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Child feeding indexes measuring adherence to New Zealand nutrition guidelines: Development and assessment

Teresa Gontijo de Castro[1,2] | Sarah Gerritsen[2,3] | Leonardo P. Santos[4] | Dirce M. L. Marchioni[5] | Susan M. B. Morton[3] | Clare Wall[2]

[1]Department of Nutrition and Dietetics, Faculty of Medical Sciences, University of Auckland, Auckland, New Zealand

[2]Department of Epidemiology and Biostatistics, School of Population Health, University of Auckland, Auckland, New Zealand

[3]Centre for Longitudinal Research, School of Population Health, University of Auckland, Auckland, New Zealand

[4]Department of Nutrition, Federal University of Pelotas, Pelotas, Brazil

[5]Department of Nutrition, School of Public Health, University of Sao Paulo, São Paul, Brazil

Correspondence

Teresa G. de Castro, Department of Nutrition and Dietetics, Faculty of Medical Sciences, University of Auckland, Grafton Rd - Bldg 219, Level B, Room B01. 1010 Auckland, New Zealand.

Email: t.castro@auckland.ac.nz

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Abstract

New Zealand (NZ) lacks nationally representative or generalisable information on the dietary intakes of pre-schoolers. We used Growing Up in New Zealand cohort data to i) develop child feeding indexes (CFIs) based on National Food and Nutrition Guidelines for 2- and 4.5-year-olds; ii) describe the cohort adherence to the guidelines at 2 ($n = 6046$) and 4.5 years ($n = 5889$) and; iii) assess the CFIs' convergent construct validity, by exploring associations with maternal sociodemographic and health behaviours and with child body mass index for age (BMI/age) and the waist-to-height ratio at 4.5 years. The CFIs scores ranged from 0 to 11, with 11 representing full adherence to the guidelines. Associations were tested using multiple linear regressions and Poisson regressions with robust variance (risk ratios [RR], 95% confidence intervals, 95% CI). The CFIs mean scores (SD) at 2 and 4.5 years were, respectively, 6.13 (1.21) and 6.22 (1.26) points. Maternal characteristics explained, respectively, 27.2% and 31.9% of the variation in the CFIs scores at 2 and 4.5 years. In the adjusted model at the 4.5-year interview, in relation to girls ranked in the 5th quintile, those in the 2nd (RR, 95% CI: 1.48; 1.03; 1.24) and 4th (1.53; 1.05; 2.23) quintiles of the CFI were more likely to have BMI/age > +2z (World Health Organization growth standards) at 4.5 years. At 2 and 4.5 years, most children fell short of meeting national guidelines. The associations between the CFIs scores at both time points with maternal characteristics and with children's body size at 4.5 years were in the expected directions, confirming the CFIs' convergent construct validity among NZ pre-schoolers.

KEYWORDS

child feeding, childhood diet, childhood obesity, dietary intake assessment, food-based dietary guidelines, inequalities

1 | INTRODUCTION

The establishment of unhealthy eating habits in early childhood is linked to childhood obesity and other risk factors for noncommunicable diseases which are tracked throughout the life course (Ambrosini et al., 2012, 2014; Fernández-Alvira et al., 2017; Pala et al., 2013; Skouteris et al., 2020). Therefore, the period from conception to age 5 years has been identified as a highly sensitive window for strategies to prevent childhood obesity via targeting social inequities and improving nutrition. New Zealand (NZ) had the second-highest rate of child/adolescent obesity among countries of the Organisation for Economic Cooperation and Development/European Union (United Nations Children's Fund-UNICEF, 2019).

However, NZ lacks information, nationally representative, or generalisable, about the dietary intake of under 5 year olds and the sociodemographic predictors of intake. This is crucial information for guiding targeted interventions aiming at equitable optimal nutrition in early life. Three recent studies, using data from *Growing up in New Zealand* (*GUiNZ*), a nationally generalisable birth cohort, have described the dietary practices of infants and their maternal determinants, focusing on diet quality (Castro et al., 2021), breastfeeding duration (Castro et al., 2017), and the timing of food introduction (Ferreira et al., 2022). Nevertheless, information on dietary intake and practices of pre-schoolers is currently lacking.

Dietary intake indexes (scores) measure the whole of diet and it is commonly based on the degree of adherence to food and nutrition evidence-based guidelines (Marshall et al., 2014; Smithers et al., 2011; Wajers et al., 2007). In relation to individual assessments of nutrients and foods, this a priori holistic dietary assessment has the advantage to evaluate the cumulative impact of the whole diet over time on health outcomes and to predict diet-related diseases later in life (Marshall et al., 2014; Smithers et al., 2011; Wajers et al., 2007).

Previous studies conducted or including pre-schoolers in different countries have characterised diets using a measurement of the whole diet, such as dietary intake scores (dietary indexes) (Burrows et al., 2014; Delshad et al., 2019; Golley et al., 2011; Huybrechts et al., 2010; Jarman et al., 2020; Kranz et al., 2008; Kyttälä et al., 2014; Manios et al., 2009; Serra-Majem et al., 2004; Voortman et al., 2015). However, the development and assessment of the utility of these indexes are still understudied, and further research is needed to better understand diet quality in early childhood and its relationships with health-related outcomes (Marshall et al., 2014).

In NZ, previous studies developed and assessed dietary indexes measuring adherence to National Food and Nutrition Guidelines (NFNG) among adolescents (Wong et al., 2013), children (Delshad et al., 2019), and infants (Castro et al., 2021). The index developed for adolescents ($n = 41$) presented good reliability and reasonable agreement with a 4-day estimated food record (4DFR) (Wong et al., 2013). The index developed for pre-schoolers/schoolers ($n = 65$) had good reliability and moderate relative validity when contrasted with a 4DFR (Delshad et al., 2019). However, both mentioned studies (Delshad et al., 2019; Wong et al., 2013) were based on small and convenience samples, limiting the generalisability of the use of the indexes to the ethnic diverse NZ children and young people. On the other hand, the infant feeding index (IFI) was based on dietary information collected with a food frequency questionnaire (FFQ) involving 6343 infants from the *GUiNZ* cohort study. The IFI showed good construct convergent validity with maternal sociodemographic and health behaviour characteristics and with children's body size at the age of 4.5 years, indicating the usefulness of the index for the multiethnic and contemporary NZ infants (Castro et al., 2021).

Key messages

- Data from a nationally generalisable New Zealand birth cohort was used to i) develop child feeding indexes (CFIs) for 2 and 4.5-year-olds based on National Food and Nutrition Guidelines (NFNG); ii) describe the cohort's adherence to the NFNG; and iii) assess the CFIs' construct validity.
- There was low adherence to the overall NFNG at 2 and 4.5 years and adherence was predicted by inequalities in maternal sociodemographics and health behaviours.
- In unadjusted regressions, children ranked in the 2nd–4th quintiles of the CFIs, in relation to those ranked in the highest quintiles (5th), were more likely to have higher body size and adiposity at 4.5 years. In adjusted model, girls with lower adherence to the NFNG at 4.5 years were more likely to have BMI/age > +2z at 4.5 years.
- Associations between CFIs scores with maternal characteristics and child adiposity were in the expected directions, confirming the indexes` construct validity.

In this study, using data from the *GUiNZ* study, we aimed to: i) develop child feeding indexes (CFIs) based on NFNG for 2- 4.5-year-olds; ii) describe the adherence of the cohort at 2 and 4.5 years with the guidelines; and ii) assess the CFIs' convergent construct validity, by exploring associations with antenatal maternal sociodemographic and health behaviours and with child body size at 4.5 years.

2 | METHODS

2.1 | GUiNZ, the population of study, and ethical approval

This study used data from the contemporary NZ birth cohort study, *GUiNZ*, which enroled 6822 pregnant women and their 6853 children who survived to age 6 weeks (Morton et al., 2015). Pregnant women's eligibility was determined by an estimated delivery date between 25 April 2009 and 25 March 2010 and residence within three contiguous district health boards in NZ. At birth, the cohort was broadly generalisable by ethnicity and socioeconomic position to all

NZ births from 2007 to 2010. *GUiNZ* was conducted according to the guidelines of the Declaration of Helsinki and all procedures involving human subjects were approved by the Ministry of Health's Northern Y Regional Health and Disability Ethics Committee (NTY/08/06/055). Written informed consent was obtained from all mothers/caregivers (Morton et al., 2015).

We used information from four *GUINZ* data collection waves (antenatal and when the cohort was aged approximately 6 weeks, 2 years, and 4.5 years) and from the *National Minimum Dataset (NMDS). The NMDS* is a system that registers all hospital admissions in NZ and it is linkable to the *GUiNZ* cohort data. This data linkage was needed so the children chronically dependent on complex technologies within the cohort could be identified based on the International Statistical Classification of Diseases, 10th revision, Australian modification (World Health Organization, 2016).

Data on maternal sociodemographic and health behaviour characteristics were obtained from the maternal antenatal, 2- and 4.5-year face-to-face computer-assisted personal interviews (CAPIs). Children's perinatal information (sex, fetal count, birth weight, and gestational age) was obtained from the 6-week computer-assisted telephone interview. Information on children's dietary intake was obtained from the 2- and 4.5-year children's CAPIs. At the 4.5-year CAPI, information on children's screen use was collected and children's weight (W), height (H), and waist circumference (WC) were measured by trained interviewers.

Of the 6853 children enroled in the cohort, the respective proportions of children for whom the 2- and 4.5-year interviews were completed were 92% (n = 6237) and 90% (n = 6156) (Morton et al., 2017). Supporting Information: Figure S1 describes the number of children studied during the 2- and the 4.5-year interviews and the number of children included in the analyses performed. To describe the cohort's adherence to individual NFNG for 2–18-year-olds (Ministry of Health, 2015) children who were chronically dependent on complex technologies were excluded because the national guidelines apply only to healthy children. To describe the cohort's adherence to all NFNG, a further 20 children (0.3%) at 2 years and 12 children (0.2%) at 4.5 years were excluded because they had missing information for the CFIs. To examine the associations between the children's score in the CFIs at 2 and 4.5 years and maternal sociodemographic and health behaviour characteristics, twins and triplets were excluded to guarantee that only independent observations were included in the analyses. Finally, to examine the associations between children's score in the CFIs at both time points and child body mass index for age (BMI-for-age) and waist-to-height ratio (WtHR) at 4.5 years, it was excluded: i) children with missing information for BMI-for-age or for WtHR and/or; ii) whose measurements of W, H, and/or WC collected had poor reliability (the definition of poor reliability is described in Section 2.4).

2.2 | Dietary intake assessment and development of the CFI at 2 and 4.5 years

GUiNZ used semiquantitative food frequency questionnaires (FFQs) to assess children's dietary intakes at 2 and at 4.5 years (containing sixty-two food items). These FFQs were adapted from the validated 80-item quantitative FFQ used by the Southampton women's survey which assessed the dietary quality and nutrient intake of 3-year-olds (Jarman et al., 2014). However, *GUiNZ* FFQs were designed to measure the cohort's adherence to the nationally recommended intake of food groups for pre-schoolers, rather than for evaluating children's usual intakes (Ministry of Health, 2015). To guarantee the inclusion of the most consumed foods by the NZ pre-schoolers, *GUiNZ* FFQs food lists were revised based on nationally representative information on dietary intake for 5–14-year-olds (Ministry of Health, 2003) and on information from a study conducted in Auckland-NZ with 6–23-month-olds (Wall et al., 2009). The only difference in the food lists of the FFQs used at 2 and at 4.5 years was that "toddler formula milk" and "toddler prepared meals" were part of the 2-year FFQ but not of the 4.5-year FFQ. Similarly, "avocados" and "crackers" were part of the 4.5-year FFQ but not of the 2-year FFQ.

At the 2- and 4.5-year interviews, mothers were asked to report their children's usual intake in the previous 4 weeks as well as the serving sizes typically eaten (two or more, one, ½, and ¼ servings). Showcards containing the photos of usual servings of foods/food groups listed in the FFQs were shown to participants to help them answering this question.

We used *GUiNZ* FFQs data to develop the CFIs measuring the cohort's adherence to the NFNG (Ministry of Health, 2015) that were current when the 2- and 4.5-year interviews took place (in 2011 and 2013, respectively). The selection and scoring of the indicators to compose the CFIs were made in collaboration with the Nutrition and Physical Activity Policy Team of the NZ Ministry of Health. These indicators were created using statements in the NFNG (Ministry of Health, 2015) that were applicable to 2–5-year-olds and that could be measured with the *GUiNZ* data (for details, consult Table 1). The CFIs contained 11 indicators measuring: i) intakes of recommended core food groups (fruits; vegetables; milk and milk products or suitable alternatives; breads and cereals; and lean meat, poultry, fish, shellfish, eggs, legumes, nuts, and seeds); ii) intakes of wholegrain breads and cereals and low-fat milk and milk products; iii) foods and drinks with limited intakes recommended: processed meats and specified drinks (such as fruit juice, cordial, fruit drink, fizzy drinks—including diet options, sports drinks, sports water, and energy drinks); and intakes of foods with high content of added sugars, sodium, and saturated fat (Table 1). Information on the list of food items included in the quantification of the indicators of the CFIs at 2 and 4.5 years is provided in Supporting Information: Table S1.

Each indicator of the CFIs had a maximum score of 1.0 point and the maximum score of the CFIs was 11.0 points (with 11 points meaning that all guidelines were fully met and a higher score reflecting greater overall compliance with the NFNG (Ministry of Health, 2015). For indicators described in i) and ii), we adopted a crescent gradient scoring starting from 0.0 point (intake = zero serving/daily) to 1.0 point (intake ≥ daily recommended number of servings). For indicators described in iii), we

TABLE 1 Indicators and scoring of the child feeding indexes at the 2- and 4.5-year interviews and links to the New Zealand National Food and Nutrition Guidelines (2–18-year-olds)

Indicators	Categories/scoring		Maximum indicator score	Linking statement in the National Food and Nutrition Guidelines (2–18 year-olds) (27)
Vegetables Total daily intake (serving)	None	0	1.0	*Eat each day vegetables and fruit, including different colours and textures.*
	>0 and ≤0.25 serving/day	0.11		Recommendation for pre-schoolers: At least two servings daily.
	>0.25 and ≤0.50 serving/day	0.22		Scoring based on total daily intake.
	>0.50 and ≤0.75 serving/day	0.33		
	>0.75 and ≤1.00 serving/day	0.44		
	>1.00 and ≤1.25 serving/day	0.55		
	>1.25 and ≤1.50 serving/day	0.66		
	>1.50 and ≤1.75 serving/day	0.77		
	>1.75 and <2 serving/day	0.88		
	≥2 serving/day	1.00		
Fruits Total daily intake (serving)	None	0	1.0	*Eat each day vegetables and fruit, including different colours and textures.*
	>0 and ≤0.25 serving/day	0.11		Recommendation for pre-schoolers: At least two servings daily.
	>0.25 and ≤0.50 serving/day	0.22		Scoring based on total daily intake.
	>0.50 and ≤0.75 serving/day	0.33		
	>0.75 and ≤1.00 serving/day	0.44		
	>1.00 and ≤1.25 serving/day	0.55		
	>1.25 and ≤1.50 serving/day	0.66		
	>1.50 and ≤1.75 serving/day	0.77		
	>1.75 and <2 serving/day	0.88		
	≥2 serving/day	1.00		
Breads and cereals Total daily intake (serving)	None	0	1.0	*Eat each day breads and cereals, increasing wholegrain products as children increase in age.*
	>0 and ≤0.50 serving/day	0.11		Recommendation for pre-schoolers: At least four servings daily.
	>0.50 and ≤1.00 serving/day	0.22		Scoring based on total daily intake.
	>1.00 and ≤1.50 serving /day	0.33		
	>1.50 and ≤2.00 serving /day	0.44		
	>2.00 and ≤2.50 serving/day	0.55		
	>2.50 and ≤3.00 serving/day	0.66		
	>3.00 and ≤3.50 serving/day	0.77		
	>3.50 and <4.00 serving /day	0.88		
	≥4 serving/day	1.00		
Breads and cereals (wholegrains) Total daily intake (serving)	*Scoring at 24 months*		1.00	*Eat each day breads and cereals, increasing wholegrain products as children increase in age.*
	None	0		Recommendation for pre-schoolers: Wholegrain options need to increase as children get older.
	>0 and <=0.20 serving/day	0.17		Scoring based on total daily intake.
	>0.20 and ≤0.40 serving/day	0.34		Maximum scores given at the 2- and 4.5-year interviews differed once the guidelines recommend increase in intake of

TABLE 1 (Continued)

Indicators	Categories/scoring		Maximum indicator score	Linking statement in the National Food and Nutrition Guidelines (2–18 year-olds) (27)
				these items as increased age. Maximum scores were given to children who at the 2- and 4.5-year interviews had intakes equal of higher than the median distribution of the GUiNZ population who took part of the 2- and 4.5-year interviews.
	>0.40 and ≤0.60 serving/day	0.51		
	>0.60 and ≤0.80 serving/day	0.68		
	>0.80 and <1.20 serving/day	0.85		
	≥1.20 serving/day	1.00		
	Scoring at 54-months		1.00	
	None	0		
	>0 and ≤0.30 serving/day	0.17		
	>0.30 and ≤0.60 serving/day	0.34		
	>0.60 and ≤0.90 serving/day	0.51		
	>0.90 and ≤1.20 serving/day	0.68		
	>1.20 and <1.50 serving/day	0.85		
	≥1.50 serving/day	1.00		
Milk and milk products or suitable alternatives Total daily intake (serving)	None	0	1.00	*Eat each day milk and milk products or suitable alternatives, preferably reduced or low-fat options.*
	>0 and ≤0.25 serving/day	0.11		Recommendation for pre-schoolers: At least 2–3 servings daily.
	>0.25 and ≤0.50 serving/day	0.22		Scoring based on total daily intake. Maximum score given if intake ≥minimum recommended daily serving size (2).
	>0.50 and ≤0.75 serving/day	0.33		
	>0.75 and ≤1.00 serving/day	0.44		
	>1.00 and ≤1.25 serving/day	0.55		
	>1.25 and ≤1.50 serving/day	0.66		
	>1.50 and ≤1.75 serving/day	0.77		
	>1.75 and <2 serving/day	0.88		
	≥2 serving/day	1.00		
Milk and milk products or suitable alternatives (low-fat) Total daily intake (serving)	None	0	1.00	*Eat each day milk and milk products or suitable alternatives, preferably reduced or low-fat options. Include reduced or low-fat milk everyday.*
	>0 and ≤0.25 serving/day	0.20		Scoring based on total daily intake.
	>0.25 and ≤0.50 serving/day	0.40		
	>0.50 and ≤0.75 serving/day	0.60		
	>0.75 and <1.0 serving/day	0.80		
	≥1.0 serving/day	1.00		
Lean meat, poultry, fish, shellfish, eggs, legumes, nuts and seeds Total daily intake (serving)	None	0	1.0	*Eat each day lean meat, poultry, eggs, seafood, legumes, nuts, and seeds (limit processed meats).*

(Continues)

TABLE 1 (Continued)

Indicators	Categories/scoring		Maximum indicator score	Linking statement in the National Food and Nutrition Guidelines (2–18 year-olds) (27)
	>0 and ≤0.125 serving/day	0.11		Recommendation for pre-schoolers: at least 1-2 servings/daily.
	>0.125 and ≤0.250 serving/day	0.22		Scoring based on total daily intake. Maximum score given if intake >minimum recommended daily serving size (1).
	>0.250 and ≤0.375 serving/day	0.33		
	>0.375 and ≤0.500 serving/day	0.44		
	>0.500 and ≤0.625 serving/day	0.55		
	>0.625 and ≤0.750 serving/day	0.66		
	>0.750 and ≤0.875 serving/day	0.77		
	>0.875 and <1.00 serving/day	0.88		
	≥1.00 serving/day	1.00		
Limit processed meats Total weekly intake (serving)	≤1.00 serving/week	1.00	1.00	*Eat each day lean meat, poultry, eggs, seafood, legumes, nuts and seeds (limit processed meats).*
	>1.00 serving/week	0		Scoring based on total weekly intake. Maximum score given if intake ≥1 serving/week.
Limit specified drinks Total weekly intake (serving)	≤1.00 serving/week	1.00	1.00	*Limit drinks such as fruit juice, cordial, fruit drink, fizzy drinks (including diet drinks), sports drinks, and sports water. Energy drinks or energy shots are not recommended.*
	>1.00 serving/week	0		Scoring based on total weekly intake. Maximum score given if intake ≥1 serving/week.
	>1.00 serving/week	0		
Prepare or choose preprepared foods- snacks and drinks low in sugar-especially added sugars Total weekly intake (serving)	0 serving/week	1.00	1.00	*Prepare or choose preprepared foods- snacks and drinks low in sugar-especially added sugars.*
	>0 and ≤1.00 serving/week	0.50		Scoring based on total weekly intake. Maximum score given if intake was equal zero (1.00 point); 0.50 point was given if intake limited to one serving/week and zero point was given if intakes were greater than 1 serving/week.
	>1.00 serving/week	0		
Prepare or choose preprepared foods-snacks and drinks low in salt and fats-especially saturated fat. Total weekly intake (serving)	0 serving/week	1.00	1.00	*Prepare or choose preprepared foods—snacks and drinks low in salt and fat- especially saturated fat.*
	>0 and ≤1.00 serving/week	0.50		Scoring based on total weekly intake. Maximum score given if intake was equal zero (1.00 point); 0.50 point was given if intake limited to one serving/week and zero point was given if intakes were greater than 1 serving/week.
	>1.00 serving/week	0		
Total score			11	

Abbreviation: GUINZ, Growing Up in New Zealand.

scored 1.0 point for intakes limited to ≤1 serving/week and zero point if intakes were >1 serving/week. For indicators described in iv), a maximum score (1.0 point) was provided for intakes equal to zero serving/week, 0.5 points for intakes >0 and ≤1 serving/week, and 0.0 point for intakes >1 serving/week (Table 1). Face and content validity of the CFIs were assumed, as they were developed based on academic and policymakers' expertise (Bland & Altman, 2002).

2.3 | Maternal sociodemographic characteristics and health behaviours

Maternal sociodemographic and health behaviour variables that could potentially affect children's ability to meet the NFNG (Ministry of Health, 2015) were examined. At both time points, the same maternal variables were examined when assessing maternal characteristics' influence on children's scores in the CFIs. We used the following maternal information from the antenatal interview: maternal age, highest education level, and self-prioritised ethnicity, which was based on the NZ ethnicity identification and classification used by the Statistics NZ (2020) and which prioritises the allocation of individuals to one ethnic group (self-prioritised ethnicity level 1): (1) Māori, (2) Pacific people, (3) Asian, (4) Middle Eastern, Latin American, and African (MELAA), (5) European, and (6) other. The categories MELAA and Other were combined for analysis purposes.

During the 2- and 4.5-year interviews, maternal cigarette smoking was assessed by asking the mothers if they were currently smoking regularly at least one cigarette/daily (yes/no). Based on the children's home addresses, households were classified as rural/urban. Indexes of deprivation (NZDep), presented in deciles, were also used as the small area measure of neighbourhood deprivation (Atkinson & Crampton, 2021; Salmond et al., 2021). The NZDep2006 and the NZDep2013 were used, respectively, at 2 and 4.5 years. The NZDep2006 combines nine socioeconomic characteristics from the 2006 census data collected at aggregations of approximately 100 people and assigned to individual households based on geocoded address data (Salmond et al., 2021). The NZDep2013 is derived similarly to NZDep2006, however, using 2013 census data (Atkinson & Crampton, 2021).

2.4 | Anthropometric indicators and screen use at 4.5 years

At the 4.5-year interview, children's W, H, and WC were measured according to international (for W and H) (World Health Organization, 1995) and national protocols (for WC) (Ministry of Health, 2008). Details on the equipment and protocols used have been described elsewhere (Castro et al., 2021). Measurements of W, H, and WC were taken in duplicate and if the differences between measurements were greater than 0.5 kg (for W) and 1 cm (for H and WC), a third measurement was collected. After this procedure, if differences between the two closest measurements were still greater than 0.5 kg (for W) and 1 cm (for H and WC), these measurements were considered as of poor reliability. The WHO 2006 Growth Standards (World Health Organization, 2006) were used to calculate children's BMI-for-age values, and those with values greater than +2 z-scores were classified as being overweight/obese. BMI-for-age values lower than −5 z-scores or greater than +5 z-scores were considered outlier values (World Health Organization, 2006). WtHR was estimated by dividing children's WC measurements by their height (both measurements in cm). Then, *GUiNZ* cohort WtHR values at 2 and 4.5 years were ranked in percentiles and categorised as: ≤90th and >90th. Children with WtHR >90th percentile were classified as with high WtHR.

Children's usual screen time use was classified according to international guidelines (<60 and ≥60 min/day) (World Health Organization, 2019) based on mothers/caregivers' reports of the average minutes on a usual weekday their child watched television (TV) and used electronic media.

2.5 | Statistical analysis

We used descriptive statistics for reporting proportions (categorical variables) and means and standard deviations (SDs), medians, and value range (continuous variables). Proportions and means were compared, respectively, using Pearson χ^2 tests and Student *t*-tests for independent samples.

Associations between the children's CFIs scores at 2-and 4.5-year interviews (dependent variables) and the antenatal maternal sociodemographic and health behaviour characteristics (independent variables) were examined in unadjusted and adjusted linear regression models. Associations were described using beta coefficients and 95% confidence intervals [CIs]. Univariate associations with $p < 0.15$ were used to identify variables to be tested in the multiple variable linear regression model, following a forward stepwise approach. Covariates were retained in the adjusted models if associations with the outcome had $p < 0.05$ or changed the magnitude of the β-coefficient by 10% or more.

Associations between child overweight/obesity (BMI-for-age > +2 z-scores) and WtHR values >90th percentile at 4.5 years (dependent variables) and the score in the CFIs at 2 and 4.5 years (independent variables) were examined in unadjusted and adjusted Poisson regression models with robust variance. Associations were described using risk ratios (RRs) and 95% CIs. For these analyses, at both-time points, children were categorised into quintiles of the CFIs score, according to their ranking within the complete sample and within sexes (for sex-specific analyses). We adopted a similar methodology used in previous work (Castro et al., 2021), which used an *a priori* model to select and test the independent variables in these models. This *a priori* modelling assumes that maternal sociodemographic and health behaviour variables influence both the CFI score and child adiposity, and therefore, need to be adjusted for in the models. In addition, the anthropometric outcomes measured at the 4.5-year interview were also adjusted for child sex, exact age, screen time use at that time point, birth weight, and gestational age. Univariate associations with $p < 0.15$ were used to identify the independent variables to be tested in the multiple regression models, following a forward stepwise approach. Covariates were retained in the final models if associations with the outcomes had $p < 0.05$ or changed the magnitude of RR by 10% or more. Analyses containing BMI-for-age as outcome were performed both ways, including and excluding the children with outlier values for the indicator (World Health Organization, 2006). Where relevant, analyses were also stratified by sex. All analyses were performed using SPSS software (version 25, IBM SPSS Statistics).

3 | RESULTS

3.1 | Study population

Among the cohort sample studied during the 2- and 4.5-years interviews, the mean age (SD) were, respectively, 23.34 (1.99) and 53.96 months (1.56). At 2 and 4.5 years, respectively, the proportions of singletons in the cohort were 97.6% and 95.7%; of females 48.7% and 48.8%; of children born with low birth weight (<2500 g) 4.4% at both time points; and of premature (gestational age <37 weeks) 5.8% at both time points.

3.2 | Adherence to NFNG at 2 and 4.5 years

There was a statistically significant higher CFI mean (SD) at 4.5 years in relation to 2 years (6.22 [1.26] and 6.13 [1.21] points, respectively, *p*-value *t*-test < 0.001). However, there were no statistically significant differences in the CFIs mean scores between boys and girls in both time points. Figure 1 shows the distributions of the children according to their scores in the CFIs at 2 and 4.5 years. Respectively at 2 and 4.5 years, 45.5% and 42.9% scored less than 6 points while 0.9% and 1.2% scored 9 points or more in the CFIs.

Figure 2 shows and compares the proportions of children who met each of the 11 guidelines that composed the CFIs at 2 and at 4.5 years. None of the children fully adhered to all the NFNG (Ministry of Health, 2015) at both time points. Less than 50% of the cohort met 8 of the 11 guidelines at 2 years and 5 of the 11 guidelines at 4.5 years. In relation to the 2-year interview, at the 4.5-year interview: i) a higher proportion of children met the guidelines of recommended intakes of fruits; vegetables; breads and cereals (overall and wholegrain options); milk and milk products (overall); and lean meat, poultry, fish, shellfish, eggs, legumes, nuts and seeds and ii) a lower proportion met the guidelines of recommended intakes of milk and milk products (low-fat options), guidelines of limiting intakes of processed meats and specified drinks and of choosing or preparing foods with low content of added sugars, sodium, and saturated fat.

In relation to girls, a higher proportion of boys met the recommended intakes for: Breads and cereals at 2 and 4.5 years (respectively 42.3% vs. 37.0%, $p < 0.001$; 67.8% vs. 56.7%, $p < 0.001$), wholegrain breads and cereals at 2 and 4.5 years (54.0% vs. 50.8, $p = 0.011$; 57.6% vs. 52.9%, $p < 0.001$) and choosing or preparing foods with low content of added sugars at 4.5 years (3.5% vs. 2.4%, $p = 0.014$). In relation to boys, at 4.5 years, a higher proportion of girls met the recommended intakes for: vegetables (54.0% vs. 50.0%; $p = 0.002$) and limiting intake of processed meats (29.6% vs. 27.1%, $p = 0.031$) (data not shown in table).

3.3 | Children's scores in the CFIs at 2 and 4.5 years and maternal characteristics

The unadjusted associations between the children's score in the CFIs at 2 and 4.5 years and the maternal sociodemographic and health behaviour characteristics were presented in Table S2. In the fully adjusted models at 2 and 4.5 years, the children were more likely to have an average lower score in the CFIs if they: were living in the most deprived neighbourhoods (deciles 9–10 vs. deciles 1–2) and had mothers: with education level equal or lower than bachelor's degree (vs. higher than bachelor's degree), who were younger than 20 years

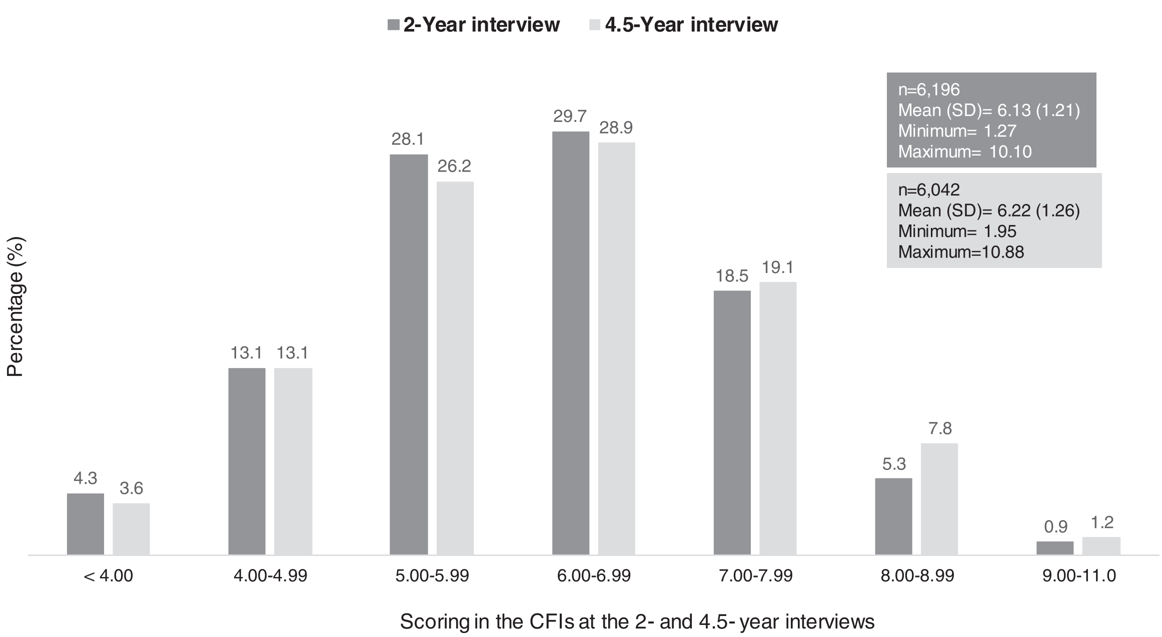

FIGURE 1 Distribution of the children according to their score in the child feeding indexes (CFI) at the 2- and 4.5-year interviews.

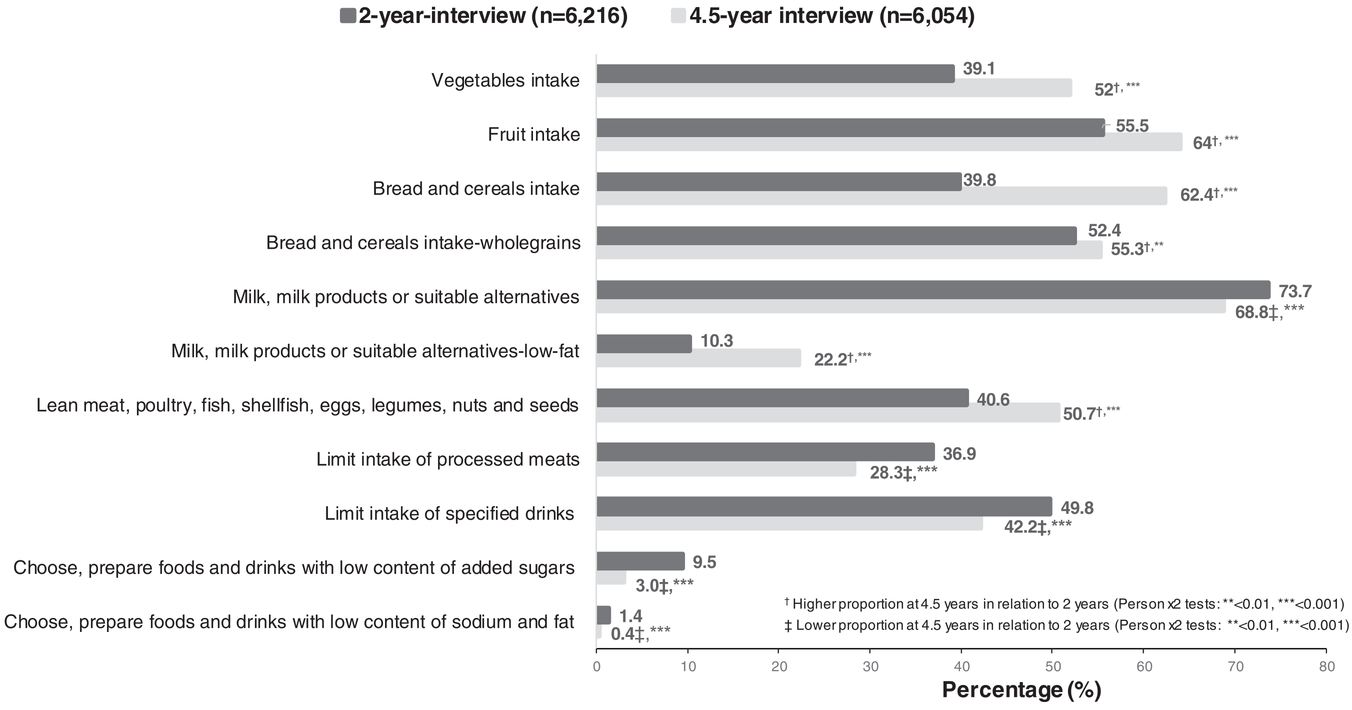

FIGURE 2 Proportion of children who met individual guidelines at the 2-and 4.5-year interviews.

of age (vs. ≥ 35 years), of Māori, Pacific, or Asian ethnicities (vs. European); and who were currently smoking (vs. nonsmokers). Respectively at 2 and 4.5 years, 27% and 32% of the variations in the CFIs scores were explained by maternal sociodemographic and health behaviour characteristics (Table 2).

3.4 | Children's scores in the CFIs at 2 and 4.5 years and anthropometric indicators at 4.5 years

Table 3 presents: i) the proportions of children with overweight/obesity (BMI-for-age > +2z) and with values of WtHR >90th percentile at 2 and 4.5 years, according to their ranking in the quintiles of the CFIs and, ii) the unadjusted and adjusted associations between the anthropometric indicators at 4.5 years (dependent variables) and their scoring in the CFIs at 2 and 4.5 years (for all cohort and by sex). In all unadjusted models and at both time points, there were statistically significant associations between children's scores in the CFIs and the anthropometric outcomes examined. Overall and in analyses stratified by sex, children ranked in the 1st–4th quintiles of the CFIs (in relation to those in the 5th quintile-highest) were more likely to have overweight/obesity or WtHR >90th percentile at 4.5 years. In the adjusted model, girls ranked in the 4th and 2nd quintiles of the CFI at 4.5 years (in relation to those ranked in the 5th quintile) were more likely to have overweight/obesity at 4.5 years (outcome included children with outlier values for BMI-for-age). Sensitivity analysis excluding girls with outlier values for BMI-for-age showed that those ranked in the 4th quintile of the CFI at 4.5 years (in relation to those in the 5th quintile) remained more likely to have overweight/obesity at 4.5 years. For all other sets of adjusted analyses (models) presented in Table 3, the significance of these associations disappeared, indicating that the previous significant associations in the unadjusted analyses were confounded by maternal characteristics.

4 | DISCUSSION

Results from this nationally generalisable cohort of NZ children showed that there was moderate to low adherence to individual NFNG (Ministry of Health, 2015) at two time points during the pre-school years, with sex differences for some of them. Overall, less than half of the cohort met 8 of the 11 individual guidelines at 2 years and 5 of the 11 guidelines at 4.5 years. There was also low adherence to the overall NFNG (Ministry of Health, 2015) in both time points, where, approximately 4 in 10 children scored less than 6 points in the CFIs and only approximately one in 100 children scored ≥9 points (of a total of 11 points).

The degree of adherence to the NFNG (Ministry of Health, 2015) was predicted by inequalities in maternal sociodemographic and health behaviour characteristics, which explained, respectively, 27.2% and 31.9% of the variation in the CFIs scores at 2 and 4.5 years. Children ranked in the 2nd–4th quintiles of the CFIs at 2 and 4.5 years, in relation to those ranked in the highest quintiles (5th), were more likely to have BMI/age > +2z or WtHR >90th percentile at 4.5 years in all unadjusted models (overall and stratified by sex). However, in the adjusted models, these associations remained significant only for girls with BMI/age > +2z at 4.5 years.

TABLE 2 Adjusted associations between the child feeding indexes scores (at the 2- and 4.5-year interviews) and maternal sociodemographic and health behaviour characteristics (all cohort)

Maternal sociodemographic and health behaviour characteristics	2-year interview[a]			4.5-year interview[b]		
	Adj. β[c]	95% CI	*p*	Adj. β[c]	95% CI	*p*
Highest level of education (antenatal)						
Higher than bachelor's degree	1	–		1	–	
Bachelor's degree	**−0.10**	**−0.19; −0.02**	**0.045**	**−0.13**	**−0.22; −0.03**	**0.012**
Diploma/Trade cert/NCEA 5–6	**−0.36**	**−0.45; −0.27**	**<0.001**	**−0.36**	**−0.46; −0.27**	**<0.001**
Secondary school/NCEA 1–4	**−0.41**	**−0.51; −0.31**	**<0.001**	**−0.45**	**−0.55; −0.34**	**<0.001**
No secondary school qualification	**−0.48**	**−0.64; −0.33**	**<0.001**	**−0.53**	**−0.69; −0.37**	**<0.001**
Self-prioritised ethnicity (antenatal)						
European	1	–		1		
Māori	**−0.24**	**−0.34; −0.14**	**<0.001**	**−0.30**	**−0.41; −0.20**	**<0.001**
Pacific	**−0.36**	**−0.46; −0.26**	**<0.001**	**−0.51**	**−0.62; −0.41**	**<0.001**
Asian	**−0.34**	**−0.43; −0.25**	**<0.001**	**−0.48**	**−0.57; −0.39**	**<0.001**
MELAA and others	−0.13	−0.30; 0.03	0.10	−0.11	−0.28; 0.062	0.21
Age group (antenatal)						
≥35 years	1	–		1	–	
20–34 years	−0.05	−0.20; 0.02	0.17	0.02	−0.05; 0.09	0.53
<20 years	**−0.29**	**−0.45; −0.12**	**0.001**	**−0.25**	**−0.42; −0.07**	**0.005**
Currently smoking (at the 2- and 4.5-year interviews)						
No	1	–		1	–	
Yes	**−0.21**	**−0.30; −0.11**	**<0.001**	**−0.23**	**−0.33; −0.34**	**<0.001**
Neighbourhood deprivation-quintiles[d] (at the 2- and 4.5-year interviews)						
1–2	1	–		1	–	
3–4	−0.02	−0.12; 0.08	0.70	0.02	−0.08; 0.11	0.72
5–6	−0.01	−0.19; 0.01	0.54	−0.09	−0.18; 0.01	0.72
7–8	−0.03	−0.13; 0.07	0.52	**−0.11**	**−0.21; −0.01**	**0.039**
9–10 most deprived	**−0.18**	**−0.28; −0.08**	**0.001**	**−0.24**	**−0.34; −0.14**	**<0.001**

Abbreviations: Adj. β, adjusted beta-coefficient; CI, confidence interval; MELAA, Middle Eastern, Latin American, and African; NCEA, *National Certificate of Educational Achievement*.

[a]*N* = 6021 children at the 2-year interview (excluded twins/triplets and children chronically dependent on complex health technologies). Adjusted R^2 of the multivariate model = 0.27. Missing (*n*)-2-year interview: Maternal education antenatally (35); maternal ethnicity antenatally (34); maternal age antenatally (17); maternal smoking status at the 2-year interview (<10[¶]); and neighbourhood deprivation index 2006 (145).

[b]*N* = 5509 children at the 4.5-year interview (excluded twins/triplets and children chronically dependent on complex health technologies). Adjusted R^2 of multivariate model model = 0.32. Missing (*n*)-4.5-year interview: Maternal education antenatally (60); maternal ethnicity antenatally (62); maternal age antenatally (46); maternal smoking status at the 4.5-year interview (<10[¶]); and neighbourhood deprivation index 2013 (330).

[c]Average increase or decrease in the child feeding index score in relation to the categories of reference.

[d]Neighbourhood deprivation index 2006 (2-year interview) and neighbourhood deprivation index 2013 (4.5-year interview).

[¶]As per the Growing Up in New Zealand study anonymity requirement, "<10" represents greater than zero and less than 10 children in the cell.

The NZ national recommended number of servings of core food groups is the same for 2–5-year-olds (Ministry of Health, 2015). Thus, it is likely that the higher adherence to the minimum recommended number of servings of core food groups reported in our study among older pre-schoolers (4.5 vs. 2 years) for fruits; vegetables; breads and cereals; milk and milk products (low-fat); and lean meats and substitutes may be explained by the fact that children's intakes of these foods are expected to increase as they grow older. However, at both time points, the low proportions of children meeting the recommended intakes for vegetables (39.1% at 2 years and 52% at 4.5 years) and fruits (55.5% at 2 years and 64% at 4.5 years) were concerning. For fruits, these proportions were similar

TABLE 3 Unadjusted and adjusted associations between the anthropometric indicators at 4.5 years and children's scores in the child feeding indexes at the 2- and 4.5-year interviews (for all the cohort, for boys and for girls).

Child feeding index score at the 2- and 4.5-year interviews (in quintiles)	2-year interview							4.5-year interview						
	N	Unadj. RR	95% CI	*p*	Adj. RR	95% CI	*p*	*N*	Unadj. RR	95% CI	*p*	Adj. RR	95% CI	*p*
BMI/A > +2z, including outlier values at 4.5 years (cohort)														
5th quintile	110	1						109	1					
4th quintile	135	1.21	0.96; 1.54	0.11	–	–	–	149	**1.39**	**1.11; 1.76**	**0.005**	–	–	–
3rd quintile	164	**1.60**	**1.28; 2.00**	**<0.001**				150	**1.43**	**1.13; 1.80**	**0.003**			
2nd quintile	181	**1.63**	**1.30; 2.00**	**<0.001**				186	**1.73**	**1.38; 2.15**	**<0.001**			
1st quintile	166	**1.56**	**1.25; 1.96**	**<0.001**				183	**1.72**	**1.37; 2.14**	**<0.001**			
BMI/A > +2z, excluding outlier values at 4.5 years (cohort)														
5th quintile	104	1						102	1					
4th quintile	127	1.21	0.95; 1.55	0.13	–	–	–	142	**1.42**	**1.12; 1.81**	**0.004**	–	–	–
3rd quintile	156	**1.61**	**1.27; 2.02**	**<0.001**				139	**1.42**	**1.12; 1.81**	**0.004**			
2nd quintile	168	**1.61**	**1.28; 2.03**	**<0.001**				169	**1.69**	**1.34; 2.13**	**<0.001**			
1st quintile	152	**1.53**	**1.21; 1.93**	**<0.001**				174	**1.75**	**1.39; 2.20**	**<0.001**			
BMI/A > +2z, including outlier values at 4.5 years (girls)[a]														
5th quintile	43	1						39	1			1		
4th quintile	57	1.31	0.90; 1.90	0.17	–	–	–	70	**1.84**	**1.26; 2.67**	**0.001**	**1.53**	**1.05; 2.23**	**0.026**
3rd quintile	76	**1.83**	**1.29; 2.61**	**0.001**				57	**1.49**	**1.01; 2.20**	**0.044**	1.18	0.80; 1.73	0.41
2nd quintile	75	**1.77**	**1.24; 2.52**	**0.002**				85	**2.17**	**1.52; 3.11**	**<0.001**	**1.48**	**1.03; 2.14**	**0.035**
1st quintile	60	1.42	0.98; 2.06	0.07				73	**1.91**	**1.32; 2.77**	**0.001**	1.16	0.79; 1.68	0.46
BMI/A > +2z, excluding outlier values at 4.5 years (girls)[b]														
5th quintile	42	1						37	1			1		
4th quintile	56	1.31	0.90; 1.92	0.16	–	–	–	67	**1.86**	**1.27; 2.72**	**0.002**	**1.56**	**1.06; 2.29**	**0.025**
3rd quintile	71	**1.77**	**1.23; 2.54**	**0.002**				55	**1.52**	**1.02; 2.26**	**0.041**	1.19	0.80; 1.77	0.38
2nd quintile	71	**1.72**	**1.20; 2.47**	**0.003**				79	**2.14**	**1.48; 3.11**	**<0.001**	1.46	1.00; 2.13	0.05
1st quintile	53	1.39	0.88; 1.91	0.19				68	**1.89**	**1.29; 2.76**	**0.001**	1.15	0.78; 1.70	0.48
BMI/A > +2z, including outlier values at 4.5 years (boys)														
5th quintile	73	1						70	1					
4th quintile	73	1.04	0.77; 1.41	0.79	–	–	–	84	1.20	0.90; 1.62	0.22	–	–	–

(Continues)

TABLE 3 (Continued)

Child feeding index score at the 2- and 4.5-year interviews (in quintiles)	2-year interview							4.5-year interview						
	N	Unadj. RR	95% CI	*p*	Adj. RR	95% CI	*p*	*N*	Unadj. RR	95% CI	*p*	Adj. RR	95% CI	*p*
3rd quintile	89	1.28	0.98; 1.70	0.09				89	1.30	0.97; 1.74	0.07			
2nd quintile	103	**1.47**	**1.11; 1.93**	**0.007**				103	**1.53**	**1.16; 2.03**	**0.003**			
1st quintile	107	**1.57**	**1.19; 2.06**	**0.001**				110	**1.60**	**1.21; 2.11**	**0.001**			
BMI/A > +2z, excluding outlier values at 4.5 years (boys)														
5th quintile	67	1						65	1					
4th quintile	67	1.05	0.76; 1.44	0.78	–	–	–	78	1.21	0.89; 1.65	0.22	–	–	–
3rd quintile	85	1.33	0.99; 1.79	0.06				81	1.28	0.95; 1.74	0.11			
2nd quintile	95	**1.48**	**1.11; 1.98**	**0.008**				92	**1.49**	**1.11; 2.00**	**0.008**			
1st quintile	100	**1.61**	**1.21; 2.14**	**0.001**				106	**1.66**	**1.25; 2.20**	**0.001**			
WtHR > 90th at 4.5 years (cohort)														
5th quintile	83	1						86	1					
4th quintile	101	1.20	0.91; 1.59	0.20	–	–	–	115	**1.37**	**1.05; 1.78**	**0.022**	–	–	–
3rd quintile	120	**1.54**	**1.18; 2.00**	**0.002**				119	**1.44**	**1.10; 1.87**	**0.007**			
2nd quintile	138	**1.66**	**1.29; 2.16**	**<0.001**				128	**1.51**	**1.17; 1.96**	**0.002**			
1st quintile	111	**1.40**	**1.07; 1.84**	**0.015**				117	**1.39**	**1.07; 1.82**	**0.015**			
WtHR > 90th at 4.5 years (girls)														
5th quintile	42	1						39	1					
4th quintile	47	1.11	0.74; 1.65	0.61	–	–	–	56	1.33	0.90; 1.96	0.16	–	–	–
3rd quintile	57	1.43	0.98; 2.08	0.07				45	1.46	0.99; 2.13	0.06			
2nd quintile	65	**1.58**	**1.10; 2.29**	**0.015**				66	**1.54**	**1.05; 2.25**	**0.027**			
1st quintile	47	1.14	0.77; 1.70	0.51				59	1.35	0.92; 1.99	0.13			
WtHR > 90th at 4.5 years (boys)														
5th quintile	36	1						41	1					
4th quintile	46	1.33	0.87; 2.02	0.19	–	–	–	54	1.47	0.99; 2.18	0.05	–	–	–
3rd quintile	59	**1.71**	**1.15; 2.54**	**0.009**				58	1.17	0.78; 1.77	0.45			

TABLE 3 (Continued)

Child feeding index score at the 2- and 4.5-year interviews (in quintiles)	2-year interview							4.5-year interview						
	N	Unadj. RR	95% CI	p	Adj. RR	95% CI	p	N	Unadj. RR	95% CI	p	Adj. RR	95% CI	p
2nd quintile	62	1.79	1.20; 2.65	0.004				60	1.69	1.16; 2.47	0.006			
1st quintile	58	1.75	1.17; 2.60	0.006				54	1.54	1.04; 2.26	0.003			

Abbreviations: Adj. RR, adjusted relative risk; BMI/A: body-mass-index for age; CI, confidence interval; Unadj. RR, unadjusted relative risk; WtHR: waist-to-height.

[a]N = 2640. Associations between the anthropometric indicator at 4.5 years and the score in the child feeding index (quintiles) at 4.5 years. Multivariate model adjusted by children's birth weight, maternal education antenatally, maternal ethnicity antenatally, maternal age antenatally, maternal current smoking status at the 4.5-year interview, and neighbourhood deprivation index 2013.

[b]N = 2622. Associations between the anthropometric indicator at 4.5 years and the score in the child feeding index (quintiles) at 4.5 years. Multivariate model adjusted by children's birth weight, maternal education antenatally, maternal ethnicity antenatally, maternal age antenatally, maternal current smoking status at the 4.5-year interview, and neighbourhood deprivation index 2013.

to those reported for 2–5-year-old Americans in a nationally representative sample in 2008 (45%) (Kranz et al., 2008) but lower than the one reported for 4–7-year-olds participants of the Australian Children's Nutrition and Physical Activity Survey in 2007 (76%) (Golley et al., 2011). *GUiNZ* proportions of children meeting recommended intakes of vegetables at 2 and 4.5 years were, however, higher than those reported for 2–5-year-old Americans (46%) (Kranz et al., 2008) and 4–7-year-old Australians (15%) (Golley et al., 2011).

There were high intakes of discretionary foods among the *GUiNZ cohort* at 2 and 4.5 years, where more than half of the cohort did not adhere to the recommendations of limiting intakes of processed meats and specified drinks (usually sugary) and the majority did not follow the guidelines of limiting intakes of foods with high content in sodium, saturated fat and added sugars. Despite the overall higher CFI mean at 4.5 years in relation to 2 years, there was a smaller proportion of children at 4.5 years (in relation to 2 years) who met the guidelines of avoiding discretionary foods. This suggests an overall reduction of diet quality between 2 and 4.5 years within the *GUiNZ* cohort related to higher intakes of highly processed foods.

We also reported some sex differences in the level of adherence for some indicators of the CFIs at both time points, but there were no differences in means of the CFIs scores between boys and girls at both time points. This was similar to observation reported for the dietary guideline index for children and adolescents, which measured adherence to Australian National Guidelines among 4–16-year-olds (Golley et al., 2011). This finding was contrary, however, to findings reported for indexes developed for 2–5-year-olds in Greece (Manios et al., 2009) and in the United States (US) (Kranz et al., 2008) and for 25-month-olds in the Netherlands (Voortman et al., 2015), all which showed significantly higher mean indexes scores for boys. The overall poor diet compliance to NFNG among the *GUiNZ* cohort at 2 and 4.5 years confirms findings reported from a Dutch population-based prospective cohort study of 25-month-olds (Voortman et al., 2015) and from nationally representative samples of 2–5-year-olds in Greece (Manios et al., 2009) and in the US (Kranz et al., 2008) and for 4–16-year-olds in Australia (Golley et al., 2011). The NZ study that developed an index measuring adherence to NFNG in a small convenience sample of 2–8-year-olds demonstrated a higher level of adherence to national guidelines than our study, where over 75% of participants scored more than 70 points (in a total score of 100) (Delshad et al., 2019).

At both time points, almost a third of the variation in the CFIs score was explained by differences in maternal sociodemographic and health behaviour characteristics. However, apart from the study of Jarman et al. (2020) (which reported that sociodemographic characteristics explained only 6% of the score variation of an index measuring adherence to National Canadian Nutrition Guidelines among 3-year-olds), comparisons with previous studies (Burrows et al., 2014; Delshad et al., 2019; Golley et al., 2011; Huybrechts et al., 2010; Kranz et al., 2008; Kyttälä et al., 2014; Manios et al., 2009; Serra-Majem et al., 2004; Voortman et al., 2015) are difficult because they have not reported the contribution that sociodemographic and health behaviour characteristics made to the variation of the indexes score.

The significant independent associations between maternal sociodemographic and health behaviours with children's scores in the CFIs at 2 and 4.5 years were in the expected directions, confirming previous observations from other countries among pre-schoolers (Golley et al., 2011; Kranz et al., 2008; Kyttälä et al., 2014; Manios et al., 2009; Serra-Majem et al., 2004; Voortman et al., 2015). A lower level of maternal education was also independently associated with pre-schooler's lower dietary index scores in nationally representative studies in Greece, Spain, Finland, and Australia (Golley et al., 2011; Kyttälä et al., 2014; Manios et al., 2009; Serra-Majem et al., 2004) but not among 25-month-olds in the Netherlands (Voortman et al., 2015). Similar to our findings, children of mothers who smoked also scored lower in diet quality indexes in Finland (Kyttälä et al., 2014) and in the Netherlands (Voortman et al., 2015). Ethnic differences in scores of diet quality of 2–5-year-olds were also reported for a nationally representative sample in the US, where Mexican–Americans had better diet quality than non-Hispanic White children (Kranz et al., 2008). Additionally, we have previously reported that neighbourhood deprivation and maternal age, education level, self-prioritised ethnicity, and smoking habits also influenced the *GUiNZ* cohort level of adherence to NZ national infant feeding guidelines (Castro et al., 2021). Thus, findings from Castro et al. (2021) and from the present study indicate that culturally sensitive strategies aiming at improving maternal education and health behaviours could impact in higher diet quality during the first 5 years in NZ.

Despite the recognition that diet quality (measured by whole of diet indexes) during early life may contribute to the development of overweight/obesity later in childhood, there are few published longitudinal studies in this area (Marshall et al., 2014; Wajers et al., 2007). Two previous nationally representative cross-sectional investigations examined the associations between pre-schoolers' scoring in diet quality indexes and measures of adiposity) (Golley et al., 2011; Kranz et al., 2008). Among 4–7-year-old Australians there was weak positive associations between score in the diet quality index and BMI z-score ($\beta = 0.005$; 95% CI: 0.000–0.009; $p = 0.046$) and waist z-score ($\beta = 0.007$; 95% CI: 0.002–0.0011; $p = 0.002$) (Golley et al., 2011). A study conducted with 2–5-year-old Americans reported a significant decrease in the proportion of children with overweight/risk of overweight among the children ranked in the lowest quartile of an index score measuring diet quality (vs. those ranked in the highest quartile). However, these analyses were not adjusted for any potential confounding factor (Kranz et al., 2008). Findings from our present longitudinal study identified that, for most models tested, the significant associations between the level of adherence to the overall NFNG at 2 and 4.5 years with children's overweight/obesity and values of WtHR >90th percentile at age 4.5 years were confounded by maternal sociodemographic and health behaviour characteristics. Among girls, there was an independent and significant adjusted association between lower scores in the CFI at 4.5 years and overweight/obesity (BMI-for-age) at 4.5 years. We have previously reported similar findings for the *GUiNZ* cohort, where infant girls with lower scores in an IFI presented a higher risk of developing overweight/obesity at 4.5 years, independently of their mother's sociodemographic and health behaviour characteristics (Castro et al., 2021). However, the influence of sex on the magnitude of associations between adherence to NFNG in early childhood and overweight/obesity at 4.5 years within the cohort may still be a consequence of sex differences in patterns of other risk factors for childhood obesity that were not assessed/adjusted for in this and in the previous study (Castro et al., 2021). These risk factors include family environments, health and physiological markers, and genetics (Anderson & Whitaker, 2018; Govindan et al., 2013; Sweeting, 2008).

One of the strengths of this investigation is the fact that this is the first nationally generalisable study in NZ to provide information on the diet quality of pre-schoolers and its main maternal sociodemographic and health behaviour determinants. This is also the first longitudinal investigation that proved: i) the content and face validity of dietary indexes for NZ pre-schoolers (once the indicators and scoring of the CFIs were determined by expert academics and policymakers), and ii) the indexes' construct validity, illustrated by the significant associations between the indexes score and: maternal sociodemographic and health behaviours and children's body size at age 4.5 years. Furthermore, this study is amongst the few investigations worldwide to examine the associations between the whole-of-diet adherence to national guidelines among pre-schoolers and measures of adiposity in childhood using indexes with established validity. There are similarities in dietary guidelines worldwide, such as promoting diets with high fibre content from fresh produces and whole grain products and low content of saturated fat, sodium, and sugar (World Health Organization, 2021). However, the validation assessment of age-specific dietary indexes based on national guidelines is important, as there are intracountries variations in population characteristics and cultures which are important to be considered when examining the usefulness of the indexes in each country's context.

We weighted equally the indicators of the CFIs, treating these indexes as a package of dietary recommendations that support the growth, development, and health of children, which can be considered a limitation of the study. Nevertheless, this weighting approach is consistent with most published dietary indexes and reduces conscious and subjective inferences to a minimum (Wajers et al., 2007). Additionally, the comparisons of our findings with previous studies did not account for the differences in the indexes regarding the total number of indicators, weighting, and scoring. In general terms, we compared if higher adherence to NFNG (Ministry of Health, 2015) was associated with the samples' sociodemographic characteristics and with children's measure of adiposity.

5 | CONCLUSION

The findings of this study can be used to guide targeted food and nutrition policies aiming at improving dietary quality during the pre-school years in NZ. Additionally, the independent significant associations between lower adherence to NFNG and higher risk of overweight/obesity at 4.5 years suggest that adequate dietary intake during the pre-school years represents a potential strategy to impact in the reduction of the prevalence of childhood obesity in NZ. Our research confirms the CFIs' construct validity at 2 and 4.5 years which can be used in future investigations examining the longitudinal effect of the level of adherence to NFNG in early life on child and youth health and well-being within the *GUiNZ* cohort.

AUTHOR CONTRIBUTIONS

Teresa Gontijo de Castro, Sarah Gerritsen, and Clare Wall designed the study. Teresa Gontijo de Castro cleaned, prepared, and conducted the data analyses. Teresa Gontijo de Castro, Sarah Gerritsen, Leonardo P. Santos, Dirce M. L. Marchioni, Susan M. B. Morton, and Clare Wall contributed to the data interpretation. Teresa Gontijo de Castro, Sarah Gerritsen, Leonardo P. Santos, and Clare Wall drafted the manuscript. Dirce M. L. Marchioni and Susan M. B. Morton revised the manuscript draft critically. Teresa Gontijo de Castro had primary responsibility for the final content. All listed authors reviewed and approved the final version of the manuscript.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data are available upon reasonable request. Anyone who wants to use Growing Up in New Zealand data needs to first submit a Data Access Application. Further information on the possibilities can be found here: https://www.growingup.co.nz/access-growing-data.

ORCID

Teresa Gontijo de Castro http://orcid.org/0000-0003-1275-4072
Sarah Gerritsen http://orcid.org/0000-0002-8365-5023
Leonardo P. Santos http://orcid.org/0000-0002-3993-3786

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