Meal-Skipping Behaviors and Body Fat in 6-Year-Old Children

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Objective To assess the prospective associations of breakfast, lunch, and dinner skipping at age 4 years with body fat (ie, percent fat mass, body mass index [BMI], and weight status) at age 6 years.

Study design Data were analyzed from 5913 children participating in the Generation R Study, a population-based prospective cohort study in Rotterdam, The Netherlands. Meal-skipping behaviors were assessed through parent-report questionnaires. Children's weight and height were objectively measured and converted to BMI SDSs. Weight status (ie, overweight or normal weight) was defined according to age- and sex-specific cutoff points. At age 6 years, percent fat mass was assessed by dual-energy X-ray absorptiometry. Linear and logistic regression analyses were performed, adjusting for covariates and BMI at age 4 years.

Results Breakfast skipping at age 4 years was associated with a higher percent fat mass at age 6 years (β = 1.38; 95% CI, 0.36-2.40). No associations were found with BMI or weight status. Furthermore, no associations were found between lunch and dinner skipping at age 4 years and body fat at age 6 years.

Conclusion Breakfast skipping at age 4 years is associated with a higher percent fat mass at age 6 years. Further prospective studies, including intervention studies, are warranted to extend the evidence base on the directionality and causality of this association. *(J Pediatr 2016;168:118-25)*.

The childhood overweight epidemic has coincided with a decline in daily breakfast consumption,[1] leading to the hypothesis that breakfast skipping may be involved in the etiology of childhood overweight. This hypothesis is supported by observational studies showing positive associations between breakfast skipping and the risk of childhood overweight[2-6]; however, most of these studies used a cross-sectional design, which hinders the ability to draw conclusions about the directionality of the association.[7,8] Moreover, few studies have examined the associations of lunch skipping and dinner skipping with children's body fat.[9,10]

Studies on the associations between meal-skipping behaviors and childhood overweight have generally used body mass index (BMI) or weight status (overweight vs normal weight) as measures of children's body fat.[2-4,6,9,10] Even though BMI is widely used, owing to its feasibility and correlation with other body fat measures, it does not discriminate between fat mass and lean mass and thus is a measure of excess weight rather than excess body fat.[11] In contrast, percent fat mass as measured by dual-energy X-ray absorptiometry (DXA) is considered a more accurate measure of body fat in children.[11]

The aims of the present study were to assess the prevalence and tracking of children's meal-skipping behaviors between age 4 and 6 years, and to assess the prospective associations of meal-skipping behaviors at age 4 years with body fat at age 6 years.

Methods

This study was embedded in the Generation R Study, a population-based prospective cohort study from fetal life onward.[12] The study was conducted in accordance with the guidelines proposed in the World Medical Association's Declaration of Helsinki and was approved by the Medical Ethical Committee of Erasmus Medical Center, University Medical Center Rotterdam. Written informed consent was obtained from parents of all participating children. Of the 9749 known live born children of the Generation R cohort, 8305 still participated in follow-up studies from 5 years. At age 6 years, 6690 children visited a dedicated research center in the Erasmus Medical Center, Sophia's Children's Hospital, where body fat data were collected.[12] Participants with missing information on BMI or fat mass (n = 330) were excluded from the current analyses. To avoid clustering of data, we also excluded second children (n = 441) and third children (n = 6) of the same mother, leaving a study population of 5913 participants.

Meal-skipping behaviors were assessed by parent-reported questionnaires when the children were 4 years old and again at 6 years old. At age 4 years,

BMI	Body mass index
DXA	Dual-energy X-ray absorptiometry

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The Generation R Study is made possible by financial support from Erasmus Medical Center, Rotterdam, Erasmus University Rotterdam, and the Netherlands Organization for Health Research and Development (ZonMw). The present study was supported by an additional grant from ZonMw (No 102047). O.F. works in ErasmusAGE, a center for aging research across the life course funded by Nestlé Nutrition (Nestec Ltd), Metagenics, Inc, and AXA. The other authors declare no conflicts of interest.

http://dx.doi.org/10.1016/j.jpeds.2015.09.039

children's weekly consumption of breakfast, lunch, and dinner was assessed with answer categories including "never," "1-2 days per week," "3-4 days per week," "5-6 days per week," and "every day" (coded as 1-5). At age 6 years, the number of days on which children consumed breakfast, lunch, and dinner was assessed separately for weekdays (coded as 0-5) and weekend days (coded as 0-2), and the scores were summed to calculate total weekly consumption (0-7). Because of highly skewed distributions, meal skipping was defined as consumption <7 days per week.

BMI was measured at age 4 years and 6 years. At age 4 years, weight and height were measured at community child health centers by trained staff following standard schedules and procedures. Height was measured in a standing position without shoes using a Harpenden stadiometer (Holtain Ltd, Crymych, United Kingdom). Weight was measured without clothing and shoes using a mechanical personal scale (Seca, Hamburg, Germany). BMI was calculated as weight divided by height squared (kg/m^2). Using the Growth Analyzer program (Growth Analyzer 3.0; Dutch Growth Research Foundation, Rotterdam, The Netherlands), BMI SDS adjusted for age and sex were constructed based on Dutch reference growth curves.[13] At age 6 years, height and weight (in lightweight clothes and without shoes) were measured in the Generation R research center in the Erasmus Medical Center, Sophia's Children's Hospital. Children's weight status (overweight, including obesity, vs normal weight) was defined according to age- and sex-specific cutoff points proposed by the International Obesity Task Force.[14]

DXA scans (iDXA; GE Healthcare, Wauwatosa, Wisconsin) were performed to obtain percent fat mass. Children were scanned while supine with the feet together in a neutral position and hands flat by the sides. All DXA scans were obtained using the same device and software (enCORE2010; GE Healthcare) and were performed by well-trained and certified research staff.

Based on earlier studies on risk factors of childhood overweight,[7,15,16] the child's sex, age, ethnic background (ie, native Dutch, other Western, or non-Western),[17] family socioeconomic position (ie, maternal educational level [high, mid-high, mid-low, low],[18] maternal employment status [paid job, no paid job], household income [<€2000/month, €2000-€3200/month, >€3200/month]),[19] paternal BMI, and children's lifestyle behaviors were considered important covariates. Maternal prepregnancy BMI was calculated on the basis of self-reported prepregnancy weight and measured height at enrollment. Paternal BMI was calculated on the basis of measured weight and height at enrollment. Children's physical activity behaviors (ie, sports participation, outdoor play, active transport to/from school), sedentary behaviors (ie, television viewing, computer game use), and dietary behaviors (ie, consumption of sugar-containing beverages and high-calorie snacks) were assessed in parent-reported questionnaires at age 4 and 6 years.

Statistical Analyses

Descriptive statistics were used to characterize the study population. Differences between boys and girls were assessed using the χ^2 test for categorical variables and 1-way ANOVA for normally distributed continuous variables. The McNemar test was used to compare the prevalences of meal skipping at age 4 and 6 years. Two-year tracking of children's meal-skipping behaviors was evaluated in 2 ways.[20] First, Spearman rho correlation coefficients were calculated to assess the correlation between children's relative rank positions in number of days of meal skipping at 4 years and 6 years. Second, tracking patterns were generated using cross-tabulation of (dichotomized) meal-skipping behaviors at age 4 and 6 years, in which children were allocated to 1 of 4 categories: stable meal consumption (ie, meal consumption at both time points), stable meal skipping (ie, meal skipping at both time points), decrease in meal skipping (ie, meal skipping at age 4 years and meal consumption at age 6 years), and increase in meal skipping (ie, meal consumption at age 4 years and meal skipping at age 6 years).

Associations between meal-skipping behaviors at age 4 years and body fat at age 6 years were assessed using a series of multiple linear and logistic regression models. Separate crude models contained meal-skipping behaviors at age 4 years as the independent variable and indicators of body fat at age 6 years as dependent variables. In the first set of models, associations were adjusted for the first group of covariates, including family socioeconomic position, ethnic background, and parental BMI. In the second set of models, associations were additionally adjusted for other meal-skipping behaviors. In the third set of models, associations were additionally adjusted for children's lifestyle behaviors that may act as mediators is the associations between meal-skipping behaviors and children's body fat. In the final set of models (full models), BMI at age 4 years was added to the models. The same analyses were performed using tracking patterns as the independent variable. Interaction effects of meal-skipping behaviors with child's sex, BMI at age 4 years, and ethnic background were assessed by adding separate interaction terms to the full models.

In addition, 2 sensitivity analyses were conducted. First, tests for trends were examined by repeating the analyses using meal-skipping variables at age 4 years as continuous independent variables. Second, cross-sectional analyses were performed using meal-skipping behaviors and body fat indicators measured at age 6 years.

Multiple imputation was applied to handle missing data in the meal-skipping behaviors, potential confounders, and BMI at age 4 years.[21] Five imputed datasets were generated using a fully conditional specified model, thus taking into account the uncertainty of the imputed values. Pooled estimates from these 5 imputed datasets were used to report β values, ORs, and their 95% CIs. Imputations were based on the relationships among all of the variables included in this study. All analyses were conducted with SPSS version 21.0 for Windows (IBM, Armonk, New York). A P value <.05 was considered to indicate a significant association.