Preventive Medicine 87 (2016) 81–88

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

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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ARTICLE INFO

Article history:
Received 25 June 2015
Revised 16 February 2016
Accepted 18 February 2016
Available online 23 February 2016

Keywords:
Intervention
Children
Physical activity
Diet
Sedentary behavior

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.

1. Introduction

The prevalence of overweight and obesity in children and adolescents has increased in most developed countries, including Finland, during the past decades (Janssen et al., 2005; de Onis et al., 2010; Vuorela et al., 2009). Over 15% of girls and over 10% of boys at preschool or primary school age are overweight or obese in Finland (Vuorela et al., 2009; Eloranta et al., 2012). 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 (Viitasalo et al., 2012, 2014; Veijalainen et al., 2013). 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

Abbreviations: BMI, body mass index; BMI–SDS, body mass index–standard deviation score; PANIC, Physical Activity and Nutrition in Children.

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http://dx.doi.org/10.1016/j.ypmed.2016.02.027
0091-7435/

adulthood (Morrison et al., 2007, 2008; Mattsson et al., 2008; Nguyen et al., 2010).

Lifestyle changes, such as increasing physical activity, decreasing sedentary behavior and improving diet, since childhood is the cornerstone for the prevention of overweight, type 2 diabetes and cardiovascular diseases (Kumanyika et al., 2008; Paulweber et al., 2010; Perk et al., 2012). Lifestyle interventions have been rather effective in the treatment of childhood overweight, obesity and other cardiometabolic risk factors in the short term (Ho et al., 2013), but the effects have been modest in the long-term (Waling et al., 2012; Kalarchian et al., 2009). 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 (Kaitosaari et al., 2003; 2006; Hakanen et al., 2006; Khan et al., 2014; Reilly et al., 2006). Many of these studies have reported little or no effect of lifestyle interventions on cardiometabolic risk factors among children (Reilly et al., 2006; Wang et al., 2015; Hrafnkelsson et al., 2014). 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 (Kaitosaari et al., 2003; 2006; Macias-Cervantes et al., 2009; French et al., 2011). One reason for the modest effects in most studies may be that the intensity and duration of the lifestyle interventions have been insufficient (Harris et al., 2009; Showell et al., 2013; Kipping et al., 2014). Not emphasizing the individual needs of families and parental involvement may also have decreased adherence to the interventions (Showell et al., 2013; Kipping et al., 2014; Gerards et al., 2011).

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.

2. Methods

2.1. 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 (Fig. 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 (Fig. 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.

2.2. 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 min and 6 dietary counseling sessions of 30–45 min 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 (Ministry of Social Affairs and Health, 2005) and the diet intervention was based on the Finnish Nutrition Recommendations (National Nutrition Council, 2005).

2.3. 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 (Ministry of Social Affairs and Health, 2005; National Nutrition Council, 2005) but no active intervention at baseline.

2.4. 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 (Väistö et al., 2014). The types of physical activity in the questionnaire included organized sports, organized exercise other than sports, unsupervised physical activity, physically active school transportation and