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Three-year intervention effects on food and beverage intake - results from the non-randomized Copenhagen school child intervention study (CoSCIS)

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Short running head: Results of a school-based intervention (CoSCIS)

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Short running head: Intervention effects on food and beverage intake

Abbreviations

SES, socio-economic status

SSB, sugar-sweetened beverage

BMI, body mass index

IQR, interquartile range

OR, odds ratio

CI, confidence interval

HBSC, Health Behaviour in School-aged Children

PE, Physical education

SD, standard deviation

Abstract

Background: The diet of Danish children does generally not comply with the official dietary guidelines. With the aim to improve well-being and life style of local school children the non-randomized Copenhagen School Child Intervention Study was initiated.

Objectives: To examine the three-year effect of the Copenhagen School Child Intervention Study on the children's intake of selected foods and beverages and whether an intervention effect depended on maternal education level.

Methods: All children entering a public school in 2001 in two sub-urban municipalities of Copenhagen, Denmark, were invited (n= 1024). A total of 307 children provided information on dietary intake (7-days food record) pre- and post- intervention and on maternal education and were included in the present study. Analyses were performed as logistic regressions assessing the odds of changing the intake of food and beverages during the intervention period.

Results: Significantly higher odds for increasing the intake of fruit was observed among children in the intervention group compared to the comparison group (OR: 1.92, 95% CI: 1.26 to 2.93, p=0.002). This effect was especially evident among children of mothers with short education (OR: 6.71, 95% CI: 1.75 to 25.65, p=0.005). In the same group of children the odds of increasing the intake of vegetables was 1.95 (95% CI: 0.88 to 4.28, p=0.10) and 0.48 for soft drinks (95% CI: 0.22 to 1.06, p=0.07), respectively. Also, higher odds for increasing the intake of white bread was observed in the intervention group among children of mothers with a long education (OR: 2.17, 95% CI: 1.17 to 4.03, p=0.01).

Conclusion: Children in the intervention group, particularly those of mothers with short education, had higher odds of increasing the intake of fruit during the three -year intervention period.

Introduction

The high prevalence of overweight and obesity observed in many countries including Denmark (1,2) has personal and societal costs, since overweight children suffer from both short and long term health consequences (2-6). In Denmark (7,8) and most Western countries (9,10) the prevalence of overweight and obesity is highest among children of parents with low socio-economic status (SES). Diet is considered an important factor in the prevention of overweight and obesity (11), and the official food-based dietary guidelines in Denmark have been introduced with the aim to reduce the risk of lifestyle diseases including overweight/obesity, coronary heart disease, diabetes and some types of cancer later in life (13). However, the dietary intake among Danish children and adolescents generally does not comply with the dietary guidelines, as the intake of fatty meat- and dairy products, sugar-sweetened beverages (SSBs) and sweets provides a higher intake of saturated fatty acids and added sugar than recommended, and the intake of fish, vegetables and wholegrain products is lower than recommended (13). The intake of fruit is relatively higher among the youngest children and closer to the recommendations, than among older children (> 10 years) and adolescents. Thus, the intake does not increase with age as recommended (14). In addition, Danish adolescents (age 11-15 years) from low SES families comply less with the national guidelines, since they consume fruit and vegetables less frequently and consume SSBs, sweets and fast food more often than adolescents from high SES families (15). A similar trend has been observed among the Danish children (aged 4-14 years), mainly among boys. Moreover, in that age group no difference in the intakes of SSBs, sweets and pizza was observed dependent on SES in that study (8).

Public schools have been suggested as an obvious and important arena for introducing health-promoting initiatives among children (16). In 2001 the Copenhagen School Child Intervention Study (CoSCIS) was initiated with the aim to evaluate the health promoting initiative of the

municipality of Ballerup focusing on improving dietary intake and physical activity among school children in the municipality. Numerous school-based intervention studies with the aim to improve dietary intake have been published previously; however, few of the studies assess the intervention effect for children from different social classes (2,18,19). Therefore the aim, of the present study was to examine: 1) the effect the CoSCIS on the intake of specific foods (fruit, vegetables, sweets, white bread, coarse bread, rye bread and fish) and beverages (soft drinks, SSBs and fruit juice); and 2) whether the intervention effect depended on the maternal educational level.

We hypothesized that: 1) after the three-year intervention the children from the intervention group would have a higher intake of fruit and vegetables and a lower intake of sweets, soft drinks and SSBs than the children from the comparison group; and 2) that the effect of the intervention would be stronger among children of mothers with long education compared to children of mothers with short education.

Subjects and methods

Intervention

In 1999 an initiative with the focus to promote a healthy lifestyle and improve well-being among the local school children in a suburban community of Copenhagen, Denmark, (Ballerup) was initiated (17). The initiative was multi-component and consisted of both classroom-based activities, and environmental changes. Briefly described it consisted of:

1) Two additional physical education (PE) lessons per week. The standard PE lessons (two lessons (90min)/week) in Denmark are mandatory for the pupils and are delivered as two weekly classes. In the ten schools included in the intervention the standard PE lessons were increased from two to four PE lessons per week (180 min) from preschool to third grade. These additional PE lessons were provided by the usual PE teachers (17,18).

2) Additional education of PE teachers. Each year all the PE teachers employed at the intervention schools received additional education consisting of a one-day course and six afternoon sessions (three hours) with practical and theoretic training. The focus of the education was on the development of the body, healthy living and diet (18). Moreover, the facilities for PE were improved at the intervention schools (17,18) and for the PE teachers to exchange knowledge a network was established (19).

3) Improvement of schoolyard environment. To stimulate the children at the intervention schools to be more physically active during recess, the school yard environment was improved at the intervention schools (18). However, these were established over time.

4) Parent involvement. At the intervention schools the children's parents could choose to receive regular newsletters from the school, with information concerning healthy diet and food preparation.

5) Implementation of school canteens. At the intervention schools, school canteens that intended to sell healthy meals and snacks were established. The aim was to give pupils at the intervention

schools the opportunity to buy healthy meals during the school hours; to promote the use of the school canteens by children that did not bring packed lunch from home; and to offer the children an opportunity to become involved in administrating the canteen and thereby improve their knowledge about healthy food (19). Like the school yards, the school canteens were not implemented at day one of the intervention. Moreover, servings in the school canteens were often snacks rather than meals and some modifications were made over time to the meals served compared to the recipes originally provided (19).

6) Health education in the curriculum. From first to third grade, health education was incorporated into the general curriculum.

The municipality of Ballerup initiated and handled the implementation of the intervention parts while pre- and post-measurements of diet, physical activity and anthropometrics were handled by the research group. Also, at the same points in time the research group collected measurements in the comparison group, school children in the municipality of Tårnby (22).

Subjects

All public schools in the municipality of Ballerup (ten) served as a non-randomized intervention group. The public schools (eight) in another suburban municipality of Copenhagen (Tårnby) were chosen as comparison schools, since the sociodemographic characteristics of the municipality in Tårnby resembles those of Ballerup (20). Thus, all children entering pre-school in a public school in Ballerup or Tårnby in 2001 (n=1024) were invited to participate in the study (Figure 1). Of these, 69% of the children's parents or caregivers provided written consent (17,20). Pre-intervention characteristics of all participants have been reported elsewhere (17,21). Neither participants, teachers, school leaders nor researchers were blinded to the study condition assignment.

Information on anthropometrics, physical activity and dietary intake was collected from the children

and their parents prior to the intervention (in school year 2001-02 at age 6 years of the child) and after the intervention period (in school year 2004-05 at age 9 years of the child).

Ethics

The study was approved by the Ethical Committee of Copenhagen County (case no. KA00011gm) and all procedures were in accordance with the Helsinki declaration of 1975 as revised in 1983.

Written information about the study was given to all school leaders, teachers and parents prior to the study.

Dietary assessment

Using pre-printed food records the dietary intake of the children was recorded for seven consecutive days by the parents or caregivers, both pre- (spring 2002) and post-intervention (spring 2005). The food records were developed by the National Food Institute, Technical University of Denmark and have been used in the Danish nationwide dietary surveys since 1995 (22). For the use among children two previously published studies based on the same dietary data have evaluated the pre-printed food record against an estimated energy expenditure using ActiReg measurements (23) or a fixed physical activity level (24). The studies showed that total energy intake was underreported with 7% or not misreported among the children aged 7-8 years, respectively (26) (27). According to a typical Danish meal pattern the food records were divided into four sections consisting of: breakfast, lunch, dinner and in-between snacks. Each meal was further divided into several sub-sections with beverages, bread, cereals, vegetables etc. and pre-printed with the most common foods and drinks and supplemented with an open-ended category (20). To estimate the amount eaten, household measurements, and photo series illustrating common Danish foods in different portion sizes were used (20,25).

The completed food records were scanned using Eyes & Hands version 5.2 and afterwards individual intakes were calculated using the General Intake Estimation System (version 1.000, released 26 February 2010, developed by the National Food Institute, Technical University of Denmark) and the Danish Food Composition Databank (version 6) (26).

The intake of a number of foods and beverages, considered as particularly interesting based on the food-based dietary guidelines, were examined in details. These included intake of fruits, vegetables, soft drinks, fruit juice, SSBs, sweets, three different types of bread (white bread, coarse bread and dark rye bread (typical Danish bread high in dietary fibre, often eaten for lunch)) and fish. These foods were defined as following:

Fruit: fresh, canned, dried fruit and jam (excluding fruit juice)

Vegetables: fresh, canned and frozen vegetables (including ketchup and fried onion, excluding potatoes)

Soft drink: carbonated sugar-sweetened soft drinks

Fruit juice: 100% apple juice and 100% orange juice

SSBs: soft drink, squash

Sweets: chocolate, candy, jelly, caramel, and marzipan

White bread: bread reported as white bread in the food records

Coarse bread: bread reported as coarse bread in the food records, including bread with variable content of wholemeal and wholegrain, and not necessarily in accordance with the official definition of wholegrain bread.

Rye bread: bread recorded as rye bread in the food records

Fish: fatty fish, lean fish and shell fish

Total energy intake [kJ] was calculated as (carbohydrates [g] – dietary fibre [g]) x 17 kJ/g + dietary fibre [g] x 8 kJ/g + protein [g] x 17 kJ/g + fat [g] x 37 kJ/g + alcohol [g] x 29 kJ/g as recommended by the Nordic Nutrition Recommendations (27). The reported total energy intake was evaluated according to estimated total energy expenditure based on basal metabolic rate (estimated with a predictive equation (28)) and physical activity (based on accelerometer measurements (21)) which has been described in detail elsewhere (29).

Physical activity

Physical activity was measured in four consecutive days (two weekdays and two weekend-days) using an uniaxial activity monitor (MTI 7164; Manufacturing Technology, Fort Walton Beach, FL) (17,36). The children were instructed to wear the accelerometer at all times, except during sleep and water-based activities. The accelerometer was placed on the lower back, as close to the center of gravity as possible using an elastic belt. The monitor was attached one day before it was set to record, for the children to get familiar with it, and to prevent unnatural high levels of physical activity in the beginning of the recording period (17,36). Children that had accumulated more than eight hours of activity per day for at least three days were included in the analyses (17,36) and mean “count per minutes (cpm)” was calculated for each child. Since swimming constituted a considerably amount of the additional physical education lessons provided in the intervention schools, the post-intervention measure was afterwards adjusted for the time spend on water-based activities. This adjustment has been described in more detail elsewhere (21).

Socioeconomic status

Prior to the intervention the mothers gave information on education level in a questionnaire using two questions. The first question was “*what school education have you achieved or are you currently*

completing?”, and could be answered using one of four fixed answers (from less than seven years of education to completed high school or equivalent), or an open-ended answer with the possibility to state other types of education. The second question was “*do you have a vocational education?*”, with the possibility to answer “*no*” or seven different named vocational educations. The answers were divided into three categories; short: completed elementary school only (≤ 10 years); medium: completed high school (12 years) or a short education (3 years), long: completed college or university. Maternal education was used as a proxy for SES in the present study, as previous cross sectional (30-32) and longitudinal (33-35) studies have shown that it is more closely associated with the eating habits of the child than parental education.

Statistics

Descriptive characteristics of the participants pre-intervention were calculated by intervention/comparison group, and differences between the two groups were tested using unpaired t-test or Wilcoxon rank-sum test for continuous variables depending on the distribution of the data, and Chi-squared test for categorical variables. Data were analysed using Stata version 12.0 (StataCorp LP, College Station, Texas, USA), and $p < 0.05$ was considered statically significant.

Dietary intake pre-intervention is presented by intervention/comparison group and maternal educational level. Differences in intake of food and beverage items between the intervention and the comparison group were tested using an unpaired t-test or Wilcoxon rank-sum test depending on the distribution of the variable. Differences in dietary intake between the three categories of maternal education level were tested using one-way analysis of variance (ANOVA).

For the present analyses, the model assumptions for the multiple regression analyses regarding homogeneity and normal distribution of the residuals, were not fulfilled. For this reason, multiple logistic regression analyses at the individual level was used to assess the odds ratio of increasing vs.

maintaining or decreasing the dietary intake from pre- to post-intervention in the intervention group compared to the comparison group (37). The exposure was treated as a dichotomous variable (intervention/comparison group), with the comparison group as the reference, and a dummy variable created for the intervention group, to assess the effect of being in the intervention group relative to being in the comparison group.

Analyses were adjusted for pre-intervention intake of the food/ beverage item and a cluster effect by school to take into account the design of the study. Interactions were tested for in relation to gender and SES.

The association between intake pre-intervention and change in intake was significantly non-linear for the intake of vegetables ($p=0.0001$), sweets ($p=0.01$), soft drinks ($p=0.0004$), and SSBs ($p=0.0001$), why the pre-intervention intake was included in the models as second-order polynomials.

To take into account possible differences between the intervention and the comparison group supplementary analyses were made adjusted for age and gender. The analyses were repeated including only children where the food records were assessed as acceptable records when comparing reported energy intake with estimated energy expenditure.

Results

Subjects

A total of 307 children with information on dietary intake pre- and post- intervention and on maternal education level, were included in the analyses (184 from the intervention group and 123 from the comparison group) (**table 1**). Using unpaired t-test or Wilcoxon rank-sum test for continuous variables, and Chi-squared test for categorical variables, the intervention and comparison groups differed, pre-intervention in age and maternal education level ($p=0.01$ for both). Children from the intervention group were slightly older than the children from the comparison group and more children from the intervention group had mothers with long education (40% vs. 25%), while more children from the comparison group had mothers with short education (35% vs. 25%) or medium education (41% vs. 35%) ($p=0.01$).

Compared to children not having information on both dietary intake and maternal education level, the children included in the analyses tended to have a higher BMI ($p=0.10$). Also, more of the mothers tended to have a short education ($p=0.09$) and a high BMI ($p=0.01$) compared to the children that were included in the analyses. No differences were observed for weight, height, age, intervention/comparison status or physical activity between children included and not included in the analyses. Regarding dietary intake the children included in the analyses had a higher intake of vegetables and coarse bread ($p=0.04$ for both) pre-intervention than those not included in the analyses (data not shown).

Pre-intervention dietary intake

In general, intervention and comparison children had similar intakes of the selected foods and beverages pre-intervention (**table 2**) except that the intake of coarse bread, was higher in the intervention group than in the comparison group ($p=0.004$). Also, there was a trend towards a

higher intake of both soft drinks and SSBs in the comparison group than in the intervention group ($p=0.10$ for both).

Stratified by maternal educational level, significant differences in the intakes of fruit ($p=0.03$) and vegetables ($p=0.002$) were observed between the three categories of maternal education among children in the intervention group pre-intervention (**table 3**). Also, a trend towards a difference was observed for the intake of coarse bread ($p=0.05$). These intakes tended to increase with increasing maternal education (**figure 2 and 4**). Among children from the comparison group no significant differences were observed depending on maternal educational level, except for a trend towards increasing intake of fruit with increasing maternal education level ($p=0.09$).

Dietary evaluation

Pre-intervention 262 children had information on physical activity and were available for dietary evaluation, while 253 children had information on physical activity post intervention. Of these children 217 could be included in the dietary evaluation both pre- and post-intervention. Comparing the reported total energy intake with the estimated energy expenditure, 167 children were assessed as acceptable reporters both pre- and/or post- intervention and 48 as under-reporters pre- or post-intervention (pre-intervention: $n=11$ post-intervention $n=42$). Two children with information both pre-and post-intervention were assessed as over-reporters pre-intervention, while no children were assessed as over-reporters post-intervention. No significant difference in reporting status was observed between the intervention and comparison group neither pre- nor post-intervention ($p>0.57$). However, significant difference in reporting status was observed with maternal education level (pre-intervention: $p=0.01$, post-intervention: $p=0.02$), where less children of mothers with long education were assessed as under-reporters.

Overall intervention effect on the intake of selected foods and beverages

Using logistic regression analyses children from the intervention group had higher odds of increasing their intake of fruit from pre- to post-intervention (OR: 1.92, 95% CI: 1.26 to 2.93, $p=0.002$) compared to children from the comparison group. No other significant differences were observed on the dietary intake. Similar trends were observed for the intakes of vegetables ($p=0.07$) and fruit juice ($p=0.08$) (table 4). Looking at the actual intakes for fruit and vegetables, the apparent higher odds of increased intakes observed in the intervention group compared to the comparison group were actually the result of a decreased intake of fruit, where the intake decreased more in the comparison group than in the intervention group (figure 1).

No significant effect of the intervention was observed for the intake of any of the other foods or beverages. A significant interaction was seen between fruit intake and maternal educational level ($p=0.0003$), while no overall interaction was observed between intake of any other food or beverage item or with gender.

Intervention effect on dietary intake assessed by maternal education level

Using logistic regression analyses, stratified by maternal education level, the intervention effect on the fruit intake remained significant among children of mothers with short education (<10 years). In that group, children from the intervention group had almost seven fold (OR: 6.71, 95% CI: 1.75 to 25.65, $p=0.005$) higher odds of increasing their intake compared to children from the comparison group (adjusted for pre-intervention fruit intake and cluster effect by school) (**table 5**). Again, the apparent increased intake was mainly due to a decreased intake in the comparison group, and a stable intake in the intervention group rather than an increased intake in the intervention group. Further, adjustment for gender or age gave virtually similar result. Among children of mothers with medium and long education, no significant difference in the intake of fruit was observed between

the intervention and the comparison group. Using linear regression to assess the magnitude of the increase, we found that children in the intervention group, who had mothers with short education, had a 50 g (95% CI: 13 to 87) higher intake of fruit per day post-intervention than children of mothers with short education from the comparison group (data not shown).

A trend towards increased intake of vegetables was also observed in the intervention group among children of mothers with short education compared to the similar group of children from the comparison group (OR: 1.95, 95% CI: 0.88 to 4.28, $p=0.10$). Here, the magnitude of change was 5 g (95% CI: -21 to 30). For fruit juice no significant intervention effect was observed when stratified by maternal education level.

A trend towards an intervention effect was observed for intake of soft drinks among children of mothers with short education. In that sub-group, children from the intervention group had lower odds of increasing their intake of soft drinks relative to children from the comparison group (OR: 0.48, 95% CI: 0.22 to 1.06, $p=0.07$). Using regression analyses we could demonstrate a 38 g (95% CI: -83 to 7.0) lower daily intake of soft drinks, among children of mothers with short education from the intervention group compared to children from the comparison group. Another intervention effect was that children of mothers with long education from the intervention group had about twice as high odds (OR: 2.17, 95% CI: 1.17 to 4.03) of increasing their intake of white bread ($p=0.01$) relative to the comparison group. Here the difference was a 7 g (95% CI: -9 to 24) increase per day, among children in the intervention group of mothers with long education compared to the similar group of children from the comparison group.

Stratified by maternal education level, significant interactions were observed between gender and intervention/comparison status in the analysis of coarse bread for children of mothers with long

education ($p=0.02$), in the analysis of rye bread for children of mothers with medium education ($p=0.006$), and in the analyses of fish ($p<0.001$) for children of mothers with short education. Further stratification of the analyses by gender showed significantly higher odds for increasing the intake of coarse bread among girls of mothers with long education (OR: 4.63, 95% CI: 1.79 to 11.96, $p=0.002$). Also, higher odds for increasing the intake of fish was observed among boys (OR: 6.48, 95% CI: 1.76 to 23.84, $p=0.005$) of mothers with a short education, while lower odds were observed among girls (OR: 0.14, 95% CI: 0.02 to 0.95, $p=0.04$) of mothers with short education, and among boys of mothers with a long education (OR: 0.21, 95% CI: 0.04 to 1.09, $p=0.06$). For the intake of rye bread no significant effects of the intervention was observed when the analyses were stratified by gender in any of the three categories of maternal education.

Sensitivity analyses

Analyses adjusted for age and gender gave virtually similar results. In the analyses that were restricted to include children assessed as acceptable reporters ($n=167$), only the observed higher odds of an increased intake of fruit among children of mothers with short education remained significant (OR: 14.24, 95% CI: 3.60 to 56.28, $p<0.001$) whereas no significant effect on the intake was observed for other foods or beverages.

Discussion

Overall, this three-year intervention study showed that particularly the intake of fruit may be influenced by a school-based intervention. Post-intervention, the higher intake of around 50 g fruit daily was particularly evident among children from less educated families. Also, a trend towards a higher intake of vegetables and a lower intake of soft drinks was observed among intervention compared to comparison children from less educated families. Moreover, only intervention children from well-educated families increased the intake of white bread whereas intervention children from less educated families did not. The results are contrary to what we hypothesised but are very encouraging, as the dietary intake of children from less educated families generally is poorer and less in accordance with public dietary recommendations and thus needs improvements more than the diet of children from well-educated families.

In a recently published review and meta-analysis of school-based interventions, including studies with the aim to improve the intake of fruit and vegetables among children (5-12 years), the authors concluded that school-based interventions seem to moderately improve fruit intake, but have minimal impact on vegetable intake (38). Potentially children have higher preference for fruit than vegetables which may make it easier to increase fruit consumption (39) which is in support of the results of the present study.

Decrease in the intakes of soft drinks and SSBs have also been reported as the result of previous school-based interventions (40-43). In the present study we did not see significant changes; however there was a trend that the intervention reduced the intake of soft drinks among children in the intervention group, particularly among those of mothers with short education. In contrast, no intervention effect was observed on the intake of SSBs, which may indicate that more focus has been put on reducing the intake of soft drinks than on reducing the intake of squash and fruit juice,

and that parents may not be aware of the fact that other sweet drinks than soft drink may have the same high sugar and calorie content as soft drinks.

Higher odds for increasing the intake of white bread were observed among children of mothers with a long education from the intervention group. This goes against the current food-based guidelines where the focus is on increasing the intake of wholegrain products. However, the food-based guidelines that was in use at the time of the intervention were from 1994, and here the advice related to intake of bread and grain was not specified to be wholegrain (12).

We identified few studies, only, that examined intervention effects of multi-component school-based interventions among different socio-economic groups (2,18,19). However, in line with our results, it has been reported in a previously published Swedish study, that after a 4-year intervention; families with low parental education had higher odds for healthy food choices in regard to dairy products and fast food (44).

The intervention

The intervention introduced in the present study was multi-component. That means that several initiatives were introduced simultaneously, which unfortunately makes it difficult to determine which parts of the intervention were effective. Moreover, the municipality took care of implementing the intervention parts, which lead to that not all initiatives were introduced at day one of the intervention, or at the same time across the schools e.g. the school canteens and school yards. However, the main intervention assumed to have affected the children's dietary intake in the present study was the introduction of the school canteens and information about healthy food and preparation to the parents via newsletters. Since we have no information on how many children used the school canteens or how many parents received the newsletters, we are not able to evaluate this further. Also, we have no information on whether the staff in the canteens followed the recipes

provided. The intervention effect observed in the present study may also partly be a simple regression towards the mean phenomena, since we observed higher intakes or trends towards higher intakes of fruit and vegetables with increasing maternal education level in the intervention group, and not in the comparison group. The analyses were however adjusted for pre-intervention intakes and were moreover stratified by maternal education level, and hence we find it unlikely that the results can be explained by regression towards the mean, solely.

Information bias

Underreporting (45,46), recall bias (45), and social desirability bias (45,47) are well-known limitations related to self-reported dietary intake, even when reported by parents. Furthermore, particularly for this age group, it may be argued that parents may have a particularly limited knowledge of their child's dietary intake, especially intakes during time spend away from home (45). However, as most Danish children, and particularly the young children often bring packed lunch boxes to school, and the child self-purchase of foods may have been limited (48). Hence, the parents may have a reasonable knowledge about of the children's dietary intake during the school hours. Based on the evaluation of the dietary intake, fewest under-reporters were observed among children of mothers with long education both pre-intervention and post-intervention. No difference in misreporting was observed between intervention and comparison group, which supports the validity of the results of the study. Unfortunately, we have no information on which foods or beverages that may potentially have been be misreported, and thus how it may have affected the results. An increased knowledge on health due to the intervention may have lead parents to report a healthier dietary intake post-intervention than actually true. Assuming that this was particularly evident for parents in the intervention group the presented results would have been inflated.

Selection bias

Unfortunately there was a high dropout rate through the study why selection bias may have affected the results. Assuming that eating habits of overweight/obese children are more difficult to change, the lower BMI among the participants compared to non-participants and children not included in the analyses could have inflated the results. Moreover, it may be, that primarily the more health conscious children and parents chose to participate in the study, and hence may have been more motivated to change their diet than other children. Therefore, our results may not be generalized to all children of similar age. Finally, it cannot be excluded that multiple comparisons, which increases the risk of type I error, may explain some of the effect of the intervention observed in the present study (49). Correcting for this using the Bonferroni method (50), none of the results remained significant.

Strengths

The strengths of the present study include that dietary information is obtained using a 7-days food record which enables analyses at the individual level. Moreover, we had information on maternal education level that allows analyses by socio-economic status. The information on physical activity was measured objectively which enables an evaluation of the reported dietary intake. Finally, due to the fact this study was initiated and handled by a municipality our results may apply if a similar study was implemented at other places.

In the present study we observed that children from the intervention group were less likely to decrease their intake of fruit and vegetables, and more likely to decrease their intake of soft drinks after a three- year multi-component school-based intervention. These improvements were particularly evident among the children of less educated mothers.

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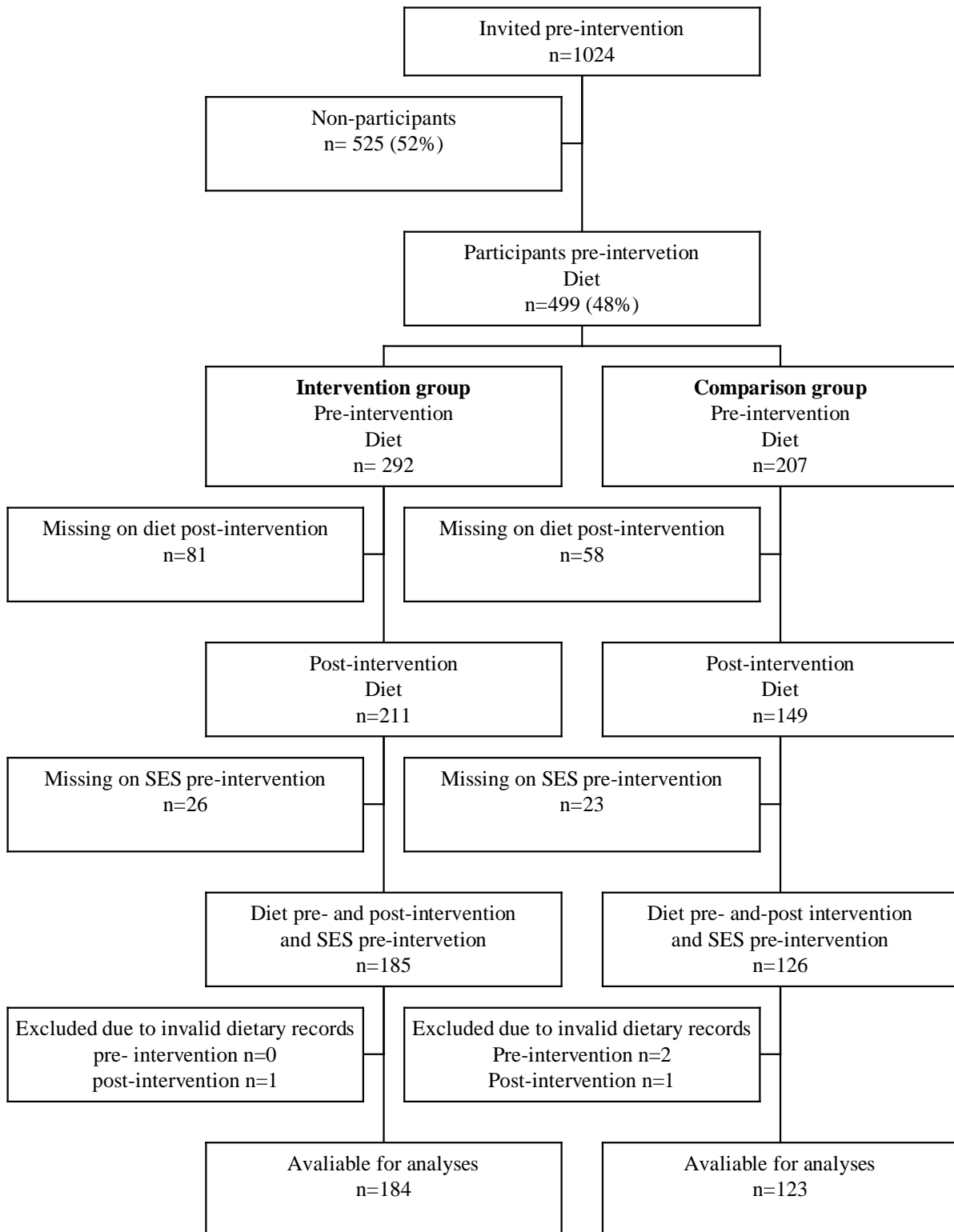


Figure 1

Table 1 Pre-intervention characteristic of the participants by intervention/comparison group

	Intervention (n=184)		Comparison (n=123)		P
	Median	(IQR)	Median	(IQR)	
Boys n (%)¹	95	(52%)	52	(42%)	0.11
Age (y)^{2, 3}	6.8	(6.5; 7.0)	6.7	(6.4; 6.9)	0.01
Weight (kg)^{2,4}	23.8	(22.2; 26.3)	23.7	(21.6; 25.7)	0.73
Height (cm)^{2,4}	123.6	(120.2; 126.4)	122.9	(119.5; 125.4)	0.19
BMI (kg/m²)^{2,4}	15.6	(14.9; 16.5)	15.8	(14.7; 16.6)	0.64
Physical activity (cpm)^{5, 6}	700	(593;845)	710	(595; 861)	0.65
Maternal BMI (kg/m²)^{2, 7}	22.5	(20.7; 24.7)	22.3	(20.8; 25.0)	0.58
Maternal education, short n (%)¹	46	(25%)	43	(35%)	0.01
Maternal education, medium n (%)¹	64	(35%)	50	(41%)	
Maternal education, long n (%)¹	74	(40%)	30	(25%)	

¹Differences between intervention and comparison group tested by Chi-squared test. Significant and borderline significant results are marked with bold

² Differences between intervention and comparison group tested by unpaired t-test. Significant and borderline significant results are marked with bold

³Comparison group n=122

N, number of observations; SD, standard deviation; CPM, counts per minute

⁴ Comparison group n=121

⁵ Differences between intervention and comparison group tested by Wilcoxon rank-sum test

⁶ Intervention group n=160, comparison group n=102

⁷ Intervention group n=176, comparison group n=118

Table 2 Pre- and post-intervention intake of food and beverages (g/d) by intervention/comparison group¹

	Time	Intervention (n=184)		Comparison (n=123)		p
		Median	(IQR)	Median	(IQR)	
Fruit (g/d)	Pre-intervention	118	(69; 186)	131	(69; 216)	0.43
	Post-intervention	103	(57; 161)	105	(47; 165)	0.77
Vegetables (g/d)	Pre-intervention	121	(89; 167)	138	(88; 181)	0.18
	Post-intervention	116	(75; 163)	99	(76; 159)	0.43
Sweets (g/d)	Pre-intervention	23	(14; 35)	25	(16; 34)	0.57
	Post-intervention	24	(15; 35)	24	(14; 36)	0.65
SSBs (g/d)	Pre-intervention	296	(168; 409)	321	(171; 475)	0.10
	Post-intervention	186	(104; 314)	207	(114; 391)	0.16
Soft drinks (g/d)	Pre-intervention	114	(57; 171)	114	(57; 200)	0.10
	Post-intervention	100	(29; 171)	114	(57; 200)	0.09
Fruit Juice (g/d)	Pre-intervention	26	(0; 77)	26	(0; 103)	0.22
	Post-intervention	26	(0; 118)	51	(0; 129)	0.22
White bread (g/d)	Pre-intervention	49	(35; 70)	56	(34; 76)	0.24
	Post-intervention	60	(39; 88)	64	(39; 86)	0.98

Coarse bread (g/d)	Pre-intervention	13	(4; 26)	8	(3; 17)	0.004
	Post-intervention	11	(4; 33)	11	(5; 22)	0.03
Rye bread (g/d)	Pre-intervention	63	(44; 82)	62	(48; 81)	0.71
	Post-intervention	59	(37; 85)	63	(45; 82)	0.49
Fish (g/d)	Pre-intervention	9	(3; 18)	7	(2; 16)	0.32
	Post-intervention	7	(2; 17)	7	(2; 17)	0.51

¹Differences between intervention and comparison group were tested by Wilcoxon rank-sum test.

Significant and borderline significant results are marked with bold

N, number of observations; IQR, interquartile range; SSBs, sugar-sweetened beverages

Table 3 Pre- and post-intervention intakes of food and beverages (g/d) by maternal education level and intervention/comparison group

	Maternal education	Intervention (n=184)				Comparison (n=123)				P ¹	P ²
		Pre-intervention		Post-intervention		Pre-intervention		Post-intervention			
		Median	(IQR)	Median	(IQR)	Median	(IQR)	Median	(IQR)		
Fruit (g/d)	Short	86 ^a	(43; 150)	92	(71; 146)	111	(70; 205)	79 ^a	(28; 137)	0.11	0.17
	Medium	136 ^a	(88; 212)	118	(70; 172)	115	(42; 202)	96 ^a	(51; 165)	0.17	0.32
	Long	118 ^a	(64; 198)	94	(43; 158)	174	(116; 233)	138 ^a	(75; 208)	0.04	0.01
Vegetables (g/d)	Short	102 ^a	(58; 125)	95 ^a	(66; 133)	132	(81; 181)	91	(70; 145)	0.02	0.85
	Medium	123 ^a	(88; 193)	119 ^a	(79; 152)	139	(95; 188)	98	(71; 153)	0.62	0.55
	Long	126 ^a	(101; 175)	125 ^a	(86; 192)	146	(89; 179)	145	(90; 187)	0.97	0.95
Sweets (g/d)	Short	18	(13; 32)	22	(17; 33)	23	(16; 35)	20	(13; 33)	0.25	0.57
	Medium	25	(17; 37)	24	(15; 38)	26	(14; 34)	26	(14; 36)	0.55	0.97
	Long	22	(12; 35)	26	(16; 35)	22	(16; 31)	25	(15; 42)	0.61	0.85

SSBs (g/d)	Short	323	(179; 471)	207	(100; 350)	286	(171; 486)	257	(114; 400)	0.91	0.39
	Medium	320	(213; 461)	186	(102; 316)	355	(161; 486)	225	(114; 429)	0.92	0.26
	Long	257	(143; 361)	171	(114; 286)	373	(218; 471)	164	(86; 348)	0.02	0.78
Soft drinks (g/d)	Short	114	(57; 200)	114	(29; 214)	114	(57; 200)	143 ^a	(57; 229)	0.82	0.15
	Medium	118	(57; 200)	107	(50; 171)	114	(86; 229)	100 ^a	(57; 200)	0.55	0.50
	Long	86	(29; 171)	71	(29; 150)	143	(86; 229)	86 ^a	(36; 129)	0.04	0.96
Fruit Juice (g/d)	Short	0	(0; 77)	39	(0; 103)	30	(0; 129)	51	(0; 129)	0.19	0.36
	Medium	26	(0; 90)	26	(0; 129)	26	(0; 103)	58	(0; 154)	0.78	0.53
	Long	26	(0; 77)	26	(0; 116)	39	(0; 77)	26	(0; 129)	0.29	0.62
White bread (g/d)	Short	51	(39; 68)	55	(36; 84)	43	(31; 76)	64	(42; 76)	0.54	0.64
	Medium	51	(34; 78)	61	(43; 88)	58	(43; 71)	63	(34; 89)	0.57	0.85
	Long	46	(33; 69)	64	(39; 90)	60	(42; 79)	64	(42; 86)	0.004	0.82
Coarse bread (g/d)	Short	7 ^a	(2; 23)	11	(0; 29)	6	(4; 17)	11	(0; 23)	0.66	0.67

	Medium	11 ^a	(4; 27)	11	(0; 29)	8	(3; 16)	10	(6; 17)	0.33	0.88
	Long	17 ^a	(9; 29)	20	(9; 35)	8	(3; 17)	10	(0; 17)	0.006	0.006
Rye bread (g/d)	Short	70	(48; 85)	65	(37; 86)	62	(45; 81)	59	(45; 74)	0.22	0.37
	Medium	61	(44; 74)	58	(35; 89)	65	(43; 79)	67	(46; 82)	0.35	0.39
	Long	62	(41; 80)	59	(37; 82)	61	(51; 85)	65	(48; 97)	0.35	0.20
Fish (g/d)	Short	7	(3; 14)	6	(0; 16)	9	(2; 15)	6	(0; 14)	0.80	0.57
	Medium	9	(3; 18)	7	(2; 17)	5	(2; 15)	7	(2; 14)	0.22	0.91
	Long	11	(2; 20)	8	(2; 18)	8	(3; 18)	8	(3; 17)	0.73	0.85

¹ Difference between intervention and comparison group pre-intervention assessed using Wilcoxon rank-sum test. Significant and borderline significant results are marked with bold

² Difference between intervention and comparison group post-intervention assessed using Wilcoxon rank-sum test. Significant and borderline significant results are marked with bold

^a Significant difference between the three groups of maternal education groups ($p < 0.05$), tested using one-way analysis of variance, ANOVA

N, number of observations, IQR, inter quartile range; SSBs, sugar-sweetened beverages

Table 4 Odds ratios for increasing the intake of selected food and beverages from pre-to post-intervention among children in the intervention group (n=184) compared to the comparison group (n=123)

	Crude ¹			Adjusted ²				
	OR	95% CI	p	OR	95% CI	p		
Fruit	1.92	1.26	2.93	0.002	1.99	1.29	3.08	0.002
Vegetables	1.53	0.97	2.40	0.07	1.36	0.93	1.99	0.11
Sweets	1.24	0.77	2.01	0.38	1.19	0.75	1.89	0.47
Soft drinks	0.69	0.42	1.16	0.16	0.75	0.46	1.22	0.25
SSBs	0.74	0.47	1.14	0.17	0.80	0.52	1.24	0.33
Fruit Juice	0.73	0.52	1.03	0.08	0.78	0.55	1.11	0.17
White bread	1.00	0.58	1.73	1.00	0.98	0.56	1.72	0.94
Coarse bread	1.08	0.74	1.58	0.69	1.02	0.68	1.53	0.92
Rye bread	0.79	0.48	1.29	0.34	0.76	0.45	1.27	0.30
Fish	1.05	0.56	1.95	0.88	0.96	0.54	1.70	0.89

¹Analyses made using logistic regression with the comparison group as reference, adjusted for pre-intervention intake of the dietary component of interest and school cluster. Significant and borderline significant results are marked with bold

²Analyses made using logistic regression with the comparison group as reference, adjusted for pre-intervention intake of the dietary component of interest, maternal education level and school cluster. Significant and borderline significant results are marked with bold

OR, odds ratio; CI, confidence interval; SSBs, sugar-sweetened beverages

Table 5 Odds ratios for increasing the intake of selected food and beverages from pre-to post-intervention in among children in the intervention group relative to the comparison group stratified by maternal education level

	Short maternal education (n=89)				Medium maternal education (n=114)				Long maternal education (n=104)			
	OR	95% CI		p	OR	95% CI		p	OR	95% CI		p
Fruit	6.71	1.75	25.65	0.005	1.35	0.60	3.02	0.47	0.66	0.29	1.48	0.31
Vegetables	1.95	0.88	4.28	0.10	0.85	0.38	1.93	0.70	1.58	0.64	3.91	0.32
Sweets	1.16	0.46	2.93	0.76	1.21	0.67	2.17	0.53	1.15	0.53	2.51	0.72
Soft drinks	0.48	0.22	1.06	0.07	0.71	0.30	1.68	0.44	1.43	0.52	3.92	0.49
SSBs	0.78	0.31	1.94	0.59	0.54	0.21	1.39	0.20	1.28	0.46	3.57	0.63
Fruit Juice	1.05	0.59	1.86	0.87	0.70	0.25	1.93	0.49	0.68	0.23	1.98	0.48
White bread	0.61	0.22	1.72	0.35	0.80	0.35	1.83	0.59	2.17	1.17	4.03	0.01
Coarse bread	1.01	0.47	2.21	0.97	0.69	0.33	1.41	0.30	1.83	0.87	3.86	0.11
Rye bread	0.76	0.30	1.93	0.57	0.80	0.31	2.08	0.65	0.68	0.26	1.78	0.43
Fish	1.07	0.43	2.66	0.89	1.06	0.40	2.80	0.91	0.73	0.32	1.67	0.46

¹Analyses made using logistic regression with the comparison group as reference, adjusted for pre-intervention intake and school cluster and stratified by maternal education level. Significant and borderline significant results are marked with bold

OR, odds ratio; CI, confidence interval; SSBs, sugar-sweetened beverages

Figure 2

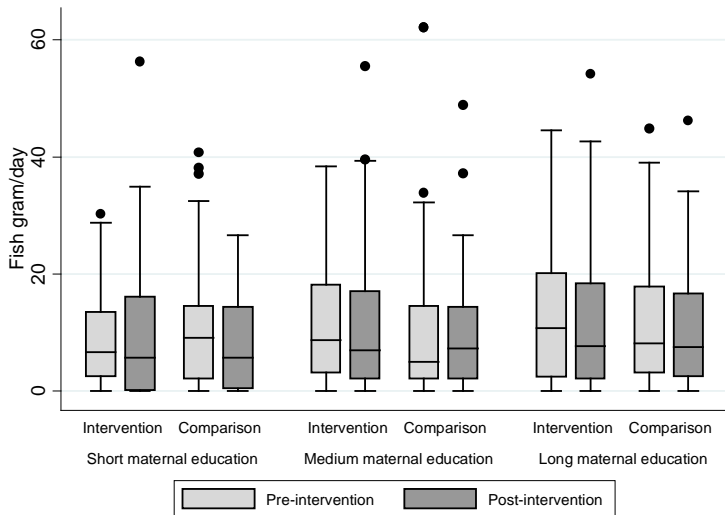
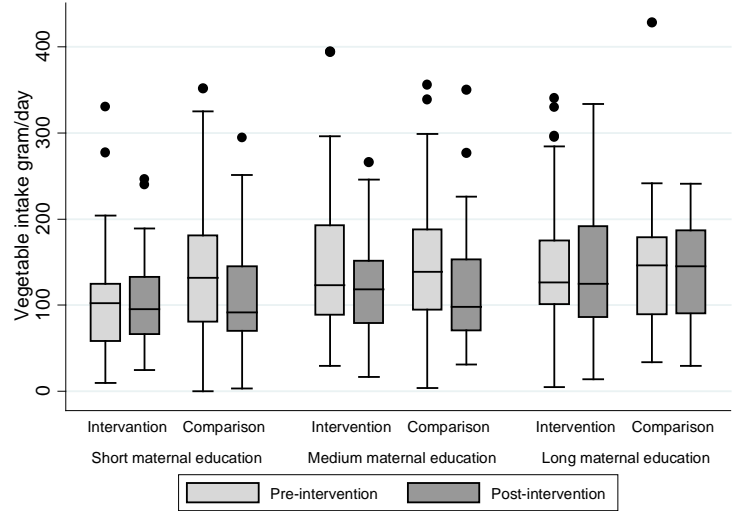
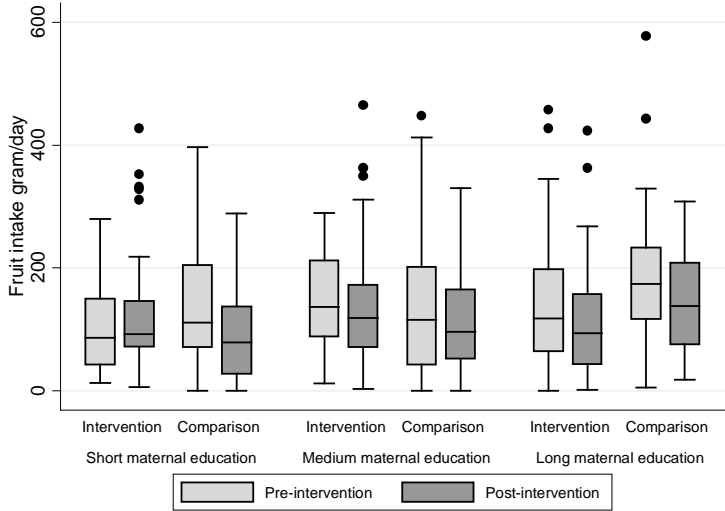


Figure 3

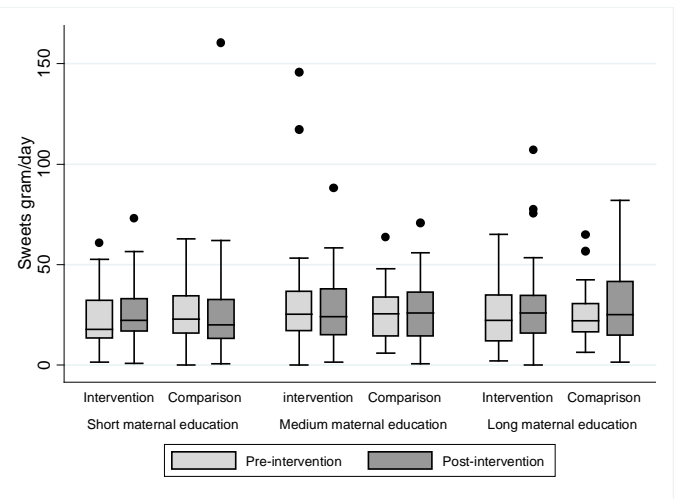
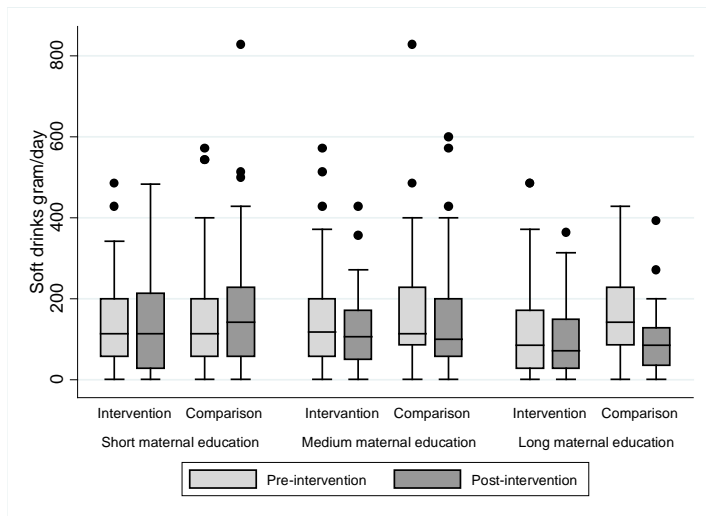
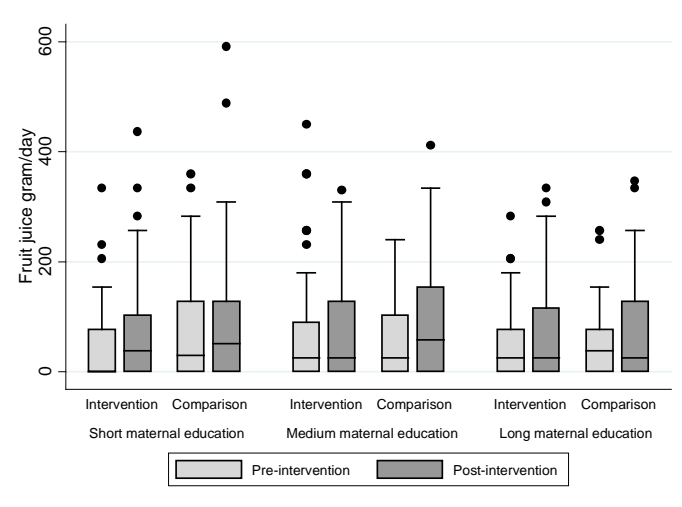
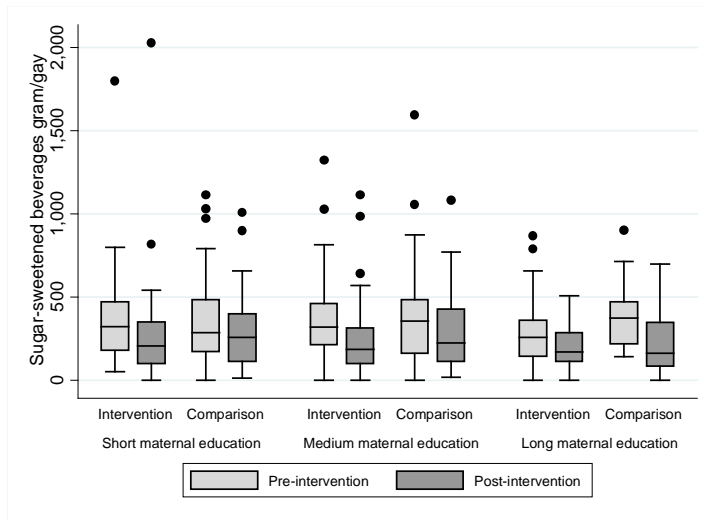


Figure 4

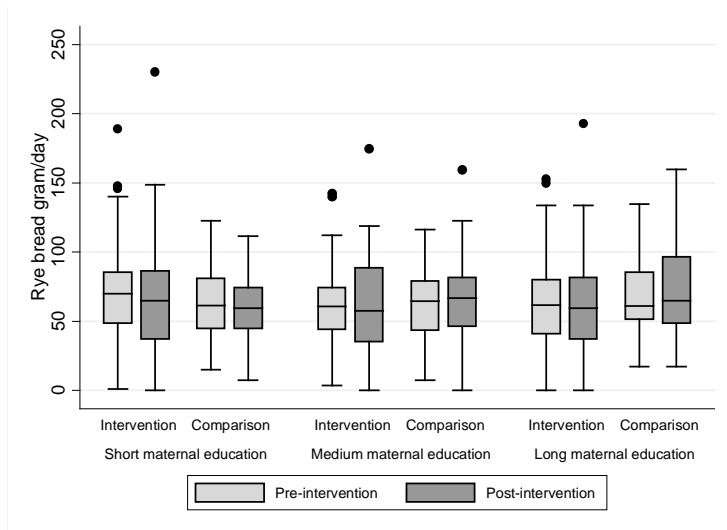
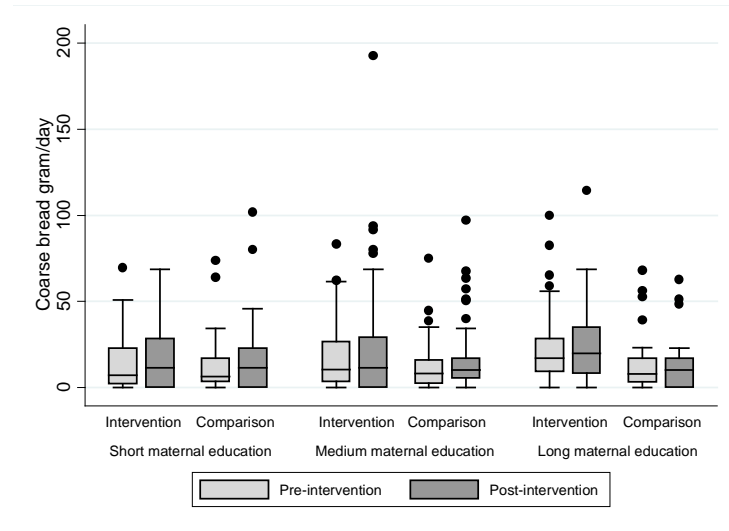
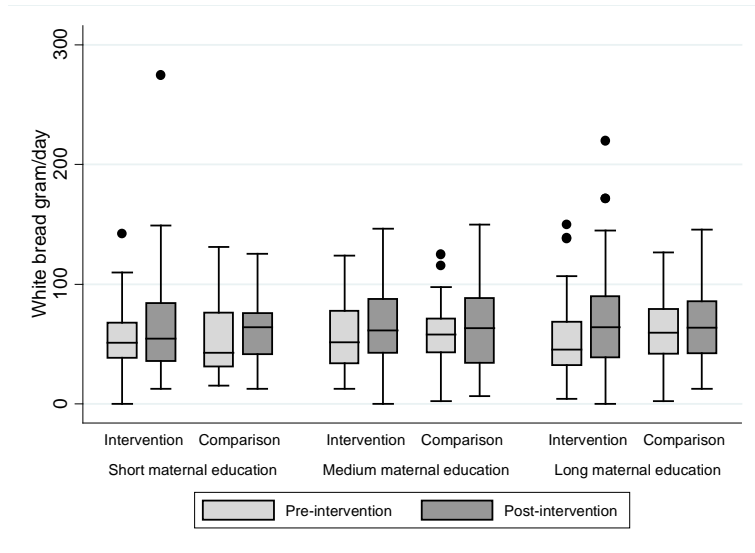


Figure legends

Figure 1 Flow chart of the participants included in the present study

Figure 2 Intake of fruit, vegetables and fish pre- and post-intervention by intervention/comparison status and maternal education level

Figure 3 Intake of soft drinks, sugar-sweetened beverages, fruit juice and sweets pre- and post-intervention by intervention/comparison status and maternal education level

Figure 4 Intake of white bread, coarse bread and rye bread pre- and post-intervention by intervention/comparison status and maternal education level