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Parental socioeconomic status and change in physical activity among children attending a family-based obesity treatment program

Master Thesis in Clinical Health Science – Obesity and Health

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Abstract

Background: Physical activity is associated with health and a normal weight status and is therefore recommended in childhood obesity treatment. To produce more effective treatment for obese children, there is a need to investigate how social factors affect the outcome of these treatments. Children with low parental socioeconomic status (SES) are particularly at high risk for being obese and having a sedentary lifestyle. The impact of socioeconomic status in the treatment of obese children in general, and particular regarding physical activity, is however not known.

Objective: The aim of this study was to investigate the effect of parental socioeconomic status on change in physical activity among obese children during participation in a family-based treatment program at St. Olav University Hospital.

Material and method: This intervention study included 58 children with obesity (BMI ≥ 2 SDS). The treatment program promoted physical activity and a healthy diet for the participating families. Children were classified into high- or low parental socioeconomic status based on their parents' occupation. Physical activity was assessed by accelerometer at baseline and after two years.

Results: Similar to the normal weigh population of children, all participants reduced their level of physical activity over the two years of observation. A high level of physical activity at baseline was strongly associated with a greater reduction in physical activity after two years, and the reduction was significantly more pronounced in children with high parental socioeconomic status.

Conclusions: The intervention was more successful in maintaining the physical activity level in children with low parental SES compared to children with high parental SES. This result emphasizes the need for more individualized treatment for obese children. Studies with larger sample sizes are needed to fully explore the relationship between change in physical activity and parental SES.

1. *Introduction*

1.1 Prevalence of childhood obesity

During the last decades, overweight and obesity has increased among adults as well as children worldwide (1). In Norway, the Bergen Growth Study from 2007 found children aged 4-15 years to have a significant increase in weight-for-height and skin folds over the last 30 years, with the heaviest children becoming heavier (2). A large, population-based health survey (HUNT), conducted in the county of Nord-Trøndelag also found an increasing prevalence of overweight and obesity from 1995-1997 to 2006-2008. From the last survey, 20 % of the girls and 22 % of the boys aged 13-16 years were registered as overweight or obese (3). A recent national survey among 8-year-olds – including over 3000 cases (participation rate 89 %) reported a stable prevalence of overweight and obesity of 16 % from 2008 to 2012, with an intermediate higher prevalence of 19 % in 2010 (4, 5). This supports several international studies where the prevalence of childhood overweight appears to be plateauing (1, 6). As an example, Lissner and coworkers found stabilized rates of overweight and obesity among Swedish children aged 10-11 years, between 1999 and 2005 (7). Furthermore, data from 6-year-olds in Germany shows a reversing prevalence in both sexes between 2004 and 2008, although differences between German states were reported (8). The prevalence of childhood obesity is, however, still on an unacceptably high level which emphasizes the importance of preventing and treating childhood obesity (6).

1.2 Obesity, physical activity and health

Overweight and obesity is defined by the World Health Organization (WHO) as an abnormal or excessive fat accumulation who may impair health. Overweight and obesity is most frequently classified by the use of body mass index (BMI) (-calculated as weight in kilograms divided by height in meters squared-) . For adults overweight is classified as BMI $\geq$ 25 and obesity is classified as BMI $\geq$ 30 (9). The International obesity task force (IOTF) has provided own age and gender adjusted BMI scores for children between 2 and 18 years, that corresponds to the adult BMI values for overweight and obesity, also called isoBMI (10).

Childhood obesity is associated with short and long term medical- as well as psychosocial problems (11-14). Results from the Bogalusa Heart Study showed an elevated waist/height ratio to associate with adverse cardiovascular risk factors among overweight children (15).

Data from the same study, found low-density lipoprotein and BMI in Childhood to independently correlate with elevated cardiovascular risk factors in young adulthood, although the causality of the association could not be established (16). Obesity has also been reported to cause psychosocial difficulties in childhood, such as stigmatization, low self-esteem, depression, anxiety and behavioral problems (14). In a systematic review obese children was shown to have lower quality of life than normal weight controls (12). Obesity related co-morbidities become more prominent in adulthood and is associated with increased mortality (11).

Physical activity refers to any bodily movement produced by skeletal muscles that require energy expenditure (17). An accelerometer is the most frequently utilized instrument in measuring physical activity for scientific purposes (18). The accelerometer measures total physical activity in counts per minute (CPM) which is calculated as the sum of the recorded acceleration, divided by minutes the accelerometer has been used. Physical activity in moderate to vigorous intensity (moderate to vigorous physical activity = MVPA), is also utilized as a measure of physical activity (19).

Regular physical activity is beneficial for our physical and mental well-being (20-22). Time spent in MVPA among youth was in a meta-analysis associated with a positive effect on cardiovascular risk factors regardless of time spent in sedentary activities (21). A review by Biddle and coworkers also found physical activity to have positive effect on psychosocial outcomes in youth (20). Furthermore, convincing evidence shows that regular physical activity reduces the risk of overweight among children (23, 24), and physical activity has been found to have a positive effect on cardiovascular risk factors among obese youth regardless of weight-loss (25). Unfortunately, overweight and obesity has been reported to reduce children’s participation and performance in physical activity (19).

Sedentary behavior has, on the other hand, been associated with promotion of weight gain or maintenance of a high weight status among youth (26), as well as a higher risk of type 2 diabetes, hypertension, dyslipidemias and in long term; cardiovascular diseases and some cancers (25). Thus, there is strong evidence that physical activity have a preventive effect against cardiovascular disease as well as weight gain.

1.3 Physical activity among normal weight and overweight youth, and in treatment of obesity

A survey among 3538 Norwegian schoolchildren found physical activity to decline with age. Among 6-year-old girls and boys 87 % and 96 %, respectively, fulfilled the national recommendations of 60 minute a day in moderate physical activity. The corresponding rates were 70 % for 9-year-old girls and 86 % for 9-year-old boys, and 43 % and 58 % for the 15-year-old girls and boys. These results show that boys are more active than girls at all age levels. Overall, Norwegian children were more physical active during spring and summer, and less physical active during fall (27).

Regarding overweight, this national survey revealed some differences in physical activity compared with normal weight youth. There was significantly higher physical activity level among normal weight 9-year-old boys compared to their overweight peers. Furthermore, - a higher percentage of the normal weight 9-year-olds as well as 6-year-old girls, fulfilled the recommendation of 60 minute in MVPA each day (27). This is in accordance with previous studies that report a stronger association between overweight in childhood and a lower physical activity level compared with normal weight children, in total physical activity as well as MVPA (28, 29). Moreover, Trost and coworkers found obese children to have lower levels of self-efficacy related to physical activity as compared with normal weight children (29). Obese children are also less involved in community organizations promoting physical activity, and they more seldom have a physical active male guardian (29). In general, overweight and obese children tend to have a lower physical activity level than their normal weight peers.

Parents serve as role models for their children’s lifestyle behaviors (30). Regarding physical activity in particular, parental physical activity appear to be a strong predictor of physical activity among obese children (31). Therefore, in treatment of childhood obesity, interventions in physical activity including the whole family are recommended and appears to be important supplemental components in addition to introduction of a healthy diet and behavioral therapy (32).

A review of obesity treatment programs by Atlantis and coworkers, found physical activity for 155-180 minutes in MVPA per week to be effective for reduction in body fat. The effect on body weight and central obesity were, however, inconclusive (33). A systematic review investigating the effect of childhood obesity treatment on change in physical activity, reported 15 of 20 randomized controlled trials to have a positive effect in minimum one physical activity parameter. However, only three studies had good methodical quality and different measures of physical activity made it hard to compare the results (34).

Since physical activity prevents weight gain as well as health problems (25), and physical activity habits in childhood appears to be traced into adult life (35), promotion of physical activity in childhood obesity treatment is of high importance.

1.4 Socioeconomic differences in health

It is well documented that socioeconomic status (SES) measured in education, occupation or income is associated with health in adults (36, 37), and in Norway, a clear inverse relationship has been reported between SES and mortality among adults aged 45-60 years (38). Galobardes and colleagues also found socioeconomic circumstances both in childhood and adulthood to be determinants of cardiovascular disease, in particular stroke, later in life (39). Furthermore, low SES appears to be associated with conflicted, unsupportive and neglectful family relations, which may cause psychosocial problems in childhood (40).

SES and standard of health is often seen to persist over generations as the social environment generates typically life patterns which involve certain opportunities (41). It is also suggested that the socioeconomic hierarchy in itself is a reason for the socioeconomic health differences, as the wealthy and affluent always will be able to convert their privileged situation into better health (41). Although the government has implemented equalizing strategies (42), increasing health inequalities between socioeconomic groups has been reported in Norway (43).

1.5 Childhood obesity and parental SES

While an inverse effect is common in developing countries, the prevalence of obesity typically declines as SES increases in western countries (44). A study among Norwegian schoolchildren with low parental SES reported twofold odds of being overweight compared to children with high parental SES (45). This result is in concordance with a systematic review where 15 of the 20 cross-sectional studies included found parental SES to be inversely associated with their children's overweight (46). The ability to receive and implement health knowledge in high SES families is thought to play a role in the development of obesity (47). Furthermore, families with high SES more frequently have access and affordability to healthy foods, local sporting facilities and sport equipment (48-50).

Galobardes and colleagues found a significantly reduced score on self-reported social acceptance and physical appearance in 8-year-olds with low parental SES compared to normal-weight and obese peers with a higher parental SES (39). Thus, since a correlation between psychosocial stressors and childhood obesity has been detected (48), stress associated to low parental SES (40) may also influence the child's obesity development.

1.6 Children's physical activity and parental SES

Ball and coworkers reported an association between low parental SES and reduced physical activity level in children, using maternal education as a measure of SES and accelerometer data to measure physical activity (51). This relation was also found in two cohort studies measuring physical activity in 8- to 11-year-old children, but the difference was not significant after controlling for BMI. The same cohorts found, however, a significant association between SES groups and sedentary behavior, with increased sedentary behavior among children with low parental SES (52). A cross-sectional study from over 2200 of the children in the Bergen Growth Study showed significant association between lower parental SES and self-reported less time spent doing sports, enhanced screen time and having TV in the bedroom (47). Tandon and colleagues also reported low parental SES to associate with children's screen time, but no differences in MVPA or sedentary behavior between high and low parental SES was detected (50). These results show conflicting results regarding the relationship between parental SES and childhood physical activity.

Among adolescents, in contrast to children, there is a stronger evidence for an association between low parental SES and a lower physical activity level, but the findings are far from uniform (53). It is suggested that the health consequences of socioeconomic differences might first emerge in early adulthood (51).

Since low physical activity among individuals with low SES could contribute to obesity and maintenance of the social differences in health, it has been recommended to address SES in implantation of childhood obesity treatment strategies (52, 54).

1.7 Childhood obesity treatment and parental SES

Some school programs focusing on preventing obesity have investigating the differences in parental SES (55-58). The multi-component school-based intervention HEIA (Health in adolescents) was conducted among Norwegian 11-year-olds. Children who had parents with 13-16 years of education increased their physical activity more than those with a lower and higher parental education (55). Furthermore, the HEIA study revealed a beneficial effect on BMI among children with high parental education (56). A similar program carried out in Germany also found children with high parental SES to benefit more from the intervention regarding change in weight status (58). Hollar and coworkers (57) on the other hand, reported particular beneficial effect on BMI and blood pressure in low income children. This was also a school based obesity preventing program.

Parental SES was not detected as a predictor of weight control, during a 12 month outpatient program for German overweight and obese children, aged 7 to 15 years (59). This is in concordance with results from a study by Braet, who also found no difference in parental SES regarding change in weight status after a two year inpatient obesity treatment program (60).

Adding up the research on the field, low parental SES is associated both with childhood obesity (45, 46) and low physical activity in childhood (51-53). There are, however, conflicting results regarding differences between SES groups in effect of interventions treating or preventing childhood obesity (55-60). Despite recommendations to address SES in the treatment of obese children (52, 54), scarce information is found on this area (32, 49). To our knowledge no study has investigated the effect of parental SES on physical activity in an outpatient obesity program.

1.8 A family based childhood obesity treatment program at St. Olav University Hospital

In 2005 an intervention study started at St. Olav University Hospital, including 99 obese children 7-12 years of age. After the two year follow up, a moderate, but significant reduction in body fat was found (61). The children had a physical activity level slightly below the mean physical activity among Norwegian children in the same age group (62), both at baseline and when the treatment was finished. The treatment had therefore no increasing effect on physical activity (61).

The present study will address whether parental SES affected change in physical activity among these treatment seeking, obese children.

2. *Aim of the study*

The objective of this study is to investigate the effect of parental socioeconomic status on change in physical activity among obese children during participation in a family-based treatment program at St. Olav University Hospital.

HO: There is no difference in change in physical activity between obese children with high parental SES and low parental SES, during participation in a family-based treatment program at St. Olav University Hospital.

H1: Children with high parental SES have a more positive change in physical activity compared to children with low parental SES, during participation in a family-based treatment program at St. Olav University Hospital.

3. *Method*

3.1 Design

This study is based on a randomized controlled trial, including 99 children from 2005-2010, that compared the effect of two different family interventions on childhood obesity. The observations were located at baseline, six months and after two years.

3.2 Participants

The participants in the present study included 58 children who had one valid objective physical activity registration in addition to the baseline registration. Similar results in change in physical activity were found from baseline to six months (N=46), and from baseline to two years (N=43). Thus, this study focused on change in physical activity from baseline to two years, but also included the 15 participants with valid registrations only at baseline and six months. The participants also needed to have parents with registered SES. A previous study found no difference in change in physical activity between the two intervention groups (61), therefore, data were pooled into one group in the present study.

3.3 Procedure of the main study

The participants were referred by their general practitioner to obesity treatment at St. Olav University Hospital between April 2005 and February 2008. Inclusion criteria were age between seven and twelve, BMI ≥ 2 Standard Deviation Score (SDS) (10), being able to participate in group intervention and having at least one parent who could participate in the intervention. Exclusion criteria were mental disability, situations where parental responsibility were not clarified and serious drug or alcohol abuse- or psychopathology among parents, as well as underlying organic cause of obesity. Evaluation of these criteria was performed by a pediatrician specialized in obesity treatment.

The parents of those who met the inclusion criteria participated in an introduction day at St. Olav University Hospital before deciding to join the study. Off all treatment seeking children in the inclusion period, 80 % joined the study. A flowchart (Fig. 1) shows the procedures and drop-outs during the study. A drop-out of 10 % was registered at six months and at two years this number was 19 %. Objective physical activity level was measured by accelerometers. Reasons for missing valid accelerometer data was lack of use by the children (N=33), technical failure (N=28) and loss of accelerometer (N=5).

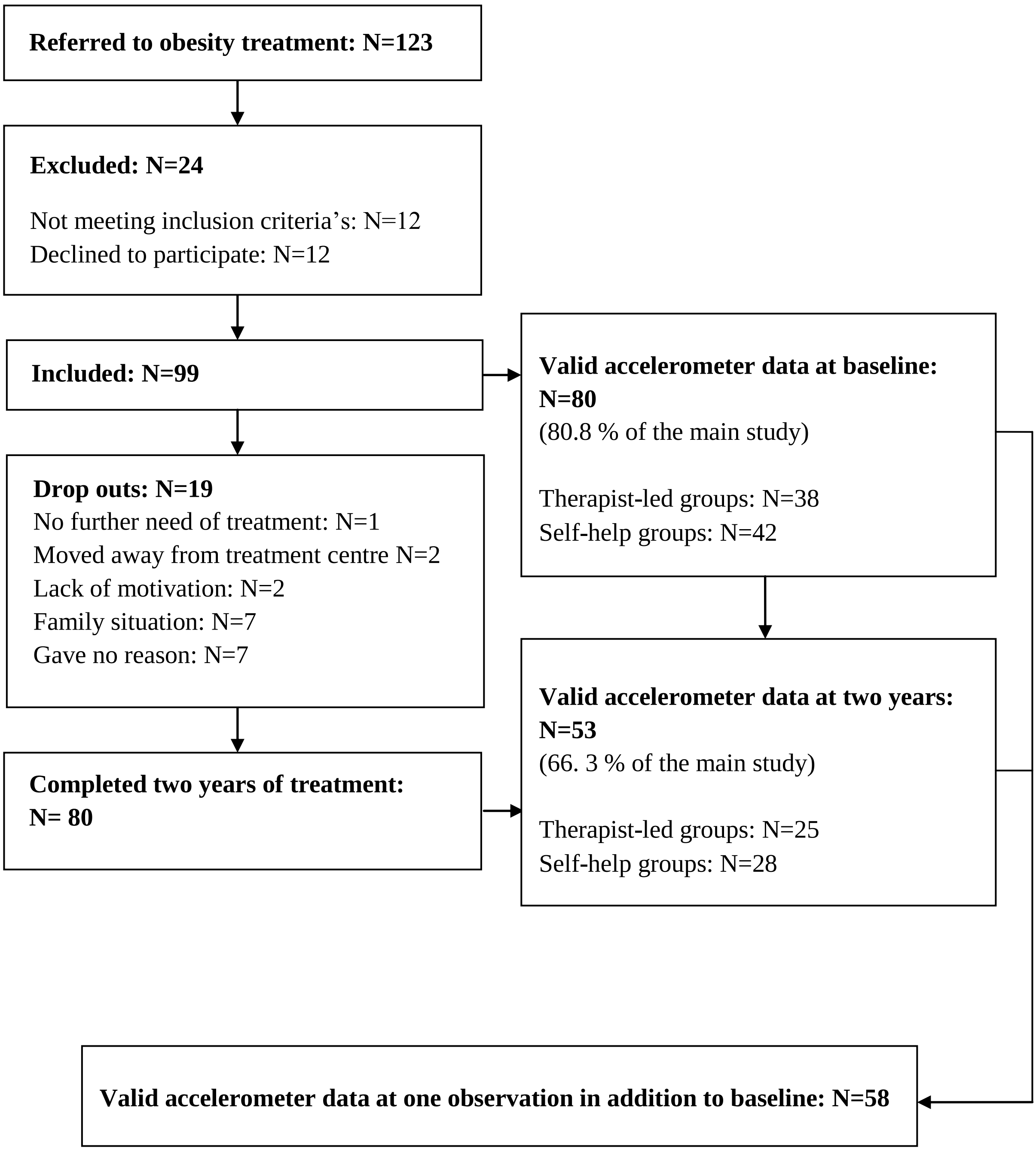

Figure 1: Procedure and drop out of the main study including valid accelerometer registrations

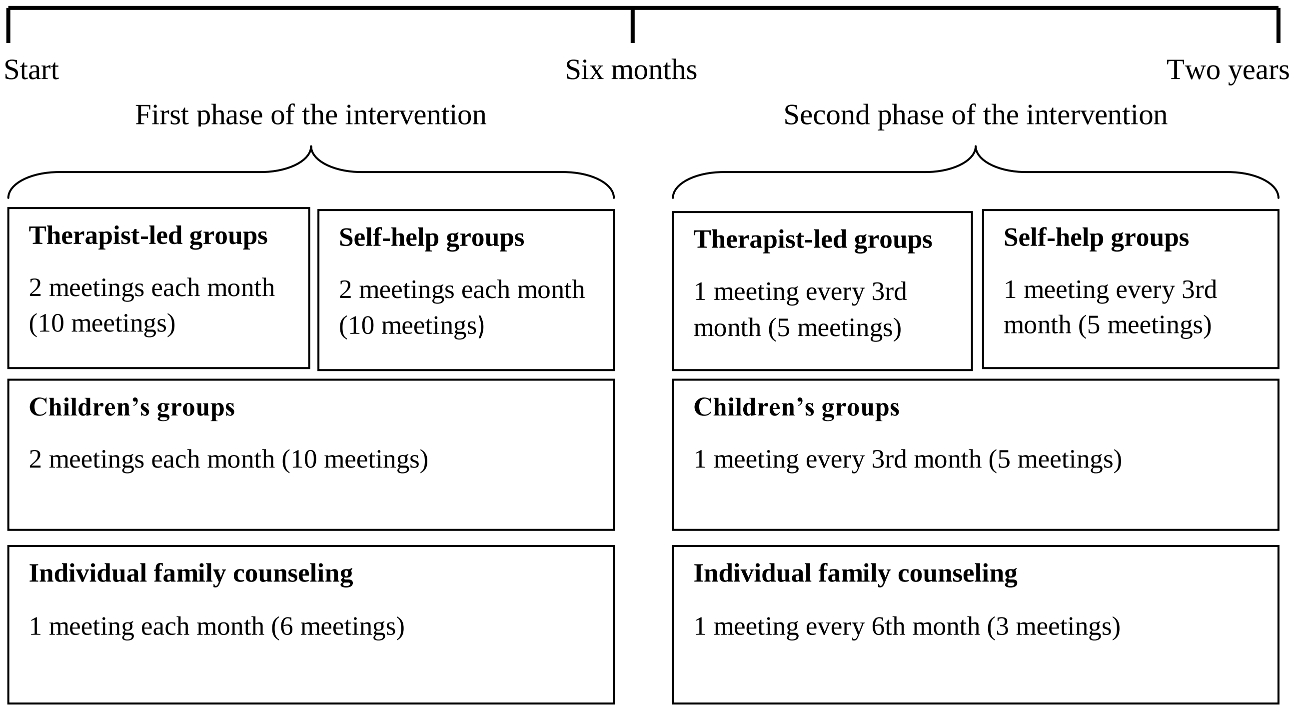

Figure 2: An overview of the two year intervention period

3.3.1 Randomized intervention groups

Participating parents were randomly divided in two intervention groups, stratified by the age, sex and BMI of their child. A computer-generated list of random numbers placed them either in a *therapist-led group* or a *self-help group*. While two therapists were present in all the therapist-led group sessions, the self-help groups only got initiated and organized by a professional. This can be categorized as initiated self-help (63). As oppose to the therapist led-group, the self-help group did not receive any skill-training or advice from professionals concerning obesity treatment.

3.3.2 General intervention

Individual family counseling was offered all families regardless of intervention group. In these counseling sessions individual goals for the child and its family were appointed and their progress achieving these goals evaluated. Parallel to the parent groups (the intervention arms), all children also participated in age segregated groups of six to eight children. The aim was to boost the children's self-efficacy and give them positive experiences regarding physical activity and healthy eating. Both the individual family counseling and the children's groups were led by a physiotherapist and a clinical dietician. The first six months with intervention was the period with most frequent sessions and details about the whole intervention is summarized in Fig. 2.

All sessions were located at St. Olav University Hospital and data (except body fat) was collected by the members of the treatment staff.

3.4 Outcome variables in the present study

Change in physical activity is in this study referred to as the difference in CPM between baseline and two years. Forty-three participants had valid accelerometer measures at baseline and at two years. There were no in-between difference in baseline variables between participants in this study (N=58) and the main study (N=99) (Table 1). Children in the present study did also have similar baseline variables to children who only had valid accelerometer data at baseline (N=21) (data not shown).

3.5 Sample size

Since the present study is based on data from the main study carried out at St. Olav University Hospital, there was no chance influencing the sample size. Other interventional studies measuring objective physical activity among obese children show inequalities in their sample sizes. The sample sizes in these studies are often calculated based on detecting a difference in weight status, not physical activity (60, 64)..

3.6 Measures

3.6.1 Physical activity

An Actigraph GTIM accelerometer (ActiGraph LLC, Pensacola, FL, U.S.) was used to collect data on children's physical activity. This is a small, lightweight motion sensor which detects normal human movements in a vertical plane. The accelerometer is worn on the hip attached to an elastic belt. The Actigraph accelerometer has been validated when used by children (65-

67). Children were instructed to use the accelerometer seven consecutive days, except when they were sleeping, bathing/showering or swimming, and they were also encouraged to retain their normal activity pattern during the observations. This information was given the same day as the children started to use the accelerometer. Measure of physical activity at baseline and at two years was carried out between the middle of March to the end of April.

Accelerometers register and save data in counts which is a mean value, calculated over a specific time period (18). In this study 60 seconds time spans were recorded and accelerometer analysis software was used to process the data (MAHUffe) (MRC Epidemiology Unit, 2010). To make sure the data was valid, only activity data from children who registered at least 480 minutes/day for at least three days were included (28, 68). Consecutive sequences of nil-counts > ten minutes were excluded from the study to avoid misinterpretation between the lack of use of the monitor and inactivity. This exclusion criterion is also used by other comparable studies (28, 68, 69). In accordance with previous studies, MVPA was classified as minutes per day with more than 2000 counts (68, 69).

3.6.2 Measure of parental SES

At baseline the parent's registered their occupation by questionnaire and this information was coded from a national standard classification of occupation, which is based on the International Standard Classification of Occupations (ISCO-88) (70). The ISCO-88 incorporate the skills required for competent performance of a job, including educational level (71). The occupations were classified into 1) unskilled workers, 2) farmers/fishermen, 3) skilled workers, 4) lower professionals 5) higher professionals and 6) leaders. Since the small sample size made it hard to investigate SES against the treatment effect in each of the six groups, and since the number of people in each group was unequally distributed, the six groups were divided into two categories. Unskilled workers, farmers/fishermen and skilled workers were categorized as low SES, and lower professionals, higher professionals and leaders were categorized as high SES. In each family SES was defined by the parent with the highest classified occupation.

3.6.3 Measure of body fat

Total body fat was measured with dual Energy X-ray Absorptiometry (DXA, Discovery QDR). The children wore light clothes and no shoes during the measure. DXA is validated and is a utilized instrument measuring body composition in children (72) . Fat mass divided by weight gives the percentage of total body fat which is used as an index of adiposity (73).

3.6.4 Measure of BMI Standard Deviation Score (SDS)

BMI was measured while the children were wearing light clothes and no shoes. Weight was obtained by using a digital scale (Seca 930, Vogel and Halke, Hamburg) and height was measured to the nearest 0.1 cm by a stadiometer (Hyssna Limfog AB, Sweden). BMIS SDS is calculated as the child's BMI (kg/m^2) minus the mean age- and sex adjusted BMI, divided by the BMI standard deviation of the reference group (74). International reference values by Cole and colleagues were here utilized (75), and the Nova Nordisk Nordinet® was used for calculations.

3.6.5 Measure of parental BMI

The parents followed the same procedure as the children when measuring BMI. The parental BMI was defined as maternal BMI. If this value could not be obtained, paternal BMI value was utilized. Maternal BMI, more so than paternal BMI, have been reported to effect the outcome in weight control interventions (59).

3.7 Statistical analyses

Shapiro-Wiik Test showed violation of the normality assumption according to the outcome variables and, therefore non-parametric Mann-Whitney U Tests was performed to explore differences between high- and low parental SES and outcome variables. To detect the variables affecting change in physical activity, Spearman Correlation Test was applied. Furthermore, Multiple Linear Regression Analysis was used to investigate the effect of parental SES on change in physical activity, controlled for intervening variables. The residuals from the Multiple Linear Regression Analyses showed normality, which can justify utilizing this parametric test.

3.8 Ethics

The main study has been approved by the regional committee for research ethics (REK), and informed consent was obtained from all parents involved. In this study the anonymity of the participants has been preserved and all ordinary research-ethical guidelines followed.

4. *Result*

The participants had a median age of 10.3 and a median BMI SDS of 3.07. At baseline 7 % of the parents were classified as unskilled workers, 3.5 % was farmers/fishermen, 48 % skilled workers, 22.5 % lower professionals, 5 % higher professionals and 14 % leaders. Twenty-four of the children were classified with high parental SES, and 34 with low parental SES.

Baseline characteristics in children with low- and high parental SES were compared in Table 1. Parents with low SES were having significantly higher BMI score than parents with high SES. Furthermore, children with low parental SES had lower physical activity level than children with high parental SES (569.8 CPM versus 678.1 CPM), higher percentage of body fat (42.1 % versus 40.5 %) and higher age (10.6 years versus 9.4 years), but none of these differences were statistically significant.

	Main study (N=99)	Pooled study (N=58)			
	All cases	**All cases**	**Low parental SES**	**High parental SES**	**p-value***
Participants (N)	*99*	*58*	*34*	*24*	-
Girls (N)	*48*	*32*	*19*	*13*	*.89*
Boys (N)	*51*	*26*	*15*	*11*	
Age (Years)	*10.3 (9, 11.7)*	*10.3(8.6, 11.3)*	*10.6 (9.3, 11.7)*	*9.4 (8.4, 11)*	*.054*
Therapist led group (N)	*47*	*28*	*15*	*13*	*.46*
Self-help group (N)	*52*	*30*	*19*	*11*	
Physical activity (CPM) [A]	*599 (476, 832) N=79*	*608 (504, 826)*	*570 (492, 788)*	*678 (560, 835)*	*.43*
MVPA [B]	*93 (51, 140)*	*91 (52, 142)*	*81.0 (46.1, 129.4)*	*129.5 (58.3, 184.5)*	*.11*
BMI SDS [C]	*3 (2.7, 3.4)*	*3.1(2.7, 3.4)*	*3.1 (2.8, 3.4)*	*3.0 (2.6, 3.4)*	*.35*
Body fat (%) [D]	*40.4 (38.2, 43.4)*	*41.5 (39.1, 44.2)*	*42.1 (39.7, 44.2)*	*40.5 (37.5, 44.5)*	*.43*
Parent BMI [E]	*30.7 (26.4, 36)*	*30.8 (26.4, 37)*	*32.6 (28.9, 36.4)*	*27.1 (24, 38.5)*	*.039*

Table 1: Baseline data for high- and low parental socioeconomic status (SES)

Values are presented as median value (25-75 percentiles).

***** Applicable to differences between children with high- and low parental SES analyzed by Mann-Whitney U Test.

[A] CPM = Counts per minute.

[B] MVPA = Moderate to vigorous physical activity. Measured as minutes per day with counts>2000.

[C] BMI SDS = BMI Standard Deviation Score. Calculated as the child's BMI (kg/m$^{2)}$ minus the mean of the age- and sex- specific BMI divided by the BMI standard deviation of the reference group.

[D] Measured by Dual Energy X-ray Absorptiometry (DXA).

[E] Measured as maternal BMI score (Kg/m$^{2)}$. If not available, parental BMI was used.

Table 2 presents changes in outcome measures between high- and low parental SES. Participants in both SES groups reduced their physical activity from baseline to two years. Children with low parental SES reduced their median physical activity with 11 percent less than children with high parental SES (- 15 % versus - 26 %), but the difference was not statistically significant. Furthermore, it could seem like children with low parental SES also reduced their MVPA less than children with high parental SES (- 1 min. versus – 22 min.). While an identical reduction in BMI SDS was seen between the SES groups, children with low parental SES reduced their body fat with 0.8 percent from baseline to two years whereas children with high parental SES increased their body fat with 0.2 percent. This difference was, however, not statistically significant.

	All cases	Low parental SES	High parental SES	p-value*
Change in CPM [A]	*-139(-235, 5) N=43*	*-87 (-234, 8) N=22*	*-179 (-256, 52) N=21*	*.38*
Change in CPM [A] (%)	*-23*	*- 15 N=22*	*- 26 N=21*	*.38*
Change in MVPA [B]	*-12 (-40, 9)*	*-1 (-40, 10)*	*-22 (-51, 8)*	*.34*
Change in body fat (%) [C]	*-0.4 (-4.1, 1.2) N=56*	*-0.8 (-4.1, 1.2) N=33*	*0.2 (-4.4, 1.4) N=23*	*.59*
Change in BMI SDS [D]	*-0.1 (-0.4, 0) N=56*	*-0.1 (-0.4, 0.1) N=33*	*-0.1 (-0.5, 0) N=23*	*.39*
Change in parental BMI [E]	*-0.1(-1.7, 1) N=51*	*-0.2 (-1.5, 0.9) N=30*	*0.1 (-2.9, 1.8) N=21*	*.69*

Table 2: Change in outcome-measures between high- and low parental socioeconomic status (SES) from baseline to two years

Values are presented as median (25-75 percentiles).

***** Applicable to differences between children with high- and low parental SES analyzed by Mann-Whitney U Test.

[A] CPM = Counts per minute.

[B] MVPA = Moderate to vigorous physical activity. Measured as minutes per day with counts>2000

[C] Measured by Dual Energy X-ray Absorptiometry (DXA).

[D] BMI SDS = BMI Standard Deviation score. Calculated as the child's BMI minus the mean of the age- and sex- specific BMI divided by the BMI standard deviation of the reference group.

[E] Measured based on the maternal BMI score (Kg/m$^{2)}$. If not available, paternal BMI was used.

Appendix 1 shows the correlation analyses between change in physical activity and baseline variables. Higher age and lower physical activity at baseline correlated significantly with less reduction in physical activity.

Appendix 2 shows correlation analyses between change in physical activity and change in other variables over the two years observation. Change in body fat percent was found to have a significant negative correlation to change in physical activity, where increase in physical activity was associated with a decrease in body fat and conversely. Furthermore, a reduction in body fat was associated with a reduction in BMI SDS. This was anticipated since BMI has been detected as an approximation of body fat among children (76).

Table 4 shows the association between change in physical activity and parental SES tested in multivariate analyses described in four models. Overall, parental SES had no statistically significant effect on change in physical activity when adjusting for children's age and change in body fat percent (Model 1). Change in body fat percent was, however, significantly effecting change in physical activity ($p<.05$). Adding baseline physical activity to the model (Model 2), this variable turns out to be the only one significantly associated with change in physical activity. The B-value for change in body fat percent was substantially reduced, and this inconsistency in the parameter-estimate from model 1 to model 2 was most likely due to an association between change in body fat percent and baseline physical activity. Since Model 2 explains 75.8 % of change in physical activity, while Model 1 explains 17.4 %, baseline physical activity appears as a more robust variable than change in body fat percentage.

Because physical activity at baseline was so strongly associated with change in physical activity after two years we also tested weather this effect differed between high and low parental SES. We found a statistically significant interaction between socioeconomic status and physical activity at baseline when adjusting for change in body fat and physical activity at baseline (Model 3), indicating children with high parental SES to have a more pronounced reduction in their physical activity than those with low parental SES. A calculated example for a child with a median level of baseline physical activity (608 CPM) and change in body fat percent (-0.4) shows that those with high parental SES reduced their physical activity with 55 CPM more than those with low parental SES:

Low parental SES:

$342.7 – 0.74x608 – 5.01x-0.4 = 342.7 – 450 + 2 = – 105$ CPM

High parental SES:

$342.7 – 0.74x608 – 5.01x-0.4 – 0.09x608 = 342.7 – 450 + 2 – 54.7 = – 160$ CPM

Model 3 explain 77.6 % of change in physical activity. Model 4 shows that the different treatment groups did not significantly affect change in physical activity.

	B	95 % Confidence interval Lower bound	Upper bound	p-value	Adjusted R^2
Model 1					
Intercept	*- 357.8*	*-784.8*	*69.2*	*.098*	
Parental SES	*- 19.5*	*-142.5*	*103.5*	*.75*	
Change in body fat (%)	*- 18.8*	*-34.8*	*-2.8*	*.022*	
Age	*17.2*	*-28.4*	*62.8*	*.45*	*0.174*
Model 2					
Intercept	*473.0*	*184.4*	*761.8*	*.002*	
Parental SES [A]	*-26.9*	*-93.5*	*39.8*	*.42*	
Change in body fat (%)	*-6.2*	*-15.2*	*2.8*	*.17*	
Age	*-10.8*	*-36.2*	*14.6*	*.39*	
PA at baseline [B]	*-0.81*	*-0.98*	*-0.64*	*.000*	*0.758*
Model 3					
Intercept	*342.7*	*229.1*	*456.3*	*.000*	
Change in body fat (%)	*-5.01*	*-12.79*	*2.78*	*.201*	
PA at baseline	*-0.74*	*-0.91*	*-0.58*	*.000*	
PA at baseline * parental SES	*-0.09*	*-0.18*	*0.00*	*.049*	*0.776*
Model 4					
Intercept	*348.7*	*227.8.*	*469.6*	*.000*	
Change in body fat (%)	*-5.12*	*-13.03*	*2.79*	*.198*	
PA at baseline	*-0.75*	*-0.91*	*-0.63*	*.000*	
PA at baseline * parental SES	*-0.09*	*-0.18*	*0.01*	*.063*	
Treatment group	*-10.4*	*-74.7*	*54.0*	*.75*	*0.771*

Dependent variable: Change in physical activity from baseline to two years. [A] Parental SES = parental socioeconomic status. [B] PA at baseline = Registered physical activity at baseline, measured in counts per minute.

Table 3: Determinants of change in physical activity from baseline to two years

5. *Discussion*

5.1 Result from the present study compared to previous research

Our results shows that the obese children reduced their level of physical activity over the two year follow up period, a change in activity pattern that equals results from normal weight children (27). In the present study, however, a high level of physical activity at baseline was strongly associated with a greater reduction in physical activity after two years, and the reduction was significantly more pronounced in families with high socioeconomic status. Thus, our intervention was more successful in maintaining the level of physical activity in children with low parental SES compared to children with high parental SES.

Participants in the present study showed similarities with normal populated children regarding change in physical activity. Children with low parental SES were in ours study found to have a median CPM of 567 at baseline, whereas children with high parental SES had 678 CPM. This demonstrate children with high parental SES to have a higher physical activity level than general populated 9-year-old children from the same geographical area in Norway, having a mean of 613 CPM (27). In comparison, the 11-year-olds in the school-based, obesity preventive study HEIA had a mean physical activity level of 473 CPM in the intervention group, and 511 CPM in the control group.(55) At the two year observation, the median physical activity in the present study was 488 CPM for children with high parental SES and 483 CPM for children with low parental SES. This level of physical activity is similar to the general populated 15-year-old children from the same geographical area in Norway, which had a mean CPM of 452 (27). Children in this study are therefore no exception when they reduce their physical activity as they age two years.

Inequalities in lifestyle factors may have influenced the results, where children with low parental SES reduced their physical activity with 55 CPM less than children with high parental SES, given the same physical activity level at baseline. A significantly higher baseline BMI among parents with low SES could imply a less healthy home environment for these children, as parents serve as role models (30). Even though the relationship between SES determinants and childhood obesity is complex and not fully understood, obesity and a poor lifestyle is clearly associated with low SES. As example children with low parental SES have been found to watch television for more hours and more frequently have a television in their bedroom than children with high parental SES (47, 50). Furthermore, exposure to food advertising through more heavy media use in children with low parental SES could affect the children's food preferences (49). A low SES may also affect the family's affordability to healthy foods. Kristiansen and colleagues found children of parents with high SES to consume more fruit and vegetables and less sweets, soft drinks and fast food (47). Lack of play equipment reported in families with low SES could prevent the child from participating in activities which promote physical strain (50). Furthermore, access and affordability of local sporting facilities may be affected by parental SES (49, 77). Children with low parental SES therefore could have more to gain by participating in obesity treatment programs. Due to a greater risk of psychosocial problems (40), there is a possibility that therapeutic components are particularly advantageous in obesity treatment among low SES families.

On the other hand, one might expect children with high SES to benefit more from the treatment program as these families are assumed to have greater experience in utilizing the knowledge they have access to, and as high SES often provides a social context where health knowledge is more valued (47, 54). It is, however, possible that families with high SES, to a higher extent, took in the information they were given at the introduction day, and made lifestyle changes before the treatment program started. This could have overestimated the level of baseline physical activity for children with high parental SES.

Another explanation to the beneficial effect on physical activity among children with low parental SES might be that the different SES groups focused on different aspects to achieve a healthy lifestyle. Even though a healthy weight status is associated with physical activity (23, 24), a large amount of physical activity is needed to achieve the same favorable effect on energy balance as moderate changes in diet can (25). As neither change in body fat percent nor change in BMI SDS differed significantly between the parental SES groups, this may be a result of differences in lifestyle focus throughout the intervention period.

5.2 Comparison to previous childhood obesity interventions

Although previous studies on childhood obesity treatment seem to have avoided investigation of physical activity in association to parental SES, some obesity treatment studies have reported parental SES effect on weight status. A 12-month outpatient intervention, who included the same treatment components as the present study, found especially obese siblings, but not parental SES to predict change in weight status (59). Neither Breat could find an association between weight loss and parental SES after a two year treatment program. This intervention was, however, an inpatient program and included children higher of age compared to the present study (60). Although comparison is hard due to different outcome measures, these studies could compliment the present study, finding other outcome variables, in particular baseline physical activity, to have a stronger direct associated with change in physical activity. The reduction in physical activity explained by a high baseline physical activity level was, however, significantly more pronounced among children with high parental SES.

A positive effect on children with low parental SES has also been detected in other studies exploring change in weight status. A school-based intervention found BMI and blood pressure to improving among low income children aged 6-11-years-old. The intervention provided the children with modified school meals, a healthy lifestyle curriculum and an increased opportunity for physical activity during the school day. Being an obesity prevention program, this study had the same methodological differences as the HEIA study in comparison with the present study (57). Epstein and coworkers targeted screen-use among overweight children. In the intervention group no differences were detected between the SES-groups. However, participants with low parental SES showed a difference in BMI SDS between the intervention and control group, while no such difference was found among participants with high parental SES. Concentrating only on screen time, this intervention was having a rather narrow approach in contrast to the present study. The participants were also younger (aged 4-7 years) and only 44 % were characterized as obese at baseline (78). Thus, despite methodical differences, the present study compliment some authors finding children with low parental SES to benefit more from lifestyle interventions.

To the best of our knowledge, the Norwegian school-based intervention HEIA is the only other study that also targets obesity and change in physical activity according to parental SES. Similar to the present study, the HEIA Study had a two year multi-component approach, and the participants also used accelerometers to measure physical activity. The HEIA study focused, however, on preventing childhood obesity, and therefore also included participants included normal weight children. Their parents were less involved in the intervention, only receiving informative papers (55). Physical activity in the HEIA study was promoted in the school setting, including informative lessons, physical activity breaks in the classrooms and distribution of pedometers and sports equipment in recess. In contrast to our study, the HEIA study failed to demonstrate a direct relationship between SES and change in physical activity: change in physical activity did not differ between the children with parental education of 12 years or less, and those with parental education above 16 years (55).On the other hand, they succeeded in increasing the children's physical activity after two years, as the intervention group increased their mean physical activity with 55 CPM more than the control group. The overweight youth did, however, not change behavior to the same extent as the normal weight (55), and in coherence with the present study, this emphasizes the difficulty of designing effective interventions to promote physical activity among obese children

5.2 Methodological strengths and limitations

5.2.1 Sample

The small sample size combined with the great individual differences in the outcome variable, limits the quality of this study. Due to missing accelerometer data, the sample in this study was not as large as the main study. There was, however, no in-between differences regarding baseline variables from children in the main study and children in this study. Thus, due to the large participation rate in the main study (80, 8 %), the result from this study are fairly representative for treatment seeking obese children.

5.2.2 Measures

The use of accelerometer when measuring physical activity strengthens this study. The accelerometer has proven to be a reliable and validated measure of objective physical activity (65-67). It is also advantageous that both accelerometer measures were collected at the spring as physical activity in Norwegian children has been related to season (27).

However, the accelerometer also has limitations. The accelerometer does not register cycling activities or activities performed by the upper body and the instrument cannot be used when the children is swimming (79). The lack of activities registered could underestimate the children's physical activity. Due to the child's effort of moving a large body while running (80), obese children might prefer swimming and cycling activities. Nevertheless, these activities most often account for a minor amount of total physical activity level.

Children with high degree of obesity spend more energy on the same activity as the children with a lower degree of obesity (80). This could lead to an underestimated number of

CPM for the most obese children compared with the children who were less obese. No methods for correcting for these variations were done in this study. Result from the present study found children with low parental SES to have a higher body fat percentage at baseline than children with high parental SES, this different was, however, not statistically significant and did probably not cause any bias related to the accelerometer registrations. Larger persons also tend to move with a lower frequency of steps than smaller persons walking in the same speed (62). Since the children in this study aged two years from baseline to the final observation this might underestimate the change in physical activity. Also, children with high SES were younger than children with low parental SES, which could affect the level of baseline physical activity. Investigating accelerometer data, a study done by Reilly and coworkers did, however, not detect such size or age related differences (81).

Because the participants knew they were monitored, this might give them extra motivation for being physical active. This motivation may be especially strong during the first observation point. This could explain the high participation rate at the first observation, compared to the two year observation. Consecutive sequences of nil-counts > ten minutes were excluded from the study to avoid misinterpretation between the lack of use and inactivity. It is, however, possible that some children are inactive for more than ten minutes, providing an incorrect estimate of the physical activity.

Overall, physical activity is a complex parameter to measure, and limitations of the accelerometer could cause biases in the present study. Nevertheless, as these limitations mainly apply for both SES groups, the use of accelerometer is assumed to report a fair estimate of the children's physical activity.

The national standard classification of occupation used to measure SES, is developed considering the Norwegian occupational structure (70). This classification is based on ISCO-88, which makes comparison between nations possible, and the data can be inserted in different statistical programs (70). Other strengths of this classification is that it codes occupation based on the skills (knowledge, handling tools/material and goods produced) and educational level required to perform the job (70). Occupation is strongly related to income; therefore an association between occupation and physical activity may reflect the family's economical resources as well (82). The national standard classification of occupation also classify students and unemployed, which often is seen excluded in other occupational-based classifications (82). Since it exist a clear stepwise reverse relationship between health and

SES in Norway (38), it would have been favorable to divide the different occupational categories into more than two SES groups. This was hard to obtain due to the small sample size and unequal number of subjects in each occupational group. In the present study, the parent with the highest classified occupation was used for the classification, or else the one available. Similar utilization of SES is seen in other interventional studies (55) and is presumably a adequate estimate on the families SES.

Using body fat in the analyses strengthens this study. While only using BMI, an increase in lean mass could camouflage a decrease in body fat (83). Demonstratively, a reduction in body fat % but not BMI z-score was found to associate with a positive change in physical activity (although not significant after adjusting for baseline physical activity). Even though DXA has been reported to overestimate fat mass in children (84), a possible overestimation will in worst case lead to a systematic error as the same DXA instrument was used under both observation points.

5.3 Suggestions for further actions

Knowing which treatment elements work for children with high- and low parental SES are useful in creating efficient childhood obesity treatment programs (32). Therefore, studies with larger sample sizes are needed to fully explore the relationship between parental SES and physical activity in childhood obesity treatment.

In future obesity treatment studies, it would be interesting to measuring parental physical activity in addition to the outcome measures in the previous study. Since physical activity in adults is associated with SES (85), and also offspring physical activity (31), parental physical activity might be one determinant of how parental SES could affect change in physical activity in childhood obesity treatment.

Although a beneficial effect on change in physical activity was found for children with low parental SES, the present study did not find strong enough evidence to suggest separated treatment for obese children with high- and low parental SES. Earlier studies including solely children with low parental SES have shown promising results at preventing childhood obesity and increasing physical activity (86, 87). However, these studies were undertaken in countries with greater economical difficulties and unemployment compared to northern countries. A low SES may therefore be more social accepted in these countries compared to Norway, where people might feel more stigmatized receiving specialized treatment for having low SES. A more individualized treatment for both SES groups is probably a better approach to promote physical activity in treatment seeking, obese children. More awareness from health professionals toward aspects that can hamper a healthy lifestyle among families with low SES might be a better alternative. Furthermore, the present study demonstrates the importance of measuring baseline physical activity to determine appropriate treatment goals for physical activity, Health-professionals should also have in mind that children naturally become less physical active with age (27), and patients should make conscious that maintaining their physical activity is a realistic and successful treatment goal.

6. Conclusion

The present study including obese children attending a family-based obesity treatment program at St. Olav University Hospital, detected a high level of physical activity at baseline to strongly associate with a greater reduction in physical activity after two years. The reduction was significantly more pronounced in families with high socioeconomic status. Thus, the intervention was more successful in maintaining the physical activity level in children with low parental SES compared to children with high parental SES. This result emphasizes the need for more individualized treatment for obese children, and health professionals are encouraged to take parental socioeconomic status into consideration when tailoring treatment to promote physical activity in families with obese children. Furthermore, this study stresses the importance of monitor baseline physical activity to determine further physical activity goals in treatment of childhood obesity. To our knowledge this is the first study investigating the effect of parental SES on change in physical activity in a childhood obesity treatment. Studies with greater sample sizes are needed to fully explore this relationship.

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Appendix 1

Correlation between change in physical activity and baseline variables

	1.	2.	3.	4.	5.	6.	7.
1. Change in physical activity	-	-*.045* *(N=43)*	-*.206* *(N=41)*	***-.850**** ***(N=43)***	-*.092* *(N=43)*	-*.192* *(N=43)*	-*.072* *(N=43)*
2. Age at baseline			-*.054* *(N=56)*	-*.210* *(N=58)*	*.132* *(N=58)*	-*.190* *(N=58)*	-*.148* *(N=58)*
3. Number of children in the family			-	***.345**** ***(N=56)***	*.018* *(N=58)*	-*.083* *(N=58)*	-*.150* *(N=58)*
4. Physical activity at baseline				-	-*.157* *(N=58)*	*.121* *(N=58)*	*.018* *(N=58)*
5. Body fat (%) at baseline					-	***.464**** ***(N=58)***	*.212* *(N=58)*
6. BMI SDS at baseline						-	***.402**** ***(N=58)***
7. Parental BMI at baseline							-

**** p < .01 (2-tailed)**

Appendix 2

Correlation between change in physical activity, change in body fat percent, change in BMI SDS and change in parental BMI

		1.	**2.**	**3.**	**4.**
Baseline to two years	1. Change in physical activity	**-**	***-.465***** ***(N=43)***	*-.150* *(N=43)*	*.065* *(N=39)*
	2. Change in body fat (%)		-	***.582***** ***(N=56)***	*-.29* *(N=51)*
	3. Change in BMI SDS			-	*.061* *(N=51)*
	4. Change in parental BMI				-

**** p < .01 (2-tailed)**