Article

Perceptual and Motor Skills
2017, Vol. 124(4) 795–811

DOI: 10.1177/0031512517710880
journals.sagepub.com/home/pms

Self-Reported Versus Accelerometer-Assessed Daily Physical Activity in Childhood Obesity Treatment

Theresia M. Schnurr[1,*], Bianca Bech[1,*], Tenna R. H. Nielsen[1,2], Ida G. Andersen[2,3], Mads F. Hjorth[4], Mette Aadahl[5,6], Cilius E. Fonvig[1,2], Torben Hansen[1], and Jens-Christian Holm[1,2]

Abstract
We investigated the relationship between interview-based subjective ratings of physical activity (PA) engagement and accelerometer-assessed objectively measured PA in children and adolescents with overweight or obesity. A total of 92 children and adolescents (40 males, 52 females) with BMI ≥ 90th percentile for sex and age, aged 5–17 years had valid GT3X + accelerometer-assessed PA and interview-assessed self-reported information on PA engagement at the time of enrollment in a

[1]Section of Metabolic Genetics, Novo Nordisk Foundation Center for Basic Metabolic Research, University of Copenhagen, Denmark
[2]Department of Pediatrics, The Children's Obesity Clinic, Copenhagen University Hospital Holbæk, Denmark
[3]Department of Otorhinolaryngology and Maxillofacial Surgery, Zealand University Hospital, Køge, Denmark
[4]Department of Nutrition, Exercise and Sports, Faculty of Science, University of Copenhagen, Denmark
[5]Research Centre for Prevention and Health, Copenhagen University Hospital Glostrup, Denmark
[6]Faculty of Health and Medical Science, Department of Public Health, University of Copenhagen, Denmark

*These authors contributed equally to this project

Corresponding Author:
Theresia M. Schnurr, Section of Metabolic Genetics, Novo Nordisk Research Foundation Center for Basic Metabolic Research, University of Copenhagen, Universitetsparken 1, 2100 Copenhagen, Denmark.
Email: tmschnurr@sund.ku.dk

multidisciplinary outpatient tertiary treatment for childhood obesity. Accelerometer-derived mean overall PA and time spent in moderate to vigorous physical intensity were generated, applying cut-offs based on Vector Magnitude settings as defined by Romanzini et al. (2014), and a physical activity score (PAS) based on self-reported data. Overall, a higher self-reported PAS was correlated with higher accelerometer-assessed daily total PA levels ($r = 0.34$, $p < .01$) and children who reported a high PAS were more physically active compared with children who reported a low PAS. There was a fair level of agreement between self-reported PAS and accelerometer-assessed PA (Kappa agreement = 0.23; 95% CI = [0.03, 0.43]; $p = .01$). PAS, derived from self-report, may be a useful instrument for evaluating PA at a group level among children and adolescents enrolled in multidisciplinary obesity treatment.

Keywords
accelerometry, childhood obesity, physical activity behavior, obesity treatment, validation study

Introduction

Physical activity (PA) is considered an important variable in the mandatory assessment of modifiable lifestyle factors associated with cardio-metabolic health in overweight and obese children and adolescents (Han, Lawlor, & Kimm, 2010). Low levels of PA are potentially modifiable risk factors for developing obesity and its related childhood complications. Levels of PA have been tracked from childhood to adulthood (Malina, 1996; Telama, 2009), low PA levels during childhood may increase the risk of developing chronic diseases later in life (Froberg & Andersen, 2005; Yang et al., 2007). The World Health Organization (WHO, 2011) generally recommends that, 5–17-year-old children should perform at least 60 minutes of moderate to vigorous intensity PA (MVPA) per day. These recommendations have been adapted by many countries, including Denmark, Canada, and the UK. In these countries, it is also recommended that if the 60 minutes are segmented, each bout of MVPA activity should last at least 10 minutes (Bull et al., 2010; Pedersen & Andersen, 2011; Tremblay et al., 2011). The Obesity Committee of The Danish Pediatric Society (DPS) adapted the majority of these guidelines and emphasized that children and adolescents with overweight or obesity should perform at least one hour of exercise daily, with each session at least 20 minutes long, and generate a significant rise in pulse or sweating (Johansen et al., 2015). The DPS further urges pivotal inclusion of an assessment of engagement in PA behaviors as part of any multidisciplinary treatment in a pediatric setting (Johansen et al., 2015).

It is important to understand the links between PA levels and health in children and adolescents undergoing obesity treatment in order to develop individualized lifestyle interventions that can reduce obesity and its related health consequences. PA behavior in children and adolescents is complex and involves a mixture of school-based activities, organized sport activities, and free play within an intermittent structure (Welk, Corbin, & Dale, 2000). Questionnaires that estimate PA levels by self-report are the most common subjective means of assessing PA in children and adolescents, mainly due to their low cost and ease of use in large studies (Boon, Hamlin, Steel, & Ross, 2008; Corder, Ekelund, Steele, Wareham, & Brage, 2008). Accelerometers are a commonly used objective measure of PA (Corder et al., 2008). In general, subjective ratings seem to overestimate PA compared with objective assessment (Adamo, Prince, Tricco, Connor-Gorber, & Tremblay, 2009), and self-assessment of PA has been even less accurate in adolescents with overweight or obesity, compared with adolescents of normal weight (Slootmaker, Schuit, Chinapaw, Seidell, & Van Mechelen, 2009). Yet, accelerometers do not provide important behavioral and contextual information that is critical for developing strategies to promote PA.

Reliable and valid survey instruments for monitoring PA are essential, both for developing and evaluating the efficacy of intervention programs for increasing PA (Bauman, Phongsavan, Schoeppe, & Owen, 2006). Yet, few studies have provided PA evaluation tools for specific use with children and adolescents with overweight or obesity (Mouratidou et al., 2012). Some have suggested that subjective PA assessment tools may be better suited than objective devices for children and adolescents with overweight or obesity, as this population is typically uncomfortable (i.e., embarrassed or ashamed) with wearable activity monitors (Robertson, Stewart-Brown, Wilcock, Oldfield, & Thorogood, 2010).

The current guidelines proposed by DPS recommend a structured interview within multidisciplinary obesity treatment to ensure collection of a thorough medical history, including PA engagement. In Denmark, about one third of pediatric departments comply with these national guidelines (Eg et al., 2016), but no study has evaluated whether interview-administered questions about daily PA engagement in children and adolescents with overweight (defined as a BMI above the 90th percentile for age and sex) or obesity (defined as a BMI above the 99th percentile for age and sex) at time of enrollment in multidisciplinary treatment reflect objectively measured daily PA levels. In the present study, we investigated the relationship between interview-assessed subjective ratings of PA engagement and accelerometer-assessed objectively measured PA in children and adolescents with overweight or obesity enrolled in a multidisciplinary treatment program. We hypothesized that ratings of PA engagement, including organized and unorganized PA, would be positively related to objectively assessed PA and that overall, PA levels would be low in this population.

Method

Participants

A total of 559 children and adolescents initially older than five years of age enrolled into treatment at the Children's Obesity Clinic, Department of Pediatrics, Copenhagen University Hospital Holbæk, Denmark from October 2012 to March 2015, completed a physical examination and provided a detailed medical history, including interview-reported information on PA and inactivity. General inclusion criteria for enrollment into obesity treatment were age ≤ 22 years and a body mass index (BMI) > 90th percentile by age- and sex-adjusted reference tables (Nysom, Mølgaard, Hutchings, & Fleischer Michaelsen, 2001).

Due to study logistics and limited personnel, valid accelerometer data were available for only a subset of participants ($n = 92$), from which informed assent of the child was obtained from all patients and informed written consent was obtained from parents or caretakers of all patients younger than 18 years and directly from all patients 18 years of age and older. The study was approved by the Ethics Committee of the Region Zealand in Denmark (ID no.: SJ-104) and the Danish Data Protection Agency and is registered at ClinicalTrials.gov (ID no.: NCT00928473).

Measures

Anthropometry. Each participant's weight was measured in the nonfasting state to the nearest 0.1 kg on a digital calibrated scale while participants wore light indoor clothes without shoes (WB-100 MA: Tanita Corp., Tokyo, Japan). Height was measured by a stadiometer (ADE, Modell MZ10023, Hamburg, Germany) to the nearest one mm. BMI was calculated as weight or height squared (kg/m^2). The BMI standard deviation score for this population was calculated by the LMS method by converting BMI into a normal distribution by sex and age using the median, coefficient of variation, and a measure of the skewness based on the Box Cox power plot (Cole & Green, 1992) from Danish BMI charts (Nysom et al., 2001).

Subjective physical activity score. A structured 1-hour interview, conducted with both the patient and at least one of his or her parents or caretakers or adult family members, included a comprehensive short recall questionnaire administered by a pediatrician at the Children's Obesity Clinic on the day of enrollment. The questionnaire was designed to gather information about the patient's and family's daily routines and lifestyle, and it provided substantial clinical information from which a tailored, individual obesity treatment plan could be based (Holm et al., 2011). The questionnaire included six questions about regular engagement in PA designed to cover information about daily PA dimensions and domains, including type, intensity (low, medium, and high), frequency, and duration of organized and leisure PA during a typical week (see Supplemental Material 1).

For the present validation study, we refined a previously defined unit-less physical activity score (PAS; Fonvig et al., 2012) and included weekly participation and time spent in organized sports (soccer, swimming, gymnastics, etc.), leisure activities (activities outside organized sport teams, trampoline, play, running, dancing, etc.), and data on distances covered in weekly walking and biking. We adapted the respective intensity levels for the different activities as defined and used in The Children's Obesity Clinic to define time and intensity dimensions when calculating PAS. First, we calculated weekly hours spent walking by summing the reported weekly walking kilometers to and from school and outside school. The same was done for weekly hours spent bicycling that did not fall in the category of organized activities. Based on walking speed levels used in pedometer studies of children and prior investigation of children's walking speed to and from school (Duncan, Schofield, Duncan, & Hinckson, 2007; Mackett, Brown, Gong, Kitazawa, & Paskins, 2007; Trapp et al., 2013), we estimated an average walking speed for our study population of 3.95 km/hour and we adapted an average biking speed of 13.5 km/hour used by others as cycling speed among Swedish and Danish children (Raustorp, Boldemann, Mårtensson, Sternudd, & Johansson, 2012). We grouped children and adolescents' reported weekly walking distance as follows: 0.1 to 1.98 km =0.5 hour, 1.99 to 3.96 km = 1 hour, 3.97 to 5.94 km = 1.5 hours, and 5.95 to 7.92 km = 2 hours. No patients reported a total walking distance of more than 7.5 km per week. Similarly, we grouped participants' reported biking distance as follows: 0.1 to 6.75 = 0.5 hour, 6.76 to 13.50 km = 1 hour, 13.51 to 20.25 km =1.5 hours, and 20.26 to 27.0 km = 2 hours. There were no reports of total weekly biking distances greater than 25 km. Second, we multiplied the reported estimated time spent in organized activities with low intensity (horseback riding, bowling, etc.), walking and biking by a factor of one, time spent in leisure activities by a factor of 1.5, time spent in organized activities with medium intensity (fitness) by a factor of two, and time spent in organized activities with high intensity by a factor of three (aerobics, boxing, basketball, badminton, bicycle, dancing, soccer, gymnastics, handball, hockey, karate, running, swimming, tennis, and volleyball). Third, we summed all these derived estimates into a global PAS.

Accelerometer-assessed PA instruments. Accelerometer-assessed PA was assessed by triaxial accelerometer (wGT3X+ or wGT3XBT, ActiGraph LLC, Pensacola, FL, USA). The participants were fitted with the accelerometer during enrollment for treatment at The Children's Obesity Clinic. Participants and parents were instructed in wearing the accelerometer (on the right hip using an elastic belt during six days and nights), and only to remove it during water-based activities (swimming, showering, bathing, etc.). The accelerometers were returned in a prepaid "track and trace" envelope.

Data Processing and Analysis

The processing of PA data was conducted using ActiLife version 6.13.1 (Pensacola, FL, USA). We recorded continuous 24-hour accelerometer data. Thus, PA during waking hours needed to be separated from sporadic movements made while sleeping. We used Individual Manual Inspection to identify day-specific times of waking up in the morning and falling asleep in the evenings for each participant for each day of monitoring. This method involved manual visual inspection of activity graphs produced by the daily graphs module in the ActiLife software following a predefined sleep-scoring-protocol (see Supplemental Material 2). In brief, sleep-onset (falling asleep time) was defined as the first minute of 15 consecutive minutes of sleep and sleep-offset (waking up time) was defined as the last minute of 15 consecutive minutes of sleep. For all scoring, one minute of movement within the identified 15-minute period was accepted if it was preceded and followed by five minutes of consecutive sleep. The visual inspection was done independently by two investigators (T. M. S. and B. B.), and the results were compared. Scoring differences of more than 10 minutes were double-checked and reevaluated by both investigators simultaneously. Only the waking hours PA occurring in the periods between the identified times of wake up and times of falling asleep were included in the analyses.

Accelerometer nonwear was defined as periods of 60 minutes or more of consecutive zeroes allowing for two minutes of nonzero interruptions. These periods were removed before data analysis. The minimum requirement for wear time inclusion was four valid monitoring days, including three weekdays (Monday through Friday) and one weekend day (Saturday or Sunday), and each valid day containing at least 10 hours of valid PA assessments. Counts per minute (CPM) was used as an estimate of total PA, and cut-offs for activity categories recently defined for Vector Magnitude settings by Romanzini, Petroski, Ohara, Dourado, and Reichert (2014) were applied. These cut-offs were validated in a study of 79 adolescents (10–15 years of age) using waist worn ActiGraph GT3X accelerometers while measuring oxygen consumption at rest and when engaging in 11 types of PA with different intensities: sedentary behavior ($\leq$720 CPM), light (>720 CPM), moderate ($\geq$3028 CPM), and vigorous ($\geq$4448 CPM; Romanzini et al., 2014). In addition, time spent in MVPA was calculated by summing the last two categories. The accelerometer data were sampled in 30 Hz, the normal filter option in ActiLife software version 6.13.1 was then used to reintegrate into vector magnitude counts of 60-second epochs, and applied cut-points were scaled accordingly. Wear time (minutes or day), total PA (CPM), and the proportions of time spent in each activity threshold, presented both as a percentage of wear time and as minutes or day to ease comparison, were generated. In addition, we calculated daily time spent in MVPA with bouts lasting at least 10 minutes and allowing up to two minutes drop below

MVPA threshold to account for children's intermittent PA pattern (Cliff et al., 2014).

The applied sleep-scoring-protocol against sleep exclusion based on sleep diaries and sleep actigraphy was validated in an independent study sample of ($n = 14$) obese children and adolescents, enrolled in an ongoing study at the Children's Obesity Clinic with the same inclusion criteria as the present study sample. We found that the sleep-scoring-protocol is very similar to the newly recommended fully automated sleep-scoring algorithms (Tudor-Locke, Barreira, Schuna, Mire, & Katzmarzyk, 2013) and is comparable with the traditionally used method for sleep exclusion based on information by sleep diaries (see Supplemental Material 3 and Supplemental Table 1).

We performed all statistical analysis using R software (version 3.2.0; Team, 2016). *P* values of less than .05 were considered significant. We calculated descriptive characteristics as means ($\pm$ *SE*), median (interquartile range), or as frequencies (percentages). Sex differences were assessed using two-sample *t* test, Wilcoxon summed rank test, or proportion tests when appropriate. In Supplemental Material 4 and Supplemental Figure 1, we report accelerometer paradata (process-related data) in addition to simple wear time statistics as recommended by Tudor-Locke et al. (2015).

For comparison of self-reported and accelerometer-assessed PA data, we assessed data for normality of distribution for each of the variables. Accelerometer-assessed PA was normally distributed, whereas the PAS was right skewed. Pearson correlations coefficient (*r*) was applied to assess the potential extent of associations between self-reported and accelerometer-assessed PA. Next, we grouped participants into "low PAS" and "high PAS" based on the median PAS to assess the relationship between groups of self-rated PAS and accelerometry-assessed total PA measured in CPM. We calculated *p* for trend

Table 1. Characteristics of the Participants, Stratified by Sex.

	Total ($n = 92$)	Male ($n = 40$)	Female ($n = 52$)
Age (years)	11.2 ± 2.9	10.9 ± 2.6	11.5 ± 3.0
Weight (kg)	62.7 ± 23.4	62.3 ± 24.7	63.0 ± 22.7
Height (cm)	151.4 ± 16.0	151.4 ± 17.7	151.4 ± 14.8
BMI (kg/m^2)	26.3 ± 4.9	26.6 ± 5.5	26.0 ± 4.3
BMI-for-age and sex-Z-scores	2.9 ± 0.7*	3.1 ± 0.6	2.7 ± 0.7

Note. BMI: Body mass index.
Data are means ± *SD* or number (%). P value for differences in means and proportions between females and males was calculated using *t* test.
*Significant difference between females and males ($p < .05$).

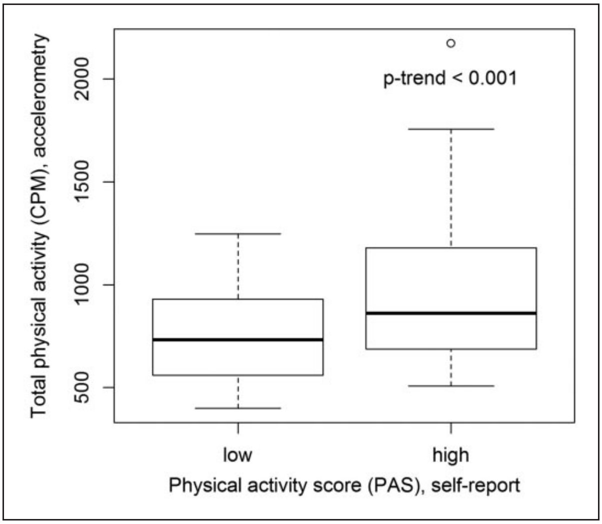

Figure 1. Boxplot of the relationship between "low PAS" and "high PAS" groups based on self-report and accelerometry-assessed total PA. Groups of self-rated PAS were created by splitting into "low PAS" and "high PAS" based on the median PAS (5.5). $p_{\text{for trend}} < 0.001$ across of the two groups of self-rated PAS.

across the two groups. For the cross-tabulation pairs of subjective PAS and total objective total PA (in CPM), we additionally grouped participants into "low total PA" and "high total PA" based on median accelerometer-assessed total PA and used the R-package "fmsb" classification agreement that is based on Cohen's kappa coefficient, to evaluate the agreement of the subjective and objective methods in classifying participants into *low* and *high*. Kappa statistics are described as almost perfect (0.81–1.0), substantial (0.61–0.80), moderate (0.41–0.60), fair (0.21–0.40), slight (0.10–0.20), or poor (<0.10; Landis & Koch, 1977).

Results

Participant Characteristics

The characteristics of our participants are given in Table 1. As detailed in the Supplemental Material 4 (*Accelerometer paradata*), we had valid baseline data available from accelerometry-assessed PA in 92 participants (52 girls) aged 5.6 to 17.3 years, with a median wear time duration of 6 days representing the analytical sample of the study group for accelerometry-assessed PA.

We compared participants with valid accelerometer data with all patients ($n = 559$) to evaluate whether these 92 participants were representative of the children and adolescents enrolled in obesity treatment. The girls were fully representative but the boys were younger (10.9 ± 2.6 vs. 12.1 ± 3.0, $p = .010$) and more physically active, according to the PAS (7.4 [2.4–12.5] vs. 4.0 [0.5–9.5], $p = .021$).

Accelerometer-Assessed PA

Overall, our participants had a mean of 5.8 ± 0.8 valid accelerometer monitoring days and on average 13.4 ± 1.0 hours of valid wear time per day. Boys spent significantly more time than girls in moderate PA. There were no sex differences in daily total PA or time spent in sedentary, light, vigorous, or MVPA intensity levels. Forty-six percent (50% females, 42% males) of the enrolled children and adolescents met recommendations from the national board of health of at least one daily hour of MVPA. However, only 12% of the males and 5% of the females spent this hour in MVPA bouts lasting at least 10 minutes. Detailed values of accelerometer outcomes are presented in Table 2.

Comparisons of Objective and Subjective PA Measures

As there was missing data on questionnaire-derived PAS for one participant within the objective PA group, 91 participants were included in an analysis of associations between PAS and accelerometry-assessed total daily PA (CPM). Accelerometry-assessed PA was highly correlated with time spent in MVPA intensity activity level ($r = 0.93$, data not shown), and as PAS captures overall PA behavior, we also focused on overall daily total PA as our objective PA metric. The mean for accelerometer-assessed total PA per day was 851.0 ±314.3 CPM, and median PAS was 5.5 (1.0–11.0). The PAS and total accelerometer-assessed PA were positively correlated ($r = 0.34$, $p < .01$, $n = 91$). Total PA (CPM) in relation to groups of low and high self-rated PAS are presented in Figure 1.

Across the two groups of self-rated PAS, we found a significant trend toward increasing PAS with increased total PA ($p_{\text{for trend}} < .001$). In Table 3, the cross-tabulation of self-rated PAS tertile groups and objectively assessed PA tertile groups show that 56 out of 91 (62%) children reported their PA level in the same category as was measured objectively; 34 (61%) of these were female. Overall, 17 (19%) children overestimated their PA level as indicated by their self-reported PAS; 7 (41%) of these were female. In contrast, 18 (20%) children underestimated their PA level; 10 (56%) of these were females.

Discussion

Among our sample of 5–17-year-old children and adolescents, enrolled in multidisciplinary childhood obesity treatment, accelerometer-derived PA levels were

Table 2. Accelerometer-Derived Objective Physical Activity Measures, Stratified by Sex.

	Total ($n = 92$)	Male ($n = 40$)	Female ($n = 52$)
Total PA, CPM	851.0 ± 314.3	879.7 ± 320.8	828.9 ± 310.4
Sedentary, min/day	521.0 ± 95.6	513.5 ± 85.9	526.7 ± 103.0
Sedentary, % of wear time	65.6 ± 9.9	64.2 ± 9.7	64.9 ± 10.2
Light, min/day	221.9 ± 56.2	216.7 ± 53.3	225.9 ± 58.5
Light, % of wear time	27.7 ± 7.3	27.1 ± 6.6	28.1 ± 7.8
Moderate, min/day	28.1 ± 18.3*	43.1 ± 19.1	34.3 ± 16.8
Moderate, % of wear time	4.8 ± 2.3*	5.4 ± 2.4	4.3 ± 2.1
Vigorous, min/day	24.3 ± 19.6	26.8 ± 24.9	22.4 ± 14.2
Vigorous, % of wear time	3.0 ± 2.5	3.4 ± 3.2	2.8 ± 1.7
MVPA, min/day	62.4 ± 34.3	69.9 ± 40.1	56.7 ± 28.2
MVPA, % of wear time	7.8 ± 4.3	8.7 ± 5.0	7.0 ± 3.5
≥60 min MVPA/day	42 (45.7)	22 (42.3)	20 (50.0)
Total time in MVPA bouts/day	24.1 ± 23.7	30.8 ± 29.4	19.8 ± 16.9
≥60 min in MVPA bouts/day	8 (8.6)	6 (11.5)	2 (5.0)

Note. PA = physical activity; CPM = counts per minute; MVPA = moderate to vigorous physical intensity. Data are means ± *SD*, % of valid wear time or number (%). *P* value for differences in means and proportions between females and males using *t* test, Wilcoxon summed rank test, or proportions test as appropriate. Physical activity (PA) using the Romanzini cut-points (CPM) based on 60-second epochs, 0-720 Sedentary, 721-3027 Light, 3028-4447 Moderate, and ≥4448 Vigorous. MVPA bouts ≥ 10 min, allowing up to 2 minutes drop below MVPA threshold.
*Significant difference between females and males ($p < .05$).

Table 3. Cross Tabulation of PAS (Self-Reported PA) and Accelerometer-Assessed PA (Objective PA) in $n = 91$ Obese Children and Adolescents Undergoing Obesity Treatment.

n, all (male or female); %, all (male or female)		Objectively assessed PA (CPM)		
		High	Low	Total
Self-reported PAS	High	28 (13/15); 31% (33%/29%)	17 (10/7); 19% (25%/14%)	45 (23/22)
	Low	18 (8/10); 20% (20%/20%)	28 (9/19); 31% (23%/37%)	46 (17/29)
	Total	46 (21/25)	45 (19/26)	91 (40/51)

Note. PA = physical activity; CPM = counts per minute; PAS = physical activity score.
Groups of self-rated PAS were created by splitting based on median PAS (median = 5.5) into "low PAS" and "high PAS". Similar, groups of objectively assessed PA were created by splitting into "low total PA" and "high total PA" based on median overall daily physical activity levels (median = 790 CPM).
Kappa = 0.23 (95% CI = [0.03, 0.43], $p = .01$; fair agreement).

similar in boys and girls. Less than half of these participants met the recommendations from the WHO and the DPS of accumulating at least 60 minutes of MVPA daily (WHO, 2011), and only one out of 10 met the Danish recommendations that these 60 minutes should be spent in MVPA bouts of at least 10 minutes (Pedersen & Andersen, 2011). It is not surprising that children and adolescents enrolled in obesity treatment fail to meet national and international PA recommendations. First, it is generally observed that adolescents with overweight or obesity are less active than their normal weight peers, and PA differences by weight status have been seen even in elementary schoolers (Cooper et al., 2015). Second, the number of children fulfilling PA recommendations may generally be underestimated when using accelerometers, since these PA recommendations were based on research findings derived from self-reported PA that tends to overestimate activity (Hjorth et al., 2013). Moreover, the relationship between PA and overweight or obesity is likely bi-directional, as it has been recently suggested that lower levels of PA may be a consequence of increased adiposity (Ekelund et al., 2012; Hjorth et al., 2014; Richmond et al., 2014). Of note, however, both studies emphasized that lower levels of PA are likely to contribute to increased adiposity. No matter the direction of effect, it is important to maintain PA levels for early prevention of overweight and obesity.

It has been recommended that health professionals should support PA to prevent overweight and obesity in children (Steinbeck, 2001), and the clinical DPS emphasizes that an increase in PA is a main goal of multidisciplinary obesity treatment (Johansen et al., 2015). Therefore, a clinically relevant protocol for treating childhood obesity should include an assessment of PA engagement. The main goal of our study was to compare self-reported and objectively assessed PA in children and adolescents with overweight or obesity in a pediatric setting where time is limited and where a questionnaire-based evaluation is the most cost-effective method to estimate current PA levels. We observed a positive correlation between self-reported PAS and objectively assessed daily total PA and further found that children and adolescents who reported a high PAS were more physically active as assessed by accelerometry, compared with those who reported a low PAS. There was a fair level of agreement between the self-reported and the accelerometer-assessed data, and we found that nearly two thirds of the participants' PAS ratings matched objectively assessed PA estimates.

Our finding of fair levels of agreement between subjective and objective PA assessment in children and adolescents is in line with other findings in the literature (Adamo et al., 2009; Chinapaw, Mokkink, van Poppel, van Mechelen, & Terwee, 2010). Relative validity is most often expressed as correlation coefficients, and most studies have found low to moderate correlations, with some reporting significant correlations. Those who provided Bland-Altman plots showed generally poor individual agreement between indirect and direct measures (Adamo et al., 2009). Indirectly assessed PA has generally been overestimated, compared with accelerometry-derived PA measures, except when measured in bouts or categorized by intensity (Adamo et al., 2009). Yet, interview-derived PAS and accelerometer-derived PA do not cover the exact same days as in general, PA levels of children vary from day to day, whereas the PAS reflects typical PA engagement during the last few weeks.

Our study's limitations include possible bias from interview self-report, since younger children have limited cognitive and linguistic ability to recall or express their distinct physical activities (Sallis, 1991) and because it is difficult for family members to quantify younger children's less structured PA (Bailey et al., 1995; Baquet, Stratton, Van Praagh, & Berthoin, 2007). However, with the combined participant or family report used in this protocol, some of these limitations may have been attenuated. In addition, one might assume that within this population of children and adolescents with overweight or obesity, activity levels would be low, making it easier for respondents to remember PA data (Chinapaw et al., 2010). As data collection was interviewer administered, interviewers are another source of possible bias and data variance between different interviewers, even though interview-administered data collection has been found to be more accurate than self-administered reporting methods (Corder et al., 2008). In addition, future research might employ greater resources to procure valid accelerometer data from an even larger sample of children and adolescents undergoing multidisciplinary childhood obesity treatment. However, it should be noted that, even though objective measures such as accelerometers have been employed as criterion measure of PA in validation studies for years (Freedson, 1991; Sallis, 1991) and have been found acceptable ($r = 0.81$–0.84) for assessing intensities of children's PA (Janz, Witt, & Mahoney, 1995), accelerometers do not provide error-free estimates of PA. Accelerometers can underestimate PA because they cannot be worn during aquatic activities and they may underestimate the intensity of effort associated with walking, running, or biking up hills. Adolescents with obesity are found to tolerate high intensity exercise well when their body weight is supported (Thivel, Isacco, O'Malley, & Duché, 2016), perhaps making them particularly susceptible to these underestimates.

Collecting information about PA by interview-administered self-report allows efficient collection in a large scale pediatric setting, and our data show fair agreement between subjective self-report and objectively assessed PA in obesity treatment targeting children and adolescents. We conclude that the PAS, derived from self-report, may be a useful instrument for quantifying PA at a group level within the children and adolescents enrolled in multidisciplinary childhood obesity treatment. However, pediatricians should be aware that general PA levels within this population are low and that being classified with high PAS does not necessarily correspond to the recommended time spent in MVPA activity for the general population of children and adolescents.

Data Availability

Relevant data for the present study are within the article and its supporting information files. If you wish to see additional data, the authors confirm that, for approved reasons, some access restrictions apply to the data underlying the findings. Data are available from the Novo Nordisk Foundation Center for Basic Metabolic Research, section of Metabolic Genetics whose authors may be contacted at jholm@regionsjaelland.dk.

Acknowledgments

The authors are grateful to all the children and adolescents and their families who contributed to this study and also thank O. Troest for throughout technical assistance.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of his article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This present study was supported with funds from the Region Zealand Health Sciences Research Foundation, the Innovation Fund Denmark (grants 0603-00484B and 0603-00457B), and the Novo Nordisk Foundation (grant number NNF15OC0016544) and is part of the research activities in the Novo Nordisk Research Foundation Center for Basic Metabolic Research, University of Copenhagen (http://metabol.ku.dk/), and the Danish Childhood Obesity Biobank; Clinical Trials.gov ID-no: NCT00928473. The work of TMS was partly supported by the Danish Diabetes Academy supported by the Novo Nordisk Foundation and the research programme ‘‘Governing Obesity’’ funded by the University of Copenhagen Excellence Programme for Interdisciplinary Research (www.go.ku.dk). The Novo Nordisk Foundation Center for Basic Metabolic Research is an independent research center at the University of Copenhagen partially funded by an unrestricted donation from the Novo Nordisk Foundation (www.metabol.ku.dk).

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Author Biographies

Theresia M. Schnurr, MSc, is a PhD student at the Novo Nordisk Research Foundation Center for Basic Metabolic Research, Faculty of Health and Medical Sciences, University of Copenhagen, Denmark.

Bianca Bech did MSc in Health Sciences and is a clinical nurse specialist at the Center for Rheumatology and Spine Diseases, The Capital Region of Denmark.

Tenna R. H. Nielsen, MD, PhD, is a postdoc at The Children's Obesity Clinic, Department of Pediatrics HolbÌk, University of Copenhagen, Denmark.

Ida G. Andersen, MD, is a PhD student at the Department of Otorhinolaryngology and Maxillofacial Surgery at the Zealand University Hospital, Denmark.

Mads F. Hjorth, MSc, PhD, is an assistant professor at the Department of Nutrition, Exercise and Sports, University of Copenhagen, Denmark.

Mette Aadahl, MPH, PhD, is a senior researcher at Research Centre for Prevention and Health, The Capital Region of Denmark.

Cilius E. Fonvig, MD, PhD, is a medical doctor at the Zealand University Hospital, Denmark.

Torben Hansen, MD, PhD, is a professor of Genetics of Human Metabolism ant the Novo Nordisk Foundation Center for Basic Metabolic Research, Faculty of Health and Medical Sciences, University of Copenhagen, Denmark.

Jens-Christian Holm, MD, PhD, is a consultant in Pediatrics, associate clinical and research professor at the Zealand University Hospital and an associate professor at the Novo Nordisk Research Foundation Center for Basic Metabolic Research, University of Copenhagen, Denmark. He is the leader of the Children's Obesity Clinic in Holbaek, Denmark.