographic contexts. These insights are critical for informing equitable national nutrition policies and intervention strategies, particularly within school environments and communities with higher UPF consumption. These findings may inform targeted public health interventions aimed at improving access and affordability of whole/minimally processed foods thereby supporting healthier dietary patterns among New Zealand adolescents. Under the previous Ka Ora, Ka Ako (school lunch programme) model, students eligible for this programme consumed significantly less UPF energy compared to students who were ineligible for the programme. This suggests that the provision of free, healthy school lunches may help reduce reliance on UPFs and improve overall dietary quality among adolescents. As the programme continues to evolve, monitoring its impact on adolescent dietary intake will be essential for evaluating its effectiveness and ensuring that it contributes to long-term improvements in adolescent health and wellbeing. These findings may also inform further school-based initiatives, including the development or refinement of individual school nutrition policies, to better support healthy dietary behaviours among adolescents.

Given the substantial amount of time adolescents spend in schools, the school environment plays a pivotal role in shaping their eating behaviours and food choices. School based interventions such as nutrition education sessions for staff and students and mandating a healthy food and drink policy for school canteens, fundraising events, and field trips may contribute to improving consumption of whole foods whilst displacing dietary UPFs (Medeiros et al., 2022; Ochoa-Avilés et al., 2017).

The high intake of UPFs found in our study reflects changes that need to be implemented at a structural level. Introducing legislation restricting the marketing of unhealthy foods to children and adolescents may play a role in aiding the reduction of UPF consumption (Boyland et al., 2022; Taillie et al., 2019). This could involve abolishing all advertising of high fat high sugar foods within school zones nationwide, restricting the use of cartoon characters and associated influencers or celebrities popular with children on certain food products, and utilising time-based scheduling restrictions on television. A combination of all these techniques mandated at the government level could lead to significant improvements in adolescent nutrition and reducing UPF energy intake in this population. Simply employing a single strategy to overcome UPF consumption in adolescents alone is not enough, multi-component interventions that combine education, government policy, and local food environments are all required to make a difference. Currently in NZ, little is being done in this space with much room for advancements in this area.

Finally, whilst bread and bread products were among the top food group contributors within this study, caution should be taken when developing policies and recommendations based solely on the levels of food processing according to NOVA. Industrialised breads are a staple in NZ households, therefore advising against the consumption of breads may have nutritional consequences that could disproportionately affect households in which bread is a low cost accessible option (University of Otago and Ministry of Health, 2011). The use of iodised salt and folic acid in breads is mandatory in NZ, due to low quality local soils and the risk of neural tube defects in pregnancy, further proving their nutritional contribution to NZ diets. (Food Standards Australia New Zealand, 2025). Distinguishing against discretionary and nondiscretionary UPFs will play an important part in the development of nutrition policy surrounding UPFs in NZ.

4.3. Strengths

This study had numerous strengths, including gathering data from an ethnically and socioeconomically diverse population of adolescents. Within our sample, we had a sufficient proportion of participants that identified as Māori and Pacific ethnicities. Gathering data from these groups is important as they often experience higher rates of nutrition-related health inequities in comparison to European populations in NZ (Ministry of Health, 2024b). Furthermore, the large proportion of Māori and Pacific participants enhances the generalisability of our results. We utilised a multiple pass self-administered online 24-hour recall software, Intake24. The multiple pass method allows participants to review their food and beverage intake at numerous points throughout the duration of the recall, giving ample opportunity for participants to add any missed food items or drinks. This method has been shown to have the least over and underestimation of all dietary assessment methods when used on an adolescent population (Rankin et al., 2010).

Additionally, the use of the online software to gather dietary information reduces social desirability bias in respondents whilst providing a similar level of agreement to interviewer-led recalls at the population level, supporting their validity for estimating group intakes (Bradley et al., 2016; Drapeau et al., 2024). Finally, our study identified the top food group contributors to UPF intake across sociodemographic contexts. This level of detail moves beyond describing overall UPF intake to highlight which specific food categories are most consumed across different groups. This information is valuable for informing targeted nutrition interventions and policies directed to address inequities across various groups.

4.4. Limitations

Several limitations exist within the current study. Firstly, due to the cross-sectional nature of the research, we cannot infer causality, and we are limited to drawing associations between UPF intake and sociodemographic factors only. Cross-sectional data represents only a single snapshot in time which may not reflect seasonal or long-term patterns of dietary consumption (Cummings, 2018). Within our study we collected only a single 24-hour recall from all participants. Day to day dietary intake is highly variable across individuals, therefore a single 24-hour recall is not representative of a participants usual intake (Baranowski & Willett, 2012). On an individual basis a minimum of 2-5 24-hour dietary recalls are required to estimate intake (Castell et al., 2015). However, due to the large sample size of our study, a single 24-hour recall is sufficient for estimating the mean of the population (Baranowski & Willett, 2012). The multiple source method (MSM) is a viable option for estimating usual dietary intake by accounting for within person variation in a sub sample of participants, providing more accurate intake distributions for the entire study population (Haubrock et al., 2011).

Secondly, gathering dietary data from an adolescent population presents unique challenges. Energy under reporting tends to increase as children age and difficulties arise when adolescents transition from parental reporting to self-reporting of dietary intake, of which the onus falls on the adolescent rather than the parent as a proxy measure (Livingstone & Robson, 2000). Combining this responsibility with declining levels of interest in reporting food intakes, sporadic and irregular eating patterns, and differing eating contexts results in less accurate dietary data (Livingstone & Robson, 2000). In addition, females and adolescents with a greater BMI tend to under report due to social desirability bias (Livingstone & Black, 2003). Within our results, we excluded adolescents with reported energy intakes below 2,100 kJ (500 kcal) to reduce the influence of inaccurate reports. By utilising the online format to gather data, this may have led to improved engagement in comparison to interviewer administered or hard copies of the 24-hour recall (Forster et al., 2016).

It is important to note that the use of the NOVA classification system in this study has several limitations within the NZ context. The NZ Food Composition Database does not include information on the degree of processing, which may have introduced some misclassification when assigning foods to NOVA categories (Plant and Food Research, 2024). Moreover, common NZ mixed dishes and culturally specific items may not align entirely with a single NOVA category, requiring subjective decision and expert consensus that may differ between researchers.

Lastly, it should be noted that our sample had a significantly larger proportion of females in comparison to males. This imbalance may reduce the representativeness of the sample in relation to the wider adolescent population and may bias overall intake estimates. This further limits the generalisability of our results. Previous literature has noted that females are often overrepresented in studies of eating behaviour and nutrition, with young women more likely than men to volunteer, potentially introducing participation bias in studies (Klinge & de Vet, 2024).

4.5. Recommendations and suggestions for further research

The current study provided an overview of UPF intake among NZ adolescents and highlighted differences between sociodemographic contexts. However, due to the cross-sectional design and use of a single 24-hour recall, there are limitations in the conclusions that can be drawn from our findings. These limitations present several opportunities for future research.

For the future, it would be beneficial to undertake longitudinal research to establish the relationship between UPF consumption and health outcomes in differing age groups over time. Furthermore, the need to gather two 24-hour recalls in a subsample of participants, using the MSM, in future research is important to improve the accuracy and reliability of dietary intake estimates, as a single recall may not capture day-to-day variation in food consumption, particularly for UPFs that may be consumed irregularly (Baranowski & Willett, 2012; Haubrock et al., 2011).

Additionally, our study did not analyse differences in UPF intake across ethnic groups. In NZ, health inequities between differing ethnicities are well documented, with European and Asian ethnicities experiencing better health outcomes across many different domains when compared to Māori and Pacific ethnicities (Ministry of Health, 2024b). Examining ethnic differences in UPF intake is therefore essential when shaping future nutrition policy and intervention within NZ to ensure the health system is responsive and contributes to achieving equitable health outcomes for priority populations.

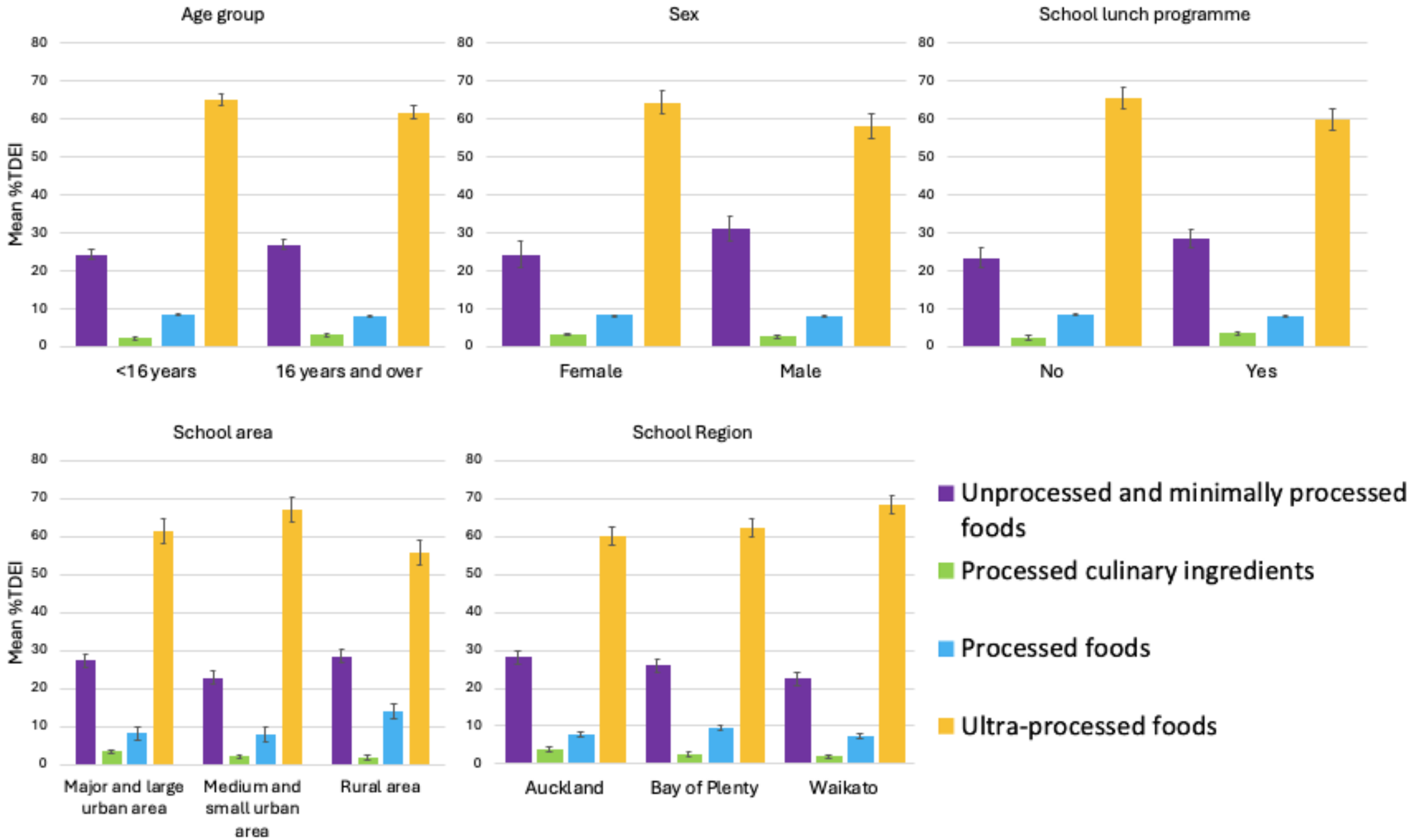
Lastly, opportunity to investigate consumption contexts including when, where, how, and with whom UPFs are being consumed will generate deeper understanding into eating behaviours in adolescents. Alongside this, gathering dietary data from a nationally representative sample, in the form of a national nutrition survey (NNS), will give a current picture of UPF intake nationwide as the last NNS was conducted in 2008/09 for the adult population, and 2002 for children (Ministry of Health, 2003; University of Otago and Ministry of Health, 2011). Although large, our sample was not representative of the entire NZ adolescent population as only 16 schools were included out of over 300 contacted. Therefore, an updated NNS would offer the prospect to investigate UPF intake not only in adolescents but across all age groups.

4.6. Conclusion

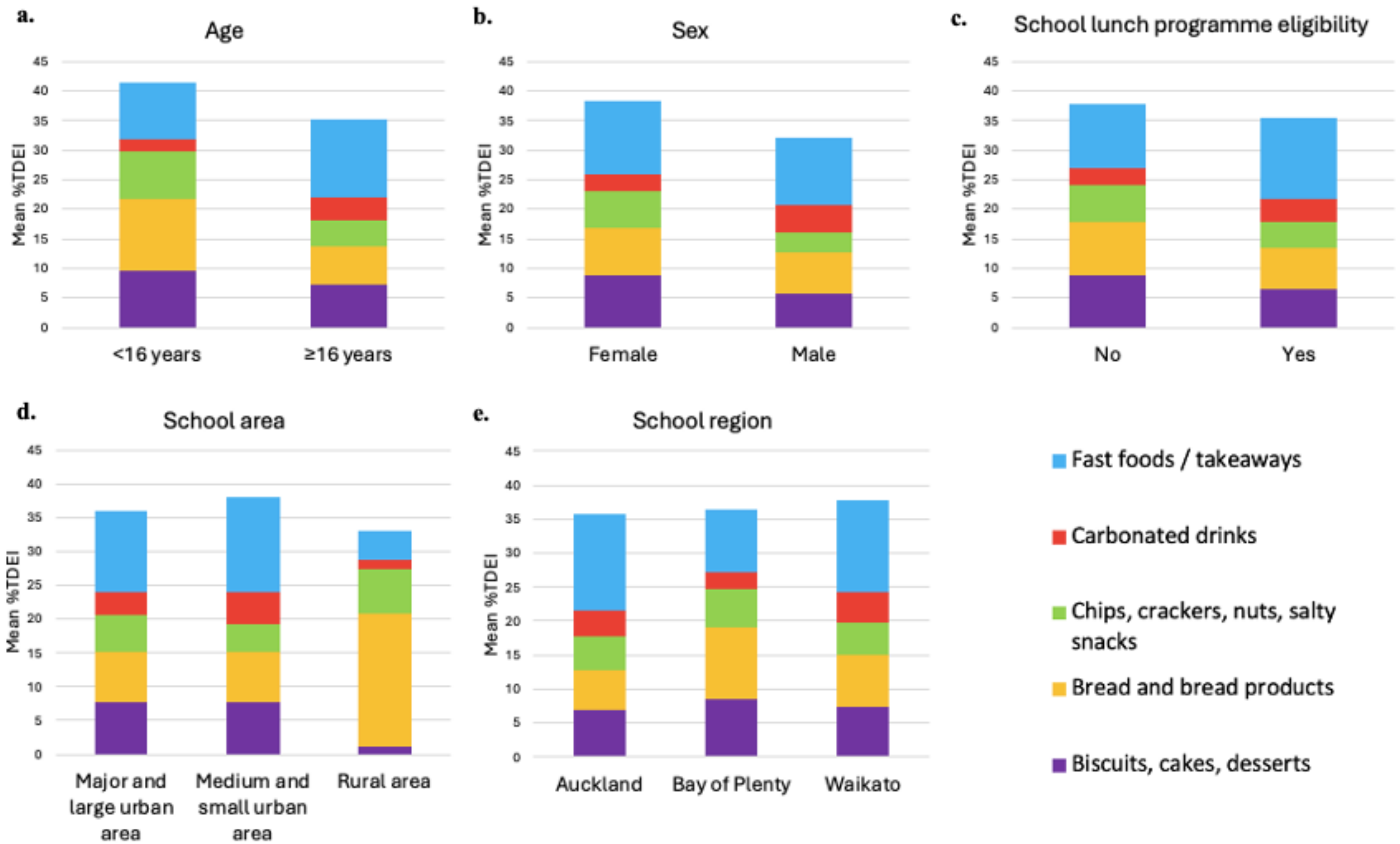
In conclusion, this research found that UPFs contribute a significant amount of energy within the adolescent diet with the top sources being fast foods and takeaways; bread and bread products; and biscuits, cakes and desserts. We also concluded that females, students in the Waikato region, living in small and medium urban areas, and students not eligible for the school lunch programme consumed significantly more UPFs. To reduce UPF consumption among this population, multi-component public health interventions that combine food environments, regional food access, school-based initiatives, and national legislation are required. Further research involving a nationally representative sample utilising the MSM, and investigations into eating contexts are needed to promote a fuller understanding of the influences on UPF consumption across all age groups.

Supplementary materials

Supplementary Figure 1: Intake of NOVA processing groups by sociodemographic variable



Supplementary Figure 2: UPF food group intake across sociodemographic factors



Supplementary Table 1: Percentage of energy from UPF food groups according to sociodemographic factor

Indicators	Bread and bread products (%)	Biscuits, cakes, desserts (%)	Breakfast cereals (%)	Cheese and cheese products (%)	Chips, crackers, nuts, salty snacks (%)	Chocolate, confectionary (%)	Fast foods/takeaways (%)	Grains, pasta, noodles (%)	Carbonated drinks (%)
Sex									
Male	7.0±12.1	5.8±12.6[1]	2.8±6.1	0.03±0.3[1]	3.3±9.1	2.5±9.3	11.3±20.5	2.3±7.7	4.7±9.0[1]
Female	8.1±12.0	8.8±12.5	8.1±12.0	0.2±0.8	6.1±11.0	2.6±8.0	12.6±20.0	2.3±7.7	2.9±6.3
Age									
<16	12.0±14.0[1]	9.6±12.0	3.1±7.0	0.1±0.6	8.2±13.1[1]	2.2±6.2	9.6±18.8	1.6±6.2	2.1±4.7[1]
≥16	6.5±11.0	7.4±12.7	2.8±6.8	0.1±0.8	4.4±9.4	2.6±8.9	13.0±20.1	2.5±8.1	3.9±8.1
School region									
Auckland	5.7±10.4	7.0±12.8	2.5±6.4	0.1±0.4	5.1±10.6	2.8±9.3	14.2±22.0[1]	2.6±7.6	3.9±7.7
Waikato	7.8±11.4	7.3±10.7	3.8±8.5	0.2±1.0	4.6±11.0	3.0±11.2	13.5±21.0	2.2±8.4	4.6±8.2
Bay of Plenty[3]	10.7±14.2[1]	8.4±12.8	2.7±5.8	0.2±1.1	5.6±10.1	2.4±6.7	9.2±16.2	2.1±7.6	2.5±6.7[1]
School area									
Major and large urban	7.5±11.5	7.8±12.8	2.6±6.2	0.1±0.8	0.1±0.8	2.7±8.4	12.1±20.0	2.2±7.1	3.3±7.1
Medium and small urban	7.6±11.4	7.6±11.4	3.6±8.2	0.2±0.9	0.2±0.9	2.9±11.0	14.0±22.1	2.0±7.8	4.7±8.8
Rural[4]	19.8±22.2[1]	1.1±2.7	1.5±5.5	0.5±1.6	0.5±1.6	0.02±0.07	4.2±10.1	8.3±16.8[2]	1.4±2.7
School lunch programme eligibility									
Yes	6.9±12.6	6.6±12.1	3.0±7.3	0.1±0.5	4.3±10.2	2.5±9.2	13.7±22.0	2.5±8.1	4.0±7.9
No	9.1±11.6	8.8±12.6	2.6±5.8	0.2±1.1	6.2±10.8	6.2±10.8	10.6±17.1	2.2±7.2	2.9±7.0

[1]($p \leq 0.05$). [2]($p \leq 0.01$).

[3]BOP participants consumed significantly more bread and bread products ($p<0.001$) to Auckland, and significantly less fast food/takeaways ($p=0.017$). BOP participants consumed significantly less carbonated drinks ($p=0.034$) compared to Waikato participants.

[4]Rural participants consumed significantly more grains, pasta, noodles than both major and large urban and medium and small urban participants ($p=0.003$). Rural participants consumed significantly more bread and bread products than medium and small urban participants ($p<0.001$).

Supplementary Table 1 continued

Indicators	Non-carbonated drinks (%)	Tea, coffee, hot chocolate (%)	Milk, milk alternatives, milk drinks (%)	Meat and meat products (%)	Meat alternatives (%)	Mixed dishes (%)	Vegetables (%)	Spreads and sauces (%)	Other (%)
Sex									
Male	2.1±6.1	0.3±1.6[1]	3.2±9.2	5.5±10.7	0	2.8±8.6	0.4±2.1	1.7±3.7	2.7±7.6
Female	2.4±6.4	0.7±3.0	3.1±7.4	4.1±8.8	0.1±1.5	2.3±6.6	0.7±3.8	1.8±3.3	2.8±5.6
Age									
<16	1.9±4.9	0.5±2.2	2.6±5.2	4.0±9.0	0	1.9±4.9	0.4±2.3	1.7±2.4	3.5±6.0
≥16	2.4±6.6	0.6±2.8	3.3±8.6	4.7±9.6	0.1±1.4	2.6±7.6	0.7±3.7	1.8±3.7	2.5±6.4
School region									
Auckland	2.2±6.8	0.6±2.9	2.8±7.8	4.4±9.6	0	3.0±8.8	0.3±2.3	1.6±3.0	2.3±6.7
Waikato	3.6±8.2	1.1±3.5	3.1±8.2	5.0±10.6	0	2.7±7.2	1.2±4.3	1.8±4.1	1.7±4.1
Bay of Plenty[2]	2.0±7.2	0.4±2.0	3.3±7.6	3.9±8.3	0.2±2.1	2.0±7.2	0.7±3.7	0.7±3.7	3.7±6.4[1]
School area									
Major and large urban	2.1±6.4	0.5±2.6	3.1±7.8	4.2±9.1	0.1±1.4	2.5±7.8	0.5±3.0	1.8±3.2	2.9±6.6
Medium and small urban	3.4±7.9	1.0±3.3	3.0±8.0	5.1±10.5	0	3.0±8.7	1.0±4.0	1.9±4.3	2.0±4.5
Rural	2.5±6.0	0.6±2.6	3.0±8.1	1.8±6.9	0	0.5±1.7	1.3±4.3	1.0±2.1	1.4±6.1
School lunch programme eligibility									
Yes	2.4±7.1	0.6±2.8	2.7±8.0	4.4±9.8	0	3.0±9.0	0.7±3.5	1.6±3.5	1.8±6.1
No	2.4±6.4	0.6±2.8	3.6±7.4	4.2±8.1	0.1±1.8	2.0±6.3	0.5±3.1	2.1±3.4	3.6±6.1

[1]($p \leq 0.05$).

[2] BOP participants consumed significantly more 'other' UPFs compared to Auckland (*p=0.031)* and Waikato (p=0.008) participants.

Notes: Values are expressed as mean±SD. Differences between groups were tested using independent t-tests and one way ANOVA. Post hoc comparisons using Tukeys HSD adjustment after ANOVA.

Abbreviations: UPF = ultra-processed food.

References

Abera, M., Hardy-Johnson, P., Abdissa, A., Workicho, A., Ali, R., Weller, S., Fall, C., Kehoe, S. H., Barker, M., & Haileamlak, A. (2021). Social, economic and cultural influences on adolescent nutrition and physical activity in Jimma, Ethiopia: Perspectives from adolescents and their caregivers. *Public Health Nutrition*, *24*(16), 5218-5226. https://doi.org/10.1017/s1368980020001664

Albertson, A. M., Affenito, S. G., Bauserman, R., Holschuh, N. M., Eldridge, A. L., & Barton, B. A. (2009). The relationship of ready-to-eat cereal consumption to nutrient intake, blood lipids, and body mass index of children as they age through adolescence. *Journal Of The American Dietetic Association*, *109*(9), 1557-1565. https://doi.org/10.1016/j.jada.2009.06.363

Almeida, L. B., Scagliusi, F. B., Duran, A. C., & Jaime, P. C. (2018). Barriers to and facilitators of ultra-processed food consumption: Perceptions of Brazilian adults. *Public Health Nutrition*, *21*(1), 68-76. https://doi.org/10.1017/S1368980017001665

Andaluz, J. L., Tisalema, E. S., & Ballesteros, L. G. (2025). Influence of marketing on the consumption of ultra-processed foods in university environments. *Revista Minerva*, *6*(17), 39-47. https://doi.org/10.47460/minerva.v6i17.192.

Askari, M., Heshmati, J., Shahinfar, H., Tripathi, N., & Daneshzad, E. (2020). Ultra-processed food and the risk of overweight and obesity: A systematic review and meta-analysis of observational studies. *International Journal Of Obesity*, *44*(10), 2080-2091. https://doi.org/10.1038/s41366-020-00650-z

Baker, P., & Friel, S. (2016). Food systems transformations, ultra-processed food markets and the nutrition transition in Asia. *Globalization and health*, *12*, 1-15. https://doi.org/10.1186/s12992-016-0223-3

Baker, P., Machado, P., Santos, T., Sievert, K., Backholer, K., Hadjikakou, M., Russell, C., Huse, O., Bell, C., & Scrinis, G. (2020). Ultra-processed foods and the nutrition transition: Global, regional and national trends, food systems transformations and political economy drivers. *Obesity Reviews*, *21*(12), e13126. https://doi.org/10.1111/obr.13126

Banna, J. C., McCrory, M. A., Fialkowski, M. K., & Boushey, C. (2017). Examining plausibility of self-reported energy intake data: Considerations for method selection. *Front Nutrition*, *4*, 45. https://doi.org/10.3389/fnut.2017.00045

Baraldi, L. G., Steele, E. M., Canella, D. S., & Monteiro, C. A. (2018). Consumption of ultra-processed foods and associated sociodemographic factors in the USA between 2007 and 2012: Evidence from a nationally representative cross-sectional study. *BMJ open*, *8*(3), e020574. https://doi.org/10.1136/bmjopen-2017-020574

Baranowski, T., & Willett, W. (2012). 24-hour recall and diet record methods. In W. Willett (Ed.), *Nutritional Epidemiology* (pp. 49-69). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199754038.003.0004

Beserra, J. B., Soares, N. I. d. S., Marreiros, C. S., Carvalho, C. M. R. G. d., Martins, M. d. C. d. C., Freitas, B. d. J., Santos, M. M. d., & Frota, K. d. M. G. (2020). Do children and adolescents who consume ultra-processed foods have a worse lipid profile? A systematic review. *Ciência & Saúde Coletiva*, *25*, 4979-4989. https://doi.org/10.1590/1413-812320202512.29542018

Bhagtani, D., Amoutzopoulos, B., Steer, T., Collins, D., Abraham, S., Holmes, B. A., Rai, B. K., Pradeepa, R., Mahmood, S., & Shamim, A. A. (2025). The adaptation, implementation, and performance evaluation of intake24, a digital 24-h dietary recall

tool for south asian populations: The South Asia biobank. *Current Developments in Nutrition*, *9*(2), 104543. https://doi.org/10.1016/j.cdnut.2025.104543
Bielemann, R. M., Motta, J. V. S., Minten, G. C., Horta, B. L., & Gigante, D. P. (2015). Consumption of ultra-processed foods and their impact on the diet of young adults. *Revista De Saude Publica*, *49*, 1-10. https://doi.org/10.1590/S0034-8910.2015049005572
Block, G. (1989). Human dietary assessment: Methods and issues. *Preventive Medicine*, *18*(5), 653-660. https://doi.org/10.1016/0091-7435(89)90036-4
Boklis-Berer, M., Rauber, F., Azeredo, C., Levy, R., & Louzada, M. L. (2021). School meals consumption is associated with a better diet quality of Brazilian adolescents: Results from the PENSE 2015 survey. *Public Health Nutrition*, *24*, 1-26. https://doi.org/10.1017/S1368980021003207
Bonilla, C., Brauer, P., Royall, D., Keller, H., Hanning, R., & DiCenso, A. (2015). Use of electronic dietary assessment tools in primary care: An interdisciplinary perspective. *Bmc Medical Informatics And Decision Making*, *15*. https://doi.org/10.1186/s12911-015-0138-6
Boskovic, A., Burgoine, T., & Hoenink, J. C. (2025). The socioeconomic patterning of great-britain's retail food environment: A repeated cross-sectional study of area-level deprivation and food outlet density from 2011-2024. *medRxiv*, 2025.2003.2007.25323573. https://doi.org/10.1101/2025.03.07.25323573
Boyland, E., McGale, L., Maden, M., Hounsome, J., Boland, A., & Jones, A. (2022). Systematic review of the effect of policies to restrict the marketing of foods and non-alcoholic beverages to which children are exposed. *Obesity Reviews*, *23*(8), e13447. https://doi.org/10.1111/obr.13447
Bradley, J., Simpson, E., Poliakov, I., Matthews, J. N., Olivier, P., Adamson, A. J., & Foster, E. (2016). Comparison of intake24 (an online 24-h dietary recall tool) with interviewer-led 24-h recall in 11–24 year-old. *Nutrients*, *8*(6), 358. https://doi.org/10.3390/nu8060358
Braesco, V., Souchon, I., Sauvant, P., Haurogné, T., Maillot, M., Féart, C., & Darmon, N. (2022). Ultra-processed foods: How functional is the nova system? *Eur J Clin Nutr*, *76*(9), 1245-1253. https://doi.org/10.1038/s41430-022-01099-1
Brassard, D., Laramée, C., Robitaille, J., Lemieux, S., & Lamarche, B. (2020). Differences in population-based dietary intake estimates obtained from an interviewer-administered and a self-administered web-based 24-h recall. *Frontiers in nutrition*, *7*, 137. https://doi.org/10.3389/fnut.2020.00137
Brien, A., Stephanie, W., Shreya, M., Selda, M., Lina, Y., Hari, N., Melody, S., & and Egli, V. (2023). Junk food, sugary drinks and xl portion sizes: Advertising on convenience stores near primary schools in Tāmaki Makaurau Auckland, Aotearoa New Zealand. *Kōtuitui: New Zealand Journal of Social Sciences Online*, *18*(1), 45-63. https://doi.org/10.1080/1177083X.2022.2058407
Brown, K. H. (2000). Application and interpretation of commonly used nutritional assessment techniques. In M. E. Gershwin, J. B. German, & C. L. Keen (Eds.), *Nutrition And Immunology: Principles And Practice* (pp. 3-13). Humana Press. https://doi.org/10.1007/978-1-59259-709-3_1
Brown, K. S., Marean, C. W., Herries, A. I., Jacobs, Z., Tribolo, C., Braun, D., Roberts, D. L., Meyer, M. C., & Bernatchez, J. (2009). Fire as an engineering tool of early modern humans. *Science*, *325*(5942), 859-862. https://doi.org/10.1126/science.1175028
Burrows, T. L., Martin, R. J., & Collins, C. E. (2010). A systematic review of the validity of dietary assessment methods in children when compared with the method of doubly

labeled water. *Journal Of The American Dietetic Association*, *110*(10), 1501-1510. https://doi.org/10.1016/j.jada.2010.07.008
Busse, K. R., Dino, M. E., Martin, S. L., Lee Mayol, N. R., Bechayda, S. A., Adair, L. S., & Ammerman, A. S. (2024). Awareness, experiences, and beliefs related to ultra-processed foods among young people in Cebu, Philippines. *Appetite*, *203*, 107688. https://doi.org/10.1016/j.appet.2024.107688
Calcaterra, V., Cena, H., Rossi, V., Santero, S., Bianchi, A., & Zuccotti, G. (2023). Ultra-processed food, reward system and childhood obesity. *Children*, *10*(5), 804. https://doi.org/10.3390/children10050804
Castell, G. S., Serra-Majem, L., & Ribas-Barba, L. (2015). What and how much do we eat? 24-hour dietary recall method. *Nutricion Hospitalaria*, *31*(3), 46-48. https://doi.org/10.3305/nh.2015.31.sup3.8750
Cediel, G., Reyes, M., da Costa Louzada, M. L., Steele, E. M., Monteiro, C. A., Corvalán, C., & Uauy, R. (2018). Ultra-processed foods and added sugars in the Chilean diet (2010). *Public Health Nutrition*, *21*(1), 125-133. https://doi.org/10.1017/S1368980017001161
Chang, K., Khandpur, N., Neri, D., Touvier, M., Huybrechts, I., Millett, C., & Vamos, E. P. (2021). Association between childhood consumption of ultraprocessed food and adiposity trajectories in the avon longitudinal study of parents and children birth cohort. *JAMA pediatrics*, *175*(9), e211573-e211573. https://doi.org/10.1001/jamapediatrics.2021.1573
Chavez-Ugalde, I. Y., de Vocht, F., Jago, R., Adams, J., Ong, K. K., Forouhi, N. G., Colombet, Z., Ricardo, L. I. C., van Sluijs, E., & Toumpakari, Z. (2024). Ultra-processed food consumption in uk adolescents: Distribution, trends, and sociodemographic correlates using the national diet and nutrition survey 2008/09 to 2018/19. *European Journal Of Nutrition*, *63*(7), 2709-2723. https://doi.org/10.1007/s00394-024-03458-z
Chen, Y.-C., Huang, Y.-C., Lo, Y.-T. C., Wu, H.-J., Wahlqvist, M. L., & Lee, M.-S. (2018). Secular trend towards ultra-processed food consumption and expenditure compromises dietary quality among Taiwanese adolescents. *Food & Nutrition Research*, *62*. https://doi.org/10.29219/fnr.v62.1565
Clark, L., Bolton, K. A., Lacy, K. E., Lim, K., Machado, P. P., & Grimes, C. A. (2025). Ultra-processed food intake and risk of obesity among schoolchildren aged 8-12 years living in victoria, australia. *Pediatric Obesity*, *20*(9), e70030. https://doi.org/10.1111/ijpo.70030
Colombet, Z., Schwaller, E., Head, A., Kypridemos, C., Capewell, S., & O'Flaherty, M. (2022). OP12 Social inequalities in ultra-processed food intakes in the United Kingdom: A time trend analysis (2008–2018). In: BMJ Publishing Group Ltd.
Costa, C. S., Rauber, F., Leffa, P. S., Sangalli, C. N., Campagnolo, P., & Vitolo, M. R. (2019). Ultra-processed food consumption and its effects on anthropometric and glucose profile: A longitudinal study during childhood. *Nutrition, Metabolism and Cardiovascular Diseases*, *29*(2), 177-184. https://doi.org/10.1016/j.numecd.2018.11.003
Cruz, G. L. d., Andrade, G. C., Rauber, F., Levy, R. B., & Louzada, M. L. d. C. (2025). Application of the nova food classification to the 2017-2018 household budget survey: Monitoring adherence to the recommendations of the dietary guidelines for the Brazilian population. *Epidemiologia e Serviços de Saúde*, *34*, e20240369. https://doi.org/10.1590/S2237-96222025v34e20240369.en
Cummings, C. L. (2018). Cross-sectional design. *The SAGE Encyclopedia of Communication Research Methods. Thousand Oaks: SAGE Publications Inc. Retrieved*.

D'Avila, H. F., & Kirsten, V. R. (2017). Energy intake from ultra-processed foods among adolescents. *Revista Paulista de Pediatria*, *35*, 54-60. https://doi.org/10.1590/1984-0462/;2017;35;1;00001

da Costa Louzada, M. L., Baraldi, L. G., Steele, E. M., Martins, A. P. B., Canella, D. S., Moubarac, J.-C., Levy, R. B., Cannon, G., Afshin, A., & Imamura, F. (2015). Consumption of ultra-processed foods and obesity in Brazilian adolescents and adults. *Preventive Medicine*, *81*, 9-15. https://doi.org/10.1016/j.ypmed.2015.07.018

Dahm, C. C., Chomistek, A. K., Jakobsen, M. U., Mukamal, K. J., Eliassen, A. H., Sesso, H. D., Overvad, K., Willett, W. C., Rimm, E. B., & Chiuve, S. E. (2016). Adolescent diet quality and cardiovascular disease risk factors and incident cardiovascular disease in middle-aged women. *Journal of the American Heart Association*, *5*(12), e003583. https://doi.org/10.1161/JAHA.116.003583

Das, J. K., Salam, R. A., Thornburg, K. L., Prentice, A. M., Campisi, S., Lassi, Z. S., Koletzko, B., & Bhutta, Z. A. (2017). Nutrition in adolescents: Physiology, metabolism, and nutritional needs. *Annals Of The New York Academy Of Sciences*, *1393*(1), 21-33. https://doi.org/10.1111/nyas.13330

De Amicis, R., Mambrini, S. P., Pellizzari, M., Foppiani, A., Bertoli, S., Battezzati, A., & Leone, A. (2022). Ultra-processed foods and obesity and adiposity parameters among children and adolescents: A systematic review. *European Journal Of Nutrition*, *61*(5), 2297-2311. https://doi.org/10.1007/s00394-022-02873-4

Dicken, S. J., Batterham, R. L., & Brown, A. (2025). Micronutrients or processing? An analysis of food and drink items from the uk national diet and nutrition survey based on micronutrient content, the nova classification and front-of-package traffic light labelling. *British Journal Of Nutrition*, *133*(3), 382-399. https://doi.org/10.1017/S0007114524003374

Dicken, S. J., Qamar, S., & Batterham, R. L. (2023). Who consumes ultra-processed food? A systematic review of sociodemographic determinants of ultra-processed food consumption from nationally representative samples. *Nutrition Research Reviews*, 1-73. https://doi.org/10.1017/S0954422423000240

Drapeau, V., Laramée, C., Lafreniere, J., Trottier, C., Brochu, C., Robitaille, J., Lamarche, B., & Lemieux, S. (2024). Assessing the relative validity of a web-based self-administered 24-hour dietary recall in a Canadian adolescent's population. *Nutrition Journal*, *23*(1), 66. https://doi.org/10.1186/s12937-024-00954-0

Education Counts. (2024, December 2021). *Ethnic group codes.* Ministry of Education. https://www.educationcounts.govt.nz/data-services/code-sets-and-classifications/ethnic_group_codes

Education Counts. (2025). *Know your region*. https://www.educationcounts.govt.nz/know-your-region

Elizabeth, L., Machado, P., Zinöcker, M., Baker, P., & Lawrence, M. (2020). Ultra-processed foods and health outcomes: A narrative review. *Nutrients*, *12*(7), 1955. https://doi.org/10.3390/nu12071955

Enes, C. C., Camargo, C. M. d., & Justino, M. I. C. (2019). Ultra-processed food consumption and obesity in adolescents. *Revista de Nutrição*, *32*, e180170. https://doi.org/10.1590/1678-9865201932e180170

Fagúndez, L. J. M., Torres, A. R., Sánchez, M. E. G., de Torres Aured, M. L., Rodrigo, C. P., & Rocamora, J. A. I. (2015). Diet history: Method and applications. *Nutricion Hospitalaria*, *31*(3), 57-61. https://doi.org/10.3305/nh.2015.31.sup3.8752

Fangupo, L. J., Haszard, J. J., Leong, C., Heath, A.-L. M., Fleming, E. A., & Taylor, R. W. (2019). Relative validity and reproducibility of a food frequency questionnaire to

assess energy intake from minimally processed and ultra-processed foods in young children. *Nutrients*, *11*(6), 1290. https://doi.org/10.3390/nu11061290
Fangupo, L. J., Haszard, J. J., Taylor, B. J., Gray, A. R., Lawrence, J. A., & Taylor, R. W. (2021). Ultra-processed food intake and associations with demographic factors in young New Zealand children. *Journal Of The Academy Of Nutrition And Dietetics*, *121*(2), 305-313. https://doi.org/10.1016/j.jand.2020.08.088
Fanzo, J., McLaren, R., Bellows, A., & Carducci, B. (2023). Challenges and opportunities for increasing the effectiveness of food reformulation and fortification to improve dietary and nutrition outcomes. *Food Policy*, *119*, 102515. https://doi.org/10.1016/j.foodpol.2023.102515
Fardet, A. (2016). Minimally processed foods are more satiating and less hyperglycemic than ultra-processed foods: A preliminary study with 98 ready-to-eat foods. *Food & Function*, *7*(5), 2338-2346. https://doi.org/10.1039/c6fo00107f
Ferreira, C. S., Silva, D. A., Gontijo, C. A., & Rinaldi, A. E. M. (2019). Consumption of minimally processed and ultra-processed foods among students from public and private schools. *Revista Paulista de Pediatria*, *37*(2), 173-180. https://doi.org/10.1590/1984-0462/;2019;37;2;00010
Field, A. (2024). *Discovering statistics using ibm spss statistics*. Sage Publications Limited.
Floros, J. D., Newsome, R., Fisher, W., Barbosa-Cánovas, G. V., Chen, H., Dunne, C. P., German, J. B., Hall, R. L., Heldman, D. R., & Karwe, M. V. (2010). Feeding the world today and tomorrow: The importance of food science and technology: An ift scientific review. *Comprehensive Reviews in Food Science and Food Safety*, *9*(5), 572-599. https://doi.org/10.1111/j.1541-4337.2010.00127.x
Food and Agriculture Organization of the United Nations. (2019). *Food-based dietary guidelines - Peru*. https://www.fao.org/nutrition/education/food-dietary-guidelines/regions/countries/peru/en/
Food and Agriculture Organization of the United Nations. (2020). *Food-based dietary guidelines - Ecuador*. https://www.fao.org/nutrition/education/dietary-guidelines/regions/ecuador/en/
Food Standards Australia New Zealand. (2014). *AUSNUT 2011-2013 food recipe file*. Retrieved from https://www.foodstandards.gov.au/ausnut-2011-13-food-recipe-file
Food Standards Australia New Zealand. (2022a). *Australian food composition database - release 2.0*
Food Standards Australia New Zealand. (2022b). *Nutrient profiling scoring criterion*. https://www.foodstandards.gov.au/business/labelling/nutrition-health-and-related-claims/nutrient-profiling-scoring-criterion
Food Standards Australia New Zealand. (2025). *Food Standards Code Legislation*. Retrieved from https://www.foodstandards.gov.au/sites/default/files/2025-12/Food%20Standards%20Code%20-%20Compilation%20%28December%202025%29_0.pdf
Forster, H., Walsh, M. C., Gibney, M. J., Brennan, L., & Gibney, E. R. (2016). Personalised nutrition: The role of new dietary assessment methods. *Proceedings Of The Nutrition Society*, *75*(1), 96-105.
Foster, E., & Bradley, J. (2018). Methodological considerations and future insights for 24-hour dietary recall assessment in children. *Nutrition Research*, *51*, 1-11. https://doi.org/10.1016/j.nutres.2017.11.001
Foster, E., Delve, J., Simpson, E., & Breininger, S.-P. (2014). Comparison study: Intake24 vs interviewer led recall final report. *Food Standards Agency*.
Foster, E., Lee, C., Imamura, F., Hollidge, S. E., Westgate, K. L., Venables, M. C., Poliakov, I., Rowland, M. K., Osadchiy, T., & Bradley, J. C. (2019). Validity and reliability of

an online self-report 24-h dietary recall method (intake24): A doubly labelled water study and repeated-measures analysis. *Journal of nutritional science*, *8*, e29. https://doi.org/10.1017/jns.2019.20
Gibney, M. J. (2019). Ultra-processed foods: Definitions and policy issues. *Current Developments in Nutrition*, *3*(2), nzy077. https://doi.org/10.1093/cdn/nzy077
Gibson, S. (2003). Micronutrient intakes, micronutrient status and lipid profiles among young people consuming different amounts of breakfast cereals: Further analysis of data from the national diet and nutrition survey of young people aged 4 to 18 years. *Public Health Nutrition*, *6*(8), 815-820. https://doi.org/10.1079/PHN2003493
Gonçalves, H. V. B., Batista, L. S., de Amorim, A. L. B., & Bandoni, D. H. (2023). Association between consumption of ultra-processed foods and sociodemographic characteristics in Brazilian adolescents. *Nutrients*, *15*(9), 2027. https://doi.org/10.3390/nu15092027
GuneyCoskun, M., Kalkan, I., Weech, M., Fallaize, R., Hwang, F., & Lovegrove, J. (2024). Perceptions and attitudes of food frequency questionnaires and technology-based dietary assessment tools: A qualitative study with turkish research-focused dietitians. *Proceedings Of The Nutrition Society*, *83*. https://doi.org/10.1017/s0029665124006840
Gupta, S., Hawk, T., Aggarwal, A., & Drewnowski, A. (2019). Characterizing ultra-processed foods by energy density, nutrient density, and cost. *Front Nutrition*, *6*, 70. https://doi.org/10.3389/fnut.2019.00070
Hall, K. D., Ayuketah, A., Brychta, R., Cai, H., Cassimatis, T., Chen, K. Y., Chung, S. T., Costa, E., Courville, A., Darcey, V., Fletcher, L. A., Forde, C. G., Gharib, A. M., Guo, J., Howard, R., Joseph, P. V., McGehee, S., Ouwerkerk, R., Raisinger, K., . . . Zhou, M. (2019). Ultra-processed diets cause excess calorie intake and weight gain: An inpatient randomized controlled trial of ad libitum food intake. *Cell Metabolism*, *30*(1), 67-77.e63. https://doi.org/10.1016/j.cmet.2019.05.008
Haubrock, J., Nöthlings, U., Volatier, J.-L., Dekkers, A., Ocké, M., Harttig, U., Illner, A.-K., Knüppel, S., Andersen, L. F., & Boeing, H. (2011). Estimating usual food intake distributions by using the multiple source method in the epic-potsdam calibration study1–3. *The Journal of Nutrition*, *141*(5), 914-920. https://doi.org/10.3945/jn.109.120394
Hermosa-Bosano, C., & López-Gil, J. F. (2025). Low self-perceived cooking skills are linked to greater ultra-processed food consumption among adolescents: The ehdla study. *Nutrients*, *17*(7), 1168. https://doi.org/10.3390/nu17071168
Huebbe, P., & Rimbach, G. (2020). Historical reflection of food processing and the role of legumes as part of a healthy balanced diet. *Foods*, *9*(8). https://doi.org/10.3390/foods9081056
Jones, J. M. (2019). Food processing: Criteria for dietary guidance and public health? *Proceedings Of The Nutrition Society*, *78*(1), 4-18. https://doi.org/10.1017/S0029665118002513
Jung, S., Kim, J. Y., Park, S., Lee, J. E., & Group, U. W. (2025). Potential misclassification of ultra-processed foods across studies and the need for a unified classification system: A scoping review. *Nutrition Research And Practice*, *19*(3), 331. https://doi.org/10.4162/nrp.2025.19.3.331
Jung, S., Park, S., & Kim, J. Y. (2022). Comparison of dietary share of ultra-processed foods assessed with a ffq against a 24-h dietary recall in adults: Results from knhanes 2016. *Public Health Nutrition*, *25*(5), 1166-1175. https://doi.org/10.1017/S1368980022000179

Juul, F., Parekh, N., Martinez-Steele, E., Monteiro, C. A., & Chang, V. W. (2022). Ultra-processed food consumption among US adults from 2001 to 2018. *The American Journal of Clinical Nutrition*, *115*(1), 211-221. https://doi.org/https://doi.org/10.1093/ajcn/nqab305

Kaikkonen, J. E., Mikkilä, V., & Raitakari, O. T. (2014). Role of childhood food patterns on adult cardiovascular disease risk. *Current Atherosclerosis Reports*, *16*(10), 443. https://doi.org/10.1007/s11883-014-0443-z

Khandpur, N., Cediel, G., Obando, D. A., Jaime, P. C., & Parra, D. C. (2020). Sociodemographic factors associated with the consumption of ultra-processed foods in Colombia. *Revista De Saude Publica*, *54*, 19. https://doi.org/10.11606/s1518-8787.2020054001176

Khandpur, N., Rossato, S., Drouin-Chartier, J.-P., Du, M., Steele, E. M., Sampson, L., Monteiro, C., Zhang, F. F., Willett, W., Fung, T. T., & Sun, Q. (2021). Categorising ultra-processed foods in large-scale cohort studies: Evidence from the nurses' health studies, the health professionals follow-up study, and the growing up today study. *Journal of Nutritional Science*, *10*, e77, Article e77. https://doi.org/10.1017/jns.2021.72

Klinge, I., & de Vet, E. (2024). Research priorities and considerations for nutrition research: Methods of sex and gender analysis for biomedical and nutrition research. *Proceedings Of The Nutrition Society*, *83*(2), 66-75. https://doi.org/10.1017/S0029665124000065

Koios, D., Machado, P., & Lacy-Nichols, J. (2022). Representations of ultra-processed foods: A global analysis of how dietary guidelines refer to levels of food processing. *International Journal of Health Policy Management*, *11*(11), 2588-2599. https://doi.org/10.34172/ijhpm.2022.6443

Kweon, S., Kim, Y., Jang, M. J., Kim, Y., Kim, K., Choi, S., Chun, C., Khang, Y. H., & Oh, K. (2014). Data resource profile: The korea national health and nutrition examination survey (knhanes). *International Journal Of Epidemiology*, *43*(1), 69-77. https://doi.org/10.1093/ije/dyt228

Lane, M. M., Gamage, E., Du, S., Ashtree, D. N., McGuinness, A. J., Gauci, S., Baker, P., Lawrence, M., Rebholz, C. M., Srour, B., Touvier, M., Jacka, F. N., O'Neil, A., Segasby, T., & Marx, W. (2024). Ultra-processed food exposure and adverse health outcomes: umbrella review of epidemiological meta-analyses. *British Medical Journal*, *384*, e077310. https://doi.org/10.1136/bmj-2023-077310

Lauria, F., Dello Russo, M., Formisano, A., De Henauw, S., Hebestreit, A., Hunsberger, M., Krogh, V., Intemann, T., Lissner, L., Molnar, D., Moreno, L. A., Reisch, L. A., Tornaritis, M., Veidebaum, T., Williams, G., Siani, A., & Russo, P. (2021). Ultra-processed foods consumption and diet quality of European children, adolescents and adults: Results from the i.Family study. *Nutrition, Metabolism and Cardiovascular Diseases*, *31*(11), 3031-3043. https://doi.org/10.1016/j.numecd.2021.07.019

Leffa, P. S., Hoffman, D. J., Rauber, F., Sangalli, C. N., Valmórbida, J. L., & Vitolo, M. R. (2020). Longitudinal associations between ultra-processed foods and blood lipids in childhood. *British Journal Of Nutrition*, *124*(3), 341-348. https://doi.org/10.1017/S0007114520001233

Lietz, G., Barton, K. L., Longbottom, P. J., & Anderson, A. S. (2002). Can the epic food-frequency questionnaire be used in adolescent populations? *Public Health Nutrition*, *5*(6), 783-789. https://doi.org/10.1079/PHN2002344

Lioret, S., Touvier, M., Balin, M., Huybrechts, I., Dubuisson, C., Dufour, A., Bertin, M., Maire, B., & Lafay, L. (2011). Characteristics of energy under-reporting in children and adolescents. *British Journal Of Nutrition*, *105*(11), 1671-1680. https://doi.org/10.1017/S0007114510005465

Liu, W., Barr, M., Pearson, A. L., Chambers, T., Pfeiffer, K. A., Smith, M., & Signal, L. (2019). Space-time analysis of unhealthy food advertising: New Zealand children's exposure and health policy options. *Health Promotion International*, *35*(4), 812-820. https://doi.org/10.1093/heapro/daz083

Livingstone, M. B. E., & Black, A. E. (2003). Markers of the validity of reported energy intake. *The Journal of Nutrition*, *133*(3), 895S-920S.

Livingstone, M. B. E., Robson, P., & Wallace, J. (2004). Issues in dietary intake assessment of children and adolescents. *British Journal Of Nutrition*, *92*(S2), S213-S222. https://doi.org/10.1079/BJN20041169

Livingstone, M. B. E., & Robson, P. J. (2000). Measurement of dietary intake in children. *Proceedings Of The Nutrition Society*, *59*(2), 279-293. https://doi.org/10.1017/S0029665100000318

Louzada, M., Costa, C. D. S., Souza, T. N., Cruz, G. L. D., Levy, R. B., & Monteiro, C. A. (2022). Impact of the consumption of ultra-processed foods on children, adolescents and adults' health: Scope review. *Cad Saude Publica*, *37*(suppl 1), e00323020. https://doi.org/10.1590/0102-311x00323020 (Impacto do consumo de alimentos ultraprocessados na saúde de crianças, adolescentes e adultos: revisão de escopo.)

Louzada, M. L. d. C., Baraldi, L. G., Steele, E. M., Martins, A. P. B., Canella, D. S., Moubarac, J.-C., Levy, R. B., Cannon, G., Afshin, A., Imamura, F., Mozaffarian, D., & Monteiro, C. A. (2015). Consumption of ultra-processed foods and obesity in Brazilian adolescents and adults. *Preventive Medicine*, *81*, 9-15. https://doi.org/10.1016/j.ypmed.2015.07.018

Louzada, M. L. d. C., Martins, A. P. B., Canella, D. S., Baraldi, L. G., Levy, R. B., Claro, R. M., Moubarac, J.-C., Cannon, G., & Monteiro, C. A. (2015). Ultra-processed foods and the nutritional dietary profile in Brazil. *Revista De Saude Publica*, *49*(00), 38. https://doi.org/10.1590/S0034-8910.2015049006132

Ludwig, D. S. (2011). Technology, diet, and the burden of chronic disease. *JAMA*, *305*(13), 1352-1353. https://doi.org/10.1001/jama.2011.380

Luiten, C. M., Steenhuis, I. H. M., Eyles, H., Ni Mhurchu, C., & Waterlander, W. E. (2016). Ultra-processed foods have the worst nutrient profile, yet they are the most available packaged products in a sample of New Zealand supermarkets. *Public Health Nutrition*, *19*(3), 530-538. https://doi.org/10.1017/S1368980015002177

Machado, P. P., Steele, E. M., Levy, R. B., Sui, Z., Rangan, A., Woods, J., Gill, T., Scrinis, G., & Monteiro, C. A. (2019). Ultra-processed foods and recommended intake levels of nutrients linked to non-communicable diseases in Australia: Evidence from a nationally representative cross-sectional study. *BMJ open*, *9*(8), e029544. https://doi.org/10.1136/bmjopen-2019-029544

Mackay, S., Vandevijvere, S., & Lee, A. (2019). Ten-year trends in the price differential between healthier and less healthy foods in New Zealand. *Nutrition & Dietetics*, *76*(3), 271-276. https://doi.org/10.1111/1747-0080.12457

Madalosso, M. M., Martins, N. N. F., Medeiros, B. M., Rocha, L. L., Mendes, L. L., Schaan, B. D., & Cureau, F. V. (2023). Consumption of ultra-processed foods and cardiometabolic risk factors in Brazilian adolescents: Results from erica. *European Journal Of Clinical Nutrition*, *77*(11), 1084-1092. https://doi.org/10.1038/s41430-023-01329-0

Magalhães, V., Severo, M., Correia, D., Torres, D., de Miranda, R. C., Rauber, F., Levy, R., Rodrigues, S., & Lopes, C. (2021). Associated factors to the consumption of ultra-processed foods and its relation with dietary sources in Portugal. *Journal of Nutritional Science*, *10*, e89. https://doi.org/10.1017/jns.2021.61

Malik, V. S., Fung, T. T., van Dam, R. M., Rimm, E. B., Rosner, B., & Hu, F. B. (2011). Dietary patterns during adolescence and risk of type 2 diabetes in middle-aged women. *Diabetes Care*, *35*(1), 12-18. https://doi.org/10.2337/dc11-0386

Marchese, L., Livingstone, K. M., Woods, J. L., Wingrove, K., & Machado, P. (2022). Ultra-processed food consumption, socio-demographics and diet quality in Australian adults. *Public Health Nutrition*, *25*(1), 94-104. https://doi.org/10.1017/S1368980021003967

Marek, L., Hobbs, M., Wiki, J., Kingham, S., & Campbell, M. (2021). The good, the bad, and the environment: Developing an area-based measure of access to health-promoting and health-constraining environments in New Zealand. *International Journal of Health Geographics*, *20*(1), 16. https://doi.org/10.1186/s12942-021-00269-x

Marino, M., Puppo, F., Del Bo', C., Vinelli, V., Riso, P., Porrini, M., & Martini, D. (2021). A systematic review of worldwide consumption of ultra-processed foods: Findings and criticisms. *Nutrients*, *13*(8), 2778. https://doi.org/10.3390/nu13082778

Marrón-Ponce, J. A., Sánchez-Pimienta, T. G., da Costa Louzada, M. L., & Batis, C. (2018). Energy contribution of nova food groups and sociodemographic determinants of ultra-processed food consumption in the Mexican population. *Public Health Nutrition*, *21*(1), 87-93. https://doi.org/10.1017/S1368980017002129

Medeiros, G. C. B. S. d., Azevedo, K. P. M. d., Garcia, D., Oliveira Segundo, V. H., Mata, Á. N. d. S., Fernandes, A. K. P., Santos, R. P. d., Trindade, D. D. B. d. B., Moreno, I. M., Guillén Martínez, D., & Piuvezam, G. (2022). Effect of school-based food and nutrition education interventions on the food consumption of adolescents: A systematic review and meta-analysis. *International Journal Of Environmental Research And Public Health*, *19*(17), 10522.

Melo, I. S. V. d., Costa, C. A. C. B., Santos, J. V. L. d., Santos, A. F. d., Florêncio, T. M. d. M. T., & Bueno, N. B. (2017). Consumption of minimally processed food is inversely associated with excess weight in adolescents living in an underdeveloped city. *PloS One*, *12*(11), e0188401. https://doi.org/10.1371/journal.pone.0188401

Mendoza, K., Monge-Rojas, R., Vargas-Quesada, R., & Mattei, J. (2025). Ultra-processed food intake is associated with a displacement of the traditional diet of Costa Rican adolescents. *Nutrition Research*, *136*, 1-14. https://doi.org/10.1016/j.nutres.2025.02.002

Ministry of Education. (2022). *Equity index variables*. Wellington Retrieved from https://www.educationcounts.govt.nz/__data/assets/pdf_file/0003/243327/Equity-Index-variables-fact-sheet-Aug-2022.pdf

Ministry of Education. (2023). *The equity index*. https://www.education.govt.nz/our-work/changes-in-education/equity-index/#video

Ministry of Education. (2025). *What is ka ora, ka ako | healthy school lunches programme?* https://kaorakaako.education.govt.nz/working-together/about-ka-ora-ka-ako/what-is-ka-ora-ka-ako--healthy-school-lunches-programme

Ministry of Health. (2003). *NZ food NZ children: Key results of the 2002 national children's nutrition survey*. Wellington Retrieved from https://www.health.govt.nz/system/files/2011-11/nzfoodnzchildren.pdf

Ministry of Health. (2012). *Food and nutrition guidelines for healthy children and young people (aged 2–18 years): A background paper – revised february 2015*. Wellington Retrieved from https://www.health.govt.nz/system/files/2012-08/food-nutrition-guidelines-healthy-children-young-people-background-paper-feb15-v2.pdf

Ministry of Health. (2022a). *Children's dietary habits - findings from the 2018/19 and 2019/20 New Zealand health survey*. Wellington Retrieved from https://www.health.govt.nz/system/files/2022-10/childrens-dietary-habits-oct22.pdf

Ministry of Health. (2022b). *Nutrition standards for ka ora, ka ako | healthy school lunches progamme*. https://kaorakaako.education.govt.nz/file-download/Nutrition%20Standards%202022.pdf

Ministry of Health. (2023). *Annual data explorer 2022/23: New Zealand health survey*. Retrieved from https://minhealthnz.shinyapps.io/nz-health-survey-2022-23-annual-data-explorer/

Ministry of Health. (2024a). *Annual data explorer 2023/24: New Zealand health survey [data file]*. Retrieved 19.01.25 from https://minhealthnz.shinyapps.io/nz-health-survey-2023-24-annual-data-explorer/

Ministry of Health. (2024b). *Tatau kahukura: Māori health chart book 2024 (4th edition)*. Wellington Retrieved from https://www.health.govt.nz/system/files/2024-12/tatau-kahukura-maori-health-chart-book-2024-v4.pdf

Ministry of Health. (2025). *Children and young people's dietary guidelines (3-17 years): Consultation document with draft recommendations*. Wellington Retrieved from https://consult.health.govt.nz/nutrition-and-physical-activity/ed299086/supporting_documents/children-young-people-dietary-guidelines-13-17-years-consultation-documentpdf

Ministry of Health Brazil. (2015). *Dietary guidelines for the Brazilian population*. Retrieved from https://bvsms.saude.gov.br/bvs/publicacoes/dietary_guidelines_brazilian_population.pdf

Ministry of Health Israel. (2020). *Israel's new national nutrition recommendations – the new nutritional rainbow: Main recommendations*. https://www.gov.il/en/pages/dietary-guidelines?chapterIndex=3

Ministry of Health Maldives. (2019). *Food based dietary guidelines for Maldives*. Health Protection Agency Retrieved from https://health.gov.mv/storage/uploads/50wNJEwA/ydrp2hei.pdf

Monteiro, C. A. (2009). Nutrition and health. The issue is not food, nor nutrients, so muchas processing. *Public Health Nutrition*, *12*(5), 729-731. https://doi.org/10.1017/S1368980009005291

Monteiro, C. A., Cannon, G., Levy, R., Moubarac, J.-C., Jaime, P., Martins, A. P., Canella, D., Louzada, M., & Parra, D. (2016). Nova. The star shines bright. *World Nutrition*, *7*(1-3), 28-38. https://worldnutritionjournal.org/index.php/wn/article/view/5

Monteiro, C. A., Cannon, G., Levy, R. B., Moubarac, J.-C., Louzada, M. L., Rauber, F., Khandpur, N., Cediel, G., Neri, D., & Martinez-Steele, E. (2019). Ultra-processed foods: What they are and how to identify them. *Public Health Nutrition*, *22*(5), 936-941. https://doi.org/10.1017/S1368980018003762

Monteiro, C. A., Cannon, G., Moubarac, J.-C., Levy, R. B., Louzada, M. L. C., & Jaime, P. C. (2018). The UN decade of nutrition, the nova food classification and the trouble with ultra-processing. *Public Health Nutrition*, *21*(1), 5-17. https://doi.org/10.1017/S1368980017000234

Monteiro, C. A., Cannon, G., Moubarac, J.-C., Martins, A. P. B., Martins, C. A., Garzillo, J., Canella, D. S., Baraldi, L. G., Barciotte, M., & da Costa Louzada, M. L. (2015). Dietary guidelines to nourish humanity and the planet in the twenty-first century. A blueprint from Brazil. *Public Health Nutrition*, *18*(13), 2311-2322. https://doi.org/10.1017/S1368980015002165

Monteiro, C. A., Cannon G., Lawrence M., Costa Louzada, M.L., Pereira Machado, P. (2019). Ultra-processed foods, diet quality, and health using the nova classification system. Rome: FAO Retrieved from https://openknowledge.fao.org/server/api/core/bitstreams/5277b379-0acb-4d97-a6a3-602774104629/content

Monteiro, C. A., Levy, R. B., Claro, R. M., Castro, I. R. R. d., & Cannon, G. (2010). A new classification of foods based on the extent and purpose of their processing. *Cadernos De Saude Publica*, *26*, 2039-2049. https://doi.org/10.1590/S0102-311X2010001100005

Monteiro, C. A., Moubarac, J.-C., Cannon, G., Ng, S. W., & Popkin, B. (2013). Ultra-processed products are becoming dominant in the global food system. *Obesity Reviews*, *14*(S2), 21-28. https://doi.org/10.1111/obr.12107

Montgomery, S. C., Donnelly, M., Bhatnagar, P., Carlin, A., Kee, F., & Hunter, R. F. (2020). Peer social network processes and adolescent health behaviors: A systematic review. *Preventive Medicine*, *130*, 105900. https://doi.org/10.1016/j.ypmed.2019.105900

Moodie, R., Stuckler, D., Monteiro, C., Sheron, N., Neal, B., Thamarangsi, T., Lincoln, P., & Casswell, S. (2013). Profits and pandemics: Prevention of harmful effects of tobacco, alcohol, and ultra-processed food and drink industries. *The Lancet*, *381*(9867), 670-679. https://doi.org/10.1016/S0140-6736(12)62089-3

Moreno, L. A., Rodríguez, G., Fleta, J., Bueno-Lozano, M., Lázaro, A., & Bueno, G. (2010). Trends of dietary habits in adolescents. *Critical Reviews In Food Science And Nutrition*, *50*(2), 106-112. https://doi.org/10.1080/10408390903467480

Moubarac, J.-C., Batal, M., Louzada, M. L., Steele, E. M., & Monteiro, C. A. (2017). Consumption of ultra-processed foods predicts diet quality in Canada. *Appetite*, *108*, 512-520. https://doi.org/10.1016/j.appet.2016.11.006

Moubarac, J.-C., Parra, D. C., Cannon, G., & Monteiro, C. A. (2014). Food classification systems based on food processing: Significance and implications for policies and actions: A systematic literature review and assessment. *Current Obesity Reports*, *3*, 256-272. https://doi.org/10.1007/s13679-014-0092-0

National Cancer Institute. (n.d.). *Dietary assessment primer: 24-hour dietary recall (24hr) at a glance*. https://dietassessmentprimer.cancer.gov/profiles/recall/

Neri, D., Martínez-Steele, E., Khandpur, N., & Levy, R. (2022). Associations between ultra-processed foods consumption and indicators of adiposity in US adolescents: Cross-sectional analysis of the 2011-2016 national health and nutrition examination survey. *Journal Of The Academy Of Nutrition And Dietetics*, *122*(8), 1474-1487. e1472. https://doi.org/10.1016/j.jand.2022.01.005

Neri, D., Martinez-Steele, E., Monteiro, C. A., & Levy, R. B. (2019). Consumption of ultra-processed foods and its association with added sugar content in the diets of US children, NHANES 2009-2014. *Pediatric Obesity*, *14*(12), e12563. https://doi.org/10.1111/ijpo.12563

Neri, D., Steele, E. M., Khandpur, N., Cediel, G., Zapata, M. E., Rauber, F., Marrón-Ponce, J. A., Machado, P., da Costa Louzada, M. L., & Andrade, G. C. (2022). Ultraprocessed food consumption and dietary nutrient profiles associated with obesity: A multicountry study of children and adolescents. *Obesity Reviews*, *23*, e13387. https://doi.org/10.1111/obr.13387

Neufeld, L. M., Andrade, E. B., Ballonoff Suleiman, A., Barker, M., Beal, T., Blum, L. S., Demmler, K. M., Dogra, S., Hardy-Johnson, P., Lahiri, A., Larson, N., Roberto, C. A., Rodríguez-Ramírez, S., Sethi, V., Shamah-Levy, T., Strömmer, S., Tumilowicz, A., Weller, S., & Zou, Z. (2022). Food choice in transition: Adolescent autonomy, agency, and the food environment. *The Lancet*, *399*(10320), 185-197. https://doi.org/10.1016/S0140-6736(21)01687-1

Ni Mhurchu, C., Morenga, L. T., Mackay, S., Bradbury, K., Follong, B., Haliburton, C., Grey, J., & Maiquez, M. (2023). New Zealand nutrition survey development: Final report and recommendations. https://doi.org/10.17608/k6.auckland.23938116

Noll, P., Noll, M., de Abreu, L. C., Baracat, E. C., Silveira, E. A., & Sorpreso, I. C. E. (2019). Ultra-processed food consumption by Brazilian adolescents in cafeterias and school meals. *Scientific Reports*, *9*(1), 7162. https://doi.org/10.1038/s41598-019-43611-x

Norris, S. A., Frongillo, E. A., Black, M. M., Dong, Y., Fall, C., Lampl, M., Liese, A. D., Naguib, M., Prentice, A., Rochat, T., Stephensen, C. B., Tinago, C. B., Ward, K. A., Wrottesley, S. V., & Patton, G. C. (2022). Nutrition in adolescent growth and development. *The Lancet*, *399*(10320), 172-184. https://doi.org/10.1016/S0140-6736(21)01590-7

O'Connor, L. E., Herrick, K. A., & Papier, K. (2024). Handle with care: Challenges associated with ultra-processed foods research. *International Journal Of Epidemiology*, *53*(5). https://doi.org/10.1093/ije/dyae106

Ochoa-Avilés, A., Verstraeten, R., Huybregts, L., Andrade, S., Van Camp, J., Donoso, S., Ramírez, P. L., Lachat, C., Maes, L., & Kolsteren, P. (2017). A school-based intervention improved dietary intake outcomes and reduced waist circumference in adolescents: A cluster randomized controlled trial. *Nutrition Journal*, *16*(1), 79. https://doi.org/10.1186/s12937-017-0299-5

Pagliai, G., Dinu, M., Madarena, M., Bonaccio, M., Iacoviello, L., & Sofi, F. (2021). Consumption of ultra-processed foods and health status: A systematic review and meta-analysis. *British Journal Of Nutrition*, *125*(3), 308-318. https://doi.org/10.1017/S0007114520002688

Palu, A., Santos, J. A., Coyle, D., Shahid, M., Crowther, J., Waqa, G., Bell, C., Webster, J., & McKenzie, B. (2025). Ultra-processed food consumption in the central division of Fiji. *BMC Medicine*, *23*(1), 109. https://doi.org/10.1186/s12916-025-03947-w

Pan American Health Organisation, W. H. O. (2015). Ultra-processed food and drink products in latin america: Trends. Impact on obesity, policy implications. Washington D.C: Pan American Health Organisation Retrieved from https://iris.paho.org/bitstream/handle/10665.2/7699/9789275118641_eng.pdf

Patton, G. C., Sawyer, S. M., Santelli, J. S., Ross, D. A., Afifi, R., Allen, N. B., Arora, M., Azzopardi, P., Baldwin, W., & Bonell, C. (2016). Our future: A lancet commission on adolescent health and wellbeing. *The Lancet*, *387*(10036), 2423-2478. https://doi.org/10.1016/S0140-6736(16)00579-1

Pérez-Rodrigo, C., Escauriaza, B. A., Bartrina, J. A., & Allúe, I. P. (2015). Dietary assessment in children and adolescents: Issues and recommendations. *Nutricion Hospitalaria*, *31*(3), 76-83. https://doi.org/10.3305/nh.2015.31.sup3.8755

Petridi, E., Karatzi, K., Magriplis, E., Charidemou, E., Philippou, E., & Zampelas, A. (2023). The impact of ultra-processed foods on obesity and cardiometabolic comorbidities in children and adolescents: A systematic review. *Nutrition Reviews*, *82*(7), 913-928. https://doi.org/10.1093/nutrit/nuad095

Petridou, E., Malamou, H., Doxiadis, S., Pantelakis, S., Kanellopoulou, G., Toupadaki, N., Trichopoulou, A., Flytzani, V., & Trichopoulos, D. (1995). Blood lipids in Greek adolescents and their relation to diet, obesity, and socioeconomic factors. *Annals Of Epidemiology*, *5*(4), 286-291. https://doi.org/10.1016/1047-2797(94)00094-A

Petrus, R. R., do Amaral Sobral, P. J., Tadini, C. C., & Gonçalves, C. B. (2021). The nova classification system: A critical perspective in food science. *Trends In Food Science & Technology*, *116*, 603-608. https://doi.org/10.1016/j.tifs.2021.08.010

Phalle, A., & Gokhale, D. (2025). Navigating next-gen nutrition care using artificial intelligence-assisted dietary assessment tools—a scoping review of potential applications. *Frontiers in Nutrition*, *Volume 12 - 2025*. https://doi.org/10.3389/fnut.2025.1518466

Plant and Food Research. (2024). *New Zealand food composition database: New Zealand foodfiles 2024*. The New Zealand Institute for Plant & Food Research Limited and Ministry of Health. https://www.foodcomposition.co.nz/foodfiles

Polsky, J. Y., Jovovic, S., Nardocci, M., & Moubarac, J.-C. (2024). Socio-demographic correlates of ultra-processed food consumption in Canada. *Public Health Nutrition*, *27*(1), e180. https://doi.org/10.1017/S1368980024001630

Poti, J. M., Braga, B., & Qin, B. (2017). Ultra-processed food intake and obesity: What really matters for health—processing or nutrient content? *Current Obesity Reports*, *6*(4), 420-431. https://doi.org/10.1007/s13679-017-0285-4

Public Health England. (2021). *Evaluation of change in dietary methodology in NDNS rolling programme: Stage 1*. Retrieved from https://assets.publishing.service.gov.uk/media/6149b7eee90e070446ce522c/Stage_1_evaluation_report__1_.pdf

Rankin, D., Hanekom, S. M., Wright, H. H., & MacIntyre, U. (2010). Dietary assessment methodology for adolescents: A review of reproducibility and validation studies. *South African Journal Of Clinical Nutrition*, *23*(2).

Rauber, F., da Costa Louzada, M. L., Steele, E. M., de Rezende, L. F., Millett, C., Monteiro, C. A., & Levy, R. B. (2019). Ultra-processed foods and excessive free sugar intake in the UK: A nationally representative cross-sectional study. *BMJ open*, *9*(10), e027546. https://doi.org/10.1136/bmjopen-2018-027546

Rauber, F., Louzada, M. L. d. C., Steele, E. M., Millett, C., Monteiro, C. A., & Levy, R. B. (2018). Ultra-processed food consumption and chronic non-communicable diseases-related dietary nutrient profile in the UK (2008–2014). *Nutrients*, *10*(5), 587. https://doi.org/10.3390/nu10050587

Rauber, F., Steele, E. M., Louzada, M. L. d. C., Millett, C., Monteiro, C. A., & Levy, R. B. (2020). Ultra-processed food consumption and indicators of obesity in the United Kingdom population (2008-2016). *PloS One*, *15*(5), e0232676. https://doi.org/10.1371/journal.pone.0232676

Reales-Moreno, M., Tonini, P., Escorihuela, R. M., Solanas, M., Fernández-Barrés, S., Romaguera, D., & Contreras-Rodríguez, O. (2022). Ultra-processed foods and drinks consumption is associated with psychosocial functioning in adolescents. *Nutrients*, *14*(22). https://doi.org/10.3390/nu14224831

Rebro, S. M., Patterson, R. E., Kristal, A. R., & Cheney, C. L. (1998). The effect of keeping food records on eating patterns. *Journal Of The Academy Of Nutrition And Dietetics*, *98*(10), 1163.

Reichelt, A. C. (2016). Adolescent maturational transitions in the prefrontal cortex and dopamine signaling as a risk factor for the development of obesity and high fat/high sugar diet induced cognitive deficits. *Frontiers In Behavioral Neuroscience*, *10*, 189. https://doi.org/10.3389/fnbeh.2016.00189

Rodríguez-Barniol, M., Pujol-Busquets, G., & Bach-Faig, A. (2024). Screen time use and ultra-processed food consumption in adolescents: A focus group qualitative study. *Journal Of The Academy Of Nutrition And Dietetics*, *124*(10), 1336-1346. https://doi.org/10.1016/j.jand.2024.04.015

Rosi, A., Paolella, G., Biasini, B., Scazzina, F., Alicante, P., De Blasio, F., dello Russo, M., Paolella, G., Rendina, D., Rosi, A., Tabacchi, G., Cairella, G., Garbagnati, F., Scalfi, L., & Strazzullo, P. (2019). Dietary habits of adolescents living in North America, europe or oceania: A review on fruit, vegetable and legume consumption, sodium intake, and adherence to the mediterranean diet. *Nutrition, Metabolism and Cardiovascular Diseases*, *29*(6), 544-560. https://doi.org/10.1016/j.numecd.2019.03.003

Rowland, M. K., Adamson, A. J., Poliakov, I., Bradley, J., Simpson, E., Olivier, P., & Foster, E. (2018). Field testing of the use of intake24—an online 24-hour dietary recall system. *Nutrients*, *10*(11), 1690. https://doi.org/10.3390/nu10111690

Ruggiero, E., Esposito, S., Costanzo, S., Di Castelnuovo, A., Cerletti, C., Donati, M. B., de Gaetano, G., Iacoviello, L., & Bonaccio, M. (2021). Ultra-processed food consumption and its correlates among Italian children, adolescents and adults from the Italian nutrition & health survey (INHES) cohort study. *Public Health Nutrition*, *24*(18), 6258-6271. https://doi.org/10.1017/S1368980021002767

Saravia, L., Moliterno, P., Skapino, E., & Moreno, L. A. (2022). Food diary, food frequency questionnaire, and 24-hour dietary recall. In C. B. Betim Cazarin (Ed.), *Basic Protocols In Foods And Nutrition* (pp. 223-247). Springer US. https://doi.org/10.1007/978-1-0716-2345-9_15

Sato, P. M., Couto, M. T., Wells, J., Cardoso, M. A., Devakumar, D., & Scagliusi, F. B. (2020). Mothers' food choices and consumption of ultra-processed foods in the Brazilian Amazon: A grounded theory study. *Appetite*, *148*, 104602. https://doi.org/10.1016/j.appet.2020.104602

Schulte, E. M., Avena, N. M., & Gearhardt, A. N. (2015). Which foods may be addictive? The roles of processing, fat content, and glycemic load. *PloS One*, *10*(2), e0117959. https://doi.org/10.1371/journal. pone.0117959

Shim, J. S., Oh, K., & Kim, H. C. (2014). Dietary assessment methods in epidemiologic studies. *Epidemiology and Health*, *36*, e2014009. https://doi.org/10.4178/epih/e2014009

Shim, J. S., Shim, S. Y., Cha, H. J., Kim, J., & Kim, H. C. (2021). Socioeconomic characteristics and trends in the consumption of ultra-processed foods in Korea from 2010 to 2018. *Nutrients*, *13*(4). https://doi.org/10.3390/nu13041120

Signal, L. N., Stanley, J., Smith, M., Barr, M., Chambers, T. J., Zhou, J., Duane, A., Gurrin, C., Smeaton, A. F., & McKerchar, C. (2017). Children’s everyday exposure to food marketing: An objective analysis using wearable cameras. *International Journal of Behavioral Nutrition and Physical Activity*, *14*, 1-11. https://doi.org/10.1186/s12966-017-0570-3

Simpson, E., Bradley, J., Poliakov, I., Jackson, D., Olivier, P., Adamson, A. J., & Foster, E. (2017). Iterative development of an online dietary recall tool: Intake24. *Nutrients*, *9*(2), 118. https://doi.org/10.3390/nu9020118

Sjardin, N., Reed, P., Albert, B., Mouat, F., Carter, P. J., Hofman, P., Cutfield, W., Gunn, A., & Jefferies, C. (2018). Increasing incidence of type 2 diabetes in New Zealand children <15 years of age in a regional-based diabetes service, Auckland, New Zealand. *Journal Of Paediatrics And Child Health*, *54*(9), 1005-1010. https://doi.org/10.1111/jpc.13924

Smith, L., López Sánchez, G. F., Tully, M. A., Rahmati, M., Butler, L., Barnett, Y., Keyes, H., Kostev, K., Oh, H., & Shin, J. I. (2024). Secular Trends of Fast-Food Consumption Among Adolescents Aged 12–15 Years: A Global Analysis Including 18 Countries. *Advances in Public Health*, *2024*(1), 6560025.

Smith, R., Kelly, B., Yeatman, H., & Boyland, E. (2019). Food marketing influences children's attitudes, preferences and consumption: A systematic critical review. *Nutrients*, *11*(4). https://doi.org/10.3390/nu11040875

Srour, B., Kordahi, M. C., Bonazzi, E., Deschasaux-Tanguy, M., Touvier, M., & Chassaing, B. (2022). Ultra-processed foods and human health: From epidemiological evidence to mechanistic insights. *The Lancet Gastroenterology & hepatology*, *7*(12), 1128-1140.
Statistics New Zealand. (2023). *Urban rural 2023 (generalised)*. https://datafinder.stats.govt.nz/layer/111198-urban-rural-2023-generalised/
Statistics New Zealand. (2022). Design of forms for the 2023 Census. https://www.stats.govt.nz/assets/Reports/Design-of-forms-for-the-2023-Census/Design-of-forms-for-the-2023-Census.pdf#:~:text=•%20Age%20%2F%20date%20of,•%20Iwi%20affiliation
Steele, E. M., Baraldi, L. G., da Costa Louzada, M. L., Moubarac, J.-C., Mozaffarian, D., & Monteiro, C. A. (2016). Ultra-processed foods and added sugars in the US diet: Evidence from a nationally representative cross-sectional study. *BMJ open*, *6*(3), e009892. https://doi.org/10.1136/ bmjopen-2015-009892
Stuckler, D., McKee, M., Ebrahim, S., & Basu, S. (2012). Manufacturing epidemics: The role of global producers in increased consumption of unhealthy commodities including processed foods, alcohol, and tobacco. *PloS Medicine*, *9*(6), e1001235. https://doi.org/10.1371/journal.pmed.1001235
Superior Health Council. (2019). *Dietary guidelines for the Belgium adult population*. Brussels: SHC Retrieved from https://www.health.belgium.be/sites/default/files/uploads/fields/fpshealth_theme_file/20190902_shc-9284_fbdg_vweb.pdf
Sushil, Z., Vandevijvere, S., Exeter, D. J., & Swinburn, B. (2017). Food swamps by area socioeconomic deprivation in New Zealand: A national study. *International Journal of Public Health*, *62*, 869-877. https://doi.org/10.1007/s00038-017-0983-4
Taillie, L. S., Busey, E., Stoltze, F. M., & Dillman Carpentier, F. R. (2019). Governmental policies to reduce unhealthy food marketing to children. *Nutrition Reviews*, *77*(11), 787-816. https://doi.org/10.1093/nutrit/nuz021
Tavares, L. F., Fonseca, S. C., Rosa, M. L. G., & Yokoo, E. M. (2012). Relationship between ultra-processed foods and metabolic syndrome in adolescents from a Brazilian family doctor program. *Public Health Nutrition*, *15*(1), 82-87. https://doi.org/10.1017/S1368980011001571
Thompson, F. E., & Byers, T. (1994). Dietary assessment resource manual. *The Journal of Nutrition*, *124*, 2245s-2317s. https://doi.org/10.1093/jn/124.suppl_11.2245s
Thompson, F. E., & Subar, A. F. (2017). Dietary assessment methodology. *Nutrition in the Prevention and Treatment of Disease*, 5-48. https://doi.org/10.1016/B978-0-12-802928-2.00001-1
Tsochantaridou, A., Sergentanis, T. N., Grammatikopoulou, M. G., Merakou, K., Vassilakou, T., & Kornarou, E. (2023). Food advertisement and dietary choices in adolescents: An overview of recent studies. *Children*, *10*(3), 442. https://doi.org/10.3390/children10030442
U.S Census Bureau. (n.d, 15 May 2024). *Subject definitions*. https://www.census.gov/programs-surveys/cps/technical-documentation/subject-definitions.html#incometopovertyratios
University of Otago and Ministry of Health. (2011). *A focus on nutrition: Key finding of the 2008/09 New Zealand adult nutrition survey*. Wellington Retrieved from https://www.health.govt.nz/system/files/2011-10/a-focus-on-nutrition-v2.pdf
Vandevijvere, S., De Ridder, K., Fiolet, T., Bel, S., & Tafforeau, J. (2019). Consumption of ultra-processed food products and diet quality among children, adolescents and adults

in Belgium. *European Journal Of Nutrition*, *58*(8), 3267-3278. https://doi.org/10.1007/s00394-018-1870-3

Vandevijvere, S., Jaacks, L. M., Monteiro, C. A., Moubarac, J.-C., Girling-Butcher, M., Lee, A. C., Pan, A., Bentham, J., & Swinburn, B. (2019). Global trends in ultraprocessed food and drink product sales and their association with adult body mass index trajectories. *Obesity Reviews*, *20*(S2), 10-19. https://doi.org/10.1111/obr.12860

Vandevijvere, S., Mackay, S., D'Souza, E., & Swinburn, B. (2014). How healthy are New Zealand food environments. *A comprehensive assessment*, *2017*, 25.

Vandevijvere, S., Soupen, A., & Swinburn, B. (2017). Unhealthy food advertising directed to children on New Zealand television: Extent, nature, impact and policy implications. *Public Health Nutrition*, *20*(17), 3029-3040. https://doi.org/10.1017/S1368980017000775

Vargas-Quesada, R., Monge-Rojas, R., Rodríguez-Ramírez, S., Araneda-Flores, J., Cacau, L. T., Cediel, G., Gaitán-Charry, D., Pizarro Quevedo, T., Pinheiro Fernandes, A. C., Rovirosa, A., Sánchez-Pimienta, T. G., & Zapata, M. E. (2025). Adherence to the eat-lancet diet among urban and rural Latin American adolescents: Associations with micronutrient intake and ultra-processed food consumption. *Nutrients*, *17*(12), 2048. https://doi.org/10.3390/nu17122048

Viner, R. M., Ozer, E. M., Denny, S., Marmot, M., Resnick, M., Fatusi, A., & Currie, C. (2012). Adolescence and the social determinants of health. *The Lancet*, *379*(9826), 1641-1652. https://doi.org/10.1016/S0140-6736(12)60149-4

Viner, R. M., Ross, D., Hardy, R., Kuh, D., Power, C., Johnson, A., Wellings, K., McCambridge, J., Cole, T. J., & Kelly, Y. (2015). Life course epidemiology: Recognising the importance of adolescence. *69*(8), 719-720. http://www.jstor.org/stable/44017576

Vitale, M., Costabile, G., Testa, R., D'Abbronzo, G., Nettore, I. C., Macchia, P. E., & Giacco, R. (2024). Ultra-processed foods and human health: A systematic review and meta-analysis of prospective cohort studies. *Advances In Nutrition*, *15*(1), 100121. https://doi.org/10.1016/j.advnut.2023.09.009

Waikato Wellbeing Project. (2025). Waikato regional foodshed analysis 2024. https://www.waikatowellbeingproject.co.nz/site_files/36997/upload_files/FoodshedInfo-12'3-WholeDocumentLR.pdf?dl=1

Wang, L., Martínez Steele, E., Du, M., Pomeranz, J. L., O'Connor, L. E., Herrick, K. A., Luo, H., Zhang, X., Mozaffarian, D., & Zhang, F. F. (2021). Trends in consumption of ultraprocessed foods among US youths aged 2-19 years, 1999-2018. *JAMA*, *326*(6), 519-530. https://doi.org/10.1001/jama.2021.10238

Welch, R. W., & Mitchell, P. C. (2000). Food processing: A century of change. *British Medical Bulletin*, *56*(1), 1-17. https://doi.org/10.1258/0007142001902923

Wiki, J., Kingham, S., & Campbell, M. (2019). Accessibility to food retailers and socio-economic deprivation in urban New Zealand. *New Zealand Geographer*, *75*(1), 3-11. https://doi.org/10.1111/nzg.12201

Willett, W. (2012a). Food Frequency Methods. In *Nutritional Epidemiology* (pp. 70-95). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199754038.003.0005

Willett, W. (2012b). Issues in analysis and presentation of dietary data. In W. Willett (Ed.), *Nutritional Epidemiology* (pp. 305-333). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199754038.003.0013

World Health Organization. (2016). Tackling food marketing to children in a digital world: Trans-disciplinary perspectives: Children's rights, evidence of impact, methodological challenges, regulatory options and policy implications for the WHO European region.

Tackling Food Marketing To Children In A Digital World: Trans-Disciplinary Perspectives: Children's Rights, Evidence Of Impact, Methodological Challenges, Regulatory Options And Policy Implications For The Who European Region.

Yang, Y., Gao, Y., Yi, X., Hu, Y., Zhao, L., Chen, L., Sui, W., Zhang, S., & Ma, S. (2024). The impact of ultra-processed foods and unprocessed or minimally processed foods on the quality of life among adolescents: A longitudinal study from China. *Frontiers in Nutrition*, *11*, 1489067. https://doi.org/10.3389/fnut.2024.1489067

Zhang, Z., Jackson, S. L., Steele, E. M., Gillespie, C., & Yang, Q. (2022). Relationship between ultraprocessed food intake and cardiovascular health among US adolescents: Results from the national health and nutrition examination survey 2007–2018. *Journal Of Adolescent Health*, *70*(2), 249-257. https://doi.org/10.1016/j.jadohealth.2021.09.031

Ziegler, A. M., Kasprzak, C. M., Mansouri, T. H., Gregory, A. M., Barich, R. A., Hatzinger, L. A., Leone, L. A., & Temple, J. L. (2021). An ecological perspective of food choice and eating autonomy among adolescents. *Frontiers In Psychology*, *12*, 654139. https://doi.org/10.3389/fpsyg.2021.654139

Appendices

A) **Food Groupings (**adapted from (Baraldi et al., 2018; Louzada, Martins, et al., 2015; Madalosso et al., 2023; Moubarac et al., 2017)

UPF food group name	**Food and drink items**
Biscuits, cakes, and desserts	Biscuits
	Custard
	Puddings
	Slices
	Doughnuts
	Muffins
	Cakes
	Crepes, fruit pies
	Jelly
	Ice cream
Bread and bread products	Commercial bread loaves
	Bagels
	Bread rolls
	Chapatti and naan
	Tortilla
	Crumpets
	English muffins
Breakfast cereals	Bran and corn flakes
	Granola
	Muesli
	Sachet oats/porridge
	Weetbix
	Chocolate cereals
	Rice bubbles
	Sultana bran
Carbonated drinks	Energy drinks

	Coca-cola
	Lemonade
	Lemon, lime, bitters
	Fruit soft drinks
Cheese and cheese products	Processed cheese slices
	Cream cheese
	Cottage cheese
	Ricotta
Chips, crackers, nuts, and other salty snacks	Potato chips
	Vegetable chips
	Pea crisps
	Corn chips
	Popcorn
	Pretzels
	Prawn crackers
	Potato chips
	Rice cakes
Chocolate and confectionary	Chocolate bars
	Chocolate truffles
	M&M's
	Rocky road
	Chocolate covered fruit
	Butterscoth sweets
	Lollipops
	Hard variety sweets
	Mints
	Chewing gum
	Licorice
Fast foods/takeaways	Burgers
	Breakfast muffins
	Pizza

	Bacon and egg roll
	Meat pies
Grains, pasta, noodles	Microwave rice
	Filled pastas
	Egg noodles
	Wheat noodles
	Instant noodles
Meat alternatives	Falafel
	Tofu
	Plant-based meats
Meat and meat products	Canned meat and fish
	Bacon
	Ham
	Deli meats
	Sausage
	Crumbed meats and fish
	Battered meats and fish
	Burger patties
Milk, milk alternatives, milk-based drinks, milk products	Cows milk
	Plant-based milks
	Coconut cream
	Sour cream
	Iced chocolate
	Milkshake
	Up & Go
	Smoothies
	Condensed milk
	Yoghurts
Mixed dishes	Stir fry
	Mexican dishes
	Boil up
	Pasta dishes

	Fried rice
	Curry
	Cottage pie
	Dumplings
	Casserole and stews
	Soups
	Sushi
	Salads
Non-carbonated drinks	Iced tea
	Tonic water
	Slushies
	Fruit juices
	Vegetable juices
	Sports drinks
	Flavoured water
Other	Alcohol
	Herb and spice mixes
	Muesli bars
	Sweetener and syrups
	Protein powder
	Stock
	Dried fruit
Spreads and sauces	Butter
	Margarine
	Jam
	Nut butters
	Mayonnaise
	Soy sauce
	Hummus
	Vegemite
	Gravy
	Mustard

Tea, coffee, hot chocolate	Instant coffee
	Iced coffee
	Chai latte
	Bubble tea
Vegetables and vegetable products	Onion rings
	Frozen fries
	Hash brown
	Canned vegetables
	Wedges
	Cassava fries
	Olives