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Parent–child relationship of physical activity patterns and obesity

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OBJECTIVE: To study differences in physical activity between normal-weight and obese children, as well as parent–child associations of obesity and physical activity.
DESIGN: Cross-sectional study.
SUBJECTS: 129 obese children (67 girls and 62 boys), 142 normal-weight controls (81 boys and 61 girls), and mothers ($n=245$) and fathers ($n=222$) of the children.
METHODS: Physical activity was assessed by a 3-day physical activity record (children and parents), by a questionnaire (children), and by one question on habitual physical activity (parents). The data were analysed by stepwise linear and logistic regressions. Obesity was assessed from relative weight (children) and BMI (parents).
RESULTS: Parent inactivity was a strong and positive predictor of child inactivity (β-coefficients 0.25 and 0.16, $P<0.001$, for mother and father inactivity, respectively). Scores of parent activity were somewhat weaker predictors of child vigorous activity hours and total physical activity level (β-coefficients 0.13–0.25, $P=0.003–0.08$). Child obesity was negatively associated with child habitual physical activity (odds ratio 0.88, $P<0.001$). In addition, parent obesity (body mass index $\geq 30\,kg/m^2$) was another strong predictor of child obesity (odds ratio 2.38–3.50, $P<0.002$).
CONCLUSIONS: The present study underscores the parents' role in childhood activity patterns and obesity. A novel finding was that the parent–child relationship of inactivity appeared to be stronger than that of vigorous activity. Hence, parents who want to reduce their children's inactivity may have to pay attention to their own lifestyle.

Keywords: children; family; inactivity; overweight; television

Introduction

The prevalence of obesity among children and adolescents has increased in most Western countries in the last few decades. The recent secular trend seems to be more closely associated with increased inactivity (that is, sedentary activities, such as watching television), than with increased intake of energy or fat.[1–3]

It is still controversial whether inactivity promotes obesity in children. Several cross-sectional studies have shown a positive association between the time spent watching television and obesity in children,[4–10] whereas other reports have failed to find a relation.[11–13] The association between children's vigorous or total physical activity and obesity is also inconsistent: some studies reported an inverse relation,[6,11,13,14] while some researchers did not find an association.[7,9,10]

The amount and kind of physical activity in children are modified by physiological, biomechanical and social factors.[15] Also, genes may explain a part of the variability in physical activity.[16] The genetic influence is observed especially in intense exercise[16] and in low-intensity, spontaneous activities.[17]

The social cognitive theory of behaviour points to the importance of model learning from parents' behaviour and of receiving reinforcements from significant others.[18] Several studies have indeed shown a weak, positive association between parental physical activity, or parental encouragement, and child physical activity.[18–21] All the above-mentioned studies examined moderate or vigorous physical exercise. However, the clustering of inactivity (time spent in sedentary activities) within families has not been investigated.

The family is a potent target for interventions to increase children's physical activity, and to prevent and improve management of childhood obesity.[18] A better insight of the parents' role in children's physical activity and obesity is needed to design and test new interventions.[15] The present study examined differences in physical activity between normal-weight and obese children, as well as parent–child associations of obesity and physical activity. Our main objective was to find out whether parental activity level and obesity associate with activity and obesity in their children.

Methods

Subjects

The study began with a survey on the prevalence of obesity among 7–12-year-old children in Kokkola, a

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town in Western Finland with a population of 33 000. The child's relative weight[22] was obtained from the previous biannual school health examination. Obesity was defined as $\geq 20\%$, and marked obesity as $\geq 40\%$ above age-specific median weight-for-height.

All children classified as obese, together with their parents, were asked to participate in the study designed to examine the parent–child relationship of physical activity and weight status. Out of the 269 obese children recruited, 201 (74.7%) agreed to participate. A normal-weight classmate of the same sex was randomly chosen for every obese participant. Out of the 201 normal-weight children recruited, 143 (71.1%) volunteered to participate. The weight-status data used to classify children were obtained 0.5–1.5 y before the present study. Seventy-two (35.8%) of the children initially classified as obese did not meet the criteria of obesity when the present weight and height were re-obtained. These children were excluded from the study. One control child, initially classified as normal-weight, was excluded because his present weight indicated obesity. Consequently, the final study population consisted of 129 obese children (67 girls and 62 boys) and of 142 normal-weight controls (81 boys and 61 girls), and of their mothers ($n = 245$) and fathers ($n = 222$). Characteristics of the children are presented in Table 1, and those of their parents in Table 2.

Assessment of physical activity

Child and parent physical activity was each assessed using two separate self-report methods. To assess present physical activity, all subjects (children and their parents) kept a 3-day physical activity record[23] on two week days and one Sunday. The record was modified from an interview method that has been described in detail by Sallis *et al*.[24] On each day, the time spent in: (1) sitting (inactive) leisure activities (television and video watching, playing with PC, reading, etc.), (2) moderate leisure activities (walking, easy cycling, working in the garden, washing floors, etc.), and (3) vigorous leisure activities (jogging or running, ball games, swimming, fast cycling, cross-country skiing, etc.), was recorded to the nearest 30 min. Parents were asked to help their children in filling in the records.

The daily physical activity level (PAL), which corresponds to the total energy expenditure divided by resting energy expenditure, was calculated for children and parents as follows: PAL = (hours sleeping $(=8)\times 1$ MET) + (hours leisure inactivity $\times$ 1.1 MET) + (hours moderate activity $\times$ 5 MET) + (hours vigorous activity $\times$ 9 MET) + (24 − 8-hours of inactivity, and moderate and vigorous activity totalled $\times$ 1.7 MET/24 h. The MET values (metabolic equivalents, corresponding to energy expenditure during activity divided by resting energy expenditure) were obtained from the consensus report by Ainsworth *et al*.[25]

In addition to present physical activity, the child habitual physical activity was assessed by the Netherlands Health Education Project Questionnaire (NHEPQ).[26] NHEPQ evaluates behaviour in everyday situations at home and at school. Two out of the eight original items ('introvert/extrovert behaviour' and

Table 1 Characteristics (mean (s.d.)) of normal-weight (control) and obese children

	Girls		*Boys*			
	Control (n = 81)	*Obese (n = 67)*	*Control (n = 61)*	*Obese (n = 62)*	*Obesity[a] (P-value)*	*Sex[a] (P-value)*
Age (y)	9.6 (1.7)	9.5 (1.7)	9.6 (1.7)	9.7 (1.7)	0.84	0.69
Height (cm)	140 (12)	143 (12)	140 (11)	145 (10)	0.006	0.37
Weight (kg)	33.5 (8.0)	47.9 (11.5)	33.5 (7.0)	49.9 (10.8)	< 0.001	0.38
Number of siblings	2.4 (2.4)	1.9 (1.5)	2.2 (1.5)	1.9 (1.5)	0.08	0.56

[a]Results from ANOVA (main effects). All interactions were non-significant ($P > 0.20$).

Table 2 Parent's BMI and physical activity patterns based on child body weight status

	Girls		*Boys*			
	Control (n = 81)	*Obese (n = 67)*	*Control (n = 61)*	*Obese (n = 62)*	*Obesity[a] (P-value)*	*Sex[a] (P-value)*
Mothers						
BMI (kg/m^2)	23.4 (3.8)	25.9 (4.5)	24.0 (3.6)	26.5 (4.5)	< 0.001	0.26
Inactivity (h/day)	2.05 (0.99)	2.21 (1.27)	2.06 (1.12)	1.99 (1.23)	0.72	0.44
Vigorous activity (h/day)	0.20 (0.30)	0.25 (0.38)	0.23 (0.35)	0.23 (0.41)	0.61	0.98
PAL[b]	1.62 (0.15)	1.62 (0.15)	1.63 (0.15)	1.63 (1.17)	0.76	0.50
Fathers						
BMI (kg/m^2	25.4 (2.7)	27.1 (3.4)	25.4 (2.7)	27.7 (4.1)	< 0.001	0.53
Inactivity (h/day)	2.35 (1.33)	2.23 (1.19)	2.09 (1.24)	2.40 (1.34)	0.59	0.78
Vigorous activity (h/day)	0.30 (0.46)	0.26 (0.49)	0.32 (0.47)	0.19 (0.33)	0.14	0.61
PAL[b]	1.63 (0.20)	1.61 (0.19)	1.66 (0.20)	1.59 (0.16)	0.09	0.79

[a]Results from ANOVA (main effects). All interactions were non-significant ($P > 0.20$).
[b]PAL = present physical activity level.

'child has few friends/many friends') were not used in the present study. The remaining six items describe characteristics of child activity. The items are evaluated by a numerical (Likert) score ranging from 1 (preference for quiet and inside activities) to 5 (preference for vigorous activities, games, playing outside, etc.). The sum of the six items (theoretical range from 6 (=low activity) to 30 (=high activity) was used as an index of child habitual activity.

The parents were asked to classify their habitual physical activity in one out of four classes: (1) vigorous leisure-time physical activity at least twice a week; (2) vigorous activity once a week; (3) weekly moderate physical activity, but no regular vigorous activity; (4) no leisure-time physical activity. This classification has been used in the Finnish cohort of the WHO/FINMONICA study.[27] Because of only a few responses in class 4, the two most inactive classes were combined to a new class 3 (no regular vigorous activity).

Ethical issues

A written informed consent was obtained from the parents of all children who participated in the study. An independent Ethical Committee of the UKK Institute for Health Promotion and Research approved this study.

Statistical analyses

The normal-weight and obese children were compared by a two-way analysis of variance (ANOVA), using sex and weight status as classifying variables. Pairwise associations were studied by Pearson product moment correlations. Determinants of child activity were tested by stepwise linear regression models. The parent's activity data were entered as independent variables, in addition to the parent's weight status (classified as overweight (body mass index (BMI) = 25.0–29.9 kg/m^2) or obese (BMI $\geq$ 30 kg/m^2); normal weight was used as the reference class), the highest education within the family (classified as comprehensive school, high school and university; college was used as the reference class), and the child sex (girl = 0, boy = 1), age, relative weight and number of siblings. Determinants of child obesity were analysed by stepwise logistic regression with child sex, age, habitual physical activity and the number of siblings, and parent weight status, habitual activity (dummy variables, inactivity was used as the reference class) and highest education as independent variables. We used backward steps, with $P < 0.05$ to enter and $P < 0.1$ to remove. All statistical analyses were done by SPSS statistical software package, version 6.1.3 (SPSS Inc., Chicago, IL, USA).

Results

A total of 152 (14.5%) of the girls and 117 (11.4%) of the boys were obese or markedly obese. The prevalence of marked obesity was 38 (3.6%) among girls and 47 (4.6%) among boys.

The obese children had significantly ($P < 0.001$) lower habitual activity scores than the normal-weight children (Figure 1). However, the present activity level, obtained from the prospective activity record, was not different between the obese and normal-weight children. Parents of the obese children had a higher ($P < 0.001$) BMI than the parents of the normal-weight children (Table 2). Parental physical activity was not associated with child obesity.

According to the activity record, the children and their parents spent approximately 2 h daily in sedentary activities (Figure 1, Table 2). However, the boys spent more time being inactive than the girls did ($P = 0.004$). The boys also tended to report more vigorous activity than the girls did ($P = 0.06$). Both the physical activity level ($P = 0.02$) and habitual physical activity score ($P = 0.001$) were higher in the boys than in the girls. The children spent on average three times more time daily in vigorous activities than their parents did. The present daily physical activity level was approximately 10% higher in children than in parents (Figure 1, Table 2). None of the sex-by-obesity interactions were significant.

Among children, the time spent in sedentary activities did not correlate ($P > 0.05$) with the vigorous activity hours, present physical activity level or habitual activity. In contrast, the vigorous activity hours correlated strongly ($P < 0.001$) with the present physical activity level ($r = 0.89$). The habitual activity scores showed a weak, but significant correlation with the vigorous activity hours and the present physical activity level from the 3-day activity record ($r = 0.35$, $P < 0.01$).

Table 3 presents pairwise parent–child and mother–father correlations for physical activity and weight status. The parent–child and mother–father correlations of inactivity were stronger than the correlations for the vigorous activity hours or the present physical activity level. Even after adjusting for several cofactors, the parent inactivity remained a strong and positive predictor of child inactivity (Table 4). The strong parent–child associations of inactivity also contributed to the best predictive power ($r^2 = 0.27$) in the corresponding regression model. Indices of parent activity were weaker predictors of the child vigorous activity and present physical activity level (Table 4). All activity indices were higher in the boys than in the girls. Relative weight was negatively associated with the habitual physical activity score, but not with any of the present activity indices.

Parent obesity (BMI $\geq$ 30 kg/m^2) was the strongest predictor of child obesity (Table 5). In addition, the

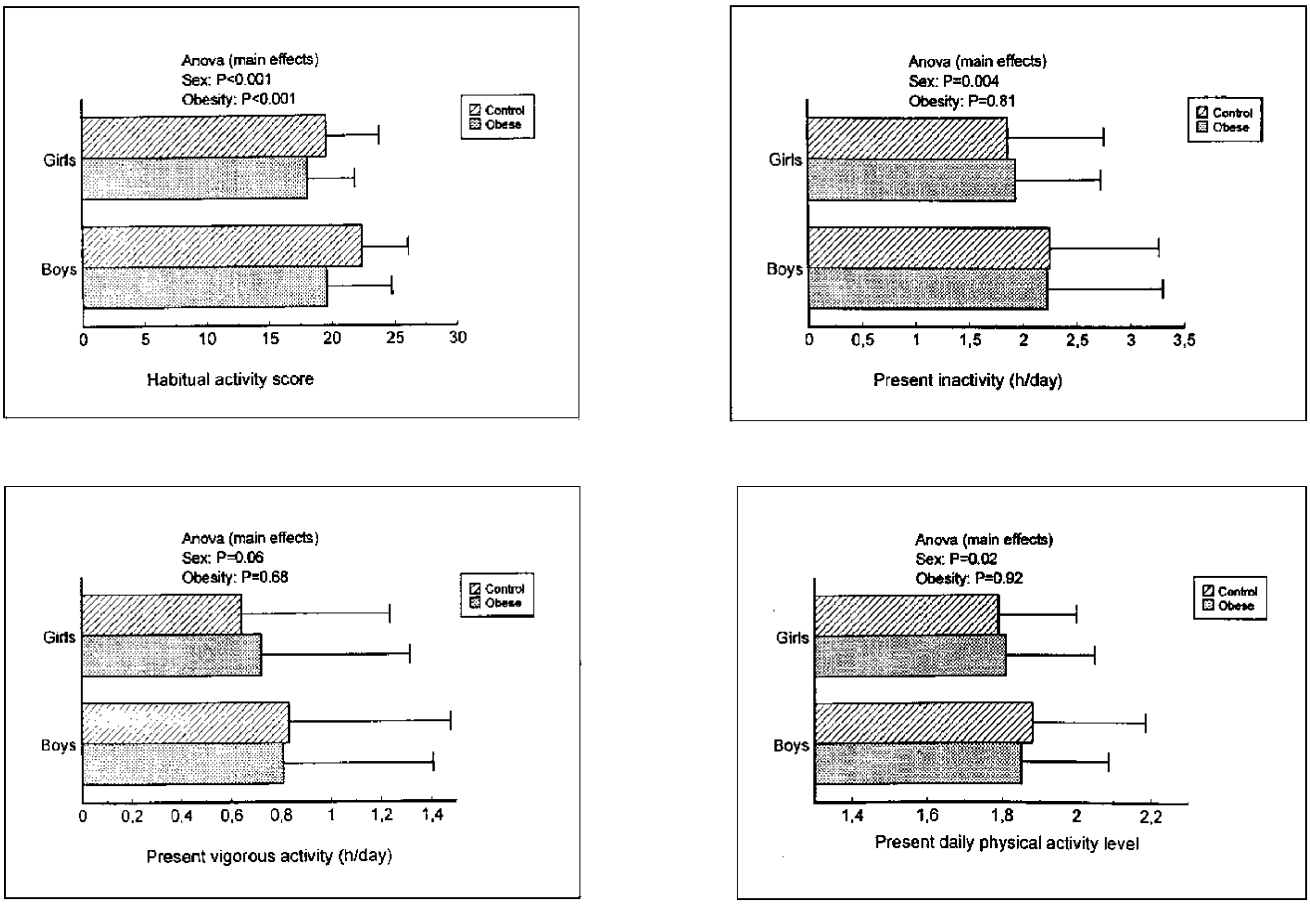

Figure 1 Habitual physical activity, and present inactivity, vigorous activity and daily physical activity level (mean and sd) in normal-weight and obese girls and boys aged 7–12 y. The main effects of ANOVA are shown; the obesity-by-sex interactions were not significant ($P > 0.28$).

Table 3 Pairwise parent–child and mother–father correlations of different components of physical activity (assessed by a 3-day physical activity record) and weight status

	Number of pairs	*Inactivity*	*Vigorous activity*	*Physical activity level*	*Weight status*[a]
Mother–father	215	0.38**	0.12	0.32**	0.25**
Mother–daughter	143	0.33**	0.28**	0.33**	0.26**
Father–daughter	129	0.29**	0.24**	0.33**	0.30**
Mother–son	119	0.47**	0.20**	0.28**	0.38**
Father–son	109	0.38**	0.08	0.09	0.34**

[a]BMI in parents, difference (%) from age-related median weight-for-height in children.
**$P < 0.01$. *$0.01 < P < 0.05$.

habitual physical activity score showed a significant, negative relation to obesity.

Discussion

In agreement with many earlier studies, the level of child habitual physical activity was weakly and inversely related to overweight.[6,11,13,14] The association was, however, dependent on the assessment tool, because physical activity levels obtained from the prospective 3-day activity record were not related to overweight. Because the recording is based on subjective evaluation of the intensity of daily activities, an overestimation of activity intensity by overweight children could mask a true association between activity and obesity.

Physical inactivity did not predict child obesity in the present study. This finding was contradictory to several other reports.[4–6,8,10] The reason for the difference may be cultural, because the average time spent in sedentary activities was shorter in Finland than in the above American studies. Also Kimm *et al*[28] were unable to identify an association between watching television and obesity in White girls, presumably because of clustering of television viewing at lower values.

The daily physical activity may be divided into several components based on the level of exertion. We

Table 4 Determinants of physical activity in 7–12-y old children in a stepwise linear regression analysis

Dependent	*Independent*[a]	*β*	*(95% CI)*	*P-value*
Present inactivity ($r^2 = 0.27$)	Child sex	0.27	(0.09–0.46)	0.004
	Child age	0.09	(−0.47–0.66)	0.002
	University[b]	−0.31	(−0.60–−0.01)	0.04
	Mother inactivity	0.25	(0.16–0.34)	< 0.001
	Father inactivity	0.16	(0.07–0.24)	< 0.001
Present vigorous activity ($r^2 = 0.11$)	Child sex (boy)	0.16	(0.03–0.30)	0.02
	Child age	0.07	(0.03–0.11)	< 0.001
	University	−0.22	(−0.42–−0.01)	0.04
	Mother vigorous activity	0.25	(0.05–0.45)	0.02
	Father vigorous activity	0.13	(−0.01–0.27)	0.08
Present physical activity level ($r^2 = 0.14$)	Child sex (boy)	0.07	(0.02–0.12)	0.007
	Child age	0.02	(0.00–0.03)	0.04
	Mother PAL[c]	0.27	(0.09–0.45)	0.003
	Father PAL[c]	0.20	(0.07–0.34)	0.003
Habitual physical activity ($r^2 = 0.10$)	Child sex (boy)	2.09	(1.01–3.17)	< 0.001
	Child relative weight	−0.04	(−0.07–−0.02)	0.003
	Father BMI > 30	−1.89	(−3.82–0.04)	0.06

CI = confidence interval.
[a]Only variables with β-coefficients with $P < 0.1$.
[b]University as parents' maximal education.
[c]PAL = present physical activity level.

Table 5 Determinants of obesity in 7–12-y-old children in a logistic regression analysis. The results are presented as odds ratios (OR) and their 95% confidence intervals (CI). The non-significant ORs for parents' habitual physical activity and education are shown

	OR	*(95% CI)*	*P-value*
Sex	1.23	(0.65–2.35)	0.52
Age	1.02	(0.84–1.22)	0.87
Number of siblings	0.80	(0.65–0.98)	0.03
Habitual physical activity	0.88	(0.82–0.94)	< 0.001
BMI (mother)			< 0.001
25–29	1.04	(0.63–1.74)	0.87
> 30	2.38	(1.22–4.64)	< 0.001
BMI (father)			< 0.001
25–29	0.82	(0.50–1.36)	0.44
> 30	3.50	(1.56–7.85)	0.002

focused on the time spent in the extremes, that is, on vigorous activity and inactivity. Our record was a modification from an interview method that was originally developed and validated by Sallis *et al*.[24] In their study, the time spent in both high intensity activities and total inactivity was assessed more precisely than the time spent in moderate activities. The potential problems in assessing moderate activity was an important reason for our focus on vigorous activity and inactivity.

Consistent with other studies,[29–32] parent obesity was a strong predictor of child overweight. The unadjusted parent–child correlations of weight-status ($r = 0.20–0.37$) were significant and similar to those ($r = 0.23–0.28$) reported by Feunekes *et al*.[30] Whitaker *et al* [31] have furthermore shown that the parent–child association of obesity is even stronger when obesity is found in both, rather than in only one of the parents. Unfortunately, because of an inadequate sample size, we could not include the interaction term with two obese parents in the stepwise regression.

The indicators of obesity are a point of concern. First, both BMI and age-adjusted weight-for-height are affected by both the fat and fat-free masses. Hence, a more direct measure of fatness (such as by skinfolds) might have been more appropriate for this study. Another methodological problem may be the different indices of obesity in parents and children. The relative weight defined as weight-for-height is adjusted for age,[22] whereas BMI cut-off points differ with age in children. However, because obesity in Finnish children is traditionally defined as relative weight, these data were available from the school records.

The clustering of physical inactivity within a family appeared stronger than the clustering of vigorous activity. It has been shown that parents influence their children's activity by modelling (being active themselves), but also by encouragement and support.[18] Therefore, we conjecture that parents may influence their children's vigorous activity level regardless of their own activity patterns.

The time spent in sedentary activities did not correlate with the vigorous activity level, which was in accordance with some other studies.[10,33,34] We argue that sedentary (television, videos and computers) and vigorous (sports) activities should be regarded as independent behavioural domains. Therefore, using for example television watching as a proxy for low physical activity is not necessarily correct, because periods of inactivity may be counterbalanced by periods of vigorous activity.

Only self-reports were used to assess physical activity in the present study. Compared with more objective measurements, such as heart rate monitoring and accelerometers, self-reports tend to inflate differences in physical activity.[35] Moreover, we cannot rule out the possibility of different reporting bias in overweight and normal-weight children. Therefore, it is

possible that the true relationship between physical activity and overweight was stronger than we found. An additional evident source of bias was that the MET values of Ainsworth *et al*[25] may not be appropriate for children.[36] However, one set of values were used because there were no *a priori* reasons why this potential source of bias would have affected the children vs parents or obese vs normal-weight comparisons.[36]

The present study underscores the parents' role in childhood activity patterns and obesity. A novel finding was that the parent–child relationship of inactivity was stronger than that of vigorous activity. Hence, parents who want to influence their children's inactivity may also have to pay attention to their own behaviour. Another important finding was that the mother's vigorous activity levels had an evident association with their son's activity. Hence, the traditional concept of strong father–son associations of physical activity should perhaps be re-evaluated. Unfortunately, the cross-sectional design of the present study is unable to identify causal associations. Longitudinal interventions are needed to show how parents' activity patterns really affect activity in their children.

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