Validation of activPALTM defined sedentary time and breaks in sedentary time in 4- to 6-year olds.

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Abstract

This study examined the classification accuracy of the activPAL™, including total time spent sedentary and total number of breaks in sedentary behavior (SB) in 4-6 year old children. Forty children aged 4-6 years (5.3±1.0 years) completed a ~150-min laboratory protocol involving sedentary, light and moderate-to vigorous-intensity activities. Posture was coded as sit/lie, stand, walk or 'other' using direct observation. Posture was classified using the activPAL™ software. Classification accuracy was evaluated using sensitivity, specificity and area under the receiver operating characteristic curve (ROC-AUC). Time spent in each posture and total number of breaks in SB were compared using paired sample t-tests. The activPAL™ showed good classification accuracy for sitting (ROC-AUC=0.84) and fair classification accuracy for standing and walking (0.76 and 0.73, respectively). Time spent in sit/lie, and stand was overestimated by 5.9% (95% CI=0.6%-11.1%) and 14.8% (11.6%-17.9%), respectively; walking was underestimated by 10.0% (-12.9%--7.0%). Total number of breaks in SB were significantly overestimated (55±27over the course of the protocol; p

Keywords

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Validation of *activ*PAL^{TM} defined sedentary time and breaks in sedentary time in 4-6 year olds.

Running title: Validity of the *activ*PAL^{TM} in preschoolers

Abstract

This study examined the classification accuracy of the *activ*PAL™, including total time spent sedentary and total number of breaks in sedentary behavior (SB) in 4-6 year old children. Forty children aged 4-6 years (5.3±1.0 years) completed a ~150-min laboratory protocol involving sedentary, light and moderate- to vigorous-intensity activities. Posture was coded as sit/lie, stand, walk or 'other' using direct observation. Posture was classified using the *activ*PAL™ software. Classification accuracy was evaluated using sensitivity, specificity and area under the receiver operating characteristic curve (ROC-AUC). Time spent in each posture and total number of breaks in SB were compared using paired sample t-tests.
The *activ*PAL™ showed good classification accuracy for sitting (ROC-AUC=0.84) and fair classification accuracy for standing and walking (0.76 and 0.73, respectively). Time spent in sit/lie, and stand was overestimated by 5.9% (95% CI=0.6%-11.1%) and 14.8% (11.6%-17.9%), respectively; walking was underestimated by 10.0% (-12.9%--7.0%). Total number of breaks in SB were significantly overestimated (55±27 over the course of the protocol; p<0.01). The *activ*PAL™ performed well when classifying postures in young children. However, the *activ*PAL™ has difficulty classifying 'other' postures, such as kneeling. In addition, when predicting time spent in different postures and total number of breaks in SB the *activ*PAL™ appeared not to be accurate.

Keywords: accelerometry; preschoolers; posture allocation

Introduction

Excessive time spent sedentary during childhood increases the likelihood of becoming overweight as an adult (13) and is adversely related to several health outcomes independent of the amount of moderate- to vigorous-intensity physical activity (MVPA) undertaken (13, 21). In addition, prolonged bouts of uninterrupted sedentary behavior (SB; >30 mins) have been associated with cardiovascular disease risk factors (15) possibly due to distinct and important physiological differences in skeletal muscle metabolism and energy expenditure which appear to exist between standing still and sitting in adults (12). However, whether or not total SB and prolonged bouts of SB affect health outcomes independent of MVPA in children and adolescents is not yet conclusive (1, 3, 5, 10, 19). Emerging evidence suggests that SB might be related to adverse health outcomes, especially in overweight and obese children (1, 5, 19). To our knowledge, no studies have reported on the effects of SB on health outcomes independent of MVPA in preschool-aged children. Understanding whether or not SB affects health outcomes in preschool children will depend on the ability to measure SB adequately.

A limitation of current SB research is the method used to measure SB. Hip-mounted accelerometers are the most common objective monitoring tool used to measure SB in children. However, the placement of accelerometers on the hip and the use of threshold values for non-waveform signals make it difficult to distinguish sitting from standing still (4), which in turn may increase measurement error when assessing SB and light-intensity physical activity (LPA). Valid measures that are able to accurately detect movement from sitting to standing are needed to determine if SB influences health outcomes in preschoolers, independent of PA. Newer accelerometer-based devices use sensors which are sensitive to both static and dynamic accelerations, which if stored in raw form make it possible to measure the angle of the device relative to the gravitational field. By measuring the angle of the device, the orientation of the body segment to which the device is attached can be determined. From this, inferences can be made about the position of the body (4).

One of the devices using this new technology is the *activ*PAL™ (PAL Technologies Ltd., Glasgow, UK), which measures the acceleration of the thigh. The *activ*PAL™ software classifies the measured signal into sit/lie, stand or walk; this method is now widely used (11, 14, 17, 20, 22). Nevertheless, to date only two studies have examined the validity of the method for estimating posture allocation (7, 9) or breaks in SB (i.e. transition from sitting to standing or walking) (8) against a criterion measure in preschool-aged children. However, the results of these studies were contradictory, with one reporting high values of sensitivity and specificity (7), another reporting low levels of sensitivity and specificity when classifying postures (9). The conflicting results might have been due to differences in how certain activities were interpreted by the direct observation method. For example, one study included kneeling as SB (i.e. sit/lie) (9), whereas another study classified this as 'other' (7). In addition, different epoch settings were used (i.e. 15s versus 1s) (7, 9). One study examined the accuracy of *activ*PAL™ defined breaks in SB (8). Davies et al. reported an overestimation of the number of breaks in SB predicted by the *activ*PAL™ in this age group (8).

To improve our knowledge of possible health benefits of reducing and/or breaking up prolonged SB and to improve our understanding of SB patterns in preschool children it is important to have objective measures which measure both time spent in different postures (e.g. sitting and standing) and breaks in SB. Consequently, the aim of this study was to examine the classification accuracy of the *activ*PAL™, including total time spent sedentary and total number of breaks in SB in 4-6 year old children.

Methods

Study participants. Forty healthy 4-6 year old children were recruited from the Illawarra region of New South Wales, Australia. Participants were recruited from childcare centres (preschools, long-day and family-day care) and excluded from the study if their parents reported they had a disease known to influence their energy balance (e.g. hypothyroidism), had a physical disability and/or were claustrophobic. No children were excluded on these grounds. The study was approved by the University of Wollongong/ SESIAHS Health and Medical Human Research Ethics Committee. Parents of participants provided informed written consent, and their children provided their assent to participate in the study.

Activity Protocol

Participants followed a 150-min structured activity protocol in the laboratory. The protocol involved child appropriate SB, LPA and MVPA. Children performed all activities in an identical order over a pre-determined duration (most activities lasted 3 to 5 min) under the guidance of a trained research assistant (Table 1). Children’s height and weight were measured using standardised procedures: height to the nearest 0.1 cm using a portable stadiometer (PE87, Mentone Educational Centre, Victoria, Australia) and weight to the nearest 0.1 kg using a calibrated electronic scale (Tanita BC-418A, Tanita Corporation of America, Illinois, USA).

Accelerometer

The *activ*PAL™ is a uni-axial accelerometer. The *activ*PAL™ software classifies periods of time in different postures, categorized as sit/lie, stand or walk, based on the inclination of the thigh. In addition, the *activ*PAL™ software identifies transitions from sit/lie to upright and from upright to sit/lie. The *activ*PAL™ was initialized with minimum sitting or upright period of 1s and time synchronized with the video camera (used for direct observation, see next section). Children were fitted with an *activ*PAL™ on the right thigh using a double sided hydrogel adhesive pad (PALstickies, PAL Technologies Ltd., Glasgow, UK), and an elastic bandage to provide additional stability.

Direct Observation

To examine the validity of the *activ*PAL™ for classifying postures and to test the accuracy of the *activ*PAL™ when predicting total breaks in SB participants were filmed during the protocol. Video footage was coded using Vitessa 0.1 (Version 0.1, University of Leuven, Belgium) which generated a time stamp every time a change in posture or intensity was coded by the observer (23). Every second following a given time stamp was coded as being at the same posture as that occurring at the point of the time stamp itself. Each second was coded in this way until a change in posture was indicated by the appearance of the next time stamp. This resulted in second-by-second coding. Children’s postures were classified as sit/lie, stand, walk, other, or off screen. Postures were classified as sit/lie whenever the child’s bottom touched the ground, a chair, or their legs (e.g. kneeling on both knees with their bottom touching the legs or heels). ‘Other’ was defined as any posture which did not fit in with the sit/lie, stand or walk categories, such as kneeling on one knee, crawling, or hanging over the edge of a chair while leaning on a table (7). One observer coded all data after completing two days of specific training using data from pilot trials. To assess inter-observer reliability, video footage of four randomly selected participants was coded by the observer and a criterion observer who had expertise in coding postures from video footage. Inter-observer reliability was 89.4%.

Data reduction

Classification accuracy for classifying postures. Posture allocation data from the *activ*PAL™ were used as 1-s epochs and aligned with second-by-second direct observation data. In the event of more than one posture occurring during the same second, either in direct observation or *activ*PAL™ data, the second was duplicated. Direct observation data were then coded using a binary classification system as follows; sit /lie (1) versus stand/walk/’other’ (0), stand (1) versus sit/lie/walk/’other’ (0) and walk (1) versus sit/lie/stand/'other' (0). For the *activ*PAL^{TM} data were coded as sit /lie (1) versus stand/walk (0), stand (1) versus sit/lie/walk (0) and walk (1) versus sit/lie/stand (0).

Validity of time spent in different postures. Time spent in sit/lie, stand and walk were calculated for the *activ*PAL^{TM} and direct observation for each participant. Direct observation data were then compared to *activ*PAL^{TM} data.

Validity of breaks in sedentary time. Breaks in SB (i.e. transitions between sit/lie and upright (i.e. stand or walk)) were coded with a custom-made Microsoft Excel, version 2010 (Microsoft Corporation Ltd., Silicon Valley, CA) macro using the second-by-second *activ*PAL^{TM} posture allocation data and second-by-second direct observation data. Transitions from stand or walk to sit/lie were not counted. The total number of breaks were calculated for each participant over the duration of the protocol. Analyses were conducted including and excluding epochs which were classified as 'other'. As, to date, there is no evidence to indicate whether these 'other' postures have the same physiological effects as either sitting or standing. Therefore, postures classified as 'other' were reclassified as both sit/lie and standing when examining the validity of breaks in SB. This means analyses were undertaken in two ways: 1) 'other' postures were reclassified as sit/lie (i.e. 'other' to upright transitions were included as sit/lie to upright transitions); and 2) other postures were reclassified as upright (i.e. sit/lie to 'other' transitions were included as sit/lie to upright).

Statistical analysis

Sensitivity, specificity, and area under the receiver operating curve (ROC-AUC) were calculated to evaluate the classification accuracy for posture allocation. The sensitivity and specificity relate to the classification accuracy of the discriminating angle within the proprietary algorithm used by the *activ*PAL^{TM} to classify sitting, standing or walking against the criterion measure of direct observation. The area under the ROC-curve (ROC-AUC) provides an indication on how accurately the discriminating angle within the proprietary algorithm used by the *activ*PAL™ can classify a behaviour (e.g. sitting), taking both sensitivity and specificity into account. ROC-AUC values were defined as excellent (0.9-1.0), good (0.8-0.9), fair (0.7-0.8) or poor (<0.7) (18). Differences in total duration of time spent in each of the postures obtained from the *activ*PAL™ and direct observation and differences in the total number of breaks in SB between *activ*PAL™ and direct observation data were examined using dependent samples t-tests. All statistical analyses were performed using STATA Version 12 (StataCorp, College Station, Texas, USA).

Results

Characteristics of study sample. Forty children completed both visits. Two had missing data due to *activ*PAL™ failure. Therefore, 38 children had valid *activ*PAL™ and direct observation data. The mean direct observation time per child was 147 min (± 28 min). Of the possible 335160 1-s epochs (38 x 147 x 60) 329456 epochs were included (98.3%). Excluded epochs were due to the child being off screen. Descriptive characteristics are presented in Table 2. Overweigh was defined according to Cole et al. cut points (6). None of the participants were obese according to the Cole et al. cut points (6).

Classification accuracy for classifying postures

Sensitivity, specificity and ROC-AUC were analyzed for sit/lie, stand, and walk. Results are reported in Table 3. For sit/lie, classification accuracy was good (ROC-AUC = 0.84 and 0.88 including and excluding the 'other' postures, respectively). Classification accuracy increased significantly when 'other' postures were excluded ($p<0.05$). Classification accuracy for standing (ROC-AUC=0.76 and 0.77 including and excluding 'other' postures, respectively) and walking (ROC-AUC=0.73 and 0.74 including and excluding 'other' postures, respectively) was fair. After excluding 'other' postures small but significant increases in classification accuracy were found ($p<0.05$).

Validity of time spent in different postures

Data were analyzed both including and excluding seconds classified by direct observation as 'other'. Time spent in different postures is shown in Figure 1. Including other postures resulted in the *activ*PAL^{TM} classifying 46.6% (±16.3%), 32.7% (±10.1%) and 20.7% (±9.1%) of the time as sit/lie, stand and walk, respectively. Corresponding direct observation data classified 40.8 % (±15.0%), 17.9% (±6.3%), 30.7% (±9.7%) and 10.6% (±7.3%) as sit/lie, stand, walk, and other, respectively. The mean difference and 95% confidence intervals of the *activ*PAL^{TM} and direct observation were +5.9% (0.6% to 11.1%), +14.8% (11.6% to 17.9%) and -10.0% (-12.9% to -7.0%) for sit/lie, stand and walk, respectively. Of the data coded as 'other' by direct observation, the *activ*PAL^{TM} classified 51.7% (±24.1%), 31.4% (±14.6%) and 16.9% (±17.3%) as sit/lie, stand and walk, respectively. Including postures classified as 'other' resulted in a significant difference between sit/lie defined by the *activ*PAL^{TM} and direct observation ($p<0.05$). When excluding postures classified as 'other', the *activ*PAL^{TM} classified 45.6% (±17.7%), 33.0% (±10.5%) and 21.4% (±9.8%) of the time as sit/lie, stand and walk, respectively. Corresponding direct observation data classified 45.2 % (±14.7%), 20.1% (±7.0%), and 34.6% (±10.9%) as sit/lie, stand and walk, respectively. The mean difference and 95% confidence intervals of the *activ*PAL^{TM} and direct observation were +0.3% (-4.8% to 5.5%), +12.9% (9.6% to 16.2%) and -13.2% (-16.3% to -10.2%) for sit/lie, stand and walk, respectively. No significant difference was found between the *activ*PAL^{TM} predicted time spent in sit/lie direct observation defined time spent in sit/lie ($p=0.58$). In addition, time classified as stand or walk was significantly different between direct observation and the *activ*PAL^{TM} with no difference when including or excluding postures classified as 'other' ($p<0.05$ for all).

Validity of breaks in sedentary time

The number of breaks throughout the duration of the protocol was 55 (±26) for the *activ*PAL™ and 20 (±11) for direct observation when excluding epochs classified as ‘other’. A significant difference was found between the two means (35±22; $p < 0.01$). Reclassifying epochs classified as ‘other’ and including them as sit/lie resulted in 79 (±38) and 55 (±26) breaks in SB identified by the *activ*PAL™ and direct observation, respectively, over the course of the protocol. Consequently this led to a smaller, but still significant, overestimation of transition occurring from sit/lie to upright (24±22) ($p < 0.01$). When reclassifying ‘other’ as upright the *activ*PAL™ coded 83 (±34) breaks over the course of the protocol, whereas 28 (±17) breaks where coded over the course of the protocol using direct observation resulting in a significant difference (55±27; $p<0.001$).

Discussion

Main findings, comparisons with other evidence and study implications

The *activ*PAL™ demonstrated good classification accuracy for sitting and fair classification accuracy for standing and walking. However, time spent sitting and standing was overestimated by the *activ*PAL™ while time spent walking was underestimated. In addition the total number of breaks was significantly overestimated by the *activ*PAL™ when using a 1s minimum sitting or upright period.

This study found a significant difference between time spent in SB estimated by the *activ*PAL™ and direct observation whereas good classification accuracy was found for SB. These results may seem contradictory, but might partly be due to the nature of the different tests used. When examining the classification accuracy *activ*PAL™ data was compared to the criterion measure on an epoch by epoch level, whereas time spent in each intensity was analyzed using total time spent in the specified intensity on child level. Consequently a larger number of data points was used when examining classification accuracy (n=329456), compared to time spent in different postures (n=38). Although, the *activ*PAL™ was found to significantly overestimate time spent sedentary, the value was 5.9%. This equates to an overestimation of 3.5 min per hour, of which the practical or clinical significance is unclear. To our knowledge, only one study has previously examined the validity of time spent in different postures against a criterion method for posture allocation in preschool-aged children (7, 9). Davies et al. (7) reported that the *activ*PAL™ significantly underestimated time spent sitting/lying, which is in contrast with the results from the current study. A clear difference between the current study and Davies et al. (7) is the amount of time classified as 'other' by direct observation. In the current study 11% of the seconds were classified as 'other', whereas in the study by Davies et al. (7) children spent 3% of their time in postures classified as 'other'. Our data showed that most of these 'other' postures were classified as sit/lie by the *activ*PAL™. In addition, when excluding postures classified as 'other' the mean differences between direct observation and the *activ*PAL™ were small and not statistically significant. The amount of 'other' postures might have contributed to the overestimation of sitting time in the current study.

Using the *activ*PAL™ to classify sit/lie and stand resulted in good sensitivity and specificity. However, when classifying walking, sensitivity was only 52.5% suggesting that the *activ*PAL™ might not be sensitive enough to distinguish standing still from walking in 4-6 year old children. To our knowledge, only two studies have previously examined the classification accuracy of the *activ*PAL™ against a criterion method for posture allocation in preschool-aged children (7, 9). De Decker et al. (9) reported poor classification accuracy for sit/lie which is not consistent with the findings in the current study. However, Davies et al. (7) reported that sensitivity and specificity for *activ*PAL™ classification of sit/lie and stand categories ranged from 86.5% to 97.3%, respectively, whereas the sensitivity for walking was approximately 77.9%. These values are slightly higher than were found in the current study.

Again, one difference between these two studies and the current study is the time classified as 'other'. De Decker et al. (9) reported that 38% of monitored time was spent in postures classified as 'other'. The large proportion of time classified as 'other' in the study by De Decker et al. (9) might have resulted in low classification accuracy for sit/lie. The findings in the current study and those from others suggest that a key factor in interpreting the results of *activ*PAL™ defined SB is the amount of 'other' postures included.

It is unknown how long preschool children typically spend in postures that are difficult to classify as sitting or standing in free-living settings such as their homes or child-care. However, because of the characteristics of their active play (e.g. playing with toys on the floor), it is plausible that they might spend a meaningful amount of time in these types of postures. Therefore, the overestimation of sitting time when using the *activ*PAL™ could potentially be more apparent in young children compared to adolescents or adults. However, as there is no evidence to indicate how these 'other' postures relate to health outcomes it is unclear how these postures should be classified and, therefore, it is difficult to determine the validity and classification of the *activ*PAL™ in young children.

This study showed an overestimation in the total number breaks in SB detected by the *activ*PAL™ compared to direct observation. Similar results were found by Davies et al. (8) who reported an overestimation of the number of breaks in SB predicted by the *activ*PAL™ (8). Additional analyses in this study showed that the difference in total number of breaks between the *activ*PAL™ and direct observation was influenced by including or excluding the epochs classified as 'other' by direct observation. By reclassifying epochs classified as 'other' to sit/lie the mean difference decreased, indicating that *activ*PAL™ may have classified the majority of the "other" postures as sit/lie. In their study, Davies et al. (8) reported that 34% of children's breaks in SB were from 'other' postures to an upright posture. Results in this study showed that 63.8% of children's transitions to upright postures were transitions from 'other' postures to upright. This may indicate that a considerable number of young children's breaks include 'other' postures. It is not known how common breaks from sitting to 'other' postures are in older children or adults. However, preschool-aged children may spend considerably more time in 'other' postures due to the sporadic and intermittent nature of their movements. Therefore, they may accumulate more breaks from or to 'other' postures. Based on two previous studies (7, 9) and the current study, time spent in 'other' postures seems to be related to the classification accuracy of the *activ*PAL™ and therefore the overestimation of breaks in SB when using the *activ*PAL™ might be more apparent in young children compared to older children or adults.

It is not clear among young children whether these breaks in SB are beneficial for health, or how frequent a break needs to occur in order to be biologically meaningful. Evidence among adults has emerged demonstrating the metabolic benefits of breaking up prolonged sitting (measured by change in posture). Breaking up sitting time increases muscle fibre recruitment which may potentially produce specific cellular signals which regulate some cardiometabolic risk factors (12). In addition, recent studies have shown that increasing the number of breaks (i.e. increasing overall physical activity energy expenditure) in sitting time is beneficially associated with metabolic risk factors independent of total sitting time and MVPA (15, 16). It is unclear whether these mechanisms and health benefits occur in preschool-aged children and whether transitioning from sit/lie to 'other' postures would be classified as a break in sitting time. However, one could argue that moving from sitting to a posture specified as 'other' would require the muscles to contract and therefore these transitions may be considered as a break. Future studies are needed to assess the importance of breaks in sitting time in preschool-aged children.

Study Limitations and Strengths

This study had several limitations. First, it was conducted in a laboratory-based environment which may limit the generalizability of the findings to free-living behaviors. Second, 11% of children's postures were classified as 'other'. Including these seconds, as is done in free-living studies, had a significant impact on the results with a significant decrease in specificity. However, as it is unclear how much time preschool-aged children spend in 'other' postures, studies are needed to examine the total amount of time spent in 'other' postures before a conclusion can be drawn about the impact of the misclassification of 'other' postures.

This study also had several strengths. The sample of 38 preschool children was relatively large, evenly distributed by sex, and approximately representative with regards to weight status. In addition, including 2.5 hr of direct observation per child as a criterion measure is a longer observational period than has been included in other studies. The protocol included a variety of child-specific and developmentally appropriate activities, ranging in intensity from SB to MVPA and including a substantial variation in postural allocation and transitions between postures which is in line with current best practice recommendations for activity monitor validation studies (2).

Conclusions

The results of this study show that the accelerometer method has reasonable classification accuracy when assessing postures on an epoch level in preschool children. However, *activ*PAL™ defined time spent in different postures was less accurate. Significant differences in the number of breaks in SB recorded by the *activ*PAL™ were found. The *activ*PAL™ is unable to classify a wide variety of 'other' postures. Therefore, future studies should examine the importance of classifying 'other' postures in young children.

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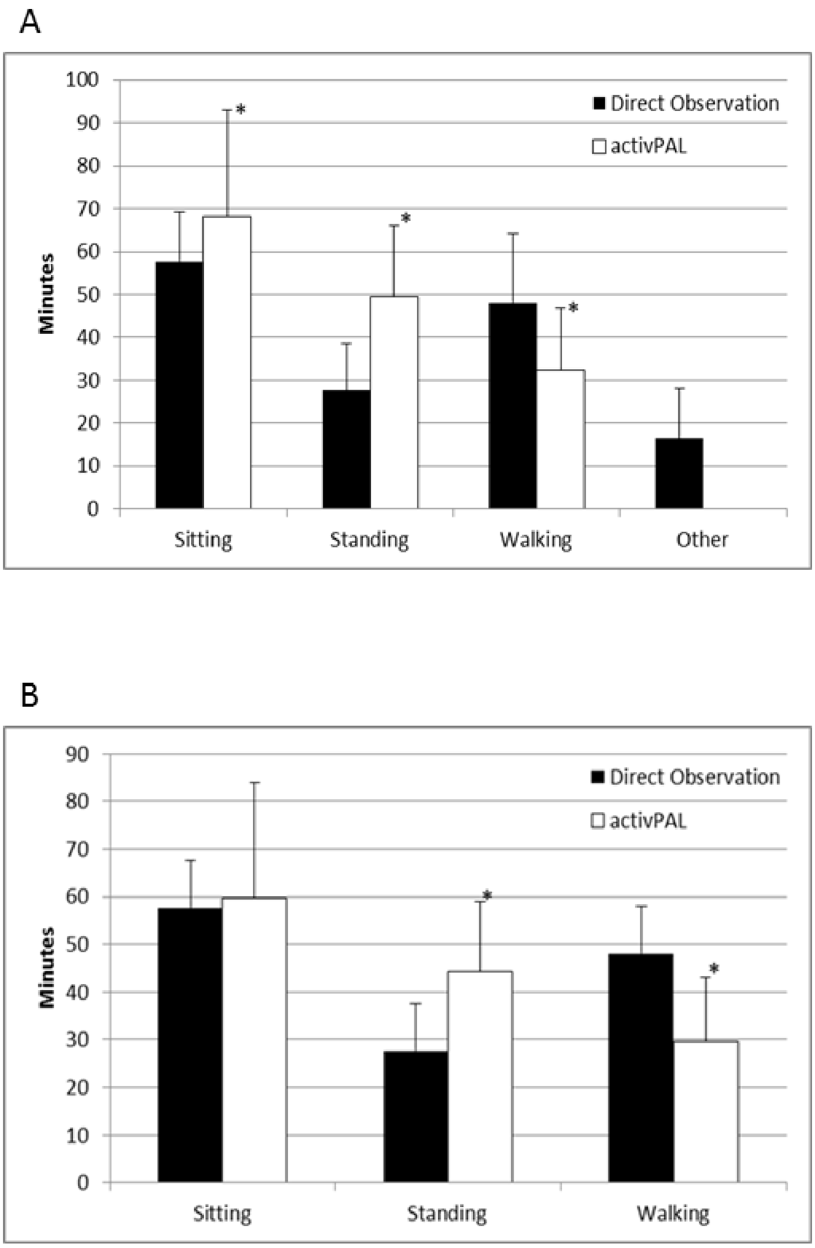

Figure 1. Time classified as sit/lie, stand, walk or other by direct observation and the *activ*PAL™. A) including postures classified as 'other'; B) excluding postures classified as 'other'.

Table 1. Activity protocol

Activity	Time (min)
Sedentary Intensity	
Watching TV–sitting in a beanbag	30
Talking on telephone with parents – sitting	2
Reading books with a cassette – sitting	5
Drawing/colouring in – sitting	10
Subtotal	**47**
Light Intensity	
Playing with toys, Lego, dolls, puzzles, games – sitting on floor	20
Drawing on a whiteboard – standing	3
Personal grooming (brushing teeth, hair, washing hands/face)	3
Dressing up in costumes	5
Playing musical instruments – standing	5
Domestic chores (hanging out washing, setting table)	4
Mini-golf	5
Walking on spot – light effort (Wii game)	2
Playing quoits	3
Subtotal	**50**
Moderate and vigorous intensity	
Cleaning (packing away toys, dusting, sweeping)	5
Running on spot – moderate effort (Wii game)	5
Hopscotch, star jumps, walking stairs	5
Shooting small basketball into small ring on wall	3

Activity	**Time (min)**
Animal walks (e.g., like a chicken, kangaroo, bear)	5
Wii sports cycling	10
Hitting a balloon in the air and catching it	5
Circuit (walking up foam stairs, jumping off, crawling through a standing hoop, and running back)	5
Running on the spot (Wii game)	5
Dancing/aerobics (Wii Game)	2
Subtotal	**50**
GRAND TOTAL	**147**

Table 2. Participant characteristics

	Total sample (n=38)	Boys (n=20)	Girls (n=18)
Age (years)	5.3 ± 1.0	5.2 ± 1.0	5.3 ± 1.1
Height (cm)	112.7 ± 8.1	114.0 ± 6.4	110.9 ± 9.7
Weight (kg)	20.4 ± 3.7	21.3 ± 2.4	19.4 ± 4.6
BMI (kg/m^2)	16.0 ± 1.5	16.4 ± 1.2	15.5 ± 1.6
% overweight*	23.7	25.0	22.2

*defined according to Cole et al. (6)

Table 3. Sensitivity, specificity and ROC-AUC for sit/lie, stand and walk.

	Sit/lie			Stand			Walk		
	Se% (95% CI)	Sp% (95% CI)	ROC-AUC (95% CI)	Se% (95% CI)	Sp% (95% CI)	ROC-AUC (95% CI)	Se% (95% CI)	Sp% (95% CI)	ROC-AUC (95% CI)
Including 'other' category	87.6 (87.4-87.8)	81.0 (80.8-81.1)	0.84 (0.84-0.84)	75.6 (75.2-75.9)	76.6 (76.5-76.8)	0.76 (0.76-0.76)	52.5 (52.2-52.8)	93.1 (93.0-93.2)	0.73 (0.73-0.73)
Excluding 'other' category	87.6 (87.4-87.8)	88.1 (87.9-88.2)	0.88 (0.88-0.88)	75.6 (75.2-75.9)	77.9 (77.7-78.0)	0.77 (0.77-0.77)	52.5 (52.2-52.8)	95.0 (94.9-95.1)	0.74 (0.74-0.74)