Breakfast Quality Index Trajectories and Association With Obesity Outcomes Among Australian Children Under 5 Years of Age

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Article

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Abstract

Background: Breakfast quality in early childhood remains understudied. This study described the changes in breakfast quality index (BQI) (i.e. trajectory) and assessed the association between BQI trajectories and obesity outcomes in early childhood.

Methods: Data of children who participated in the Melbourne InFANT Program were used (n=328). Dietary intakes were assessed at ages 1.5, 3.5 and 5.0 years using three 24-hour recalls. BQI was calculated using a revised 9-item BQI tool based on Australian dietary recommendations for young children. Group-based trajectory modelling identified BQI trajectory groups. Multivariable linear and logistic regression examined the associations between identified BQI trajectory groups and obesity outcomes at age 5 years.

Results: Mean BQI at ages 1.5, 3.5 and 5.0 years was 4.8, 4.8, 2.7 points, respectively. Two BQI trajectory groups were identified, and both showed a decline in BQI. The mean BQI of most children (74%) decreased from 5.0 to 4.0 points from ages 1.5 to 5.0 years (referred as "High BQI" group). The remaining children (26%) had a mean BQI of 4.8 and 1.2 points at age 1.5 and 5.0 years, respectively (referred as "Low BQI" group). The "Low BQI" group appeared to show higher risk of overweight (OR:1.39, 95%CI: 0.67, 2.88) at age 5 years than the "High BQI" group.

Conclusions: Two BQI trajectory groups were identified. Both groups showed a decline in breakfast quality from ages 1.5 to 5.0 years. Our study highlights the need for early health promotion interventions and strategies to improve and maintain breakfast quality across early childhood.

1. Introduction

Childhood obesity is a major public health issue and a leading risk factor for health problems worldwide[1]. In 2019, the World Health Organization (WHO) estimated that 38.2 million children globally under age 5 years were overweight or obese [2]. In 2020, the Australian Institute of Health and Welfare (AIHW) reported that a quarter of Australian children and adolescents were classified as overweight or obese [3]. Obesity is likely to persist from childhood into adulthood and has been associated with a broad range of poor health outcomes in later life [1]. The pivotal role of early nutrition and dietary behaviours in programming of long-term health has been widely recognised [4], therefore understanding the risk factors of obesity from early life is critical for obesity prevention. Given that dietary behaviours established in childhood may track across life stages [5] and have been implicated in the development of overweight and obesity, establishing healthy dietary behaviours early in life is important for optimising health across the life course.

Breakfast consumption is considered to be an important dietary habit for children [6]. Research has shown children who consumed breakfast are more likely to have better overall dietary quality than those who skipped breakfast [7]. Moreover, the quality of breakfast is also important. Better breakfast quality is associated with better overall diet quality [7]. Emerging studies have also demonstrated that poor breakfast quality is linked with increased glycaemic response and appetite, which may contribute to obesity [8]. For instance, results from a study of school-aged children revealed that children with high breakfast quality showed lower fasting glucose and lower body mass index (BMI) [9].

However, the existing evidence base is limited to older children and adults, and most studies assessed breakfast consumption at one time point. Few studies investigated changes in breakfast consumption during childhood and adolescence. Findings from studies of Spanish children aged 8-17 years [10] and German children aged 2-18 years [11] found that breakfast quality tends to decrease with age. However, it is unknown how breakfast quality changes in early childhood. Moreover, no studies to date have assessed longitudinal association between breakfast quality and obesity. Whether changes in breakfast quality contribute to obesity development remains unexplored.

Considering early childhood as a critical period for obesity prevention and the potential adverse effects of poor breakfast quality, it is important to study breakfast quality in early childhood and its relationship with body weight development. Therefore, this study aimed (i) to describe changes in breakfast quality index (BQI) (i.e. trajectories) across three-time points at ages 1.5, 3.5 and 5.0 years and (ii) to assess the association between BQI trajectories and obesity outcomes at age 5 years, in a cohort of Australian children. Knowledge on how breakfast quality changes in early childhood and its association with obesity is valuable for informing early strategies to support healthy growth and development.

2. Materials And Methods

2.1. Study design and participants

The Melbourne Infant Feeding Activity and Nutrition Trial (InFANT) was a 15-month cluster-randomised controlled trial focused on supporting first-time parents to improve young children's dietary and activity behaviours [12]. At baseline in 2008, 542 parent-child pairs, with infants approximately 4 months of age, were recruited from 62 first-time parents groups across fourteen local government areas within Melbourne, Australia [13, 14]. Participants were randomised into an intervention or control group. The intervention comprised six dietitian-delivered 2-hour group-based sessions addressing nutrition, and active play, using an anticipatory guidance framework [14]. Participants were followed up post-intervention when children were aged 3.5 and 5.0 years to assess the sustainability of the intervention effects. The detailed study protocol and intervention outcomes have been described elsewhere [12, 13, 15]. Data from children at the end of the intervention (age 1.5 years) and the two post-intervention follow-ups (ages 3.5 and 5 years) were used in the current analysis. The InFANT study was approved by the Deakin University Ethics committee in 2007 (ID number: EC 175-2007) and the Victorian Office for Children (Ref: CDF/07/1138).

2.2. Assessment of dietary intake

Child dietary intake at ages 1.5, 3.5 and 5 years was assessed using three 24-hour recalls conducted with parents or main care givers by trained nutritionists [13, 16]. The recalls were collected over three non-consecutive days, including two weekdays and one weekend day, using a 5-pass standard recall procedure based on methods used by the U.S. Department of Agriculture [17]. During the interview, parents were asked to recall all food and beverages their child consumed in the previous day (24 hours). A food measurement booklet was provided to parents to assist with portion size estimation. The collected 24-hour recall data were converted into food and nutrient intakes using the 2007 Australian Food and Nutrient (AUSNUT) database [18].

2.3. Assessment of breakfast consumption

As participants did not report food and beverage intake by individual eating occasion in the present study, eating occasion durations [19] of 15, 30 and 60 minutes that are widely used in the literature were tested in the present study. The 15-minute cut-off failed to capture breakfast foods and included only water. Moreover, a number of children (about 45% of children) reported extended breakfast consumption over 30 minutes. Eating duration of 60 minutes most appropriately captured breakfast food and beverage intakes. For the breakfast time frame, first eating occasions occurred between 5 am and 10 am in the InFANT study. As a result, this study defined breakfasted as the first eating occasion occurring between 5 am and 10 am, including all foods and beverages consumed across a maximum of 60-minute duration.

2.4. Assessment of Breakfast Quality Index (BQI)

BQI was calculated using a previously published 9-item BQI tool [10] which was adapted to the current sample based on dietary recommendations and nutrient reference values for young Australian children [20], scoring one point each for the consumption of cereals, whole grains, dairy products, fruit, vegetables; one point for the intake of Ca > 167mg for children aged 1.5- and 3.5 years (one third of 500mg/day, Recommended Dietary Intake; RDI) [20] and > 230mg of Ca for children aged 5.0 years (one third of 700mg/day RDI) [20]; one point for energy intake providing 20-25% of total daily energy intake; one point each for absence of added sugar (sugar, jam, honey), and absence of butter and margarine. Scores on the BQI ranged from 1 to 9. Detailed descriptions of each BQI food group are provided in Table S1. Multiple Source Method (MSM) was applied to combine the BQI scores from three non-consecutive days to derive a BQI score that reflects usual intake [21]. The proportion of children who received a score for each BQI item at three different time points over three non-consecutive days were assessed. BQI items were ranked from high to low based on the proportion of children meeting criteria for each item.

2.5. Assessment of child anthropometrics

Child birth weight was transcribed from child health record at study baseline. Trained staff used standardised protocol to measure children's height and weight at ages 1.5, 3.5, and 5.0 years. Height was measured using portable stadiometer (Invicta IP0955, Oadby, Leicester, UK) and weight was measured using a calibrated scale (Tanita 1592, Tokyo, Japan). The average of two measures was used in the present analysis. Body mass index z-score (zBMI) was derived using WHO age and sex specific growth standards [22]. International Obesity Task Force (IOTF) age and sex specific cut offs were used to categorise overweight and obesity [23].

2.6. Assessment of child and maternal covariates

Several child and maternal factors that have been associated with child dietary intakes and obesity risk in young children [24, 25] were considered as potential covariates in the present analysis. Parents reported child and maternal characteristics through self-administered questionnaires completed at baseline (age 4 months). Child factors included child sex, gestational age (< 37 weeks vs ≥ 37 weeks), timing of solid food introduction (before < 6 months vs at or after ≥ 6months), and breastfeeding duration (< 6 months vs ≥ 6 months). In line with previous analysis [24], the six months cut off was used for both breastfeeding duration and the timing of solid food introduction to reflect infant feeding guidelines to exclusively breastfeed for first six months of age and introduce solid foods around six months of age [26]. Maternal factors included educational level (university or non-university) and country of birth (Australia vs others). Maternal pre-pregnancy BMI was calculated using self-reported height and pre-pregnancy weight and categorised into underweight/healthy weight (< 25 kg/m^2) versus overweight/obesity (≥ 25 kg/m^2).

2.7. Statistical methods

Identifying BQI trajectories

Data analyses were performed using Stata 16.0 (StataCorp. 2019. Stata Statistical Software: Release 16. College Station, TX: StataCorp LLC.) with the significance level at $P < 0.05$. Data from the intervention and control groups were pooled for the present analysis as preliminary analyses showed there were no differences in BQI nor BMI between the two groups. Group-based trajectory modelling was conducted to identify BQI trajectory groups over three time points at ages 1.5, 3.5 and 5 years using the “Traj” command. This method utilises all available data and does not exclude participants with missing data [27, 28]. We included Children with two or more BQI measures over three time points.

Censored normal models with linear, quadratic, and cubic functions of child’s age with two to four groups were conducted. The selection of the optimal number of trajectory groups was based on model parsimony, average posterior portability (> 0.7), proportion of sample in each trajectory group (> 5%) and distinctive and clinical interpretable visual inspection of the trajectories. In addition, the highest (less negative) Bayesian Information Criterion (BIC) indicates better model fit. For BQI trajectories, three groups showed the best BIC, but included a small group (5.5 % of total sample). Two groups were therefore chosen for model parsimony. After removing the non-significant cubic function, the two-group trajectory model with quadratic (2 2) was chosen (BIC= -1148.14, AIC= -1129.49) as the final model (Table S2).

Summarizing descriptive analysis between BQI trajectories.

Descriptive analyses were conducted to summarise cohort characteristics by identified BQI trajectory groups. T-tests and Chi-squared tests were used to compare continuous and categorical child and maternal variables by BQI trajectory groups, respectively.

Association between overweight risks and BQI trajectories.

Mixed effects multivariable linear and logistic regression specifying parent groups as random effects to account for clustering was performed to examine the association between identified BQI trajectory groups and zBMI and overweight status at age 5 years, respectively. The crude model adjusted for zBMI and overweight status at age 1.5 years. Further, the model additionally adjusted for child sex, maternal country of birth, maternal education, maternal pre-pregnancy BMI and child total energy intake at age 1.5 years (Model 1). Additional model (model 2) adjusted for breastfeeding duration (≥ 6 months).

3. Results

3.1. Sample characteristics

Of the 393 children who participated at age 1.5 years follow-up, 65 children had had no or one BQI measure were excluded, resulting in 328 children being included in the group-based trajectory modelling analyses to identify BQI trajectory groups. Of 328 children, 145 children had two BQI measures (ages 1.5 and 3.5 or 5.0 years) and 183 had three BQI measures (ages 1.5, 3.5, and 5.0 years). Characteristics of those children included and excluded were similar, and there were no statistically significant differences (all P-value > 0.05) (Table S3). For the included children, there were even proportions of boys (53%) and girls (47%). Most children had birth weight ≥ 2.5 kg (93.8%), were introduced to solid foods at or after 6 months (88%) and were breastfed for ≥ 6 months (59.3%). Most mothers were born in Australia (80.8%), had healthy pre-pregnancy BMI < 25kg/m^2 (65%) and had university level education (59.5%).

For analysis between identified BQI groups and obesity outcomes, 62 children without anthropometric data at 5.0 years were excluded. This resulted in a sample of 266 children (with complete data on covariates including child sex, maternal country of birth, maternal education, pre-pregnancy BMI, and child total energy intake at 1.5 years) being included in the adjusted model 1 analysis. For the adjusted model 2 analysis, which additionally adjusted for breastfeeding duration, the final sample was reduced to 244 children (22 excluded for missing data on breastfeeding duration). The flowchart outlining the sample sizes for each analysis are shown in Figure S1.

3.2. Average BQI scores

Mean BQI (mean ± SD) at ages 1.5, 3.5 and 5.0 years was 4.8±0.9, 4.8±0.8, 2.7±1.6 points, respectively (total 9 points). The average BQI scores for children at 1.5 and 3.5 years of age were similar but declined significantly at age 5 years.

Table 1 shows the proportion of children meeting the criteria for each BQI item across three time points and items were ranked from high to low. The top three highest ranking BQI items were grains, absence of butter and margarine, and dairy products, which were consistent across all three time points. Rankings of BQI items for ages 1.5 years and 3.5 years were identical. Relative to 1.5 and 3.5 years, higher proportion of children consuming wholegrains and calcium were observed at 5 years. In contrast, proportion of children meeting the item “absence of added sugar” and consuming fruit was slightly lower at 5.0 years. Across three time points, the two lowest ranked items were consumption of 20-25% of total energy intake and vegetable intake. Detailed proportions of children meeting the criteria for each BQI item across three time points are shown in Table S4.

Table 1
Ranking of breakfast quality index (BQI) items from high to low by proportion of children meeting the criteria for each BQI item at ages 1.5, 3.5 and 5.0 years

Rank	1.5 years	3.5 years	5.0 years
1	Consumed Grains (83-84%)	Consumed Grains (90-92%)	Consumed Grains (92-95%)
2	Absence of butter and margarine (80-84%)	Absence of butter and margarine (79-83%)	Absence of butter and margarine (78-83%)
3	Consumed Dairy (80-82%)	Consumed Dairy (80-81%)	Consumed Dairy (76-78%)
4	Absence of added sugar (70-73%)	Absence of added sugar (59-63%)	Consumed wholegrains (54-63%)
5	Consumed Wholegrains (61-70%)	Consumed Wholegrains (59-66%)	Absence of added sugar (55-57%)
6	Consumed Fruit (32-40%)	Consumed Fruit (32-34%)	[a] Ca > 230 mg (28-36%)
7	[a] Ca > 167mg (26-29%)	[a] Ca > 167mg (23-26%)	Consumed Fruit (28-32%)
8	Energy intake 20-25% (13-14%)	Energy intake 20-25% (19-21%)	Energy intake 20-25% (17-21%)
9	Consumed Vegetables (< 3%)	Consumed Vegetables (< 3%)	Consumed Vegetables (< 2%)

Brackets presents the range for % of children meeting each criterion over three 24-hour recalls.

[a] According to Nutrient Reference Values [20], 500mg/day for children aged 1-3 years old and 700mg/day for children aged 4-8 years were recommended dietary intake (RDI) of calcium for a day. These numbers were calculated as 1/3 of calcium RDI for a day adjusted to the breakfast intake.

3.3. BQI trajectories

Two BQI trajectory groups were identified from the group-based trajectory modelling (Figure 1). Both groups showed similar BQI scores at age 1.5 years, with a decrease in BQI at age 5 years. Most children (74%; n=244) showed a smaller decrease from 5.0 to 4.0 points and were classified as the “High BQI” group. About a quarter (26%; n=84) of the children showed a decrease from 4.8 to 1.2 points and were classified as the “Low BQI” group. There were no statistically significant differences for all child or maternal factors between the high and low BQI groups (all P values > 0.05; Table 2).

Table 2
Characteristics by trajectory groups using a 2-group model (N=328)

Continuous variables	Low-BQI (N=84)		High-BQI (N=244)		P-value
	n	Mean (SD)	n	Mean (SD)	
Birth weight (kg)	83	3.4 (0.5)	244	3.4 (0.6)	0.58
Total energy intake (1.5y, MJ)	84	4375.6 (752.6)	244	4527.4 (835.4)	0.14
zBMI (1.5y)	83	0.6 (0.9)	239	0.9 (1.0)	0.07
zBMI (5.0y)	84	0.4 (1.0)	186	0.6 (0.8)	0.32
Gestational age (weeks)	84	39.3 (2.2)	244	39.3 (2.2)	0.92
Breastfeeding (months) [a]	78	6.6 (2, 11)	221	8.0 (3.5, 12)	0.13
Maternal pre-pregnancy BMI	84	24.4 (5.1)	244	24.4 (5.4)	0.98
Child characteristics	n	%	n	%	
Total child numbers	84		244		0.72
Boys	46	54.8	128	52.5	
Girls	38	45.2	116	47.5	
Breast feeding duration	78		221		
<6months	34	43.6	69	31.3	0.13
≥6months	44	56.4	152	68.7	
Birth weight	83		244		
Low (<2.5 kg)	4	4.8	16	6.6	
Normal (2.5 kg-4kg)	72	86.8	193	79.1	0.30
High (≥4kg)	7	8.4	35	14.3	
Gestational age	84		244		
<37 weeks	9	10.7	27	11.1	0.93
≥37 weeks	75	89.3	117	88.9	
Maternal characteristics	n	%	n	%	
Country of birth	84		244		

[a] median (25th, 75th) as it is skewed data

Continuous variables	Low-BQI (N=84)		High-BQI (N=244)		P-value
	n	Mean (SD)	n	Mean (SD)	
Australia	71	84.5	194	79.5	0.31
Others	13	15.5	50	20.5	
Educational level	84		244		
University	48	57.1	147	60.3	0.62
Non-university	36	42.9	97	39.7	
Pre-pregnancy BMI	84		244		
Healthy weight (<25)	55	65.5	158	64.8	0.91
Overweight (≥25)	29	34.5	86	35.2	

[a] median (25th, 75th) as it is skewed data

3.4. Association of BQI trajectory with BMI z-score and weight status

Associations between BQI trajectory groups and obesity outcomes are presented in Table 3. Across all models, no statistically significant differences in zBMI or overweight status were revealed between the two BQI groups. However, the low BQI group showed a tendency for a higher risk of overweight at age 5 years than the high BQI group in all models (adjusted OR was 1.42, 95%CI 0.66, 3.06; model 1).

Table 3
Results of multivariable linear and logistic regressions of BQI trajectory groups with zBMI and overweight status of children at aged 5.0 years

	BMI z-score			**Overweight**		
	β	95% CI	p	OR	95% CI	P
[a] Crude (n=266)						
Low vs High BQI	0.03	-0.17 - 0.23	0.78	1.39	0.67 - 2.88	0.38
[b] Model 1 (n=266)						
Low vs High BQI	0.01	-0.18 - 0.20	0.92	1.42	0.66 - 3.06	0.36
[c] Model 2 (n=244)						
Low vs High BQI	-0.01	-0.21 - 0.19	0.94	1.37	0.60 - 3.13	0.46
[a] crude model: adjusted for zBMI of children aged 1.5 years						
[b] model 1: adjusted for child sex, maternal country of birth, maternal education, pre-pregnancy BMI, child total energy intake at 1.5 years						
[c] model 2: additionally adjusted for breastfeeding duration upon model 1						

4. Discussion

This study is the first study to use novel longitudinal trajectory modelling to describe breakfast quality trajectories and the associations with obesity outcomes in early childhood. Two distinct breakfast quality trajectory groups from ages 1.5 to 5.0 years were identified and both trajectories showed a decline in average BQI across three time points. No statistically significant association was found between identified BQI trajectory groups and obesity outcomes, but children in the low BQI group appeared to have a higher risk of being overweight at age 5.0 years.

Most previous research on breakfast consumption in young children has been cross-sectional and limited to school-aged children and adolescents [10, 29–31]. Few studies have examined the changes in breakfast consumption and quality in young children [11, 32]. Consistent with our findings, a study (n=1081) of 2-18 year old German children found the proportion of children meeting breakfast consumption guidelines (a proxy for breakfast quality) decreased between age 2-5 years (29%) and 13-18 years (23%) between 1986 and 2007 [11]. There are no studies to date that have examined longitudinal trajectories of breakfast quality in young children. Our findings provide new longitudinal evidence on changes in breakfast quality in early childhood.

In our study, across ages 1.5, 3.5 and 5 years, most children (> 80%) consumed grains and dairy products at breakfast. In contrast, fruits and vegetables were consumed by 30% and 3% of children respectively at breakfast. This is expected as breakfast cereals and milk are commonly consumed Australian breakfast foods [33], and the high proportion of children consuming both foods aligns with the Australian societal norm for breakfast. Congruent with our study findings, Smith et al. [34] found that breakfast skippers showed lower dairy intake than breakfast consumers in Australian children aged 2- 17 years. The selection of breakfast food items can be influenced by several factors such as food availability and convenience of preparation and consumption [35]. Compared to fruit and vegetables, breakfast cereals and milk have a longer shelf life and are more likely to be available at home for consumption. Moreover, given morning is a busy time, pre-packaged breakfast cereals and milk can be readily consumed with minimal preparation, whereas vegetables may require cooking, making it difficult to consume in the morning. Additionally, the low intake of vegetables can be attributable to young children's preference for sugary foods [36–38]. Our findings suggest that increasing intakes of vegetables and fruits could improve breakfast quality among young children.

Previous studies have also reported that older children and children from low socio-economic status (SES) families were more likely to have low breakfast quality [10, 11, 39]. Low breakfast quality observed in older children and adolescents may be due to various reasons such as less parental supervision at breakfast, insufficient time in the morning and personal reasons for diet/weight loss [10, 40]. The lack of difference in child and maternal factors between two BQI trajectory groups in our study might be attributed to the younger age group examined, with young children having less control of their eating habits. Furthermore, the over-representation of highly educated mothers in our sample may have reduced the potential to detect SES differences.

Our study is the first to evaluate the association between breakfast quality and obesity in early childhood. Although there were no statistically significant differences in obesity outcomes between the two BQI trajectory groups, the low BQI group did show a tendency for higher overweight risk at age 5 years. The lack of a significant association could be explained by the small sample size and limited statistical power.

There are several hypotheses supporting a potential link between breakfast quality and obesity. First, the consumption of certain breakfast foods (such as wholegrains and dairy products) may help prevent obesity. For instance, the fibre contained in wholegrains may reduce fat absorption and/or promote satiety response, and thus lead to lower food intake [41]. Additionally, calcium in dairy products has been shown to play a favourable role in inhibition of fat absorption and regulation of lipid metabolism [42]. In contrast, some studies have revealed an association between breakfast cereal intakes and a higher obesity risk in children [8, 43]. The high sugar content and high glycaemic load of breakfast cereals may explain this increased obesity risk [43]. In particular, glucose and insulin levels tend to be low after the overnight fast, therefore high glycaemic load foods consumed at breakfast can rapidly raise blood sugar level, exacerbate insulin response, and in turn contribute to obesity risk [8]. In addition, the amount of energy consumed at breakfast may also contribute to obesity development. Consistent with our findings, two studies found most children did not consume the recommended energy intake during breakfast (20-

25%) [29, 44]. Evidence has shown inadequate breakfast energy intake was associated with unhealthy markers (i.e. blood sugar level, insulin, triglycerides, cholesterol) related to obesity [9]. Studies have reported that school-aged children with obesity tend to have low energy intakes at breakfast [45]. Further studies are needed to understand the association between breakfast quality and obesity in early childhood.

Our study has some important strengths. It is the first to identify breakfast quality trajectories in early childhood. Dietary intake was assessed using three 24hr recalls which are gold standard approaches for assessing dietary intake [12, 15]. Furthermore, anthropometry was objectively measured by trained staff rather than self-reported as occurs in most existing studies. Additionally, the utilisation of a group-based trajectory modelling enabled a novel assessment of BQI trajectories. This method does not exclude participants with missing data and can examine various trajectory modelling using unbalanced longitudinal data [27, 28]. The method also allowed the exploration of the relationship between breakfast quality trajectories and obesity outcomes rather than breakfast quality at one time point, as evaluated in other studies. In terms of assessing breakfast quality, there is no standardised tool to define breakfast quality in the literature. Based on the existing literature, our study developed a 9-item BQI including both nutrient and food groups based on breakfast recommendations to evaluate breakfast quality. The inclusion of both nutrient and food groups provides a comprehensive evaluation of breakfast quality. Further breakfast research should consider both nutrient and food groups.

Our study has some limitations that warrant discussion. The observational nature of our study cannot infer causal relationships. Although we considered a range of child and maternal covariates when assessing the association between BQI trajectory groups and obesity outcomes, unmeasured and residual confounding by other factors is possible [29]. Additionally, the small sample size may have limited the statistical power to detect significant association between BQI trajectory groups and obesity outcomes. Moreover, the current sample consisted of more highly educated mothers, which may limit the generalisability of the study findings to the Australian national population. Further research in a diverse range of populations is needed to better understand the contribution of breakfast quality in obesity and other health outcomes.

In conclusion, two BQI trajectory groups in early childhood were found in this study. Both trajectory groups showed a decline in breakfast quality from 1.5 to 5.0 years. Given the potential contribution of breakfast quality in childhood obesity, our study highlights the need for early health promotion interventions and strategies to improve breakfast quality in early life. Given that Australia's current focus on breakfast promotion is limited to primary school children and adolescents [46], our study reinforces the importance and need for breakfast promotion and intervention in early childhood.

Declarations

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Competing Interests

The authors declare that they have no conflict of interest.

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Figures

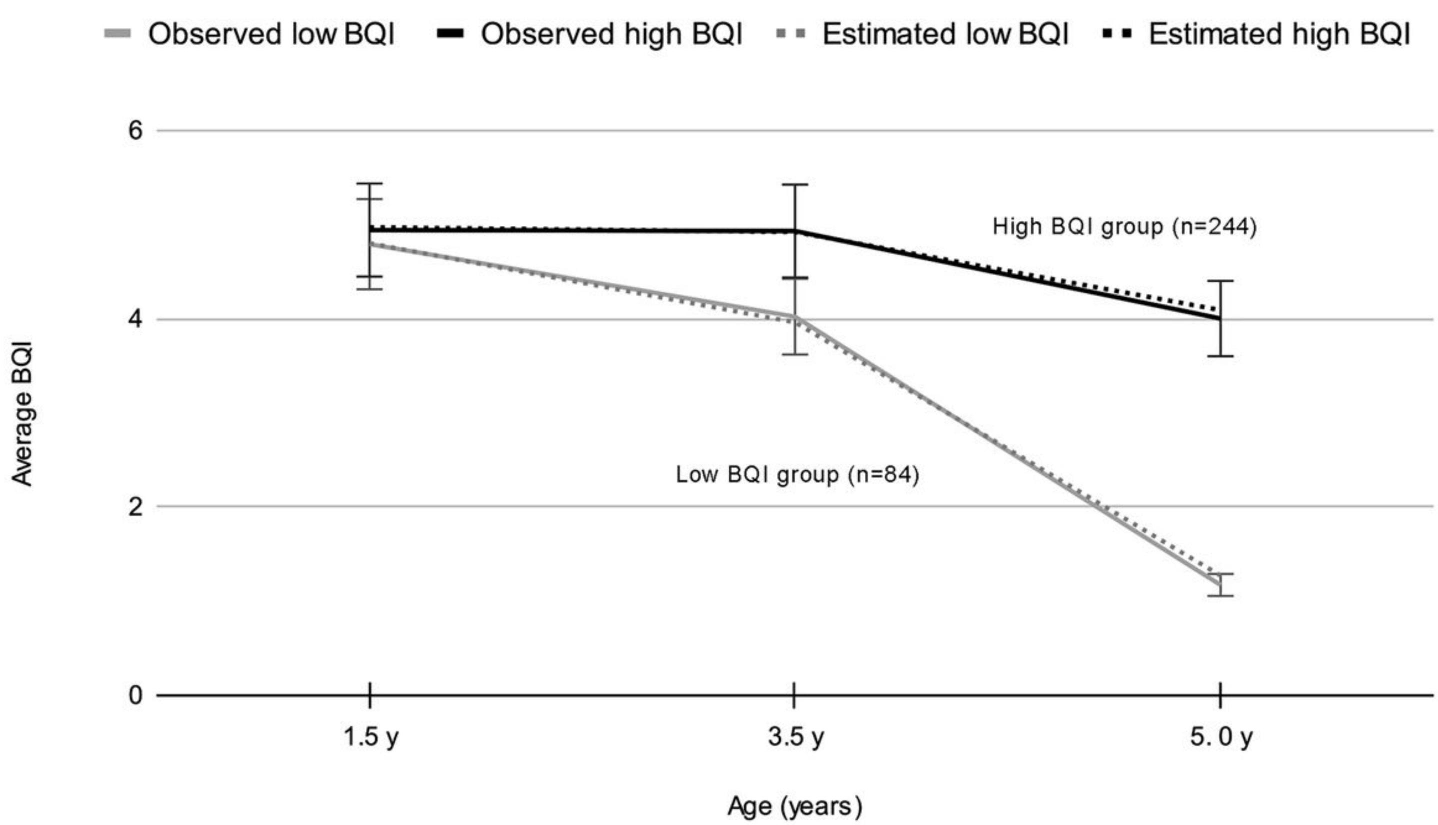

Figure 1

Comparison of average observed and predicted BQI from ages 1.5, 3.5, 5.0 years of the low BQI and high BQI trajectory groups. Both trajectory groups decreased across three different ages. The group with less decreasing BQI values was referred as the high BQI group (n=244), and the group with relatively large decreasing BQI values was referred as the low BQI group (n=84). Black lines represent high BQI group and grey lines represent low BQI group. Solid lines represent observed BQI values and dotted lines represent expected BQI values. There is no significant difference between the actually observed BQI value and the expected value.

Supplementary Files

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- Supplementarytables.docx