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The Effects of a 2-year Individualized and Family-based Lifestyle Intervention on Physical Activity, Sedentary Behavior and Diet in Children

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Abstract

Objective: To investigate the effects of a long-term, individualized and family-based lifestyle intervention on physical activity, sedentary behavior and diet quality in children.

Methods: We carried out a 2-year intervention study in a population sample of 506 children aged 6-8 years in Finland in 2007-2012. We allocated the participants at baseline in the intervention and control group. We assessed physical activity and sedentary behavior by questionnaires and diet by food records.

Results: Total physical activity (+9 min/d in intervention group vs. -5 min/d in control group, p=0.001 for time*group interaction), unsupervised physical activity (+7 min/d vs. -9 min/d, p<0.001) and organized sports (+8 min/d vs. +3 min/d, p=0.001) increased in the intervention group but not in the control group. Using computer and playing video games increased less in the intervention group than in the control group (+9 min/d vs. +19 min/d, p=0.003). Consumption of vegetables (+12 g/d vs. -12 g/d, p=0.001), high-fat vegetable-oil based margarine (+10 g/d vs. +3 g/d, p<0.001) and low-fat milk (+69 g/d vs. +11 g/d, p=0.042) and intake of dietary fiber (+1.3 g/d vs. +0.2 g/d, p=0.023), vitamin C (+4.5 mg/d vs. -7.2 mg/d, p=0.042) and vitamin E (+1.4 mg/d vs. +0.5 mg/d, p=0.002) increased in the intervention group but not in the control group. Consumption of butter-based spreads increased in the control group but not in the intervention group (+2 g/d vs. -1 g/d, p=0.002).

Conclusions: Individualized and family-based lifestyle intervention increased physical activity, attenuated increase in sedentary behavior and enhanced diet quality in children.

Trial registration. ClinicalTrials.gov: NCT01803776

Key words: intervention, children, physical activity, diet, sedentary behavior

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Abbreviations

BMI	body mass index
BMI-SDS	body mass index – standard deviation score
PANIC	Physical Activity and Nutrition in Children

Introduction

The prevalence of overweight and obesity in children and adolescents has increased in most developed countries, including Finland, during the past decades [1,2,3]. Over 15% of girls and over 10% of boys at preschool or primary school age are overweight or obese in Finland [3,4]. Overweight has been associated with the clustering of cardiometabolic risk factors, including insulin resistance, glucose intolerance, dyslipidaemia, elevated blood pressure, mildly elevated liver enzymes and arterial stiffness in children [5,6,7]. The clustering of cardiometabolic risk factors in childhood has been related to the increased risk of metabolic syndrome, type 2 diabetes and cardiovascular diseases in adulthood [8,9,10,11].

Lifestyle changes, such as increasing physical activity, decreasing sedentary behavior and improving diet, since childhood are the cornerstone for the prevention of overweight, type 2 diabetes and cardiovascular diseases [12,13,14]. Lifestyle interventions have been rather effective in the treatment of childhood overweight, obesity and other cardiometabolic risk factors in the short term [15], but the effects have been modest in the long-term [16,17]. The reason for the weak long-term effects of these interventions may be that the lifestyle changes have been small or they have not been maintained throughout the intervention period among children with overweight, obesity or other cardiometabolic risk factors.

There are few intervention studies on the effects of physical activity and diet on cardiometabolic risk factors in general populations of children [18,19,20,21,22]. Many of these studies have reported little or no effect of lifestyle interventions on cardiometabolic risk factors among children [22,23,24]. The explanation for this may be that few interventions have increased physical activity, decreased sedentary behavior or enhanced diet quality in order to improve health among children [18,19,25,26]. One reason for the modest effects in most studies may be that the intensity and duration of the lifestyle interventions have been insufficient [27,28,29]. Not emphasizing the individual needs of families and parental involvement may also have decreased adherence to the interventions [28,29,30].

Scientific evidence from long-term lifestyle intervention studies in large population samples of children is important for developing effective strategies to increase physical activity, decrease sedentary behavior and enhance diet quality in childhood. Such evidence could be used in the prevention of overweight, type 2 diabetes and cardiovascular diseases since childhood. The aim of this study was to investigate the effects of a 2-year, individualized and family-based lifestyle intervention on physical activity, sedentary behavior and diet quality in children.

Methods

Participants

The present data are from the Physical Activity and Nutrition in Children (PANIC) Study, which is a controlled physical activity and diet intervention study aimed at decreasing cardiometabolic risk in a population sample of children from the city of Kuopio, Finland. We invited 736 children 6–8 years of age who were registered for the 1st grade in the 16 primary schools, selected out of all 26 primary schools of Kuopio, in 2007–2009 (Figure 1). We received the contact information of the children's principal custodians from the city of Kuopio and sent them the invitation letters by mail. Of the 736 invited children, 512 (70%) participated in the baseline study. According to the school health examination data, the participants did not differ in age, gender distribution or body mass index - standard deviation score (BMI-SDS) from all children who started the 1st grade in the primary schools of Kuopio during years 2007–2009 (data not shown). We excluded 6 children at baseline from the intervention study because of severe physical disability or withdrawal during baseline examinations.

We allocated the 506 eligible children to the intervention group (306 children, 60%) or the control group (200 children, 40%) by matching them according to the location (urban vs. rural) and size (large vs. small) of the schools to minimize differences in baseline characteristics between the groups. Children from 9 schools were allocated to the intervention group and children from 7 schools were allocated to the control group. Dividing the children in the intervention or control group according to schools made us possible to organize after school exercise clubs conducted at schools only for the intervention group and to avoid non-intentional intervention in the control group. We included more children in the intervention group than in the control group because of a larger number of drop-outs expected in the intervention group and to have sufficient statistical power for comparison between the groups.

Of the 506 children who participated in the baseline study, 440 (87%) also attended in the 2-year follow-up study (Figure 1). The median (interquartile range) follow-up time was 2.1 (2.1-2.2) years in both groups. Data on variables used in analyses dealing with physical activity and sedentary behavior were available for 503 children (244 girls, 259 boys) at baseline and for 431 children (210 girls, 221 boys) at 2-year follow-up. Data on variables used in analyses dealing with diet were available for 425 children (208 girls, 217 boys) at baseline and for 391 children (187 girls, 204 boys) at 2-year follow-up.

The study protocol was approved by the Research Ethics Committee of the Hospital District of Northern Savo. Both children and their parents gave their written informed consent.

Intervention group

The physical activity and diet intervention aimed at decreasing cardiometabolic risk in children by increasing physical activity, decreasing sedentary behavior and enhancing diet quality. Children and their parents in the intervention group had 6 physical activity counseling sessions of 30-45 minutes and 6 dietary counseling sessions of 30-45 minutes during the 2-year intervention period. The physical activity and dietary counseling sessions were conducted 0.5, 1.5, 3, 6, 12 and 18 months after baseline. The children and their parents received individualized advice from a specialist in exercise medicine and an authorized clinical nutritionist of the study on how to increase physical activity, decrease sedentary behavior and enhance diet quality in children in everyday conditions. Each counseling session had a specific topic of physical activity, sedentary behavior and diet quality according to the goals of the intervention (Table 1) and included practical tasks on these topics for the children. The children and their parents were also given fact sheets on physical activity, sedentary behavior and diet quality, verbal and written information on opportunities to exercise in Kuopio and some financial support for physical activity, such as exercise equipment and tickets for indoor sports. Moreover, the children were encouraged to participate in after school exercise clubs organized as a part of the intervention in all 9 intervention schools by the PANIC Study and supervised by trained exercise instructors. In the exercise clubs, the children had the opportunity to learn different kinds of physical activities. The physical activity intervention was based on the Finnish Recommendations for Physical Activity of School-aged Children [31] and the diet intervention was based on the Finnish Nutrition Recommendations [32].

Control group

The children and their parents in the control group received verbal and written advice on health improving physical activity and diet according to the Finnish recommendations [9, 10] but no active intervention at baseline.

Assessment of physical activity and screen-based sedentary behavior

We assessed physical activity and screen-based sedentary behavior during a usual week at baseline and at 2-year follow-up using the PANIC Physical Activity Questionnaire that we have validated in a subsample of children from the PANIC study by the Actiheart® monitor [33]. The types of physical activity in the questionnaire included organized sports, organized exercise other than sports, unsupervised physical activity, physically active school transportation and physical activity during recess. The duration of total physical activity was calculated by summing the amount of all types of physical activity. All children in the primary schools of Finland had 90 minutes of physical education per week that was added to the duration of total physical activity. The types of screen-based sedentary behavior in the questionnaire included watching TV and videos, using a computer and playing video games and playing mobile games and was expressed in minutes per day. The duration of total screen-based sedentary behavior was calculated by summing the durations of all types of sedentary behaviors.

Assessment of diet

We assessed the consumption of foods and drinks and the intake of nutrients at baseline and at 2-year follow-up using food records administered by the parents. The consumption of foods and drinks were recorded on consecutive days, including two weekdays and two weekend days, three weekdays and one weekend day or two weekdays and one weekend day [4]. We analyzed the food records and calculated the intake of nutrients using the Micro Nutrica® dietary analysis software, Version 2.5 (The Social Insurance Institution of Finland), that utilizes Finnish and international data on the nutrient content of foods [34].

Other assessments

Body height and weight were assessed by trained research personnel. Body height was measured to accuracy of 0.1 cm by a wall-mounted stadiometer in the Frankfurt plane. Body weight was measured to accuracy of 0.1 kg after overnight fasting, empty-bladdered and standing in underwear using an InBody 720® device (Biospace, Seoul, Korea). Body mass index (BMI) was calculated by dividing body weight (kg) by body height (m) squared. BMI-SDS was calculated using Finnish references [35].

Sample size calculations

We determined the number of children required to detect at least 0.30 standard deviation difference between the intervention group (60% of children) and the control group (40% of children) with a power of 80% and a 2-sided p-value for the difference between the groups of 0.05 allowing for a 20% loss to follow-up or missing data. These power calculations provided a required sample size of at least 275 children in the intervention group and 183 children in the control group.

Statistical analyses

Statistical analyses were performed using the IBM SPSS Statistics®, Version 21 (IBM Corp., Armonk, NY, USA). Differences in demographic characteristics and anthropometrics between the intervention and control group at baseline were compared by the T-test for independent samples. We studied the effects of the 2-year intervention on physical activity, sedentary behavior and diet using linear mixed model analysis by entering study group (intervention, control group), time (baseline, 2-year follow-up) and the group*time interaction as fixed factors and participant and school as random effects in the models to account for intra-participant and intra-school correlations between the repeated measures and adjusting data for age and gender. Differences in physical activity, sedentary behavior and diet between the intervention and control group at baseline were also analysed using the linear mixed model. Differences and interactions with the p-values of <0.05 were considered statistically significant. We used the Bonferroni correction for multiple testing in analyses dealing with dietary factors because of the large number of analyses performed. The threshold of statistical significance with the Bonferroni correction was 0.0012 computed as the p-value of 0.05 divided by the number of variables used.

Results

Baseline characteristics

There were no differences in the gender distribution, age, body height, body weight or BMI-SDS between the intervention and control group at baseline (Table 2). Children in the intervention group had higher levels of organized exercise other than sports ($p=0.003$) and physically active school transportation ($p=0.017$) than children in the control group adjusted for age and gender at baseline (Table 3). Children in the intervention group also had a lower consumption of high-fat milk ($p=0.013$) and a lower intake of vitamin C ($p=0.027$) than children in the control group adjusted for age and gender at baseline (Table 4).

Effects of intervention on physical activity and sedentary behavior

Total physical activity increased in the intervention group but decreased slightly in the control group (+9 min/d in the intervention group vs. -5 min/d in the control group, p=0.001 for time*group interaction) adjusted for age and gender (Table 3). Unsupervised physical activity increased in the intervention group but decreased in the control group (+7 min/d vs. -9 min/d, p<0.001 for time*group interaction). Organized exercise other than sports decreased more in the intervention group than in the control group (-4 min/d vs. -1 min/d, p=0.011 for time*group interaction). Organized sports increased more in the intervention group than in the control group (+8 min/d vs. +3 min/d, p=0.001 for time*group interaction). Physically active school transportation decreased in the intervention group but did not change in the control group (-3 min/d vs. +1 min/d, p=0.015 for time*group interaction). Using computer and playing video games increased less in the intervention group than in the control group (+9 min/d vs. +19 min/d, p=0.003 for time*group interaction).

Effects of intervention on food consumption and nutrient intake

The consumption of vegetables increased in the intervention group but decreased in the control group (+12 g/d in the intervention group vs. -12 g/d in the control group, p=0.001 for time*group interaction) adjusted for age and gender (Table 4). The consumption of low-fat milk increased in the intervention group but did not change in the control group (+69 g/d vs. +11 g/d, p=0.042 for time*group interaction). The consumption of butter and butter-based spreads decreased slightly in the intervention group but increased in the control group (-1 g/d vs. +2 g/d, p=0.002 for time*group interaction). The consumption of high-fat vegetable oil-based margarine increased more in the intervention group than in the control group (+10 g/d vs. +3 g/d, p<0.001 for time*group interaction). The intake of dietary fibre increased in the intervention group but did not change in the control group (+1.3 g/d vs. +0.2 g/d, p=0.023 for time*group interaction). The intake of vitamin C increased slightly in the intervention group but decreased slightly in the control group (+4.5 mg/d vs. -7.2 mg/d, p=0.042 for time*group interaction). The intake of vitamin E increased more in the intervention group than in the control group (+1.4 mg/d vs. +0.5 mg/d, p=0.002 for time*group interaction). The interactions between time and group for the changes in the consumption of vegetables and high-fat vegetable oil-based margarine remained statistically significant even after Bonferroni correction for multiple testing.

Discussion

We found that the 2-year individualized and family-based lifestyle intervention aimed at increasing physical activity, decreasing sedentary behavior and enhancing diet quality improved these health behaviors in a population sample of children. Total and unsupervised physical activity increased in the intervention group but decreased in the control group. Organized sports increased more and using computer and playing video games increased less in the intervention group than in the control group. The consumption of vegetables and low-fat milk and the intake of dietary fibre and vitamin C increased and the consumption of butter and butter-based spreads decreased in the intervention group but not in the control group. The consumption of high-fat vegetable oil-based margarine and the intake of vitamin E increased more in the intervention group than in the control group.

Previous studies have reported that physical activity decreases with increasing age among children [36], which is in line with the findings in the children of the control group in the present study. However, our lifestyle intervention was successful in that total and unsupervised physical activity and organized sports increased among children in the intervention group, whereas total and unsupervised physical activity decreased in the control group. Total physical activity increased on average by 9 minutes per day in the intervention group but decreased on average by 5 minutes per day in the control group, which corresponds to about one hour increase per week in the intervention group and about half an hour decrease per week in the control group. The difference in the change of physical activity between the intervention and control group in our study was much larger than reported in a systematic review of physical activity intervention studies among children [37]. The increase of physical activity in the intervention group is also notable considering the study population of healthy children 6-8 years of age who typically have relatively high levels of spontaneous physical activity and whose physical activity tends to decline with increasing age [36]. We aimed at increasing total physical activity among children in the intervention group by an individualized and family-based lifestyle intervention and did not focus on any particular type of physical activity. We paid special attention to the individual needs of the families and parental involvement in the intervention and encouraged the children to find the type of physical activity that they enjoyed most.

Unsupervised physical activity has decreased more than other types of physical activity among children in developed countries during the last decades [38]. One reason for this trend is that it is nowadays more difficult for children to exercise without supervision because of increased traffic and other environmental risks. These environmental changes have resulted in increased transportation of children to schools by cars. We found that our family-based lifestyle intervention was successful in increasing unsupervised physical activity in children. Moreover, we recently showed that unsupervised physical activity had a stronger inverse association with cardiometabolic risk than other types of physical activity in children [33]. This finding emphasizes actions to increase unsupervised physical activity among children.

Organized sports increased among children in the intervention group. We informed the children and their parents in the intervention group about the opportunities to engage in organized exercise and sports in the city of Kuopio. Our results suggest that physical activity interventions involving parents help families find a suitable organized sport to attend for children.

Physically active school transportation decreased slightly among children in the intervention group, but this change had little effect on the change in total physical activity. Physical activity during recess decreased in the intervention and control group. One explanation for this finding could be that physically active playing decreases during the first school years. Another reason may be that we had a family-based and not school-based intervention and did not particularly aim at increasing physical activity at school.

Sedentary behavior has been reported to increase with increasing age in children [36]. We also found that screen-based sedentary behavior increased both in the intervention group and in the control group. The increase in screen-based sedentary behavior corresponds to about three hours per week in the control group and about two hours per week in the intervention group. However, only time spent using a computer and playing video games increased statistically significantly less in the intervention group than in the control group, the difference in the increase being about one hour per week. It may be easier for parents to control their children's computer use and video game playing than other types of sedentary behavior. Whereas all screen-based sedentary behaviors increased among children in our study, some earlier intervention studies have succeeded in reducing screen time among children [39,40,41,42]. One explanation for this difference may be that time spent in screen-based sedentary behaviors in our population sample of Finnish children was shorter than among children in other studies that have primarily been conducted among overweight children or in the U.S.A [39,40,41,42].

The increased consumption of vegetables in the intervention group is in line with the findings of some other previous family-based diet intervention studies [43,44]. The increased consumption of vegetables also resulted in the increased intake of dietary fibre and vitamin C. Previous studies have shown that the consumption of fruit and vegetables in children can be increased by improving knowledge on recommendations [45], increasing the consumption of these foods among parents [46] and increasing the availability of them at home [47]. Together with these findings our results indicate that interventions that increase parental involvement are effective in increasing the consumption of fruit and vegetables among children.

We found that children in the intervention group decreased the consumption of high-fat milk products but increased the consumption of low-fat milk products and high-fat vegetable-oil products. In one earlier diet intervention study, the proportion of high-fat dairy products of all dairy products decreased from 88% to 14% in response to parental dietary counseling [48]. Moreover, dietary counseling has been reported to decrease the intake of total and saturated fat among children in other family-based diet intervention studies [49,50,51]. We found however, no differences in the changes of the intake of energy from total, saturated, monounsaturated or polyunsaturated fat between the groups. The intake of vitamin E increased more in the intervention group than in the control group. One explanation for this is that the consumption of high-fat vegetable oil-based margarine that contains more vitamin E than other fat products increased more in the intervention group than in the control group.

We found no differences in the change of the consumption of foods that contain lots of sugar, such as sugar-sweetened beverages, dairy products and candies, or the intake of sucrose between the intervention and control group. The results of previous studies also suggest that it is difficult to decrease the intake of sucrose among children [43]. One explanation for these observations may be that the consumption of sugar-sweetened products that are often eaten as snacks is poorly controlled by the parents. Moreover, we found no difference in the change of the consumption of foods containing lots of salt or salt intake between the groups. This observation is also in line with the results of earlier diet intervention studies [52,53].

Study strengths and limitations

The strengths of our study are a relatively large population sample of children, a carefully conducted, individualized and family-based physical activity and diet intervention with a long follow-up, a detailed assessment of physical activity and sedentary behavior and their components and the assessment of food consumption and nutrient intake using food records. A weakness of the study is that we did not randomly allocate the children in the intervention and control group. However, we divided the children into groups by matching them according to the location and size of the schools. This allowed us to perform after school exercise clubs at schools that minimized the non-intentional intervention in the control group. The parents in the intervention group may have misreported their children's health behaviors towards recommendations at 2-year follow-up to please the researchers. However, they may also have misreported the health behaviors at baseline that is a common phenomenon in all lifestyle-related studies. Moreover, some differences in the health behaviors at baseline and follow-up between the groups could be explained by differences in environmental, socioeconomic and sociodemographic factors between the neighborhoods of the city of Kuopio. We therefore controlled for the possible random effect of the schools in the mixed model analyses. We used a questionnaire rather than an objective measure to assess physical activity and sedentary behavior at baseline and 2-year follow-up. The questionnaire was developed for the assessment of health behavior in children and allowed us to assess changes in different types of physical activity and sedentary behavior in our study sample. We have shown that physical activity assessed by the questionnaire is strongly correlated with physical activity assessed by the Actiheart® monitor [33].

Conclusions

We found that the 2-year individualized and family-based physical activity and diet intervention increased physical activity, attenuated the increase in sedentary behavior and enhanced diet quality among primary school children. Further investigation is needed to evaluate whether the improved health behavior can be maintained for a longer period of time and whether it reduces cardiometabolic risk among children.

Competing interests: The authors declare that they have no competing interests

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Figure 1. Flow chart of the PANIC Study in children between 2007 and 2012 in Finland. PANIC, Physical Activity and Nutrition in Children.

Table 1. Goals of physical activity and diet intervention in the PANIC Study between 2007 and 2012 in Finland

Goals of physical activity and diet intervention
1) to increase total physical activity by emphasizing its diversity
2) to decrease total and particularly screen-based sedentary behavior
3) to decrease the consumption of foods containing much saturated fat and particularly high-fat dairy and meat products
4) to increase the consumption of foods containing much unsaturated fat and particularly high-fat vegetable-oil-based margarines, vegetable oils and fish
5) to increase the consumption of vegetables, fruit and berries
6) to increase the consumption of foods containing much fiber and particularly whole grain products
7) to decrease the consumption of foods containing much sugar and particularly sugar-sweetened beverages, sugar-sweetened dairy products and candies
8) to decrease the consumption of foods containing much salt and the use of salt in cooking
9) to avoid excessive energy intake

Table 2. Demographic characteristics and anthropometrics at baseline between 2007 and 2009 in Finland

	Intervention group (n=306)	Control group (n=200)	p-value
Gender			
Girls (n, %)	144 (47.1)	101 (50.5)	
Boys (n, %)	162 (52.9)	99 (49.5)	0.449
Age (y)	7.6 (0.4)	7.6 (0.4)	0.421
Body height (cm)	129 (5.5)	129 (5.9)	0.480
Body weight (kg)	27.0 (4.8)	26.8 (5.3)	0.694
BMI-SDS	-0.16 (1.1)	-0.21 (1.1)	0.632

The data are means (standard deviations) and P-values from the *T*-test for independent samples for continuous variables and from Chi-Square test for sex. BMI-SDS = body mass index - standard deviation score based on Finnish reference values [35].

Table 3. Physical activity and sedentary behavior at baseline study between 2007 and 2009 and at 2-year follow-up study between 2009 and 2012 in Finland

	Intervention group				Control group				
	Baseline n=304	**2-year follow-up n=255**	**2-year change in mean**	**p-value**	**Baseline n=199**	**2-year follow-up n=176**	**2-year change in mean**	**p-value**	**p for time*group interaction**
Total physical activity (min/d)	109 (99-118)	117 (107-127)	+9 (+8%)	**0.001**	109 (97-120)	103 (92-115)	-5 (-5%)	0.085	**0.001**
Unsupervised physical activity (min/d)	44 (38-50)	51 (45-57)	+7 (+15%)	**0.001**	54 (47-60)	45 (38-52)	-9 (-16%)	**<0.001**	**<0.001**
Organized exercise other than sports (min/d)	8 (6-10)	4 (2-6)	-4 (-48%)	**<0.001**	4 (1-6)	3 (0-5)	-1 (-26%)	0.318	**0.011**
Organized sports (min/d)	8 (4-12)	16 (12-20)	+8 (+105%)	**<0.001**	8 (3-12)	11 (6-16)	+3 (+44%)	**0.001**	**0.001**
Physically active school transportation (min/d)	20 (17-23)	18 (15-21)	-3 (-13%)	**0.015**	15 (11-18)	16 (13-20)	+1 (+10%)	0.252	**0.015**
Physical activity during recess (min/d)	22 (21-23)	23 (22-24)	0 (+1%)	0.538	22 (21-23)	22 (21-23)	0 (-1%)	0.721	0.505
Screen-based sedentary behavior (min/d)	103 (97-109)	119 (113-126)	+16 (+16%)	**<0.001**	99 (91-106)	123 (116-131)	+25 (+25%)	**<0.001**	0.133
Watching television and videos (min/d)	69 (64-74)	75 (69-80)	+5 (+8%)	**0.041**	68 (62-74)	73 (67-79)	+5 (+8%)	0.093	0.996
Using a computer and playing video games (min/d)	32 (28-36)	41 (37-45)	+9 (+28%)	**<0.001**	27 (22-32)	47 (42-51)	+19 (+72%)	**<0.001**	**0.003**
Playing mobile games (min/d)	2 (1-3)	4 (3-5)	+2 (+79%)	**0.009**	4 (2-5)	4 (3-5)	0 (+2%)	0.913	0.114

Values are means (95% confidence intervals) of physical activity and sedentary behaviour at baseline and after 2-year follow-up, the 2-year changes in the means and p-values for the differences between the means at baseline and 2-year follow-up from the linear mixed models adjusted for age and gender. Study group, time and their interaction were included as fixed factors into the model and participant and school were included as random effects into the model. The P-values of <0.05 are bolded.

Table 4. Food consumption and nutrient intake at baseline between 2007 and 2009 and at 2-year follow-up between 2009 and 2012 in Finland

	Intervention group				Control group				
	Baseline (n=256)	**2-year follow-up (n=231)**	**2-year change in mean**	**p-value**	**Baseline (n=169)**	**2-year follow-up (n=160)**	**2-year change in mean**	**p-value**	**p for time* group inter-action**
Food consumption (g/day)									
High-fibre (≥5 %) products (g/d)	63 (56-70)	76 (69-83)	+13 (+20%)	**<0.001**	61 (53-69)	75 (67-83)	+14 (+23%)	**0.001**	0.864
Low-fibre (<5 %) products (g/d)	112 (102-122)	108 (98-118)	-4 (-4%)	0.367	117 (106-129)	103 (91-114)	-15 (-13%)	**0.009**	0.151
Potatoes (g/d)	77 (70-84)	76 (69-82)	-2 (-2%)	0.679	79 (71-87)	77 (68-85)	-2 (-3%)	0.642	0.924
Vegetables (g/d)	95 (85-105)	107 (97-117)	+12 (+13%)	**0.007**	110 (98-121)	97 (86-109)	-12 (-11%)	**0.024**	**0.001**
Fruit and berries (g/d)	106 (93-119)	109 (96-121)	2 (2%)	0.697	112 (97-127)	96 (81-111)	-16 (-15%)	**0.033**	0.059
High-fat (≥1 %) milk (g/d)	172 (145-198)	98 (71-124)	-74 (-43%)	**<0.001**	225 (192-257)	188 (156-220)	-36 (-16%)	**0.038**	0.101
Low-fat (<1 %) milk (g/d)	399 (359-440)	468 (427-508)	+69 (+17%)	**<0.001**	341 (294-389)	352 (305-399)	+11 (+3%)	0.621	**0.042**
High-fat (≥1 %) sour milk products (g/d)	87 (78-97)	65 (56-75)	-22 (-25%)	**<0.001**	80 (68-92)	66 (54-78)	-14 (-18%)	0.061	0.408
Low-fat (<1 %) sour milk products (g/d)	20 (13-27)	19 (12-26)	-1 (-4%)	0.865	17 (8-25)	17 (8-25)	0 (+1%)	0.979	0.898
Cheese (fat>17%) (g/d)	7 (5-9)	7 (5-9)	0 (-3%)	0.832	8 (6-10)	10 (8-12)	+1 (+17%)	0.179	0.241
Cheese (fat≤17%) (g/d)	8 (6-10)	10 (8-12)	+2 (+29%)	**0.016**	8 (6-11)	8 (5-10)	-1 (-7%)	0.637	0.057
Ice cream and pudding (g/d)	23 (16-29)	23 (17-30)	+1 (+4%)	0.737	30 (23-38)	24 (17-31)	-6 (-21%)	**0.045**	0.078
Fish (g/d)	16 (13-20)	19 (15-23)	+2 (+15%)	0.214	18 (13-22)	18 (13-22)	0 (-1%)	0.928	0.389
Red meat (g/d)	56 (51-60)	60 (55-64)	+4 (+7%)	0.186	58 (52-63)	63 (57-68)	+5 (+9%)	0.162	0.813
Sausages (g/d)	22 (18-25)	21 (18-25)	0 (-2%)	0.848	22 (18-27)	20 (16-25)	-2 (-9%)	0.417	0.614
Poultry (g/d)	16 (13-20)	22 (19-26)	+6 (+37%)	**0.005**	18 (14-23)	20 (15-24)	+1 (+6%)	0.658	0.144
Butter and butter-based spreads (g/d)	6 (5-7)	5 (4-6)	-1 (-18%)	0.090	6 (5-7)	8 (7-9)	+2 (+32%)	**0.011**	**0.002**
Vegetable oil-based margarine (fat <60 %) (g/d)	4 (3-5)	2 (1-3)	-2 (-55%)	**<0.001**	4 (2-5)	3 (2-4)	-1 (-22%)	0.190	0.114
Vegetable oil-based margarine (fat 60-80 %) (g/d)	7 (5-9)	17 (16-19)	+10 (+148%)	**<0.001**	8 (6-9)	10 (8-12)	+3 (+36%)	**0.021**	**<0.001**
Vegetable oils (g/d)	4 (4-5)	4 (4-5)	0 (+4%)	0.665	4 (3-5)	4 (4-5)	+1 (+14%)	0.237	0.525
Sugar-sweetened beverages (g/d)	128 (101-155)	139 (111-166)	+10 (+8%)	0.319	145 (113-177)	154 (122-185)	+9 (+6%)	0.496	0.913
Fruit juices (g/d)	33 (22-44)	36 (25-48)	+3 (+10%)	0.547	39 (26-53)	44 (30-57)	+4 (+11%)	0.530	0.919
Sugar and honey (g/d)	10 (9-11)	7 (6-8)	-3 (-31%)	**<0.001**	10 (8-11)	7 (6-8)	-3 (-28%)	**0.001**	0.742
Candy (g/d)	21 (17-25)	24 (20-28)	+3 (+14%)	0.130	20 (16-25)	23 (19-28)	+3 (+14%)	0.202	0.983
Chocolate and hot chocolate powder (g/d)	9 (8-11)	11 (9-12)	+1 (+15%)	0.232	9 (7-12)	11 (9-13)	+2 (+21%)	0.161	0.748
Salty snacks (g/d)	4 (2-5)	7 (5-8)	+3 (+76%)	**0.009**	4 (2-6)	7 (5-9)	+3 (+86%)	**0.013**	0.784
Energy and nutrient intake									
Energy (kcal/d)	1614 (1564-1665)	1689 (1639-1740)	+75 (+5%)	**0.002**	1669 (1610-1728)	1679 (1621-1738)	+11 (+1%)	0.719	0.092
Total fat (% of energy intake)	29.6 (28.8-30.4)	31.1 (30.3-31.9)	+1.5 (+5%)	**<0.001**	30.3 (29.3-31.3)	31.9 (30.9-32.8)	+1.6 (+5%)	**0.002**	0.907
Saturated fat (% of energy intake)	11.9 (11.5-12.4)	11.7 (11.2-12.1)	-0.3 (-2%)	0.173	12.3 (11.9-12.8)	12.5 (12.1-13.0)	+0.2 (+2%)	0.459	0.150

Monounsaturated fat (% of energy intake)	9.8 (9.6-10.1)	10.9 (10.6-11.2)	+1.1 (+11%)	**<0.001**	10.0 (9.7-10.3)	10.9 (10.5-11.2)	+0.9 (+9%)	**<0.001**	0.446
Polyunsaturated fat (% of energy intake)	4.9 (4.7-5.2)	5.8 (5.6-6.1)	+0.9 (+18%)	**<0.001**	4.9 (4.6-5.2)	5.6 (5.3-5.9)	+0.7 (+13%)	**<0.001**	0.287
Carbohydrates (% of energy intake)	52.0 (51.1-53.0)	50.5 (49.5-51.4)	-1.6 (-3%)	**<0.001**	51.6 (50.5-52.6)	50.0 (48.9-51.1)	-1.5 (-3%)	**0.002**	0.949
Sucrose (% of energy intake)	12.6 (12.0-13.3)	11.2 (10.6-11.8)	-1.4 (-11%)	**<0.001**	12.7 (12.0-13.4)	11.7 (11.0-12.4)	-1.0 (-8%)	**0.004**	0.307
Protein (% of energy intake)	16.9 (16.4-17.3)	17.0 (16.5-17.4)	+0.1 (+1%)	0.579	16.8 (16.3-17.3)	16.7 (16.2-17.3)	-0.1 (0%)	0.796	0.581
Fibre (g/d)	14.4 (13.8-14.9)	15.6 (15.1-16.2)	+1.3 (+9%)	**<0.001**	14.3 (13.6-15.0)	14.5 (13.8-15.1)	+0.2 (+1%)	0.642	**0.023**
Vitamin C (mg/d)	82.7 (77.0-88.5)	87.2 (81.5-93.0)	+4.5 (+5%)	0.217	93.0 (86.0-100.0)	85.8 (78.9-92.7)	-7.2 (-8%)	0.104	**0.042**
Vitamin D (µg/d)	5.7 (5.0-6.4)	8.3 (7.6-9.0)	+2.6 (+45%)	**<0.001**	6.0 (5.2-6.9)	7.9 (7.1-8.8)	+1.9 (+31%)	**<0.001**	0.071
Vitamin E (mg/d)	6.6 (6.3-6.9)	8.0 (7.7-8.3)	+1.4 (+21%)	**<0.001**	7.0 (6.6-7.4)	7.5 (7.1-7.8)	+0.5 (+7%)	**0.046**	**0.002**
Folate (µg/d)	189 (180-198)	191 (182-199)	+1.8 (+1%)	0.661	196 (18-206)	188 (178-198)	-7.7 (-4%)	0.114	0.134
Sodium (mg/d)	2409 (2335-2482)	2522 (2449-2595)	+113 (+5%)	**0.009**	2438 (2349-2528)	2560 (2472-2648)	+121 (+5%)	**0.020**	0.902
Calcium (mg/d)	1161 (1107-1215)	1176 (1123-1230)	+16 (+1%)	0.481	1171 (1108-1234)	1138 (1075-1201)	-33 (-3%)	0.220	0.163
Iron (mg/d)	8.2 (7.9-8.5)	8.5 (8.3-8.8)	+0.3 (+4%)	**0.029**	8.3 (8.0-8.7)	8.3 (8.0-8.6)	-0.1 (-1%)	0.747	0.100

Values are means (95% confidence intervals) of food consumption and nutrient intake at baseline and after 2-year follow-up, the 2-year changes in the means and p-values for the differences between the means at baseline and 2-year follow-up from the linear mixed models adjusted for age and gender. Study group, time and their interactions were included as fixed factors into the model and participant and school were included as random effects into the model. The threshold of statistical significance with Bonferroni correction is 0.0012 (assuming 42 tests and 0.05 significance). The P-values of <0.05 are bolded.