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## Short Communication

# Skipping breakfast and non–high-density lipoprotein cholesterol level in school children: a preliminary analysis



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## ABSTRACT

**Objective:** The objective of the study is to examine whether the increased levels of non–high-density lipoprotein cholesterol (non-HDL-c) are associated with skipping breakfast among school children.

**Study design:** A cross-sectional survey was conducted among 539 school children aged 8–12 years from the Niagara Region of Canada.

**Methods:** Non-fasting finger blood was taken for total cholesterol (total-c) and HDL-c measurements. Non-HDL-c was calculated as the difference between total-c and HDL-c. The information of skipping breakfast in a week was obtained from a questionnaire, which was categorized into three groups, i.e., none, 1–3 times and 4 + times. Demographic information and other related variables were described by the three breakfast-skipping groups.

**Results:** Approximately 44% of children (n = 182) reported skipping breakfast. There were significant differences between the three groups in the means of total-c, non-HDL-c, body mass index, waist circumference, proportions of overall health excellent, eating dinner with parent and skipping breakfast that affects learning ( $P < 0.05$ ). The number of days of skipping breakfast was weakly correlated to the level of non-HDL-c ( $r = 0.145$ ,  $P < 0.0001$ ). Multiple regression results indicated that every one more time of skipping breakfast would increase approximately 0.05 mmol/L level of non-HDL-c ( $P < 0.01$ ), on average, after adjusting for those aforementioned potential confounding variables. The adjusted mean levels of non-HDL-c were 2.77, 2.94 and 3.07 mmol/L for none, skipping 1–3 times and skipping 4 + times of breakfast, respectively; the mean differences between none and the other two groups were statistical significant ( $P < 0.05$ ).

**Conclusion:** Non-HDL-c levels is positively associated with the number of skipping breakfast among school children, and further research is needed to confirm this relationship.

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Numerous studies have confirmed that regularly taking breakfast is good for our health and well-being.<sup>1–4</sup> Skipping breakfast in adults has been found to be associated with a higher risk for incident coronary heart disease (CHD),<sup>5</sup> type 2 diabetes<sup>6</sup> and even mortality.<sup>7</sup> Children who skip breakfast not only have a worse school academic performance<sup>1</sup> but are also at a higher risk of obesity<sup>8</sup> and with more mental health issues.<sup>9</sup> Adolescents with poor breakfast habits are more likely to be with metabolic syndrome (MeTs) when they become adults, particularly at the increased risk for central obesity and high level of fasting glucose.<sup>10</sup>

High levels of non-high-density lipoprotein cholesterol (non-HDL-c) are associated with an increased risk of CHD.<sup>11,12</sup> Children and adolescents who are with insulin resistance are observed to have a higher level of non-HDL-c, whereas children and adolescents who are with higher levels of non-HDL-c are more likely to have an impaired fasting glucose level and other risk factors of MeTs.<sup>13</sup> However, it is unclear whether the levels of non-HDL-c are associated with skipping breakfast among school children. Hence, this study aims to use school health survey data collected through the Healthy Heart Schools' Program (HHSP) to explore this issue.

The HHSP has been implemented in the Niagara Region for more than 30 years. Since 2001, it focuses on developing grade 9 students' healthy habits through physical education (PE) classes with an enhanced health and PE curriculum, which included knowledge of nutritious foods, benefits of daily activity and risks of cigarette smoking. In addition, the cardiometabolic risk profiles are assessed for each student with consent. A pilot project of a similar program was implemented in 2013–2014 among approximately 1000 grade 5 students (8–12 years). Five hundred and thirty-nine students who had complete information of non-HDL-c and skipping breakfast status were included in this analysis. All students provided informed assent, and the parents/guardians provided written consent to participate in the assessment. Formal ethics approval was obtained by Heart Niagara, Inc. from the research ethics committees of the District School Board of Niagara. Brock University Research Ethics Board has also approved this secondary data analysis research (BREB#:16-048).

The level of non-HDL-c was calculated as the difference between total cholesterol (total-c) and HDL-c. Total-c and HDL-c were measured using non-fasting finger-stick capillary samples analyzed with Cholesterol LDX cassettes (Cholestech LDX System, Inverness Medical Innovations). Students completed a questionnaire, in which questions related to nutrition and other behaviours were asked. For example 'how many times have you skipped breakfast in one week (0–7/week)?', 'how often do you eat dinner with at least one parent (0–1, 2–3, 4–5, 6–7 times/week)?', 'how many times do you eat fruits/vegetables yesterday?' and 'do you think skipping breakfast will affect your school learning (agree vs. not agree)?' Based on skipping breakfast information, students were categorized as non-skipper ( $n = 357$ ), skipping breakfast 1–3 times ( $n = 129$ ) or skipping breakfast 4 + times ( $n = 53$ ). The covariates that have been examined include age (years), sex (male vs. female), general health (poor, fair, good, very good, excellent), systolic and diastolic blood pressure that were measured by following a standard protocol by a nurse,

eating dinner with parents, fruits/vegetables eating, question that skipping breakfast affects school learning and number of days having moderate physical activity at least 30 min in last week.

The characteristics of these students by skipping breakfast status are shown in Table 1. Overall, among 539 school children (265 boys and 274 girls) who were included in this analysis, 66.2% of them reported no skipping breakfast during the last week. For those skipping breakfast 1–3 times and 4 or more times, the average times of skipping breakfast were 1.8 and 5.1 times, respectively. There were no differences in mean levels of age and proportion of sex as male. The proportions of having overall excellent health were 43%, 28.1% and 32.6% for children in the non-skipping, skipping 1–3 times and skipping 4 or more times groups, respectively ( $P < 0.05$ ). For cardiovascular health indicators, no statistical significances were found in blood pressure and HDL-c among different skipping breakfast statuses. However, compared with children in the two skipping groups, children who were non-skippers had much lower mean levels of total-c (4.11, 4.22 and 4.35 mmol/L,  $P < 0.05$ ), non-HDL-c (2.76, 2.92 and 3.10 mmol/L,  $P < 0.001$ ), waist circumference (60.98, 63.01 and 64.75 cm,  $P < 0.01$ ) and body mass index (BMI) (19.06, 20.38 and 21.01 kg/m<sup>2</sup>,  $P < 0.001$ ). In addition, they also were more likely to have dinner with their parents (82.1%, 67.7% and 62.3%,  $P < 0.01$ ) and a higher proportion of agreeing that skipping breakfast affects school learning (83.9%, 72.8% and 43.4%,  $P < 0.001$ ).

Multiple regression analysis was used to model the relationship between the levels of non-HDL-c (dependent variable) and the number of skipping breakfast (a continuous variable as the predictive variable) with adjustment for all variables that showed statistical significance in Table 1 except for waist circumference, which was highly correlated to BMI, plus age and sex. Overall, the model was statistically significant ( $R^2 = 0.10$ ,  $P < 0.0001$ ). The regression coefficient for the number of skipping breakfast last week was 0.051 (95% confidence interval [CI]: 0.013, 0.090,  $P < 0.01$ ), which suggested that every one more time of skipping breakfast the last week was associated with 0.051 mmol/L increase in non-HDL-c level on average. This relationship was independent from the covariates adjusted. Other statistical significant regression coefficients included  $\beta_{\text{BMI}} = 0.045$  ( $P < 0.0001$ ),  $\beta_{\text{dinner with parent}} = -0.202$  ( $P < 0.01$ ) and  $\beta_{\text{skipping affect school learning}} = 0.17$  ( $P < 0.05$ ) (details seen in Appendix).

The adjusted mean levels of non-HDL-c from a General Linear Model (GLM) analysis with the aforementioned covariates were 2.77, 2.94 and 3.07 mmol/L for non-skippers, skipping breakfast 1–3 times and 4 or more times during the last week, respectively. The mean level of non-HDL-c among non-skippers was significantly different from that of other two groups who skipped breakfast during previous week. The  $P$ -value for trends was also less than 0.05.

Using pilot project data collected among grade 5 students in the Niagara Region, we examined the relationship between skipping breakfast status and levels of non-HDL-c and found that the levels of non-HDL-c were positively associated with the number of times of skipping breakfast. This positive relationship was not affected by adjustment of other known risk factors. Children in the non-skipping breakfast group had a significantly lower mean level of non-HDL-c than those who skipped breakfast during previous week.

**Table 1 – Characteristics of 539 school children by skipping breakfast status**

Characteristic	Skipping breakfast status during last week			P-value
	None	1–3 times	4+ times	
	n= 357	n=129	n=53	
Age (yrs., mean [SD])	10.25 [0.57]	10.26 [0.62]	10.34 [0.71]	ns
Sex as male (%)	51.8	40.3	52.8	ns
Overall health as excellent (%)	43.2	28.1	32.6	<.05
Cardiovascular health indicators				
SBP <sup>a</sup> (mmHg, mean [SD])	100.04 [10.34]	101.27 [10.05]	101.88 [9.40]	ns
DBP <sup>a</sup> (mmHg, mean [SD])	63.47 [8.15]	64.70 [7.89]	65.33 [7.70]	ns
Total cholesterol (mmol/L, mean [SD])	4.11 [0.64]	4.22 [0.83]	4.35 [0.74]	<.05
HDL cholesterol (mmol/L, mean [SD])	1.35 [0.34]	1.30 [0.38]	1.25 [0.31]	ns
Non-HDL cholesterol (mmol/L, mean [SD])	2.76 [0.64]	2.92 [0.78]	3.10 [0.75]	<.001
Waist circumference (cm, mean [SD])	60.98 [8.65]	63.01 [8.49]	64.75 [11.43]	<.01
BMI (kg/m <sup>2</sup> , mean [SD])	19.06 [3.57]	20.38 [4.11]	21.01 [5.15]	<.001
Dinner with at least one parent 6–7 times during the past week (n, [%])	293 [82.1]	86 [67.7]	33 [62.3]	<.001
At least 5 fruits/vegetables servings at home in a week (n, [%]) <sup>a</sup>	100 [28.0]	31 [24.0]	12 [22.6]	ns
Days had moderate physical activity in a week <sup>b</sup> (mean [SD])	2.57 [2.29]	2.35 [2.11]	1.93 [1.96]	ns
Agree skipping breakfast would affect learning (n, [%])	298 [83.9]	91 [72.8]	23 [43.4]	<.001
Number of breakfasts skipped last week (mean [SD])	0.00 [0.00]	1.78 [0.77]	5.11 [1.03]	<.001

SD, standard deviation; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL, high-density lipoprotein; BMI, body mass index; ns, not significant.

<sup>a</sup> Blood pressure readings were taken by a nurse.

<sup>b</sup> Moderate physical activity at least 30 minutes per day

Literature indicates that intake of poor quality or skipping breakfast in adults is associated with an increased risk for coronary heart disease, type 2 diabetes and MeTs.<sup>5,6</sup> Skipping breakfast in children and adolescents has been found to be associated with poor academic performance and an increased risk for obesity.<sup>1</sup> Our results go along with these studies on the association between skipping breakfast and the risk of obesity. The mean levels of BMI and waist girth in our study were significantly lower among those non-skippers.

A study conducted among adults on the relationship between skipping breakfast and lipid profiles and the results showed that, among younger adults (20–39 years), those who were breakfast skippers were more likely to have elevated levels of total cholesterol, low-density-lipoprotein (LDL) cholesterol and decreased HDL-c.<sup>14</sup> Our results suggest that children who were breakfast skippers had higher levels of total-c and non-HDL-c, and the levels of HDL cholesterol were lower but not statistically different. We believe this is the first study conducted among children to examine the relationship between skipping breakfast and lipid profile.

There are several limitations that should be considered when interpreting the results of this study. First, given the cross-sectional design, only associations, but not causality, can be inferred. Second, the ethnicity information was not available, although census data suggest that majority residents in the Niagara Region are Caucasians. And third, the lipid profile was evaluated with non-fasting finger blood sample, which may not be same as that measured from fast-ing venous blood sample.

In conclusion, skipping breakfast among children appears to be associated with an increased level of non-HDL-c. Further studies are needed to verify the relationship between skipping breakfast and non-HDL-c level observed in this study; thus, it may provide an efficient measure through application of

promoting eating healthy breakfast among school children to reduce cardiovascular risk.

## Author statements

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### Ethical approval

Formal ethics approval was obtained by Heart Niagara, Inc. from the research ethics committees of the District School Board of Niagara. Brock University Research Ethics Board has also approved this secondary data analysis research (BREB#:16-048).

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### Competing interests

None declared.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2018.12.006>.