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An activity-based intervention for obese and physically inactive children organized in primary care: feasibility and impact on fitness and BMI

A one-year follow-up study

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Abstract

Objective. To investigate the feasibility and impact on BMI and physical fitness of an intervention for obese and inactive children, based on physical activity and carried out in primary health care. **Design.** A prospective, longitudinal one-year follow-up study. **Setting.** The community of Kristiansand, Norway (80 000 inhabitants). **Intervention.** A 40-week structured intervention based on physical training with some lifestyle advice for the obese child and one parent. **Subjects.** A total of 62 physically inactive children aged 6–14 years with iso-BMI ≥ 30 kg/m². **Main outcome measures.** Body mass index (BMI), maximum oxygen uptake, and physical fitness in tests of running, jumping, throwing, and climbing assessed at baseline and after six and 12 months as well as number of dropouts and predicting factors. **Results.** A total of 49 out of 62 children completed the first six months and 37 children completed 12 months. Dropout rate was higher when parents reported being physically inactive at baseline or avoided physical participation in the intervention. The children's maximum oxygen uptake increased significantly after 12 months from 27.0 to 32.0 ml/kg/min (means), as did physical fitness (endurance, speed, agility, coordination, balance, strength) and BMI was significantly reduced. **Conclusion/implications.** This one-year activity-based intervention for obese and inactive children performed in primary health care succeeded by increasing cardiovascular capacity and physical fitness combined with reduced BMI in those who completed. Dropout was substantial and depended on the attendance and compliance with physical activity by the parents.

Key Words: BMI, childhood obesity, dropouts, family practice, fitness, parental participation, physical activity, primary care

The prevalence of childhood obesity has increased worldwide during the most recent decades. Up to 20% of children in several Western European countries are overweight or obese, and the heaviest children seem to be becoming even more obese [1,2]. A Norwegian study among children 4–15 years old shows that 18% of boys and 20% of girls are above the 90th weight-for-height percentile and 8% of boys and 7% of girls are above the 97.5th percentile [2]. Reduced daily physical activity and sedentary leisure activities are important and modifiable causal factors for becoming overweight as a child, in addition to excessive high-caloric food intake [3]. Differences in frequency of somatic and psychological symptoms

between obese, overweight and normal-weight adolescents represent medically and socially negative consequences [4].

Concerns exist regarding declining levels of daily physical activity among schoolchildren [5]. International guidelines recommend children and adolescents to be physically active for at least 60 minutes a day [6]. It is well documented that regular physical activity is associated with improved health and reduced risk of mortality. Inactivity is also an important risk factor for metabolic syndrome (hypertension, glucose intolerance/insulin resistance, and abdominal adiposity) in children [7]. International studies indicate that high physical

Few studies have presented intervention models for obesity among children organized by GPs. Our study focusing on physical activity showed:

- Effect on BMI and physical fitness after six months and after 12 months;
- A high dropout rate among the children, related to parents' compliance and lifestyle;
- The child's adherence to the training programme mainly depended on the attendance of the parents.

capacity in adolescence reduces the risk of cardiovascular diseases in adulthood [8]. Physical activity is shown to be effective as prevention against cancer, Type II diabetes, and cardiovascular diseases, even if patients do not reduce weight [9]. Physical activity is also important for bone density and growth in children and adolescents and has a positive influence on memory, mental capacity, and social behaviour in children, regardless of their body mass index [10]. The level of physical activity in childhood seems to continue into adulthood [11].

No commonly accepted clinical guidelines on prevention or treatment of childhood obesity existed when we started our study. Only a few studies had been carried out in a primary care setting focusing on lifestyle-induced conditions in childhood [12]. Controlled obesity prevention trials had been short-term with focus on one or a few strategies and had shown little or no impact [13]. The latest agreement, however, is that prevention should include advice on increased physical activity and improved eating patterns, and be school and family based [14–16]. A meta-analysis including studies until May 2008 shows a total beneficial effect of treatment, though with differences between studies [16].

The aim of our study was to implement and evaluate a primary care-based intervention over one year for obese and sedentary children aged 6–14 years. The intervention was based mainly on structured physical activity and included some lifestyle advice. Parental involvement was mandatory. We investigated the effects on physical capacity and fitness and BMI, and identified factors predicting dropout.

Material and methods

Design

A prospective intervention study was undertaken over one year. Data from questionnaires, clinical examination, and physical testing were analysed.

Setting and participants

The participants were recruited from the city of Kristiansand in Southern Norway (80 000 inhabitants) and surroundings. Obese children aged 6–14 years who had been referred for their obesity were invited from waiting lists at the local hospital, the department for child mental health, general practitioners, and one private paediatrician. Recruitment to the last of four intervention groups also included an announcement in the local newspaper. Children with iso-BMI (Cole) $> 30 \text{ kg/m}^2$ were included if they were physically inactive and if one of the parents was willing to participate. Physical inactivity was defined as no regular leisure time sport and/or preference for sedentary activities like watching TV or playing computer games.

Intervention

Between 2004 and 2007 the intervention was carried out in four groups of 11 to 20 participants, including a total of 62 children. All groups were given the same intervention, with a twice-weekly training programme lasting two hours for 20 weeks, followed by a once-weekly session over the next 20 weeks. The sessions included one hour's indoor and one hour's outdoor activity. They were directed by sports-educated coaches and comprised various activities and games focusing on balance, strength, endurance, and courage and on having fun. Swimming, climbing, sliding, skating, ball games, activities with music, athletics, orienteering, football, and outdoor walking (hiking) were included. The parents were encouraged to do outdoor walking with ski poles and power training in a fitness room and to also participate in some activities with the children.

A clinical nutrition physiologist lectured twice and two participating doctors and one nurse gave several brief lessons based on conventional dietary and lifestyle advice recommending at least 30–60 minutes of physical activity every day.

Outcome measures after 6 and 12 months

Cardio-respiratory aerobic fitness. Cardio-respiratory fitness was measured by a progressive indoor bicycle workload test using a "Monark 839 Ergomedic", an indirect measurement of cardiovascular physical fitness, measured by maximum volume of oxygen uptake per kilogram body weight (VO_2 peak). Workload was increased stepwise by adding 25 watts every three minutes until exhaustion. The maximum power output (watt-max) was calculated as the watts in the last completed workload relative to body weight (watts/kg) [17].

VO₂ peak is used as a measure for children instead of VO₂ max. VO₂ peak measures what the child performs at that moment, and not what he/she is physically able to reach [18]. The criteria for exhaustion were: heart rate > 185 beats/min or that the child could or would not increase workload further even after encouragement from the tester.

Motor fitness tests and coordinative tests. We used a comprehensive physical fitness test, created by Fjørtoft et al., which measures different basic motor abilities in children through complex movements in eight different activities, within running, jumping, throwing, and climbing [19]. Physical fitness is defined as a complexity of different qualities within motor abilities and strength, balance, and coordination. The tests selected by Fjørtoft et al. represent physical functions in different muscle groups. Each test measures complex abilities and is based on other validated motor tests [20–22]. The tests do not depend on motor intelligence and they represent well-known movements in active children (Figure 1).

Anthropometrics. Standard calibrated scales were used to determine height and weight [23]. Body height was determined to the nearest 0.5 cm and body weight to the nearest 0.5 kg. The children were measured dressed in T-shirt and light trousers without shoes. BMI was calculated and the international BMI limits for childhood adiposity were used [24].

Dropouts

Dropouts were invited for a final consultation with parents. If this was refused, we telephoned the

parents and asked for the reason for ending the programme.

Statistical analyses

Data were analysed by non-parametric tests using the SPSS® 15.0 statistical package. A Wilcoxon test was used to analyse within-group changes from baseline to six and 12 months, and differences between groups were analysed by Mann–Whitney U-test. Comparison of frequency between groups was confirmed by a chi-squared test. Results are given as medians and quartiles. A p-value < 0.05 was considered statistically significant.

Ethics

All procedures and methods in this study conformed to the ethical guidelines laid down in the Helsinki Declaration. The study was approved by the Regional Committee for Medical Research Ethics. Informed consent and parental agreement to participate in the intervention were mandatory.

Results

Characteristics of the participants related to gender, age group, interventional group, and completion of the programme are presented in Table I. A total of 35 out of 62 children (57%) completed the 40 weeks intervention. There were no differences in gender regarding dropout.

Table II gives data regarding BMI, age, cardio-respiratory aerobic and physical fitness, and some parental characteristics at inclusion for children who

Motor fitness/motor abilities	Run	Run	Jump	Jump	Jump	Throw	Throw	Climb
	20 m (sec)	Shuttle (sec)	Broad jump (m)	7m, two leg jump (sec)	7m, one leg jump (sec)	Tennis ball (m)	Medicine ball (m)	Wall bars (sec)
Speed	x	x						
Agility		x						
Coordination	x	x	x	x	x	x	x	x
Balance	x	x	x	x	x	x	x	x
Strength	x	x	x	x	x	x	x	x

Figure 1. Physical fitness tests with the motor abilities measured by the tests.

Table I. Participating children (n = 62) related to gender, age, intervention group, and follow-up.

	Baseline (n = 62)	6 months (n = 41)	12 months (n = 35)
Gender			
girls (n)	32	20	17
boys (n)	30	21	18
Age group			
1 (6 y – 11 y)	31	23	19
2 (12 y – 15 y)	31	18	16
Intervention group			
1	15	8	5
2	16	11	8
3	11	7	7
4	20	15	15

dropped out of the programme versus those who completed. Significantly more parents of completers reported being physically active one or more days a week. Parents of completers also participated more in the intervention, compared with parents of dropouts. The children's age, BMI, and cardiovascular aerobic capacity at baseline were equal in dropouts and completers. Table III shows that cardio-respiratory aerobic capacity improved significantly during the intervention period. Improvement was seen after 20 as well as 40 weeks. Physical fitness improved over the period and for several tests the improvement reached the level of statistical significance. BMI also decreased significantly over the intervention period.

A total of 15 children (24%) dropped out before 20 weeks, four of them due to medical problems preventing physical activity. The rest dropped out for different reasons: lack of support from parents,

problems with transport to the training facilities, preferring participation in other activities, lack of motivation, and difficulties finding time for the sessions. Another 12 children (19%) dropped out during the second part of the intervention: two due to severe health problems, five due to lack of motivation, and five did not give any reason. In total 27 children (43.5%) dropped out. One child among the six with medical problems reported that obesity made it difficult to carry out the activities. Other medical conditions were a severe ankle sprain, a broken leg, endocrinological and mental problems.

Discussion

This one-year family-based intervention comprising physical activity and some lifestyle advice for obese and inactive children organized in primary health care showed a favourable impact on physical capacity and fitness parallel to a reduction of BMI. Other multidisciplinary interventions for obese children of the same age, organized as RCTs with a focus on lifestyle and fitness, have also shown an increase in physical capacity, measured as maximum oxygen uptake [25,26]. In our study those who completed reported a feeling of success through mastering and through positive feedback. Their self-confidence for being physically active increased. Being overweight or obese is not necessarily associated with poor physical fitness and is not always caused by a sedentary lifestyle. Obesity may be a result of genetic, cultural, and neurobiological mechanisms [27], even if physical inactivity has been found to contribute significantly to the present obesity epidemic in the Western world [28].

Table II. Characteristics on inclusion for dropouts versus children who completed the intervention.

	Dropouts median (quartiles)	n	Completed median (quartiles)	n	p-value
BMI children at onset (kg/m ²)	28.3 (27.0–30.9)	27	27.4 (24.8–29.3)	35	0.09
Age (years)	12.0 (9.5–13.5)	27	11.5 (9.0–12.5)	35	0.27
VO ₂ at onset (ml/kg/min)	27 (20–30)	19	27 (25–32)	31	0.25
Jump broad (m)	1.07 (0.96–1.24)	20	1.15 (0.91–1.37)	32	0.36
Jump 7 m two legs (sec)	3.8 (3.5–4.5)	20	4.0 (3.5–4.5)	33	0.58
Jump 7 m one leg (sec)	3.6 (3.2–4.1)	20	3.7 (3.3–4.5)	33	0.45
Throw tennis ball (m)	17.5 (13.7–24.2)	17	14.9 (10.0–19.2)	33	0.07
Throw medicine ball (m)	5.3 (4.2–6.1)	19	4.3 (3.2–5.1)	33	0.02
Wall bars (sec)	7.2 (5.5–10.8)	20	8.3 (6.7–12.7)	34	0.121
Shuttle run (sec)	23.5 (22.1–25.3)	20	23.1 (21.8–24.7)	34	0.53
20 m run (sec)	4.6 (4.3–5.0)	18	4.6 (4.3–5.2)	33	0.94
BMI at onset mother (kg/m ²)	26.7 (22.4–34.4)	25	27.5 (25.3–32.1)	34	0.52
BMI at onset father (kg/m ²)	25.5 (24.7–29.4)	16	28.5 (26.1–31.1)	26	0.01
Parent participating in training (n)	9	27	29	35	<0.001
Parents physically active at onset (n)	11	26	28	35	0.002
Education above high-school level mother (n)	10	26	11	35	0.6
Education above high-school level father (n)	7	21	15	33	0.4

Note: Mann–Whitney U-test for analysing differences in continuous variables by groups, chi-squared test for comparison of frequencies between groups.

Table III. Cardio-respiratory aerobic and physical fitness, and BMI at inclusion and at six and 12 months, given as median and quartiles.

	Inclusion	n	6 months	n	p-value	12 months	n	p-value
VO ₂ (ml/kg/min)	27.0 (23.0–30.0)	50	30.0 (27.0–34.0)	28	0.004	32.0 (28.3–36.0)	28	< 0.001
Jump (m)	1.1 (0.94–1.30)	52	1.3 (0.94–1.40)	25	0.32	1.25 (0.92–1.37)	22	0.07
Jump 7 m two legs (sec)	3.9 (3.5–4.4)	53	3.4 (3.1–4.2)	20	0.20	3.5 (3.3–4.2)	27	0.001
Jump 7 m one leg (sec)	3.7 (3.2–4.2)	53	3.4 (3.1–4.2)	21	0.10	3.5 (3.0–4.1)	26	0.003
Throw tennis ball (m)	15.2 (10.8–20.2)	50	15.3 (12.3–19.0)	19	0.23	14.7 (10.2–19.0)	24	0.02
Throw medicine ball (m)	4.4 (3.6–5.6)	52	4.4 (3.7–5.1)	28	0.04	4.5 (3.9–5.7)	26	< 0.001
20 m run (sec)	4.6 (4.3–5.1)	51	4.8 (4.5–5.3)	19	0.14	4.6 (4.4–5.1)	25	0.003
Run shuttle (sec)	23.3 (21.9–24.9)	54	20.3 (19.0–24.7)	19	0.05	21.4 (20.0–24.0)	19	< 0.001
Climbing wall bars (sec)	7.9 (6.2–11.1)	54	6.6 (5.7–10.4)	20	0.15	7.4 (5.4–10.0)	25	< 0.001
BMI (kg/m ²)	27.7 (25.6–29.5)	62	26.3 (23.8–29.4)	49	< 0.001	25.5 (24.0–30.6)	39	0.01

Note: A Wilcoxon test is used to analyse within-group changes from baseline to six and 12 months.

The main weakness of our study is the lack of a control group, and we present boys and girls together. A high dropout rate is also problematic, but is well known in lifestyle interventions, as some long-term studies report dropout rates of 34–53% [29]. A recently published pilot study on a primary care-based family intervention for obesity showed 33% dropout after three months [30]. In our study 24% dropped out during the first six months and in total 43% of the included children did not complete the one-year intervention. Some of those who dropped out joined activities closer to home, but some felt stigmatized by participating in this kind of group. Parents were not always motivated to transport the child to the training sessions and came up with several excuses for not taking part in the training programme themselves. In our study parents of dropouts were less physically active at baseline and participated less in the intervention, compared with those who completed the intervention. It turned out that the parents' compliance with the intervention and their own level of physical activity at baseline correlated with the children's ability to accomplish the intervention. Another recently published study found that parental compliance is an important factor in weight-management programmes for obese children and may be assessed by the parents' cooperativeness in completing questionnaires measuring health-related quality of life [31].

Our study was planned considering the children's probability of mastering the tasks they were given. The aim was to let them have fun doing exercises and forget their prejudices regarding physical activity. The intention was that the children would continue some activities after the project ended. We also wanted the intervention to be easy to copy in other primary care settings and not to be dependent upon advanced equipment or financial supports. The outcome of this study shows that it is easier to intervene with children when parents are actively participating in training. In a future programme we will need to

motivate parents even more, in order to optimize the outcome.

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Conflicts of interest

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References

- [1] Lobstein T, Frelut ML. Prevalence of overweight among children in Europe. *Obes Rev* 2003;4:195–200.
- [2] Juliusson PB, Roelants M, Eide GE, Hauspie R, Waaler PE, Bjerknes R. Overweight and obesity in Norwegian children: Secular trends in weight-for-height and skinfolds. *Acta Paediatrica* 2007;97:1333–7.
- [3] Marshall SJ, Biddle SJ, Gorely T, Cameron N, Murdey I. Relationships between media use, body fatness and physical

- activity in children and youth: A metaanalysis. *Int J Obes Relat Metab Disord* 2004;10:1238–46.
- [4] Berg IM, Simonsson B, Ringquist I. Social background, aspects of lifestyle, body image, relations, school situation, and somatic and psychological symptoms in obese and overweight 15-year-old boys in a county in Sweden. *Scand J Prim Health Care* 2005;23:95–101.
 - [5] Strong WB, Malina RM, Blimkie CJ, Daniels SR, Dishman RK, Gutin B et al. Evidence based physical activity for school-age youth. *J Pediatr* 2005;146:732–7.
 - [6] Wedderkopp, N, Froberg K, Hansen HS, Andersen LB. Secular trends in the physical fitness and obesity in Danish 9-year-old girls and boys: Odense School Child Study and Danish Substudy of the European Heart Study. *Scand J Med Sci Sports* 2004;3:150–5.
 - [7] Andersen LB, Harro M, Sardinha L, Froberg K, Ekelund U, Brage S, et al. Physical activity and clustered cardiovascular risk in children: A cross-sectional study (The European Youth Heart Study). *Lancet* 2006;368:299–304.
 - [8] Eisenmann JC. Physical activity and cardiovascular diseases risk factors in children and adolescents: An overview. *Can J Cardiol* 2004;20:295–301.
 - [9] Brodney SB, Blair SN, Lee CD. Is it possible to be overweight or obese and fit and healthy? In Bouchard C, editor. *Physical activity and obesity*. Champaign, IL: Human Kinetics; 2000. (J Eating Disorders 2000;215–20.)
 - [10] Trudeau F, Shephard RJ. Physical education, school physical activity, school sports and academic performance. *Int J Behav Nutr Act* 2008;5:10.
 - [11] Trudeau F, Laurencelle L, Shepard RJ. Tracking of physical activity from childhood to adulthood. *Med Sci Sports Exerc* 2004;36:1937–43.
 - [12] Salminen M, Vahlberg T, Kivelä SL. Effects of family-oriented risk-based prevention on serum cholesterol and blood pressure values of children and adolescents. *Scand J Prim Health Care* 2005;23:34–41.
 - [13] Sanigorski AM, Bell AC, Cuttler PJ, Swinburn BA. Reducing unhealthy weight gain in children through primary care capacity-building: Results of a quasi-experimental intervention program, Be Active Eat Well. *Int J Obesity* 2008;32:1060–7.
 - [14] Oude Luttikhuis H, Baur L, Jansen H, Shrewsbury VA, O'Malley C, Stolk RP, et al. Interventions for treating obesity in children. *Cochrane Database Syst Rev* 2009;no.1: CD001872.
 - [15] Dobbins M, DeCorby K, Robeson P, Husson H, Tirilis D. Schoolbased physical activity programmes for promoting physical activity and fitness in children and adolescents aged 6–18. *Cochrane Database Syst Rev* 2009;no.1: CD007651.
 - [16] Kipping RR, Jago R, Lawlor DA. Obesity in children. Part 2: Prevention and management. *BMJ* 2008;337:a1848doi10.1136/bmj.a1848.
 - [17] Klasson-Heggebo L, Andersen LB, Wennlof AH, Sardinha LB, Harro M, Froberg K et al. European Youth Health Study: Graded associations between cardiorespiratory fitness, fatness, and blood pressure in children and adolescents. *Br J Sports Med* 2006;40:25–9.
 - [18] Armstrong N, Welsman J, Winsley R. Is peak VO_2 a maximal index of children's aerobic fitness? *Int J Sports Med* 1996; 17:356–9.
 - [19] Fjortoft I, Pedersen AV, Sigmundsson H, Vereijken B. Testing av fysisk form hos barn, Nordisk konferanse i bevegelsesvitenskap. [Test of physical fitness in children. Nordic conference in science of movements]. In: *Proceedings, NTNU, Trondheim*, 2003.
 - [20] Adam C, Klissouras V, Ravazzolo M, Renson R, Tuxworth W. EUROFIT: European Test of Physical Fitness. Handbook. Rome: Council of Europe, Committee for the Development of Sport. 1988.
 - [21] Bös K, Wohlman R. (1987). Allgemeiner Sportmotorischer Test AST (6–11) zur Diagnose der konditionellen und koordinativen Leistungsfähigkeit. In: *Lehrhilfen für den Sportunterricht* 36;10:145–60.
 - [22] Yarmolenko A. The motor sphere of school-age children. *Pedagogical Seminary and Journal of Genetic Psychology* 1933;42:298–318.
 - [23] Juliusson P, Vinsjansen S, Nilsen B, Sælesminde H, Vågset R, Eide GE, et al. Måling av vekt og vekst: En oversikt over anbefalte teknikker. [Measures of growth: A review of recommended techniques]. *Ped Endokr* 2005;19:23–9.
 - [24] Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: International survey. *BMJ* 2000;320:1240–3.
 - [25] Nemet D, Barkan S, Epstein Y, Friedland O, Kowen G, Eliakim A. Short- and long-term beneficial effects of a combined dietary-behavioural-physical activity intervention for the treatment of childhood obesity. *Pediatrics* 2005;115:443–9.
 - [26] Carrell AL, Clark RR, Peterson SE, Nemeth BA, Sullivan J, Allen DB. Improvement of fitness, body composition and insulin sensitivity in overweight children in a schoolbased exercise program. *Arch Ped Adol Med* 2005;159:963–9.
 - [27] Malterud K, Tonstad S. Preventing obesity: Challenges and pitfalls for health promotion. *Patient Educ Couns* 2009; 76:259.
 - [28] Ross R, Freeman JA, Jansson I. Exercise alone is an effective strategy for reducing obesity and related comorbidities. *Exerc Sport Sci Rev* 2000;28:165–70.
 - [29] Andersson K, Karlström B, Fredén S, Petersson H, Öhrvall M, Zethelius B. A two-year clinical lifestyle intervention program for weight loss in obesity. *Food Nutr Res* 2008;52:10.3402/fnr.v52i0.1656
 - [30] Robertson W, Friede T, Blissett J, Rudolf MC, Wallis M, Stewart-Brown S. Pilot of "Families for Health": Primary care-based family intervention for obesity. *Arch Dis Child* 2008;93:921–6.
 - [31] Yackobovitz-Gavan M, Nagelberg N, Phillip M, Ashkenazi-Hoffnung L, HersHKovitz E, Shalitin S. The influence of diet and/or exercise and parental compliance on health-related quality of life in obese children. *Nutr Res* 2009;29:397–404.