The Impact of Juvenile Idiopathic Arthritis
Armbrust, Wineke

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Measuring Physical Activity in Juvenile Idiopathic Arthritis: Activity Diary versus Accelerometer.

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ABSTRACT

Aim: To determine the convergent validity of an activity diary (AD) in measuring physical activity (PA) in patients with juvenile idiopathic arthritis (JIA) compared to an accelerometer, to determine how many days give reliable results, and to explore the effect of correcting the accelerometer for non-wear.

Methods: Patients with JIA (8-13 years) were recruited from 3 pediatric Rheumatology Centers in The Netherlands. PA was assessed for 7 days with an AD and an accelerometer (Actical) and was expressed as minutes rest, light PA (LPA) and moderate to vigorous PA (MVPA) and as physical activity level (PAL).

Results: Convergent validity between the AD and Actical was moderate for rest and PAL (ICC: .41). ICC’s for LPA and MVPA were less than .24. The AD overestimated PAL and MVPA compared to the Actical. Wearing the Actical 7-19 days gives reliable PA estimates on group and individual level. For the AD 13-36 days are needed. Adjusting for non-wear resulted in a clinically relevant higher outcome for LPA (Effect size: 1.12) but not for MVPA (Effect size: .44).

Conclusion: Convergent validity between the AD and the Actical is moderate to poor. In patients with JIA one-week assessment with an Actical is sufficient to measure PA (all categories) reliably. On individual level and for clinical use 3 weeks are required whereby the additional use of an AD enables correction for non-wear. When the use of accelerometers is not feasible an AD can be used increasing assessment time with one to four weeks.
INTRODUCTION

Physical activity (PA), any bodily movement produced by skeletal muscles that increases the energy expenditure above the basal metabolic level (1), contributes to the prevention of several chronic conditions and is associated with longevity and prevention of all-cause mortality (2,3). PA is also important for growth and development of children and adolescents since it can control body weight, improve fitness and self-concept and reduces high blood pressure, anxiety and depression (4,5). For patients with Juvenile Idiopathic Arthritis (JIA) it is equally important to profit from these benefits since there is accumulating evidence that PA is safe and is not damaging joints (6–8). PA is reduced in children and adolescents with JIA (9–15). Low levels of PA may contribute to occurrence and maintenance of fatigue in JIA, through interplay of disease-related, personal and environmental factors (16).

PA can be expressed as total energy expenditure (TEE) in kilojoules or kilocalories per day but also as physical activity level (PAL), which is the TEE, divided by the basal metabolic rate. PA can be categorized in mutually exclusive portions; rest, light PA (LPA), moderate and vigorous PA (MVPA) (17,18). PA pattern evolves from the time spent into each category and is most commonly used in the clinical evaluation of PA guidelines.

PA can be assessed or measured in many ways all having their pro’s and con’s (18,19) ranging from cheap and subjective questionnaires and recall diaries to accelerometers (secondary measurements) and the more precise but costly indirect calorimetry, direct observation and doubly labeled water method (primary measurements or golden standard) (20).

In JIA, self and proxy report, questionnaires, recall diaries and accelerometers or combinations of these methods have been used for measuring PA (9–15,21–23). The number of days, in which PA was measured, differed between 1 (12), 3 (9,10), 4 (21) and 7 days (11,14,15,22,23). Questionnaires and recall diaries tend to overestimate PA (24). An observational study of a physical education class in third grade school children showed that the actual MVPA time was only 37% of total physical education time (25). However also accelerometers have their flaws since they do not, or insufficiently record certain types of activity, in particular, non-ambulatory PA with arm and or limb movements during cycling and fitness training (26). Accelerometers underestimate PA, particularly by non-wear during activities like swimming and data is missing due to negligence. Therefore it has been suggested to combine two or more techniques to improve the accuracy of measurement (20). In a study in 13-15 years old adolescents PA was measured using and accelerometer and an activity diary (AD) was filled in to register activities while the accelerometer was not worn. Significant higher levels of MVPA were found when the results were corrected for non-wear (27). Since PA can vary between days, increasing the number of measured days will improve reliability of the data but will also increase the burden for patients and hence may decrease adherence. Furthermore, the precise number of days to reliably assess PA will vary by the type of instrument used and the characteristics of the patient population (28). The variability of PA in patients with JIA, especially in those with mild and acute active disease, will probably be higher than in a
healthy children and it is likely that in JIA more days need to be measured to achieve sufficient reliability.

The aims of this study were to, 1) determine the convergent validity of a 7-day AD in patients with JIA using the accelerometer as the reference measure, 2) determine how many days physical activity needs to be assessed, by the activity diary and accelerometer, to acquire reliable results, and 3) explore the effect of combining the two instruments by using the AD to correct for non-wear of the accelerometer.

PATIENTS AND METHODS

Participants were patients with JIA aged 8 to 13 years, participating in the “Rheumates@Work” study; a multi-center trial to study effects of an internet-based cognitive behavioral program on PA levels (trial number SRCTN92733069)(29). The medical ethics research board of the participating centers approved the study. Inclusion criteria for this study were: diagnosis JIA according to the International League of Associations for Rheumatology –criteria (30) and disease activity lower than 2cm on a physician global assessment scale (0-10). Exclusion criteria were co-morbidity that effected maximal exercise capacity and PA and insufficient control of the Dutch language. For current study baseline measurements of the Rheumates@Work study were used. Patients were recruited from three pediatric rheumatology outpatient clinics in The Netherlands; the Beatrix Children’s Hospital of the University Medical Center Groningen, the Wilhelmina Children’s Hospital of the University Medical Center Utrecht and from Reade, Center for Rehabilitation Amsterdam from January 2011 until September 2012.

Primary outcome measurements

Patients and one of their parents were verbally instructed how to wear and use the accelerometer and activity diary simultaneously. They also received a simple instruction manual. Only patients with complete AD with concurrent wear of the accelerometer on 7 consecutive days were eligible for this study.

Accelerometry. The Actical accelerometer (Phillips-Respironics, Oregon USA) is a small box of 2.8 x 2.7 x 1.0 centimeter, weighing 17 gram, which was worn by the patients with an elastic belt over the right hip near the anterior superior Iliac spine for 7 consecutive days. The Actical was validated for children aged 7 up to 18 years, resulting in sensitivity and specificity on group level of respectively 86-97% and 66-80% for the different categories of PA (31). It contains an omnidirectional accelerometer that monitors the occurrence and intensity of motion. The sensor integrates the amplitude and frequency of motion in an electrical current that varies in voltage. This information is used to calculate activity counts per time unit (it is possible to choose an epoch of 15, 30 or 60 seconds and for this study an epoch of 60 seconds was used) and activity related energy expenditure (AEE) in kilocalorie per day. After retrieving data from the accelerometer they were stored in an excel file as counts per minute each with their unique local time point giving 1440 time points per day. Higher counts per minute means increased PA and cut-off
points previously defined were used for thresholds of rest, LPA, MVPA (31). All time points with a minute count ≤ 100 were added as daily sedentary time. Time points with a minute count from 101 up to 1500 were added as daily LPA and ≥1501 as daily MVPA. With these cut-off points the mean time spent in rest, LPA and MVPA were calculated. PAL was computed by the formula: ((AEE * 4.1868 / 1000 + BMR) / 0.9.)/ BMR, where BMR is basal metabolic rate, computed as previously described (22). Actical data were visually inspected with help of the actogram, a graphical representation of the activity counts per minute, and non-wear time was observed and compared to non-wear time in the excel file. Non-wear time is defined as 60 consecutive minutes of zero counts with allowance for 1 or 2 minutes of counts between 0 and 100. Actical measurements were considered valid when the wearing time summed 6 or 8 hours on respectively weekend and weekdays. Eighty percent of the Actical measurements met these criteria.

7-Day Activity Diary. The AD was reliable in patients from 10 years and upwards showing intraclass correlations ranging from 0.86 to 0.95 (32) and it was validated in 15 year old adolescents against the doubly-labeled water method showing a mean difference of .01 in PAL and with limits of agreement between .49 and -.47 (33). Patients were asked to record their level of activity for 7 consecutive days. They were instructed to put a smiley in the AD at the time the accelerometer was put on in the morning and when it was taken off in the evening. Every quarter of an hour the dominant activity was scored as follows; 1 = sleeping, resting in bed or watching television; 2 = sitting, eating, writing etc.; 3 = standing, washing, combing, etc.; 4 = walking indoors (less than 4 km/hour, light home activities; 5 = walking outdoors (4-6 km/hour), cleaning bedroom, easy outdoor playing; 6 = recreational sport and leisure time activities with low intensity; 7 = recreational sport and leisure time activities with moderate intensity; 8 = recreational sport and leisure time activities with high intensity, and 9 = competition sport. In case of doubt patients or parents could contact the investigator or could describe the type of activity on the AD instead of giving a number. After completion of the AD it was returned to the investigator for screening. In case of missing values children and parents were asked to recall the activity for that period. In case a quarter of an hour had more than one entry, the first and second were chosen alternately. Remaining missing values between 9 hours pm and 7 hours am were imputed with a 1 as this was considered sleeping time. When there was a missing value with the “put on Actical” smiley the activity of the prior quarter of an hour was imputed and missing values with the “take off Actical” smiley present was imputed with the activity of the next quarter of an hour. When 4 or less missing values remained they were substituted with activity 2. In case of more than 4 remaining missing values the diary was excluded from the analysis, which occurred in 12% of the cases. PA was expressed as time (in minutes) spend in rest, LPA and MVPA. Rest time refers to activities that do not increase energy expenditure substantially above the resting level and includes activities such as sleeping, laying down and sitting activities (34) These are represented by category 1 and 2 and the energy costs are 0.98*BMR and 1.5*BMR respectively (33). Intensity thresholds between LPA and MVPA are around 4 metabolic equivalents of tasks (24). Therefore LPA is represented by categories 3, 4 and 5, with an energy cost of respectively 2.0; 2.8 and 3.3* BMR. MVPA is category 6 and higher with an energy cost of respectively 4.4; 6.5; 10.0 and 15.0*BMR. PAL was calculated by dividing TEE of each day with the BMR (22,33).
Correction of Actical data for non-wear. Non-wear time of the Actical was compared to the AD data. When LPA or MVPA was reported in the AD during non-wear of the Actical, this was corrected by adding up the equivalent number of minutes of LPA or MVPA and subtracting these from rest. A correction of 10 minutes for MVPA was considered as clinically relevant as this results in more than 1 hour MVPA per week. No corrections were made for PAL since algorithms to calculate energy expenditure uses of activity counts for each individual minute (35) whereby counts per minute can considerably differ within LPA (from 101 up to 1500) and MVPA (≥1501).

Secondary outcome measurements

Patients characteristics: age, gender, weight and length were recorded. The diagnosis was extracted from the medical chart.

Statistical analysis

Interclass correlation coefficient (ICC) was calculated for rest, LPA, MVPA and PAL measurements of Actical and AD to measure convergent validity. An ICC of ≥ 0.60 was rated as good convergent validity, ≤ 0.3 - < 0.6 was rated as poor to moderate convergent validity and < 0.3 was rated as no convergent validity (36). Single day intraclass correlation coefficients (ICC) were calculated using repeated measures of analysis of variance (ANOVA) by dividing the between patient variance by the total variance which is the sum of between patient variance, between days variance and error variance.

Differences between the AD and the Actical were analyzed using paired sample t-test. Bland Altman analysis was also conducted wherein difference between PA data measured with the AD and Actical was plotted against the average of both methods. Limits of agreement were defined as mean difference +/- 1.96*SD. Differences between Actical and AD was analysed using linear regression analyses (37,38).

The required number of days to achieve an ICC of 0.75 and 0.9 for PAL, rest, LPA and MVPA, measured with the AD and the Actical was calculated using the Spearman-Brown prophecy formula; k=(ICCto achieve/(1-ICCto achieve)*)((1-ICCsingle)/ICCsingle). An ICC of more than 0.75 was considered as a good reliability at group level and an ICC of 0.9 was considered as a good reliability at an individual level (39).

Differences between rest, LPA and MVPA measurements of the Actical without and with correction for non-wear were analyzed with paired sample t-tests after which an effect size was calculated by dividing the mean difference by the standard deviation of that difference. Bland Altman plots were drafted between the difference of rest, LPA and MVPA measured with the actical without and with correction for non-wear against the average of both. Median difference was provided with limits of agreements as indicated by 2.5-97.5%. The Statistical Package for Social Sciences (IBM SPSS Statistics 22) was used for statistical analysis.
RESULTS

Of all 83 patients, 61 (73%) filled in a complete AD with concurrent wear of the Actical on 7 consecutive days (Table 1).

Table 1. Patient characteristics (n=61)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>10.1 (1.4)</td>
</tr>
<tr>
<td>Gender, boys/girls (number)</td>
<td>24/37</td>
</tr>
<tr>
<td>Height, cm</td>
<td>144 (10)</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>35.8 (8.7)</td>
</tr>
<tr>
<td>JIA subtype (number)</td>
<td></td>
</tr>
<tr>
<td>Persistent oligo-articular</td>
<td>22</td>
</tr>
<tr>
<td>Extended oligo-articular</td>
<td>10</td>
</tr>
<tr>
<td>Polyarticular</td>
<td>17</td>
</tr>
<tr>
<td>Psoriasis related</td>
<td>3</td>
</tr>
<tr>
<td>Enthesitis related</td>
<td>3</td>
</tr>
<tr>
<td>Systemic</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 2. MVPA was highest when measured with AD (76 min), followed by the corrected Actical data (52 min) and non-corrected Actical data (50 min) (Table 2). Time spend in rest was highest when assessed with the Actical (Table 2). The ICC between the AD and Actical was .41 for both rest and PAL, indicating poor to moderate convergent validity (Table 2). The ICC for MVPA was .24 and for LPA .17 (p=.09) indicating no convergent validity (Table 2).

Table 2. Physical activity measured by means of activity diary and Actical, ICC between these data and Actical data corrected for non-wear and difference with the uncorrected data

<table>
<thead>
<tr>
<th>Activity</th>
<th>Activity diary mean(SD)</th>
<th>Actical mean(SD)</th>
<th>ICC [95%CI]</th>
<th>ActicalCORRNONWEAR mean(SD)</th>
<th>Mean Diff ActicalCORRNONWEAR * [95%CI]</th>
<th>E.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rest</td>
<td>1156(77)</td>
<td>1166(53)</td>
<td>.41 [.19; .60]</td>
<td>1145 (52)</td>
<td>-21 [-25; -16.] *</td>
<td>1.11</td>
</tr>
<tr>
<td>LPA</td>
<td>209 (79)</td>
<td>225 (40)</td>
<td>.17 [-.08; .40]</td>
<td>243 (41)</td>
<td>18 [14; 22] *</td>
<td>1.12</td>
</tr>
<tr>
<td>MVPA</td>
<td>76 (40)</td>
<td>50 (25)</td>
<td>.24 [.01; .46]</td>
<td>52 (25)</td>
<td>2.4 [.9; 3.8] *</td>
<td>.44</td>
</tr>
<tr>
<td>PAL</td>
<td>1.63(.14)</td>
<td>1.54 (.09)</td>
<td>.41 [.09; .63]</td>
<td>N.A.</td>
<td>N.A.</td>
<td></td>
</tr>
</tbody>
</table>

*(min/day); LPA= light physical activity; MVPA= moderate to vigorous physical activity; PAL= physical activity level; N.A. not applicable; ICC= Interclass correlation coefficient; ActicalCORRNONWEAR = Actical data corrected for non-wear time; * results of paired sample t-test of ActicalCORRNONWEAR - Actical with p values <.01; * p<.01; * p=.09

Effect Size: mean difference/ SDDIFFERENCE
For rest and LPA the means of the AD did not differ significantly from those of the Actical -9.9 (95% CI -28.2; 8.4, p=.29 ) and -16.2 ( 95% CI -36.8; 4.4, p=.12) respectively. For MVPA and PAL the means of the AD were significant larger than those of the Actical 26.0 (95% CI 16.1; 36.0, p<01) and 0.08 (95% CI .05-.11, p<.01) respectively. Bland Altman plots showed that the difference between AD and Actical depended on the mean of both, for all PA categories (Figure 1). For lower values of PAL Actical data were higher than AD data, whereas in the higher values of PAL AD data were higher. This trend was also seen for rest, LPA and MVPA (Table 3)

Table 3. Results of the linear regression analyses to predict the difference between AD and Actical with the mean of AD and Actical as predictor to assess proportional bias.

<table>
<thead>
<tr>
<th></th>
<th>Constant</th>
<th>β</th>
<th>95%CI of β</th>
<th>p</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rest</td>
<td>-578</td>
<td>.49</td>
<td>[.18; .80]</td>
<td>&lt;.01</td>
<td>.15</td>
</tr>
<tr>
<td>LPA</td>
<td>-231</td>
<td>.99</td>
<td>[.64; 1.35]</td>
<td>&lt;.01</td>
<td>.35</td>
</tr>
<tr>
<td>MVPA</td>
<td>-17</td>
<td>.68</td>
<td>[.35; 1.01]</td>
<td>&lt;.01</td>
<td>.22</td>
</tr>
<tr>
<td>PAL</td>
<td>-.83</td>
<td>.57</td>
<td>[.31; .84]</td>
<td>&lt;.01</td>
<td>.25</td>
</tr>
</tbody>
</table>

R²=explained variance; β= regression coefficient; LPA= light physical activity; MVPA= moderate to vigorous physical activity; PAL= physical activity level
Figure 1. Bland-Altman plots visualizing level of agreement between mean time spend in rest, light physical activity (LPA) and mean to vigorous physical activity (MVPA) in minutes/day and mean physical activity level (PAL), measured with the activity diary (AD) and Actical (Act).

Mean differences (solid horizontal lines) [limits of agreement] (dotted lines) of rest -9.9 [-150.1; 130.3] (p=.29), LPA -16.2 [-173.9; 141.3], MVPA 26.1 [-50; 102.1], PAL.08 [-.15; .32].

Regression lines run from lower left to upper right
At group level, one-week Actical measurements are reliable (Table 4). At least 13 days of AD measurements are required to obtain the same level of reliability. For clinical application at individual level 19 and 36 days of measurements are required for the Actical and the AD respectively (Table 4).

Table 4: ICC of activity diary and Actical and number of days to achieve an ICC of .75 and .90

<table>
<thead>
<tr>
<th>Activity</th>
<th>ICC single [95% CI]</th>
<th>Number of days needed for:</th>
<th>&lt; 0.75</th>
<th>≤ 0.90</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAL</td>
<td>0.21 [.12; .32]</td>
<td>11.4</td>
<td>34.3</td>
<td></td>
</tr>
<tr>
<td>Rest</td>
<td>0.32 [.23; .44]</td>
<td>6.3</td>
<td>18.8</td>
<td></td>
</tr>
<tr>
<td>LPA</td>
<td>0.36 [.26; .48]</td>
<td>5.3</td>
<td>16.1</td>
<td></td>
</tr>
<tr>
<td>MVPA</td>
<td>0.20 [.11; .31]</td>
<td>12.3</td>
<td>36.0</td>
<td></td>
</tr>
<tr>
<td>Actical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAL</td>
<td>0.33 [.23; .47]</td>
<td>6.2</td>
<td>18.6</td>
<td></td>
</tr>
<tr>
<td>Rest</td>
<td>0.37 [.27; .49]</td>
<td>5.1</td>
<td>15.1</td>
<td></td>
</tr>
<tr>
<td>LPA</td>
<td>0.37 [.27; .49]</td>
<td>5.2</td>
<td>15.5</td>
<td></td>
</tr>
<tr>
<td>MVPA</td>
<td>0.39 [.29; .51]</td>
<td>4.6</td>
<td>13.9</td>
<td></td>
</tr>
</tbody>
</table>

ICC= interclass correlation coefficient; AD= activity diary; PAL= physical activity level; LPA= light physical activity; MVPA= moderate to vigorous physical activity

There was a significant difference between mean time spend in rest, LPA, and MVPA measured with the Actical without and with correction for non-wear where after correction rest decreased with 21 minutes and LPA and MVPA increased with 18 and 2 minutes respectively (Table 2). The corresponding effect sizes were of 1.11 (rest), 1.12 (LPA) and .44 (MVPA) indicate that for MVPA the clinical relevance of correcting for non-wear is small. However for LPA the effect of correcting for non-wear is large. The Bland Altman plot for MVPA showed that for individual patients clinically relevant non-wear corrections for MVPA were made in 4 patients with a maximum of 25 minutes (Appendix 1).

**DISCUSSION**

This study showed that the AD and Actical have a poor to moderate convergent validity in patients with JIA aged 8 to 13 years. One-week measurement with an Actical and 13 days of measurements with an AD are sufficient to obtain reliable estimates of PA at group level. In individual cases and for clinical purposes almost 3 weeks of Actical and more than 5 weeks of AD measurements is required. Correction for non-wear of the Actical resulted in a significant increase in LPA and MVPA. The clinical relevance for LPA was substantial and for MVPA small. In studies where LPA is one of the outcome variables, correcting for non-wear is relevant. Correcting MVPA for non-wear is relevant for individual patients.
The poor to moderate convergent validity between the diary and the accelerometer was also found previously (40–42). Two thirds of parents of healthy children aged between 5 to 7 years overestimated PA of their children when scoring their child’s activity in an electronic diary which was compared to activity counts of the Actical. A moderate correlation (.44) was found (41). Correlations, controlled for body mass, between estimated activity related energy expenditure measured with a 3-day AD and an accelerometer in 403 healthy adolescents, were .33 for girls and .44 for boys (40). The correlation in healthy Spanish adolescents of minutes MVPA between the Actigraph activity monitor and the Bouchard AD were also moderate (.36) (42). In a review of Ekelund et al (2011) correlations between any self-report and an objective instrument were found to be low to moderate, at best (24). The poor to moderate convergent validity can be explained in 2 ways. Firstly in AD’s participants usually tend to overestimate the intensity and duration of the different types of activities and sports because of the intermittent nature of activities and sports (24). When a child reports one hour of physical education classes, normally classified as MVPA, in reality only 37% of the time will be actual MVPA while the rest of the time will be spend on sedentary or LPA (25). Accelerometers underestimate intensity and duration of certain types of activities since they are less sensitive to register activities like walking stairs, cycling and activities that mainly involve arm movements (43). Moreover compliance to wear an accelerometer for a whole period of 7 days remains an issue of concern and non-wear, reported and unreported, will again underestimate PA (43). Secondly intensity thresholds of AD’s are based on metabolic equivalents of tasks performed while thresholds of accelerometers are measured in the laboratory where body movement and energy expenditure are concurrently derived (24).

This study showed that in patients with JIA aged 8-13, one-week measurement with an accelerometer is sufficient but that for an AD at least 13 days of measurements are needed. This is in line with previous studies that found that to reliably assess PA, the number of measurement days can differ depending on the type of instrument, the purpose of the study and the characteristics (including age) of the patient population (28). Healthy younger children exhibited less day-to-day variability than healthy adolescents and therefore needed less days (4 to 5 days in 7-12 year old children compared to 8 to 9 days of monitoring in 13 to 16 year olds) to assess PA on a reliable way (44). In healthy 5 year old preschool children, 5 to 6 days of accelerometer monitoring were needed (45). For adults 3 to 5 days of monitoring appeared to be sufficient (26). In healthy and chronically ill children, as far as we know, the number of required days for the AD has never been assessed. Our results indicate that in patients with JIA, on an individual level and for clinical purposes almost 3 weeks of accelerometer monitoring is needed and 5 weeks of the AD. This is not realistic considering the effort that is being asked from the patients and their parents.

We found a significant but small increase of about 4% between MVPA measured without and with correction for non-wear. In a study including 513 healthy adolescents, correction of non-wear using Actigraph accelerometers and a non-wear diary, resulted in an increased mean MVPA of 43% (23 to 33 minutes per day increase) (27). The increase was mainly related to non-wear during aquatic activities and ball games. These findings indicate that the necessity for correction of non-wear can vary between samples and that...
in studying MVPA in JIA clinical trials correction leads to small differences at a group level. For clinical use in individual patients the use of an AD in combination with an accelerometer is recommended since in individual cases non-wear can be considerable. This study has a number of limitations. In this study only patients with JIA with no or mild disease activity were selected. Patients with high disease activity may show lower and less variable PA and are more likely to exert activities like swimming causing more non-wear. However measuring PA in low disease activity states is more useful, while this is especially the phase in which PA are regained. Another form of selection bias was caused by the willingness of patients to participate in a program aimed at improving PA since these patients possibly overestimate their PA leading to higher AD scores. In our group boys are represented more compared to the general population of patients with JIA. Boys may have different activity patterns what could have influenced our results. The age of the patients may also influence results. Patients in our study were 8-13 years old but the reliability of the AD was only assessed in children of 10 years and older (32). We tried to overcome this by instructing parents to help their children filling in the diary. Another limitation was that the AD was validated only in children aged 15 years. Imputing missing values could cause an error although only in a small proportion of the AD this was necessary. The use of an epoch of 1 minute and a valid wearing time of 6 to 8 hours are other limitations. Epoch and valid wearing time can differ over studies and make comparison more difficult. Another limitation is that we measured 7 days and used these data to calculate the number of days needed for reliable estimates. By measuring and using a single ICC compound symmetry is assumed, meaning that the correlations among days are similar (28). However due to day to day variability, correlations between days will probably differ, violating the compound symmetry assumption leading to underestimation of the required days (28).
There is a poor to moderate convergent validity between the AD and the Actical. To measure PA in groups of patients with JIA one-week assessment with an accelerometer is sufficient. On individual level and for clinical use 3 weeks are required whereby the additional use of an AD is advised to be able to correct for non-wear.
Chapter 6 Measuring PA in JIA

REFERENCE

Appendix 1. Bland-Altman plots visualizing level of agreement between mean time spend in rest, light physical activity (LPA) and mean to vigorous physical activity (MVPA) in minutes/day measured with Actical (Act) versus Act corrected (Actcorr) for non-wear.
Median (Solid line) [2.5 percentile; 97.5% percentile] (dotted lines) rest -17 [0; -87]; LPA 15 [0; 76]; MVPA 0 [0; 25].