Jennie Aronsson is a lecturer in Adult Nursing at Plymouth University, England, and a public health nurse with a special interest in outdoor health promotion. Sue Waite is a Reader in the Institute of Education at Plymouth University, England, with a particular focus on research in outdoor learning and wellbeing. Dr Maria Tighe Clark is a lecturer in nursing at University of Birmingham, England, with a special interest in public health and partnership working for health improvement. .

For communication, please email: jennie.aronsson@plymouth.ac.uk

Jennie Aronsson, Sue Waite and Maria Tighe Clark

Measuring the impact of outdoor learning on the physical activity of school age children: The use of accelerometry

In spring 2014, research was conducted evaluating the health benefits of outdoor Learning In Natural Environments (LINE)[1]. The Woodland Health for Youth (WHY) project (Aronsson et al., 2014) was a partnership project between Plymouth University (School of Nursing and Midwifery and Institute of Education), Plymouth City Council (Natural Infrastructure Team and Public Health), Plymouth Community Healthcare, Silvanus Trust (Good from Woods) and a local primary school aiming to measure the physical health benefits of LINE whilst exploring the potential for outdoor learning as a framework for 'whole-school health promotion' (Langford et al., 2014). A public health nurse was appointed as the practitioner-researcher; a role which involves clinical knowledge of the field as a means to develop appropriate methods for the study. This article describes this process, with a particular focus on accelerometry as a component in holistic evaluation of whole-school health promotion using natural environments.

Background

We live in an obesogenic environment where sedentary lifestyles are accompanied by high-calorific food intake, putting the health of our children at risk. Preventing childhood obesity is a current national priority (Public Health England (PHE), 2014a; National Institute for Health and Care Excellence (NICE), forthcoming), with a strong focus on physical activity. In addition to reducing rates of childhood obesity, increased physical activity in children is associated with multiple positive health outcomes such as cardio-metabolic health, muscular strength, bone health, cardiorespiratory fitness, self-esteem, anxiety/stress, academic achievement, cognitive functioning, attention/concentration, confidence, and peer friendship (PHE, 2015). However, physical activity levels in English children are low, with around two in ten children aged 5-15 years meeting the national physical activity target of 60 minutes or more moderate-to-vigorous physical activity every day (PHE, 2014b). Furthermore, a social gradient exists, with children from the lowest income bracket more likely to report low levels of activity (PHE, 2014b).

Kriemler et al. (2011) undertook a systematic review of initiatives that increase physical activity levels in school-aged children, and concluded that school-based initiatives reach the greatest number and most diverse population of children, with a potential to increase physical activity and overall fitness in young people. However, schools have a busy timetable delivering the national curriculum, which hinders opportunities to offer health promotion initiatives. The WHY project evolved from a need to evaluate whether outdoor learning would allow for equitable access to physical activity interventions for school age children, without compromising school's delivery of core subjects. The benefits of outdoor learning are well established and include educational attainment and child mental health and wellbeing indicators (Waite, 2011; Dillon and Dickie, 2012; Roe and Aspinall, 2012). There was a need to explore physical health outcomes in relation to outdoor

[1] The Natural Connections Demonstration Project aims to increase the number of teachers and pupils experiencing the full range of benefits that come from Learning Outside the Classroom In Natural Environments (LINE) across the curriculum, in areas of high deprivation in the south-west of England (http://www.naturalconnectionsblog.wordpress.com)

learning. The specific aim of WHY was to evaluate the physical health benefits of Learning In the Natural Environment (LINE).

Methodology

Choosing an appropriate methodology is pivotal within research management, not only because a specific research problem is best addressed by a certain methodology; the methodology that is used or developed also dictates the structure and content of the inquiry (Brew, 2001). The WHY project aimed to evaluate health benefits within the educational sector with an emphasis on partnership working with the local authority (City Council). In practice, the practitioner-researcher was supported by two supervisors from health and education. This allowed expertise and learning to be shared to produce an innovative research outcome (Bossio et al., 2014). As the research problem was anchored in real world practice, an action research methodology was adopted. Action research concerns problem-solving in a specific context, and aims to improve practice through collaboration between researchers and practitioners (Robson, 2011). The WHY practitioner-researcher role included supporting the delivery of LINE whilst carrying out the research, which meant working closely with school staff. Such involvement requires reflexivity; an awareness of the researcher's position within, and possible influence on, the research (Robertson, 2000).

Action research has the potential to employ both qualitative and quantitative methods to address the research question, allowing for multiple perspectives being incorporated through data triangulation (Mukherji and Albon, 2010). Fielding (2009) argues that this can extend the scope and depth of understanding. However, from a theoretical stance, such mixed methods research poses a clash between underpinning philosophies traditionally associated with quantitative and qualitative research. This is overcome by pragmatism, where knowledge arises from actions, situations, and consequences without being limited to any one system of philosophy and reality (Creswell, 2003). This lends itself to action research, which is a process that works in cycles of planning, acting, observing and reflecting, and is context specific (Mukherji and Albon, 2010). For the WHY project, quantitative data was collected through the measurement of physical activity and body mass index (BMI), and qualitative data was assembled via observations and reflexive diary notes written by the practitioner-researcher. The focus here will be on the development of accelerometry for the quantitative measurement of physical activity.

Accelerometry

An accelerometer is a device that measures acceleration of movement, which can be translated into physical activity (PA) levels. This provides a solid objective measurement of PA and has been used in a number of studies of children across diverse cultures around the world (Sherar et al., 2011). The decision to use accelerometry to measure PA within the WHY project crystallised through consultation and engagement with wider stakeholders for the project, including other researchers working with children in different educational and public health contexts. Two researchers independently recommended this data collection method, one of them offering to lend the accelerometers, which prompted the novel opportunity to pilot their use in the WHY project.

The WHY project used GENEActiv accelerometers (ActivInsights, Kimbolton, http://www.geneactiv.org/) which are wrist-worn accelerometers that are fairly new, yet well established as an objective and feasible measurement tool, comparable to other peer accelerometers (Esliger et al., 2011). Ethical approval for the study was obtained from Plymouth University in 2014. Ten children participated in this small-scale study following written consent from their parents/carers and oral consent from the children every morning of data collection. The participating children wore their accelerometers on their wrist of choice one day a week during school hours for five weeks, which in theory means 50 days of data collection; however due to absence of children on a few occasions the total number of data collection days amounted to 45. Comparison with the school timetable allowed data to be analysed according to PA levels during indoor and outdoor lessons and break times throughout the day.

Cut-points

Previously validated movement count cut-points

(Phillips et al., 2011) were used to determine the proportion of time spent in sedentary, light, moderate and vigorous activity. Cut-points are thresholds applied to the accelerometry 'activity counts' that are used to convert the accelerometer raw data into PA levels. To develop cut-points to use for children there are calibration experiments where children have participated in age-typical activities and accelerometry has been used to determine the activity count for an activity that is sedentary (e.g. sitting down) / light (e.g. walking slowly) / moderate (e.g. walking briskly) / vigorous (e.g. running). Different studies use different sets of activities when they conduct calibration experiments; the study by Phillips et al. (2011) was chosen for the purpose of this project because they used the GENEActiv accelerometers and looked at children close in age to the children participating in the WHY project.

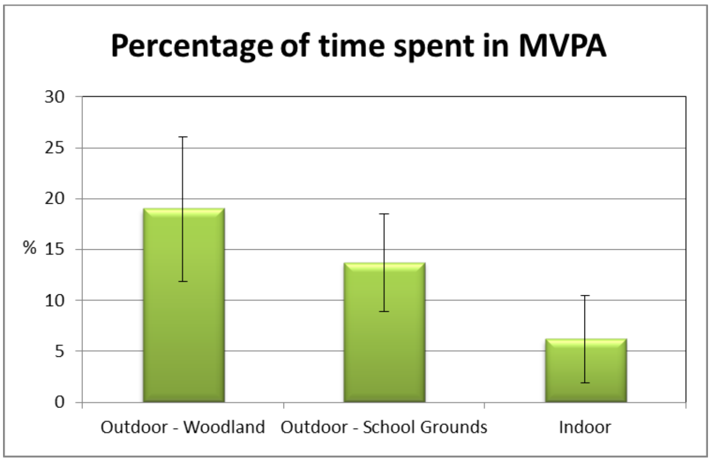
Epochs

The accelerometry raw data were downloaded using the GENEActic PC software (version 2.2) and converted into epochs; units that summarise the data collected during a set time period. An epoch size of 60 seconds is conventionally used; however research has shown that children's movements are more sporadic and intermittent than those of adults, and therefore collecting accelerometer data in shorter rather than longer epochs may capture the short bursts of activity in children more accurately (Colley et al., 2014; Rowlands et al., 2006). However, Schaefer et al. (2013) suggest that very short epochs may capture movements that are not purposeful, such as hand movement from reading. It was therefore thought that 5 seconds would be a suitable epoch length - short enough to capture children's energy burst without capturing movements of the wrist that are not purposeful. This was supported by the researcher's observations in the field (school) whereby it was noted that some children used the arm with the accelerometer to enthusiastically communicate by raising their hands while sitting in the classroom. Thus, the use of accelorometry was largely informed by simultaneous triangulation with other qualitative and quantitative data collection methods (Plano Clark and Creswell, 2008) afforded by action research.

Findings

Statistical Package for the Social Sciences (SPSS) (IBM, Version 21) was used for all statistical analysis, using paired t-test to compare PA levels between LINE and classroom learning. The main focus of the study was to compare moderate-to-vigorous physical activity (MVPA) levels, as there is a national target for children aged 5-18 to spend 60 minutes or more a day in MVPA (Department of Health (DH), 2011). The results showed that children spent a significantly larger proportion of the time doing MVPA during LINE sessions (17.0% ± 6.7 SD[2]) than during indoor lessons (6.2% ± 4.3 SD), p=0.000. The analysis also investigated if activity levels during LINE depended on if the lesson was held in the woodland or in the school ground, and found significantly higher proportions of MVPA in woodland LINE than in school ground LINE: 19.0% ± 7.1 SD in woodland LINE, 13.7% ± 4.8 SD in school ground LINE, p=0.01. Fjørtoft (2004) explains how rough surface, topography and vegetation in natural environments provide challenges for children, which enhances play, PA and motor development. Congruently, Passy and Waite (2011) identify a range of benefits to woodland LINE including greater freedom, wilder and more natural space, child-led learning, negotiated boundaries, created activities and managed risk. Figure 1 [below] shows the difference between the proportion of time children spent in MVPA depending on if they were engaged in woodland LINE, school grounds LINE, or an indoor lesson. This concurs with previous studies which have concluded that children who spend more time outside are more active (Stone and Faulkner, 2014; Cooper et al., 2010).

Figure 1.



[2] The Standard Deviation (SD) measures the amount of variation from the average value in the study sample.

While emphasising the importance of increased MVPA levels, the national recommendations (DH, 2011) together with evidence from research (Stone and Faulkner, 2014) also highlight the value of minimising sedentary behaviour. The WHY project compared the proportion of time spent in sedentary phase during outdoor lessons compared to indoor lessons and found that children spent a significantly smaller proportion of their time being sedentary during LINE sessions (44.2% ± 11.6) than during indoor lessons (60.4% ± 11.0 SD), p=0.000.

The highest levels of PA seen in this study were during break time and lunch (33.0% ± 17.3 SD), which concurs with previous studies exploring physical activities during the school day (Fairclough et al., 2008; Rauh, 2013). However, great variations were noted between individual children within the WHY project, presumably due to greater individual choice of activity during free time. Fairclough et al. (2008) noted more gender differences in activity levels during recess, and Rush et al. (2012) found that the gap in PA levels between the most active children than the least active children was bigger during recess than during the rest of the school day.

The gender imbalance related to physical activity is well-established, with a clear tendency for males to be more active than females at all ages (DH, 2011; PHE, 2014c). National statistics demonstrate that 79% of boys and 84% girls aged 5-15 years in England are not meeting the current physical activity recommendations (PHE, 2015), thus prompting policy to acknowledge the importance of increasing PA levels for girls in particular (Department for Culture, Media and Sport, 2015). Boys tend to participate more than girls in formal sports (Health and Social Care Information Centre, 2015; PHE, 2014c), and engage in more active games than do girls at school break times (Fairclough, 2008). Thus, introducing active curricular activities through outdoor experiential learning may be a more equitable way to increase PA levels for both genders. Indeed, the WHY study found that both boys and girls were more active outdoors compared to indoors. However, boys were generally more active than girls outdoors; boys spent 20.6% ± 6.5 in MVPA compared to 14.7% ± 7.1 for girls, p=0.09.

Limitations

The main limitation of the WHY project is the small sample size, which limits the external validity of the findings. Nevertheless, though the triangulation of quantitative and qualitative data, the results can be transferable to other schools in similar circumstances. The lack of a control group is another limitation, which needs to be addressed in future research.

An additional limitation is that PA was only measured during the course of a day during the five data collection days. It could be that children are less active after a school-day where they have had LINE, because they are physically tired. However, evidence extracted from the WHY reflective log suggests that children spend time in the woodland with their family after school, which would entail being physically active (walking to and within the woods, and probably engaging in activity through playing in the woods). This may be due to families increased interest, knowledge and confidence in accessing the woodland through LINE. Research has shown that children who are active during the school day are also more active after school (Rauh, 2013). This study suggests that children may in fact be inspired by LINE to spend more time outdoors outside of school, consequently increasing the total amount of PA.

Discussion and conclusions

Accelerometry proved to be useful as a component in holistic evaluation of whole-school health promotion using natural environments. Within the action research context, the WHY project dedicated considerable time to the methodology associated with accelerometry, assessing the suitability and deciding on appropriate cut-points and epoch lengths for children. The GENEActiv accelerometers offered an easy way of obtaining an objective measurement of PA and were well accepted by the participating children. This was an important contribution since the GENEActiv accelerometers are relatively new on the market.

The interdisciplinary action research design was found valuable as it allowed for emergent reflections to feed into the research cycle and inform the process. This flexibility enhanced the experience of partnership, as previously described by Richardson and Grose (2013), to become the lens though which the WHY project was observed. Additionally, the interdisciplinary element brought valuable aspects into promoting a whole-school approach to health, in line with the Odense Statement on health-promoting schools, which stipulates that health-promoting schools offer "concrete and well-evaluated examples of effective links between education and health that support "health in all policies" in the European Region" (Schools for Health in Europe, 2013, p.3). This study suggests that public health nurses can usefully lead practitioner-informed research for interdisciplinary practice.

The WHY project linked school-based initiatives and access to green space with increased physical activity levels, which suggests possible positive long-term health outcomes. The participating children were significantly more active during outdoor LINE sessions than during indoor lessons, and were especially active when LINE was held in the nearby woodland as opposed to the school grounds. These findings were triangulated with other methods of data collection not described here, namely BMI measurements and observational data/reflective log entries, to suggest that LINE may be associated with positive health outcomes for school age children.

Further research on a larger scale and over a longer period, with appropriate use of accelerometry, coupled with an exploration of the leadership role in promoting physical activity, would enable robust evidence to be gathered to develop and inform wider partnership approaches to whole-school health promotion.

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