The study of children's physical activity

Peter Pagels\textsuperscript{1} Cecilia Boldemann\textsuperscript{2} Anders Raustorp\textsuperscript{3}

\textsuperscript{1}PhD student in public health sciences at Karolinska Institutet, senior registrar at Linnaeus University, Kalmar. E-mail peter.pagels@lnu.se. \textsuperscript{2}Associate professor, public health sciences, Karolinska Institutet, and Centre for Epidemiology and Community Medicine. E-post: Cecilia.Boldemann@ki.se. \textsuperscript{3}Associate professor, physiotherapy, and senior lecturer, University of Gothenburg. E-mail: anders.raustorp@gu.se.

Preschool children's physical activity is an important health promoter against several of the lifestyle diseases. Therefore it is important that the preschool environment encourages preschool children to healthy physical activity. In the Kidscape project we studied preschool children's physical activity during their stay at the preschool. The aim was to identify factors in the outdoor environment that influence children's activity patterns. Activation patterns were studied with both subjective methods (CARS and qualitative observation) and objective methods (pedometri and accelerometry). The results showed that preschool children's physical activity was higher in preschools with a good schoolyard environment. Conclusion: preschool outdoor environment can promote a healthy physical activity in preschool children.

Background

Why should we measure physical activity in children at preschool?

From an early childhood man has a unique capability of moving around in a lot of different ways by walking, running, cycling, swimming etc. From a biological perspective it is obvious that these capabilities were created in order to adapt to a multitude of environments in the search for food and other things necessary to sustain life. Some historians believe that mankind some 10000 years ago switched from living like nomads to a rather stationary life in organized societies. Even in those days we probably started developing certain health problems directly related to a physically less demanding life. In the modern society of today with its decreasing demand of occupational physical effort these health problems have escalated. Motion sensors such as accelerometers and pedometers are today commonly used in research as these devices store information in an unobtrusive and objective way, and are easy to handle.

There are serious consequences in the form of increasing prevalences of lifestyle diseases such as cardiovascular and metabolic diseases, certain cancers such as bowel cancer, and musculoskeletal diseases (O'Keefea JO et al. 2011).

Medical research has shown that important medical preventive action against these conditions is to decrease
sedentariness and to increase physical activity from a very early start, in fact as early in life as possible (Guinhouya BC & Hubert H, 2011, Oliver M et al. 2007). In order to develop and to specify these actions the focus of research should be as early as at preschool level, as it offers opportunities for early action to impact life style patterns, as well as opportunities to have an influence on the physical environment that the children are confined to during the major part of the day. Play and locomotion fuel children’s development. Running around, climbing and bouncing are a part of verbal, emotional and social development. The vital importance of physical activity for people’s health has been in focus since the mid-90s. (USDHHS, 1996). Research has shown that even moderate physical activity yields considerable health gains (Blair SN & Morris JN, 2009). It has also been stated that activity patterns established in childhood tend to have long-term effects up to adult age (Telama R. et al., 2005). Recommendations for preschool children state 60-180 minutes of at least moderate physical activity (Strong et al. 2005).

Definitions
Physical activity is defined as all movement carried out by skeletal muscles that contribute to metabolic increase (Caspersen et al. 1985). This concept is to be seen as an umbrella concept for human behavior that includes daily activities, transports, occupational activity, housework, gardening, aerobics etc. (USDHHS, 1996). There are some factors which are significant for the impact of physical activity, namely frequency, duration, intensity and type of activity. Frequency refers to how often physical activity takes place, commonly the number of episodes of moderate to vigorous physical activity during the course of a week or a day. Its duration refers to all uninterrupted time spans of physical activity.

Method
How do we measure physical activity? Measuring the relationship between physical activity and health impact in preschool children requires reliable methods to assess frequencies (regularity), intensity (level of activity), duration, and that also gives a picture of the type of activity that is carried out. Subjective as well as objective methods (direct observation, self-reports) and objective measurement (heart rate, motion sensors) may be applied in measuring physical activity (Welk et al. 2002). Applying a mix of both subjective and objective methods may be preferred when studying children’s physical activity patterns, especially when it comes to making changes in the physical environment or to bring about behavior change. Subjective measurement will amongst others tell you about the type of physical activity that is carried out, and the way children have experienced it, whereas objective measurement give a detailed picture of the duration, intensity and frequency of the physical activity.

Subjective methods in the Kidscape project
One subjective method that was used in the Kidscape project when studying the preschool children’s physical
activity during outdoor stay in KIDS-CAPE. It is a mode of quantitative observation termed Children’s Activity Rating Scale (CARS). CARS categorizes physical activity into five escalating intensity levels (Puhl et al. 1990) which have also been tested and validated on young children (Durant et al. 1993). These intensity levels are defined as follows: 1) stationary without movement (the child is quite still), 2) stationary and moving (the child sits or stands on the same spot but moves its torso, arms or legs), 3) slow translocation e.g. ambling around, 4) medium-intensive translocation e.g. walking quickly, 5) rapid translocation, e.g. running. The observations were made when the children were outdoors. For speedy registration and download of each separated child’s CARS data we used a pre-programmed PDA device. Observations were carried out systematically with the outdoor environment being divided into sections (behavior settings) which were scanned in a set order. Each section was observed from the right to the left and as soon as a child was seen in the range of vision its CARS value was registered. At the same time a mark was made on a map of the outdoor area of where that observation had taken place (Figure 1). This method, “behavior mapping”, is in detail described by Cosco et al. (2010). Opposite to motion sensors such as pedometers and accelerometers, bodily movements e.g. without moving the torso such as ballgames, digging in the sandbox, tricycling may be registered by CARS.

During outdoor stay qualitative observations were made of the children’s physical activity. During these observations the observer slowly wandered about registering the type of physical activity, and whether this took place alone, by two, three or in a group. Interaction and use of the physical en-

Figure 1. Mapping of the preschool children's location in the outdoors. One dot corresponds to one child.
environment was also registered during these observation rounds. Maps were used to register these observations.

Objective methods for the measurement of physical activity

Motion sensors such as accelerometers and pedometers are today commonly used in research as these devices store information in an unobtrusive and objective way, and are easy to handle.

Pedometry

Pedometers are cost-effective, reliable and yield summed-up total data for one measurement period which may be useful for screening, guidance, surveillance and evaluation (Tudor-Locke C & Bassett DR Jr. 2004, Welk et al. 2000). Pedometers are very suitable when to convey an easily understandable message - and thereby a public health goal - to a general public audience, as data such as steps per day are easy to assimilate. The downside of the pedometer is the inability to measure intensity other than as steps per minute, and that it is not time-stamped. From the viewpoint of medical research it is data of the quality of movement that is important i.e. its intensity and exactly when it took place. The pedometer does not yield reliable values for certain common types of physical activity such as cycling, swimming and weight-carrying activities. On the other hand a conversion formula for e.g. cycling has been elaborated (Raustorp et al. 2013). The pedometer is also highly unreliable in “wrong” positions, for instance if being mounted upside down which easily happens in field studies with small children, especially if the device is attached to a removable belt instead of to the band of the trousers.

Accelerometry

The accelerometer too is a reliable motion sensor with a basic function resembling that of the pedometer, i.e. the mechanism is a little sensor that responds to change in direction. The accelerometer used in the Kidscape I project is an Actigraph GT1m which has been calibrated for children against heart rate, (Janz KF et al. 1994), indirect calorimetry (Melanson EL et al. 1995), observations (Fairweather SC et al. 1999) and metabolism by doubly labeled water (Ekelund U et al. 2001). Actigraph GT1m’s register translocation (as does the pedometer) at one horizontal level, but the Actigraph GT3X available nowadays enables the registration of movements at three different levels at the same time: horizontal, frontal and transversal. Further, this time-stamped device registers the intensity of translocation at these levels and when it takes place. This is of great significance when it comes to assessing the quality of physical activity and thereby the pattern of activity. Accelerometers are able to distribute translocation data according to a preset registration epoch. Epochs ranging from a few up to 60 seconds are applied in research (McClain JJ et al. 2008). The sum of translocation during one epoch may be used to distribute the material along different intensity levels such as inactivity, light, moderate or vigorous physical activity. The threshold values of the different levels are set using so-called cut points, a pre-determined number of entries during one epoch.
that needs to be obtained for a certain activity level. Cut points may be changed in the accelerometer which makes it possible to adjust the device to various ages. Unfortunately there are no general guidelines for these cut points, however, some review articles supply good information for the determination of cut points (Sirard et al. (2005), Trost et al. 2010, Kim Y. et al. 2012). In Kidscape I we applied cut points according to the recommendations by Sirard et al (Table 1).

Apart from the cost the downside with the accelerometer is that it is likewise unable to yield reliable values of cycling, swimming and weight-carrying activities. Moreover, reliability decreases at high intensities. Fuzzy guidelines for the determination of cut points and the length of epochs are also a problem.

Results

Quantitative observations of physical activity as assessed by CARS was made at two preschools in downtown

Table 1. Cut points according to Sirard et al. (2005)

<table>
<thead>
<tr>
<th>Age</th>
<th>Inactivity</th>
<th>Light activity</th>
<th>Moderate activity</th>
<th>Vigorous activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-year-old</td>
<td>0-301</td>
<td>302-614</td>
<td>615-1230</td>
<td>&gt;1230</td>
</tr>
<tr>
<td>4-year-old</td>
<td>0-363</td>
<td>364-811</td>
<td>812-1234</td>
<td>&gt;1235</td>
</tr>
<tr>
<td>5-year-old</td>
<td>0-398</td>
<td>399-890</td>
<td>891-1254</td>
<td>&gt;1254</td>
</tr>
</tbody>
</table>

Table 2. CARS observed values, F1.

Table 3. CARS observed values, F2.
Malmö, preschool 1 (F1) practicing outdoor education, with 70 attending children aged 3-5 years, and preschool 2 (F2) attended by 57 children aged 3-5 years, practicing traditional preschool education. The outdoor environment of F1 was graded as good, i.e. triggered active play, whereas F2 was graded lower in this respect. The surface of F1 was three times the size of the one at F2 (3701 m² and 1053 m² respectively) with a translocation surface of 53 m²/child (F1) and 18 m²/child (F2) respectively.

The mean CARS value of intensity was observed to be significantly higher at F1 (2.51) compared to F2 (2.37) (Tables 2 and 3). In both preschools the intensity of translocation differed significantly between boys and girls. We also studied social interaction along with the registration of CARS values. F1 had significantly lower levels of physical activity during social communication in a group, and the highest intensities were observed during occasions when the child was on its own.

Physical activity, its frequency, duration and intensity, was higher when outdoors compared to indoor stay (Raustorp et al. 2012). At F1 the children’s step count amounted at an average to 8490 steps per day, compared to F2 where the children merely obtained an average of 5557 steps per day. The total average step count of all 11 preschools participating in Kidscape I was for girls 7313 (±3017) steps per day, for boys 8385 (±3442) steps per day (Pagels P. et al. 2010). The time of moderate and vigorous physical activity during preschool time also differed (18 at F1 and 15 minutes at F2), in both cases far from the recommended 60 minutes (Raustorp et al. 2012).

For preschool children to obtain 60 minutes of moderate to vigorous physical activity published data have benchmarked 10000 -14000 steps daily (Tudor Locke et al 2011).

**Conclusion**

The levels of physical activity that have been measured in the Kidscape I project are insufficient. Parents may thus not count on satisfactory levels of physical activity during preschool time for part of their children. However, the design of the outdoors may promote healthy levels of physical activity in preschool children.
References


English articles


