

Meal pattern among Norwegian primary-school children and longitudinal associations between meal skipping and weight status

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Abstract

Objective: To investigate meal pattern longitudinally and explore whether meal skipping was associated with overweight among Norwegian children and adolescents.

Design: Longitudinal study. Children's meal frequencies were reported by their parents using a retrospective FFQ. Weight and height were measured by public health nurses. Descriptive data comparing 4th and 7th grade were analysed by paired-sample *t* tests for continuous variables and χ^2 tests for categorical variables. Odds ratio estimates, including confidence intervals, with BMI category (normal/overweight) as the dependent variable, were determined through logistic regression analyses.

Setting: Primary schools, Telemark County, Norway.

Subjects: A cohort of 428 Norwegian boys and girls; 4th graders in 2007, 7th graders in 2010.

Results: The number of children eating four main meals per day (regular meal frequency) decreased from 4th grade (47%) to 7th grade (38%; $P = 0.001$). Those who ate regular meals in 4th grade but not in 7th grade had higher odds (OR = 3.1; 95% CI 1.1, 9.0) of being overweight in 7th grade after adjusting for gender, maternal education and physical activity, but the odds ratio was not statistically significant after adjusting for overweight in 4th grade (OR = 2.8; 95% CI 0.7, 11.6).

Conclusions: The present study showed significant increases in overall meal skipping among children between 4th and 7th grade. The results indicate an association between overweight and meal skipping, but additional prospective and longitudinal analyses and intervention trials are warranted to confirm this relationship.

Keywords
Weight status
Meal skipping
Food habits
Children
Longitudinal

Eating regular meals is one of the potential energy balance-related behaviours⁽¹⁾. Meals are often defined as eating breakfast, lunch, dinner and small snacks such as mid-morning, mid-afternoon and evening⁽²⁾. Main meals are in many countries breakfast, lunch and dinner, but can differ; e.g. in Norway there is usually a fourth main meal: evening meal (served in the evening due to an earlier dinner compared with most countries). Children's meal pattern in the USA have changed over a two-decade period, making skipping of meals more prevalent⁽³⁾. Unhealthy dietary habits, including irregular breakfast eating, have also been reported among Norwegian adolescents^(4,5). Worldwide, the prevalence of obesity increased dramatically during the last decades^(6–9),

although new findings support a levelling off in children and adolescents from Australia, Europe, Japan and the USA⁽¹⁰⁾. In Norway, increasing prevalence of overweight has been observed in children and adolescents over the last decades⁽¹¹⁾. Still, there is overwhelming agreement that the levels of overweight and obesity among children are too high.

High meal frequency (4 or 5 *v.* ≤ 3 meals/d) has been observed to be inversely associated with childhood obesity in cross-sectional studies^(2,12–14). Longitudinal associations between a regular meal pattern/high meal frequency and obesity are scarce in this field, but a 10-year observational study among American adolescent girls revealed that a frequency of 3+ meals/d was positively related to a lower

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BMI-for-age *Z*-score⁽¹⁵⁾. The study also revealed that the percentage of girls skipping meals increased from the age of 9 to 19 years⁽¹⁵⁾.

Food habits and meal patterns, which are learned and acquired in childhood, tend to persist into later ages. Evidence also shows that childhood overweight tracks into adulthood⁽¹⁶⁾. Therefore, a focus on eating regular meals could be a possible target for early prevention of overweight and obesity in children and possible longitudinal associations are of particular interest to investigate causality.

The aims of the present study were to: (i) assess the meal pattern of Norwegian schoolchildren in 4th and 7th grade and describe longitudinal changes; and (ii) assess the association between meal skipping and overweight.

Methods

Participants and study design

The present data were obtained from a study of primary-school pupils in Telemark County, Norway. Data collection took place in the spring of 2007 and spring of 2010, when the children were in primary school grades 4 (9–10 years old) and 7 (12–13 years old), respectively. The detailed methods for the 4th grade data collection have been described previously⁽¹⁷⁾. An identical procedure was used for data collection in the 7th grade⁽¹⁸⁾.

In brief, all primary schools in Telemark County were invited to participate in the study at both time points. In 2007 (4th grade), 110 schools were invited and seventy agreed to participate. Due to merging of some schools in the period between the two data collection points, 104 schools were invited in 2010 and fifty-three agreed to participate. Of the fifty-three schools participating in 2010, forty-six also attended in 2007 and six schools were new participants.

In total, written parental consent to inclusion in the study was received for 1045 out of 1477 invited children in the 4th grade and 1095 out of 1503 invited children in the 7th grade. This represented about half of the county's 4th and 7th grade pupils at the respective time points.

Weight and height measurements were obtained for 955 (4th grade) and 865 (7th grade) children, while complete weight/height and meal frequency data were obtained for 924 and 690 pupils, respectively. In total, 428 children (207 boys and 221 girls) provided complete weight, height and meal frequency data at both time points.

The study was conducted according to the guidelines laid down in the Declaration of Helsinki and ethical approval and research clearance were obtained from the Norwegian Social Science Data Services. The parents and the children received separate information letters. The parents gave their written consent to participate including a confirmation that their child wanted to participate too.

Dietary information

The children's habitual daily consumption of main meals (breakfast, lunch, dinner and evening meal) during the last 6 months was reported by their parents using a retrospective FFQ that included information about meal frequencies. Meal frequencies were registered with eight response alternatives ranging from 'never/rarely' to 'daily'. The questionnaire was based on a short FFQ developed for use with children in grades 4 and 8 in Norway⁽¹⁹⁾, but was modified to include more dietary questions. Before the study, the FFQ was tested on a sample of parents and followed up by qualitative interviews⁽²⁰⁾. Identical FFQ were used at both time points and the questionnaires were distributed at school and returned to school.

The numbers of days reported eating breakfast, lunch, dinner and evening meals were then collapsed into dichotomous variables. Children who ate these main meals fewer than 7 d/week were classified as breakfast, lunch, dinner and evening-meal skippers, respectively. Children who ate these main meals every day were classified as regular breakfast, lunch, dinner and evening-meal consumers. These dichotomous variables were then combined to create a summary variable referred to as 'all regular meals', i.e. those eating all meals (1) *v.* those skipping meals (0) in respectively 4th and 7th grade. For the longitudinal analyses in the present study, the children were further categorized into a new variable to describe meal skipping longitudinally, giving a variable of four categories: (i) CONTINUED skippers (skipping meals at both time points); (ii) START all meals (meals skippers in 4th grade, eat all meals in 7th grade); (iii) STOP all meals (eat all meals in 4th grade, meal skippers in 7th grade); and (iv) ALL meals (eat all meals at both time points).

Other variables

To measure physical activity, the parents provided information about how many hours their children spent on sports or exercise that made them sweat or feel breathless outside school, with response alternatives ranging from 'none' to 'seven hours or more during a normal week'.

Maternal educational level was collected by asking for the highest completed education and divided into three categories: (i) 'primary and lower secondary education' (10 years or less); (ii) 'upper secondary education' (3 to 4 years of secondary education); and (iii) 'university or university college'.

BMI categories

The weight and height of all the participating children were measured by public health nurses at each school at both time points. The children were weighed wearing light clothing (i.e. trousers, T-shirt, socks), using identical calibrated, electronic scales measuring in 100 g increments. BMI (kg/m²) of each child was calculated on the basis of

these measurements. Child BMI categories (underweight, normal weight, overweight, obese) were calculated using sex- and age-specific cut-off points of the International Obesity Task Force^(21,22). Due to small numbers, we included underweight children in the normal-weight group and obese children in the overweight group.

Statistics

Descriptive data comparing 4th and 7th graders in Norway were analysed by paired-sample *t* tests for continuous variables and χ^2 tests for categorical variables. Four separate groups were described (i.e. CONTINUED skippers, START all meals, STOP all meals and ALL meals). ALL meals, as the preferred meal pattern, was compared with the rest of the study sample. Odds ratio estimates, including confidence intervals, with weight status as the dependent variable, were determined through logistic regression analyses (Table 2). All of the following logistic regression models were adjusted for maternal education and gender. Furthermore, model 1 included meal pattern (CONTINUED skippers, START all meals, STOP all meals *v.* ALL meals as the reference; Table 2). Model 2 included meal pattern and physical activity and model 3 included meal pattern, physical activity and overweight status in 4th grade (Table 2). All statistical analyses were performed using the statistical software package IBM SPSS Statistics 19.0.

Results

The children with complete data in both 4th and 7th grade were generally from families with somewhat higher educational level than those without complete data (56% *v.* 51% of the parents, respectively, had 'university or university college'; $P=0.003$). No difference in participation with regard to gender was observed.

In 4th grade, a total of 203 (47%) of the children were reported to eat all four meals every day whereas 146 (34%), sixty-six (15%), eleven (3%) and two (1%)

children ate three, two, one or none of these main meals every day during a week, respectively. In 7th grade, a total of 166 (38%) of the children were reported to eat all four meals every day whereas 143 (33%), ninety-one (21%), twenty-two (5%) and eight (2%) children ate three, two, one or none of the main meals every day during a week, respectively.

In both 4th and 7th grade, approximately 90% of the children had regular breakfast habits and 85% consumed dinner regularly (Table 1). Further, the results showed a significant decrease in the proportion reporting to eat regular lunch meals, from 81% to 75% ($P=0.010$), and regular evening meals, from 67% to 53% ($P<0.001$), between 4th and 7th grade. Thus, the frequency of children who ate all four main meals regularly decreased significantly from 4th grade (47%) to 7th grade (38%; $P=0.001$). No gender differences in meal skipping were observed in 4th grade or 7th grade (data not shown). A significant increase in physical activity ($P<0.001$), but no change in the overweight prevalence among children was observed from 4th to 7th grade (Table 1). Tracking of 4th grade overweight/obese children ($n=68$) showed that forty-four (65%) remained overweight/obese in 7th grade (Fig. 1). Among the 4th grade normal-weight children ($n=360$), 339 (94%) remained normal weight and twenty-one (6%) became overweight/obese in 7th grade (Fig. 1).

Among the total sample, 41% of the children skipped meals in both 4th and 7th grade (CONTINUED skippers) whereas 11% reported to eat all meals only in 7th grade (START all meals) and 21% reported to eat all meals only in 4th grade (STOP all meals; data not shown). A total of 27% of the children reported to eat all meals (ALL meals) at both time points (data not shown).

Those included in the category STOP all meals did have greater odds of being overweight in 7th grade, adjusting for sex, maternal education and physical activity, than those who ate ALL meals (OR = 3.1; 95% CI 1.1, 9.0), but the odds ratio was not statistically significant after adjusting for overweight in 4th grade (Table 2). The odds of being

Table 1 Descriptive data of the study sample of primary-school children (4th graders in 2007, 7th graders in 2010), Telemark County, Norway ($n=428$)

	4th grade	7th grade	<i>P</i> value*
BMI category			
Underweight (%)	3	1	0.655
Normal weight (%)	81	85	
Overweight (%)	14	12	
Obese (%)	2	3	
Physical activity outside school (h/week)	3.3	4.5	<0.001
95% CI	3.3, 3.4	4.4, 4.7	
Meal pattern			
Regular breakfast (%)	91	90	0.263
Regular lunch (%)	81	75	0.010
Regular dinner (%)	85	84	0.569
Regular evening meal (%)	67	53	<0.001
Regular all 4 meals (%)	47	38	0.001

*Paired-sample *t* test was used to analyse changes in physical activity and χ^2 tests were used to analyse changes in all other variables.

overweight in 7th grade among those included in the categories START all meals and CONTINUED skippers was not significantly different from those who ate all meals.

Discussion

The present study showed an overall increase in meal skipping with increasing age. While the frequency of breakfast and dinner skippers remained relatively stable (approximately 10% and 16%, respectively), significant increases in skipping lunch (from 19% to 25%) and evening meals (from 33% to 47%) were reported between 4th and 7th grade. Few other studies have described longitudinal changes in meal pattern among children and adolescents.

In agreement with results from the present study, a cross-sectional study among children of pre-school age in Canada reported that one-tenth of the children ate breakfast on fewer than 7d/week⁽²³⁾. An American study showed

that 20% of 4th grade students were skipping breakfast and/or lunch at least three times per week⁽¹⁵⁾, whereas a Finnish study reported that practically all children between 10 and 11 years old (99%) had breakfast, 94% had lunch and 80% had dinner regularly⁽²⁴⁾. Among Swedish adolescents in 9th grade, only 76% of girls and 88% of boys reported to eat breakfast regularly⁽²⁵⁾. Unhealthy dietary habits, including irregular breakfast eating, have also been reported among Norwegian adolescents^(4,5).

In addition to age- and regional-related trends, studies from the 1970s to today have reported a tendency towards a decrease in meal frequency and going from regular meals to skipping main meals among children and adolescents^(3,26).

The relationship between meal pattern and overweight has been widely debated; several cross-sectional studies have observed a positive association between meal skipping and the prevalence of overweight^(2,25,27-30), while others have not supported these associations⁽³⁾. However, few longitudinal studies have been published. We have previously shown that children adhering to a 'varied Norwegian' eating pattern, which included regular breakfast and eating lunch, were less likely to remain overweight⁽¹⁸⁾. The present study showed that those who stopped eating regular meals after 4th grade were three times more likely to be overweight in 7th grade compared with those who ate regular meals in both 4th and 7th grade after adjusting for physical activity. However, this relationship did not remain significant after adjusting for overweight in 4th grade, but remained of comparable amplitude. Not surprisingly, overweight in 4th grade appeared to be the most important predictor of overweight in 7th grade. We have previously reported a high degree of BMI tracking from 4th to 7th grade in the same cohort⁽¹⁸⁾. However, adjusting for physical activity had a larger impact than overweight at 4th grade on the estimated odds ratios for meal skipping. This indicates an important association between physical activity, regular meal pattern and overweight.

Other longitudinal studies have reported an inverse relationship between meal frequency and BMI^(10,19,31-33),

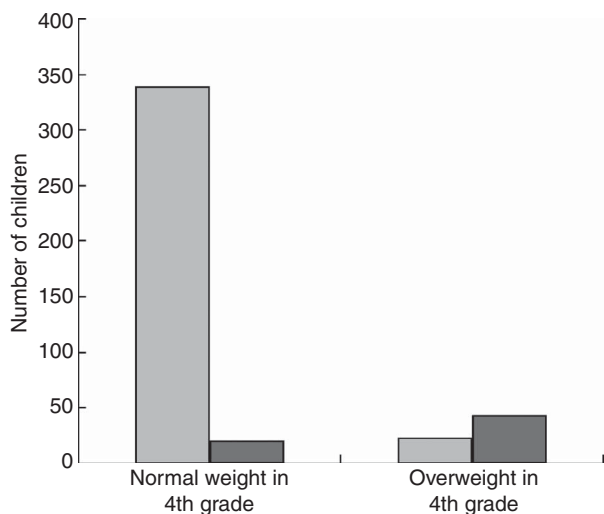


Fig. 1 Changes in BMI status between 4th and 7th grade among a sample of primary-school children (4th graders in 2007, 7th graders in 2010), Telemark County, Norway (n 428): □, normal weight in 7th grade; ■, overweight in 7th grade

Table 2 Logistic regression models describing odds of being overweight in 7th grade, adjusted for physical activity and overweight in 4th grade, among a sample of primary-school children (4th graders in 2007, 7th graders in 2010), Telemark County, Norway (n 428)

	Model 1		Model 2		Model 3	
	OR	95% CI	OR	95% CI	OR	95% CI
CONTINUED skippers*	2.0	1.0, 4.2	2.3	0.9, 6.1	1.8	0.5, 6.2
START all meals*	1.8	0.7, 4.9	2.5	0.7, 8.4	1.4	0.3, 7.2
STOP all meals*	1.9	0.8, 4.5	3.1	1.1, 9.0	2.8	0.7, 11.9
ALL meals*	1.0	Ref.	1.0	Ref.	1.0	Ref.
Physical activity			0.7	0.6, 0.9	0.6	0.4, 0.8
Overweight in 4th grade					58.1	21.9, 154.1

Ref., reference category. All three models were adjusted for gender and maternal education. *CONTINUED skippers = meal skippers at both time points; START all meals = meal skippers in 4th grade, eat all meals in 7th grade; STOP all meals = eat all meals in 4th grade, meal skippers in 7th grade; ALL meals = eat all meals at both time points.

but contrary to the present study, a 9-year American longitudinal study described that this association was not significant after adjusting for physical activity⁽³³⁾.

An important strength of the present study is the longitudinal design, which allowed for examining long-term associations between effects of meal regularity and overweight. The objective measurement of the children's weight and height at both time points, further categorized into BMI categories by international criteria^(17,18), is another major strength of the study.

A lack of statistically significant associations, despite a high odds ratio between irregular meal consumption and overweight in the analyses after adjusting for all confounders, may be explained by insufficient statistical power. The present study also has other limitations. First, it included the use of parental self-reported data. Although validated survey components were used, self-reported data may represent recall bias and response bias regarding dietary habits⁽³⁴⁾. Under-reporting of food intake has been widely reported, and this is particularly evident for individuals who are overweight^(6,7). We cannot exclude the possibility that parents of overweight children may have under-reported unhealthy meal habits. However, this might be a minor problem in the present study as parents reported only meal habits and not detailed information about children's food intake. In Norway, there are no school-prepared meals, so most children bring their own lunchbox consisting of cold sandwiches. Most schools offer a milk prescription programme and water is available from the tap. Some misreporting of children's lunch consumption is likely, as parents normally are aware of what the children bring for lunch at school, but not if they actually eat it. In addition, the results from the present study may partly be limited by the sample size, i.e. a relatively low number of overweight children who were defined as meal skippers. Despite the limitations mentioned, few other longitudinal studies have focused on the association between meal pattern and overweight.

Conclusion

The present study showed significant increases in overall meal skipping among children between 4th and 7th grade. The results indicate an association between overweight and meal skipping, but additional prospective and longitudinal analyses and intervention trials are warranted to confirm this relationship. The results indicate that a focus on a regular meal pattern should be considered when developing guidelines to prevent childhood overweight.

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