



Breakfast skipping and overweight/obesity in first grade primary school children: A nationwide register-based study in Iceland

Anita Aanesen^{1,2} | Peter T. Katzmarzyk³ | Linda Ernstsén²

¹Health Care Institution of North Iceland, Iceland

²Department of Public Health and Nursing, Faculty of Medicine and Health Sciences, Norwegian University of Science and Technology, Trondheim, Norway

³Pennington Biomedical Research Center, Baton Rouge, Louisiana, USA

Correspondence

Linda Ernstsén, Department of Public Health and Nursing, Faculty of Medicine and Health Sciences, Norwegian University of Science and Technology, Trondheim, Norway.

Email: linda.ernstsen@ntnu.no

Summary

Although several studies have revealed an association between skipping breakfast and overweight (OW) or obesity (OB) in older children and adolescents, less is known about that association in younger children. The purpose of our study was to assess the association between skipping breakfast and OW/OB in children in the first grade. The sample included 4360 children (51.5% boys) aged 5.6 to 7.4 years who participated in the annual health examination in Iceland during 2016 and 2017, completed by 91% of all first graders in Iceland. Binary logistic regression analysis with odds ratios (ORs) and 95% confidence intervals (CIs) was used to assess the association between skipping breakfast and OW/OB. Skipping breakfast was assessed as not eating breakfast on the day of the assessment, whereas OW or OB was based on measured height and weight relative to the International Obesity Task Force reference. The final analyses were adjusted for bedtime, well-being in school, commuting to school and physical activity. 7.2% of the boys ($n = 162$) and 7.5% of the girls ($n = 158$) had not eaten breakfast. After multivariable adjustment, a statistically significant association emerged between skipping breakfast and OW/OB in girls (OR 1.66, 95% CI 1.17-2.36) but not in boys (OR 1.02, 95% CI 0.63-1.63). Because the study's results suggest an association between skipping breakfast and OW/OB only in first-grade girls in Iceland, sex-based differences should be further investigated to inform future strategies for preventing OW and OB in young children.

KEYWORDS

breakfast habits, skipping breakfast, overweight, obesity, register-based study

1 | INTRODUCTION

Worldwide, the number of children with overweight (OW) or obesity (OB) increased from 32 to 42 million between 2000 and 2013, and similarly rising rates in more recent years have ranked OW and OB in children as one of the greatest challenges for today's healthcare systems.¹ Estimated costs related to OW and OB total EUR 10 billion in

Europe,² and in the United States, medical costs associated with common diseases caused by OB are projected to skyrocket by USD 48 to 66 billion per year by 2030.³ Furthermore, OB occurring in childhood which passes through to adulthood increases the risk of OB-related complications.⁴

In a recent prospective study involving 17- to 23-year follow-up of a nationally representative cohort of US adults, skipping breakfast was

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2020 The Authors. Clinical Obesity published by John Wiley & Sons Ltd on behalf of World Obesity Federation

associated with a significantly increased risk of mortality from cardiovascular disease.⁵ Both cross-sectional^{6,7} and prospective studies^{8,9} additionally suggest an association between breakfast habits and OW or OB in children and adolescents. Such findings have been partly supported by a recent meta-analysis of 14 cross-sectional studies and two prospective studies on skipping breakfast and OW or OB in children and adolescents.¹⁰ For example, in a cross-sectional study of 6941 children aged 9 to 11 years from 12 countries representing a wide range of economic development, Zakrzewski et al.¹¹ found that regularly eating breakfast was associated with lower body mass index (BMI) than occasional and rare consumption were. In another meta-analysis of 16 cross-sectional studies on skipping breakfast and OW and OB amongst 59 328 children or adolescents aged 6 to 20 years from Europe, the authors concluded that eating breakfast was associated with a reduced risk of OW as well as OB.¹² However, in this meta-analysis, only one study had included relatively young children, with one group aged 6 to 10 years vs another aged 11 to 14 years,¹³ and it remains unclear whether 6-year-olds are truly comparable to 10-year-olds. After all, children less than 7 years old have different milestones in both physical and cognitive development compared to 10-year-olds,¹⁴ and they are far more dependent upon their parents than older children are. Thus, OB prevention efforts may need to begin earlier in life, when children remain dependent upon parental feeding practices. To support such efforts, it is important to gain insight into the breakfast habits of younger children from more homogeneous age groups.

From another angle, studies on the relationship between breakfast habits and OW or OB in young schoolchildren have been few, and knowledge about sex-based differences in that relationship remains scarce. Recent numbers indicate that more girls than boys have OW in Nordic countries such as Norway and Iceland,^{15,16} while cross-sectional studies have revealed that more girls than boys are skipping breakfast,¹⁷ as well as that skipping breakfast increases in frequency as children age.¹⁸ Therefore, the chief aim of our study was to explore whether an association exists between skipping breakfast and OW or OB amongst children in the first grade in Iceland. A secondary aim was to assess whether the association between skipping breakfast and OW or OB was modified by sex.

2 | METHODS

2.1 | Study population

In Iceland, as in other Nordic countries, education is mandatory for children aged 6 to 16 years. Most institutions of education are funded by the state, and very few private schools operate in the country. This study's sample included children in the first grade, who spend 30 hours on pedagogical activities per week (ie, Monday to Friday), and most children begin their classes at 8 AM and finish by 2 PM. Iceland's schools have different routines regarding meals, such that some offer lunch at a cost whereas others do not. Children in the first grade usually bring packed food to school, and they often have a light meal before or after lunch depending when they leave the school.

What is already known about this subject

- Overweight and obesity in children is one of the greatest challenges for today's healthcare systems.
- Skipping breakfast is associated with overweight and obesity in school-aged children and adolescents.

What this study adds

- In this nationwide register-based study of Icelandic first grade primary school children, prevalence of breakfast skipping was similar in boys and girls (7.2% vs 7.5%).
- Icelandic girls in first grade primary school who skipped breakfast had 66% higher odds for being overweight/obese compared to girls who had breakfast.
- The association between breakfast skipping and overweight/obesity was not found in boys.

In our study, the total population included 4793 first-grade children from 165 public schools in Iceland during 2016 and 2017. A total of 4752 children participated in the annual health examination; of them, 392 were excluded due to missing data about covariates used in our study. Thus, the sample consisted of 4360 children (ie, 91% of the total population), including 2246 boys (52.5%) and 2114 girls (48.5%).

Data collection was performed by trained school nurses at the annual health examination events, which were administered by Ískrá, an Icelandic register database that stores all information from school health services in Iceland. In addition to the clinical measurement of the children's weight and height, information about health-related issues was collected from September 2016 to May 2017 via a questionnaire interview with each child conducted by a school nurse. The children's parents were encouraged to attend the interviews with their children, and some of them did. Because the data were collected for administrative use, the questions were designed to capture information relevant to the youngest schoolchildren's physical health and well-being.

2.2 | Breakfast skipping

Breakfast skipping was measured by asking 'Have you eaten breakfast today?' with two response options: 'Yes' and 'No'.

2.3 | Anthropometric measurements

Body weight was measured by using a validated digital scale with a precision of ± 0.1 kg, whereas height was measured by using a wall-mounted stadiometer with a precision of ± 0.1 cm. Both

measurements were taken while the children wore light clothing but no shoes. BMI was calculated as weight in kilograms divided by the squared value of height in metres (kg/m^2). All anthropometric measurements were performed according to standardized techniques by trained school nurses. Age- and sex-specific international cut-off values for OW and OB proposed by the International Obesity Task Force (IOTF) were used to define OW and OB.¹⁹

2.4 | Confounders

Studies have suggested that factors such as physical inactivity and sedentary behaviours,^{20,21} reduced sleep length^{22,23} and discomfort or stress at school are associated with OW and OB amongst schoolchildren,^{24,25} and that those factors are also associated with skipping breakfast.²⁶⁻²⁸ In our study, physical activity was assessed by asking two questions: 'Do you participate in sport activities, or do you often play outdoors?' with the response categories 'Yes', 'No' or 'Do not know'; and 'How did you get to school today?' with the response categories 'Walking or cycling' or 'Was driven'. Sleep routine was captured by asking 'What time should you go to bed when you have school the next day?' with the response categories 'Before 9 PM', 'After 9 PM' and 'Do not know'. Well-being in school was assessed by asking 'How do you enjoy school?' with the following response categories: 'Enjoying school', 'Not enjoying school' and 'Do not know'.

TABLE 1 Baseline characteristics of Icelandic boys ($n = 2246$) and girls ($n = 2114$) in first grade in primary school 2016/2017

	Total sample ($n = 4360$)	Boys ($n = 2246$)	Girls ($n = 2114$)
Breakfast skipping			
No	4040 (92.7)	2084 (92.8)	1956 (92.5)
Yes	320 (7.3)	162 (7.2)	158 (7.5)
IsoBMI			
Normal weight	3584 (82.2)	1959 (87.2)	1625 (76.9)
Overweight	583 (13.4)	208 (9.3)	375 (17.7)
Obesity	193 (4.4)	79 (3.5)	114 (5.4)
Physical activity			
Yes	4031 (92.5)	2087 (92.9)	1944 (92.0)
No	215 (4.9)	96 (4.3)	119 (5.6)
Do not know	114 (2.6)	63 (2.8)	51 (2.4)
Commuting to school			
Walking/cycling	2134 (48.9)	1086 (48.4)	1048 (49.6)
Driven	2226 (51.1)	1160 (51.6)	1066 (50.4)
Bedtime			
Before 9 PM	3234 (74.2)	1643 (73.2)	1591 (75.3)
After 9 PM	250 (5.7)	155 (6.9)	95 (4.5)
Do not know	876 (20.1)	448 (19.9)	428 (20.2)
Well-being in school			
Enjoying school	4185 (96.0)	2139 (95.2)	2046 (96.8)
Not enjoying school	71 (1.6)	46 (2.0)	25 (1.2)
Not sure	104 (2.4)	61 (2.7)	43 (2.0)

Notes: Data are presented as numbers (%).

The Scientific Committee for Health Care in Reykjavik and the University of Iceland (Vís-HH-UI), the National Bioethics Committee in Iceland, the Data Protection Authority in Iceland and the Regional Norwegian Committee for Medical and Health Research Ethics approved our study.

2.5 | Statistical analysis

To compare the results with the majority of scientific literature on skipping breakfast amongst children, OW and OB were analysed together as the outcome variable OW/OB.

Differences between children who skipped and did not skip breakfast were analysed with chi-square tests (χ^2). Odds ratios (ORs) and 95% confidence intervals (CIs) for OW/OB associated with skipping breakfast were estimated by using logistic regression models adjusted for sport activity, commuting to school, bedtime and well-being in school. In those models, children who did not skip breakfast served as the reference category, and the covariates were dummy-coded with the most favourable categories used as the reference. To evaluate the contribution of confounders we used four regression models. Model I did not include covariates; Model II included sport activity and commuting to school; Model III additionally included well-being in school; and Model IV added bedtime to the other covariates.

From a public health perspective, estimating additive interaction is desirable because it allows assessing whether it would be preferable to direct an intervention towards certain subgroups if resources are limited. Therefore, and in line with recommendations for epidemiological studies,²⁹ interaction between sex and skipping breakfast was assessed on both a multiplicative scale (ie, using the interaction term sex \times skipping breakfast) and an additive scale. Effect modification on the additive scale³⁰ was assessed by computing the relative excess risk due to interaction (RERI) = $OR_{AB} - OR_A - OR_B + 1$.³¹

Provided that the effects of both exposures were not confounded, RERI greater than 0 implied a sufficient-cause interaction under the monotonicity assumption—that is, that the effects of exposure are never preventive for any individual. By contrast, RERI greater than 1 implied a sufficient-cause interaction without requiring that assumption.³⁰ Two-tailed *P* values less than .05 were considered to indicate statistical significance. The Statistical Package for the Social Sciences version 25.0 (IBM, Armonk, New York) was used to analyse the data.

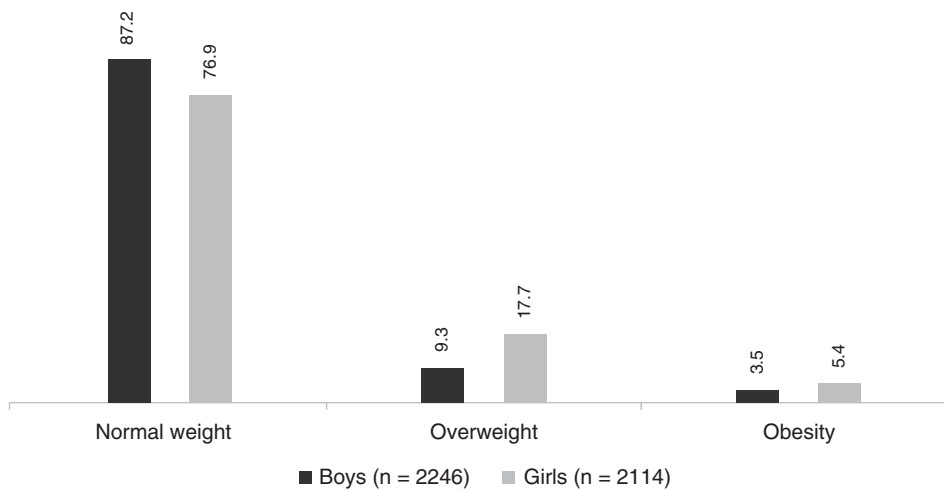


FIGURE 1 Weight categories (%) by sex for Icelandic children in first grade in primary school 2016/2017

TABLE 2 Baseline characteristics of Icelandic boys (n = 2246) and girls (n = 2114) in 1

	Boys		P	Girls		P
	Breakfast (n = 2084)	Not breakfast (n = 162)		Breakfast (n = 1956)	Not breakfast (n = 158)	
IsoBMI			.039			.010
Normal weight	1819 (87.3)	140 (86.4)		1519 (77.7)	106 (67.1)	
Overweight	197 (9.5)	11 (6.8)		335 (17.1)	40 (25.3)	
Obesity	68 (3.3)	11 (6.8)		102 (5.2)	12 (7.6)	
Physical activity			.325			.600
Yes	1941 (93.1)	146 (90.1)		1802 (92.1)	142 (89.9)	
No	87 (4.2)	9 (5.6)		108 (5.5)	11 (7)	
Do not know	56 (2.7)	7 (4.3)		46 (2.4)	5 (3.2)	
Commuting to school			.022			.008
Walking/cycling	1022 (49.0)	64 (39.5)		986 (50.4)	62 (39.2)	
Driven	1062 (51.0)	98 (60.5)		970 (49.6)	96 (60.8)	
Bedtime			.286			.004
Before 9 PM	1533 (73.6)	110 (67.9)		1488 (76.1)	103 (65.2)	
After 9 PM	141 (6.8)	14 (8.6)		82 (4.2)	13 (8.2)	
Do not know	410 (19.7)	38 (23.5)		386 (19.7)	42 (26.6)	
Well-being in school			<.000			.574
Enjoying school	1995 (95.7)	144 (88.9)		1895 (96.9)	151 (95.6)	
Not enjoying school	35 (1.7)	11 (6.8)		23 (1.2)	2 (1.3)	
Not sure	54 (2.6)	7 (4.3)		38 (1.9)	5 (3.2)	

Notes: Grade in primary School 2016/2017 stratified by breakfast skipping. Data is presented as numbers (%). Differences in proportions are tested with χ^2 test.

TABLE 3 Logistic regression (Enter) with odds ratios (OR) and 95% confidence intervals (CI) on the association between not eating breakfast and overweight/obesity in Icelandic boys in first grade of primary school 2016/2017 (n = 2246)

	Model I		Model II		Model III		Model IV	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Breakfast	1	Reference	1	Reference	1	Reference	1	Reference
Not breakfast	1.08	0.68-1.72	1.05	0.65-1.68	1.03	0.64-1.65	1.02	0.63-1.63

Notes: Model I: Unadjusted. Model II: Adjusted for physical activity and commuting to school. Model III: Adjusted for model II+ well-being in school. Model IV: Adjusted for model III+ bedtime.

TABLE 4 Logistic regression (Enter) with odds ratios (OR) and 95% confidence intervals (CI) on the association between not eating breakfast and overweight/obesity in Icelandic girls first grade of primary school 2016/2017 (n = 2114)

	Model I		Model II		Model III		Model IV	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Breakfast	1	Reference	1	Reference	1	Reference	1	Reference
Not breakfast	1.71	1.20-2.42	1.69	1.19-2.39	1.69	1.20-2.39	1.66	1.17-2.36

Notes: Model I: Unadjusted. Model II: Adjusted for physical activity and commuting to school. Model III: Adjusted for model II+ well-being in school. Model IV: Adjusted for model III+ bedtime.

TABLE 5 Adjusted^a odds ratios (OR) and 95% confidence interval (CI) for sex and breakfast eating in context of overweight/obesity (combined analyses and tests of additive interaction) amongst Icelandic children in first grade of primary school 2016/2017 (n = 4360)

	Breakfast				Not breakfast				RERI (95% CI) ^b
	Total	Overweight/obesity	OR	(95% CI)	Total	Overweight/obesity	OR	95% CI	
Boys	2084	265	1.00		162	22	1.05	0.65-1.67 ^{OR_B}	1.25 (0.04-2.46)
Girls	1956	437	1.99	1.68-2.40 ^{OR_A}	158	52	3.29	2.30-4.70 ^{OR_{AB}}	

^aAdjusted for physical activity, commuting to school, bedtime and well-being in school.

^bRelatively increased risk due to biological interaction (RERI): $OR_{AB} - OR_A - OR_B + 1$.

3 | RESULTS

Table 1 provides descriptive characteristics of the total sample and according to sex. The sample consisted of 51.5% (n = 2246) boys and 48.5% (n = 2114) girls, varying in age from 5.6 to 7.4 years (M = 6.3, SD = 0.31). Prevalence of not eating breakfast was nearly the same in boys (7.2%; n = 162) and girls (7.5%; n = 158). The prevalence of OW/OB was 17.8% (n = 776) overall, 12.8% in boys (n = 287) and 23.1% in girls (n = 489).

Figure 1 displays the distribution of three weight categories by sex according to IOTF cut-offs.¹⁹ None of the children was underweight (not shown). More boys had normal weight than girls, and more girls had OW/OB than boys.

Table 2 describes the population stratified by sex and skipping breakfast. OW was more prevalent in boys who had eaten breakfast than boys who had not (9.5% vs 6.8%); however, the opposite was observed for boys with OB, 6.8% of whom had not eaten breakfast compared to 3.3% who had. By contrast, more girls with OW had not eaten breakfast than ones who had (25.3% vs 17.1%), whereas more girls with OB had not eaten breakfast than their counterparts who had (7.6% vs 5.2%).

Significantly, greater proportions of boys and girls who skipped breakfast were driven to school than ones who had eaten breakfast. Moreover, significantly more girls who had eaten breakfast also reported that going to bed before 9 PM was preferable on school nights. Amongst boys who skipped breakfast, 6.8% reported enjoying school, compared to 1.7% of the boys who had eaten breakfast.

The results of the multivariable analyses for boys appear in Table 3. No evidence emerged to support an association between skipping breakfast and OW/OB in boys, regardless of coming from the unadjusted (OR 1.08, 95% CI 0.68-1.72) or adjusted analyses (OR 1.02, 95% CI 0.63-1.63).

Table 4 presents the results from the multivariable analyses for girls. Girls who skipped breakfast were significantly more likely to be OW/OB than girls who had eaten breakfast (unadjusted OR 1.71, 95% CI 1.20-2.42). Adding potential confounders reduced only slightly OR to 1.66 (95% CI 1.17-2.36).

The result for the test gauging interaction on a multiplicative scale was not statistically significant (P = .126). However, RERI for OW/OB due to the interaction between sex and skipping breakfast was 1.25 (95% CI 0.04-2.46), which implies that skipping breakfast confers a higher risk of OW/OB for girls than boys (Table 5).

4 | DISCUSSION

In this register-based study of all first-grade schoolchildren in Iceland, the prevalence of skipping breakfast was 7.2% in boys and 7.5% in girls. Girls who skipped breakfast had 66% greater odds of being OW or OB than girls who had eaten breakfast. By contrast, no association between skipping breakfast and OW or OB emerged amongst boys. Of the boys, 13.4% were determined to have OW and 4.4% to have OB, while the corresponding numbers amongst the girls were 17.7% and 5.4%. The estimates for the girls align with the prevalence of OW and OB in 6-year-old children provided by the WHO in 2013; however, 6-year-old boys in Iceland had somewhat less OW and OB than the WHO's figures.³²

Amongst children in Iceland's primary schools in our study, the prevalence of skipping breakfast, from 7.2% to 7.5%, takes partial support from the findings of a recent systematic review of 37 studies on the association of skipping breakfast with weight and cardiometabolic risk factors in children and adolescents.³³ According to Monzani et al.,³³ skipping breakfast amongst adolescents and girls ranged from 10% to 30% and showed an increasing trend. Results from Sweden (ie, with children aged 7-9 years) and from the Netherlands (ie, with children aged 6 years) included in their review included prevalence rates of skipping breakfast of 4.6% and 6.4%, respectively, which are somewhat less than those rates found in our study.

Our study's major findings include a statistically significant relationship between skipping breakfast and OW or OB in girls but not in boys. That finding was supported by the result of the test of additive interaction, which suggests that sex modified the effect of skipping breakfast on the odds of having OW or OB. RERI exceeded 1, which implies a sufficient-cause interaction without requiring the monotonicity assumption.³⁰ The few studies that have included the youngest children (ie, 2-8 years old) also reported an association between skipping breakfast and OW or OB^{13,34}; however, only one of them involved stratifying the analysis by sex.³⁴ Mushtaq et al. reported that skipping breakfast was associated with OW in girls only.³⁵ Another cross-sectional study in Poland concluded that skipping breakfast or eating it irregularly was a risk factor for OB for girls but not for boys.³⁶ However, results from longitudinal studies,^{37,38} as well as a review of 16 cross-sectional studies and a recently meta-analysis,¹⁰ suggest that skipping breakfast is associated with OW and OB in boys and girls,¹² although not all of those studies involved using formal statistical tests for sex-based differences. Furthermore, in most studies involving statistical testing for effect modification, researchers have used a multiplicative scale with an interaction term, which is unsuitable to assess whether an intervention would benefit some subgroups more than others, which has been identified as an important public health issue.³⁰

The observed sex-based differences may be attributed to different factors. Results suggest that the foetal environment poses consequences for the long-term cardiometabolic health of infants and children, as well as we females seem particularly susceptible to developing disrupted glucose homeostasis and increased adiposity as a result of exposure to environments high in sugar and in utero

undernutrition, respectively.³⁹ Differences in dietary intake and eating behaviours between boys and girls have also been shown,⁴⁰ and along those lines, cultural aspects such as thinness as a criterion for beauty amongst girls may also exert influence. In Japan, a recent study on the association between eating breakfast and childhood OB followed 42 663 children aged 1.5 years until they were 12 years old.⁴¹ The results confirmed that 12% to 32% of their mothers and fathers had skipped breakfast when the child was 1.5 years old and that the strongest association with skipping breakfast surfaced when both parents had skipped breakfast. Moreover, skipping breakfast in children was significantly associated with OW (OR 1.18, 95 CI 1.05-1.32) and OB (OR 2.16, 95% CI 1.55-2.99). Those findings support the influence of context and the correlation between parents' and children's breakfast habits during early childhood.

In a systematic review and meta-analysis of 91 intervention studies involving children aged 2 to 18 years, Micha et al. concluded that in 17 of the studies, the school environment in terms of food—for example, providing breakfast—generally did not decrease adiposity but that specific food-related school policies could improve targeted dietary behaviours, including increased fruit intake.⁴² In a recent study evaluating the effect of eating breakfast in the classroom and receiving breakfast-specific nutrition education focused on OW and OB amongst children (mean age = 10.8 years, SD = 0.96) in low-income urban communities, participation in the school breakfast programme increased as a result of the intervention, although the intervention did not affect the combined incidence of OW and OB.⁴³ However, and surprisingly, because the incidence and prevalence of OB were greater in schools hosting the intervention than in control schools after 2.5 years, the authors concluded that further research is needed to identify approaches to increase participation in breakfast programmes that do not increase OB in students. In Iceland, some schools offer school lunch at a cost; however, no information about children who eventually had lunch arranged by their school was used in our study.

Several cross-sectional studies have revealed an unambiguous association between skipping breakfast and OW or OB in children, especially in ones aged 9 to 16 years.^{44,45} In a study of 9- to 11-year-olds from 12 countries all over the world, the association varied by site, and non-significant associations were found in Australia, Finland and Kenya.¹¹ The level of human development, cultural practices, socio-economic factors and the availability of school breakfast programmes may have contributed to disparities in children's frequency of eating breakfast across the countries.

The major strength of our study was that nearly all children in first grade in Iceland were included in the sample, which afforded a unique opportunity to address the relationship between eating breakfast and both OW and OB at the national level. Another strength was that trained nurses objectively measured the children's height and weight, as well as conducted the health-focused interviews with them.

It is nevertheless important to note the limitations of our cross-sectional design, which limited the results to assessing associations without shedding light on causal mechanisms. Because data about children who did not participate were unavailable, it was impossible to

compare them to participants included in the analyses. Amongst other limitations, the data from interviews with questionnaires not formally validated for use with children 5 to 7 years old. Second, different age-specific classification systems can yield different results regarding the prevalence of OW and OB⁴⁶; thus, using the IOTF classification¹⁹ may have caused the prevalence of excess weight, particularly OB,⁴⁷ to be underestimated, which could have affected the results. Beyond that, the questions used to capture possible confounding factors lacked precision, which may explain their relatively small contribution following adjustment. Third, the prevalence of skipping breakfast was difficult to compare across studies due to differences in its definition. In a recent systematic review of 39 studies on skipping breakfast amongst children and adolescents,³³ a wide range of definitions of *skipping breakfast* were used, and six of those studies used the same definition used in our study—that is, of not having eaten breakfast on the day of the assessment. Nevertheless, that measure probably does not reflect the daily breakfast habits of all children included. The highly heterogeneous assessment of skipping breakfast is well known and suggested as a topic concerning methodology for future studies to examine as a way to produce more significant results.³³

Last, both skipping breakfast and OW or OB in early childhood could be influenced by different mechanisms, including genetics, factors during pregnancy and both contextual and environmental factors. In a US study, home environment in relation to food explained a great deal about children's diets, including that both social (eg, mealtime structure) and physical aspects (eg, food availability) of that environment were strongly associated with the consumption of healthy vs unhealthy foods.⁴⁸ Several studies have revealed that the prevalence of OB is greater amongst children in rural vs urban areas in some countries^{49,50}; therefore, it is likely that geographical factors influenced the associations observed in our study. However, such factors were not considered in the study due to a lack of access to the children's addresses (eg, whether they lived in rural or urban districts of Iceland) and the unavailability of data regarding their parents' socio-economic status and breakfast habits. However, because breakfast consumption is a parental feeding practice for children in the age group studied, future research on skipping breakfast and OW or OB should include family-related factors.

In summary, our study revealed an association between skipping breakfast and OW or OB amongst first-grade girls in Iceland but not boys. Those sex-based differences should be further investigated to inform future health programmes and early interventions directed towards preventing OW and OB during early childhood.

ACKNOWLEDGEMENTS

We wish to thank the Scientific Committee for Health Care in Reykjavik and the University of Iceland (Vís-HH-UI) for providing us with the opportunity to use information from the Ískrá database.

CONFLICT OF INTEREST

No conflict of interest was declared.

ORCID

Linda Ernstsén  <https://orcid.org/0000-0003-4883-4699>

REFERENCES

- World Health Organization. Report of the Commission on Ending Childhood Obesity: Implementation Plan: Executive Summary; 2017. World Health Organization. <https://apps.who.int/iris/handle/10665/259349>. Accessed September 12, 2018.
- Fry J, Finley W. The prevalence and costs of obesity in the EU. *Proc Nutr Soc.* 2005;64(3):359-362.
- Wang YC, McPherson K, Marsh T, Gortmaker SL, Brown M. Health and economic burden of the projected obesity trends in the USA and the UK. *Lancet.* 2011;378(9793):815-825.
- Lobstein TBL, Uauy R. Obesity in children and young people: a crisis in public health. *Obes Rev.* 2004;5(suppl 1):4-104.
- Rong S, Snetselaar LG, Xu G, et al. Association of skipping breakfast with cardiovascular and all-cause mortality. *J Am Coll Cardiol.* 2019;73(16):2025-2032.
- Koca T, Akcam M, Serdaroglu F, Dereci S. Breakfast habits, dairy product consumption, physical activity, and their associations with body mass index in children aged 6-18. *Eur J Pediatr.* 2017;176(9):1251-1257.
- Amigo-Vázquez I, Busto-Zapico R, Errasti-Pérez JM, Peña-Suárez E. Skipping breakfast, sedentarism and overweight in children. *Psychol Health Med.* 2016;21(7):819-826.
- Stea TH, Vik FN, Bere E, Svendsen MV, Oellingrath IM. Meal pattern among Norwegian primary-school children and longitudinal associations between meal skipping and weight status. *Public Health Nutr.* 2015;18(2):286-291.
- Timlin MT, Pereira MA, Story M, Neumark-Sztainer D. Breakfast eating and weight change in a 5-year prospective analysis of adolescents: project EAT (eating among teens). *Pediatrics.* 2008;121(3):e638-e645.
- Ardehshirlarijani E, Namazi N, Jabbari M, et al. The link between breakfast skipping and overweight/obesity in children and adolescents: a meta-analysis of observational studies. *Journal of Diabetes & Metabolic Disorders.* 2019;18(2):657-664
- Zakrzewski J, Gillison F, Cumming S, et al. Associations between breakfast frequency and adiposity indicators in children from 12 countries. *Int J Obes Suppl.* 2015;5(suppl 2):S80-S88.
- Szajewska H, Ruszczyński M. Systematic review demonstrating that breakfast consumption influences body weight outcomes in children and adolescents in Europe. *Crit Rev Food Sci Nutr.* 2010;50(2):113-119.
- Vanelli M, Iovane B, Bernardini A. Breakfast habits of 1,202 northern Italian children admitted to a summer sport school. Breakfast skipping is associated with overweight and obesity. *Acta Bio Medica Atenei Parmensis.* 2005;76(2):79-85.
- Kuther TL. *Lifespan Development: Lives in Context, Chap. 7: Physical and Cognitive Development in Early Childhood.* Newbury Park, California: Sage Publications Inc.; 2019.
- Folkhelseinstituttet. Barn, miljø og helse. Risiko- og helsefremmende faktorer. Rapport mai 2016. Oslo; 2016. <https://fhi.no/globalassets/produksjonsmigring/dokumenter/barn-miljo-og-helse-pdf.pdf>. Accessed January 10, 2017.
- Stordal E, Bjartveit Kruger M, Dahl NH, Kruger O, Mykletun A, Dahl AA. Depression in relation to age and gender in the general population: the Nord-Trøndelag Health Study (HUNT). *Acta Psychiatr Scand.* 2001;104:210-216.
- Fayet-Moore F, Kim J, Sritharan N, Petocz P. Impact of breakfast skipping and breakfast choice on the nutrient intake and body mass index of Australian children. *Nutrients.* 2016;8(8):12.
- Dubois L, Girard M, Kent MP, Farmer A, Tatone-Tokuda F. Breakfast skipping is associated with differences in meal patterns,

- macronutrient intakes and overweight among pre-school children. *Public Health Nutr.* 2009;12(1):19-28.
19. Cole TJ, Lobstein T. Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. *Pediatr Obes.* 2012;7(4):284-294.
 20. Katzmarzyk PT, Barreira TV, Broyles ST, et al. Relationship between lifestyle behaviors and obesity in children ages 9-11: results from a 12-country study. *Obesity.* 2015;23(8):1696-1702.
 21. Sisson SB, Broyles ST, Baker BL, Katzmarzyk PT. Television, reading, and computer time: correlates of school-day leisure-time sedentary behavior and relationship with overweight in children in the US. *J Phys Act Health.* 2011;8:S188-S197.
 22. Cappuccio FP, Taggart FM, Kandala NB, et al. Meta-analysis of short sleep duration and obesity in children and adults. *Sleep.* 2008;31(5):619-626.
 23. Wu YH, Gong QH, Zou ZQ, Li H, Zhang XH. Short sleep duration and obesity among children: a systematic review and meta-analysis of prospective studies. *Obes Res Clin Pract.* 2017;11(2):140-150.
 24. Wilson SM, Sato AF. Stress and paediatric obesity: what we know and where to go. *Stress Health.* 2014;30(2):91-102.
 25. Balantekin KN, Roemmich JN. Children's coping after psychological stress. Choices among food, physical activity, and television. *Appetite.* 2012;59(2):298-304.
 26. Freitas IF, Christofaro DGD, Codogno JS, Monteiro PA, Silveira LS, Fernandes RA. The association between skipping breakfast and biochemical variables in sedentary obese children and adolescents. *J Pediatr.* 2012;161(5):871-874.
 27. Westerlund L, Ray C, Roos E. Associations between sleeping habits and food consumption patterns among 10-11-year-old children in Finland. *Br J Nutr.* 2009;102(10):1531-1537.
 28. Ganasegeran K, Al-Dubai SAR, Qureshi AM, Al-Abad A, Rizal AM, Aljunid SM. Social and psychological factors affecting eating habits among university students in a Malaysian medical school: a cross-sectional study. *Nutrition Journal.* 2012;11(1):48. https://pubmed.ncbi.nlm.nih.gov/22809556/?from_single_result=Ganasegeran+K%2C+Al-Dubai+SAR%2C+Qureshi+AM%2C+Al-Abad+A%2C+Rizal+AM%2C+Aljunid+SM.
 29. Knol MJ, VanderWeele TJ. Recommendations for presenting analyses of effect modification and interaction. *Int J Epidemiol.* 2012;41(2):514-520.
 30. VanderWeele TJ, Knol MJ. A tutorial on interaction. *Epidemiol Methods.* 2014;3(1):33-72.
 31. Andersson T, Alfredsson L, Källberg H, Zdravkovic S, Ahlbom A. Calculating measures of biological interaction. *Eur J Epidemiol.* 2005;20(7):575-579.
 32. Lee SJ, Moody-Ayers SY, Landefeld CS, et al. The relationship between self-rated health and mortality in older black and white Americans. *J Am Geriatr Soc.* 2007;55(10):1624-1629.
 33. Monzani A, Ricotti R, Caputo M, et al. A systematic review of the association of skipping breakfast with weight and cardiometabolic risk factors in children and adolescents. What should we better investigate in the future? *Nutrients.* 2019;11(2):387.
 34. Smetanina N, Albaviciute E, Babinska V, et al. Prevalence of overweight/obesity in relation to dietary habits and lifestyle among 7-17 years old children and adolescents in Lithuania. *BMC Public Health.* 2015;15(1):1001.
 35. Mushtaq MU, Gull S, Mushtaq K, Shahid U, Shad MA, Akram J. Dietary behaviors, physical activity and sedentary lifestyle associated with overweight and obesity, and their socio-demographic correlates, among Pakistani primary school children. *Int J Behav Nutr Phys Act.* 2011;8(1):130.
 36. Januszek-Trzciakowska A, Małeczka-Tendera E, Klimek K, Matusik P. Obesity risk factors in a representative group of Polish prepubertal children. *Arch Med Sci.* 2014;10(5):880-885.
 37. Küpers L, De Pijper J, Sauer P, Stolk R, Corpeleijn E. Skipping breakfast and overweight in 2- and 5-year-old Dutch children—the GECKO Drenthe cohort. *Int J Obes (Lond).* 2014;38(4):569-571.
 38. Alshairi NA, Somerset SM. Skipping breakfast in early childhood and its associations with maternal and child BMI: a study of 2-5-year-old Australian children. *Eur J Clin Nutr.* 2016;70(4):450-455.
 39. Dearden L, Bouret SG, Ozanne SE. Sex and gender differences in developmental programming of metabolism. *Mol Metabol.* 2018;15:8-19.
 40. Barstad LH, Juliusson PB, Johnson LK, Hertel JK, Lekhal S, Hjelmestaeth J. Gender-related differences in cardiometabolic risk factors and lifestyle behaviors in treatment-seeking adolescents with severe obesity. *BMC Pediatr.* 2018;18:61.
 41. Okada C, Tabuchi T, Iso H. Association between skipping breakfast in parents and children and childhood overweight/obesity among children: a nationwide 10.5-year prospective study in Japan. *Int J Obes (2005).* 2018;42(10):1724-1732.
 42. Micha R, Karageorgou D, Bakogianni I, et al. Effectiveness of school food environment policies on children's dietary behaviors: a systematic review and meta-analysis. *PLoS One.* 2018;13(3):27.
 43. Polonsky HM, Bauer KW, Fisher JO, et al. Effect of a breakfast in the classroom initiative on obesity in Urban School-aged children: a cluster randomized clinical trial. *JAMA Pediatr.* 2019;173:326.
 44. Lehto R, Ray C, Lahti-Koski M, Roos E. Meal pattern and BMI in 9-11-year-old children in Finland. *Public Health Nutr.* 2011;14(07):1245-1250.
 45. Tin S, Ho S, Mak K, Wan K, Lam T. Breakfast skipping and change in body mass index in young children. *Int J Obes (Lond).* 2011;35(7):899-906.
 46. Ahrens W, Pigeot I, Pohlmann H, et al. Prevalence of overweight and obesity in European children below the age of 10. *Int J Obes (Lond).* 2014;38(S2):S99-S107.
 47. Reilly JJ, Kelly J, Wilson D. Accuracy of simple clinical and epidemiological definitions of childhood obesity: systematic review and evidence appraisal. *Obes Rev.* 2010;11(9):645-655.
 48. Ranjit N, Wilkinson AV, Lytle LM, Evans AE, Saxton D, Hoelscher DM. Socioeconomic inequalities in children's diet: the role of the home food environment. *Int J Behav Nutr Phys Act.* 2015;12(1):54.
 49. Ells LJ, Hancock C, Copley VR, et al. Prevalence of severe childhood obesity in England: 2006-2013. *Arch Dis Child.* 2015;100(7):631-636.
 50. Johnson Iii JA, Johnson AM. Urban-rural differences in childhood and adolescent obesity in the United States: a systematic review and meta-analysis. *Child Obes.* 2015;11(3):233-241.

How to cite this article: Aanesen A, Katzmarzyk PT, Ernstsen L. Breakfast skipping and overweight/obesity in first grade primary school children: A nationwide register-based study in Iceland. *Clin Obes.* 2020;e12384. <https://doi.org/10.1111/cob.12384>