Original Research Paper

Physical Activity in the Early Childhood Education Centre Environment

Patricia Lucas and Grant Schofield
Auckland University of Technology

Key words: young children, physical activity, environment, accelerometer

Abstract

This investigation describes the physical activity behaviours of children attending early childhood education centres and the possible influence of environmental factors on the levels of these behaviours. Participants (N=78) aged between 3 -5 years wore accelerometers for approximately 18 hours over several days of centre attendance. The raw accelerometer data was used to calculate minutes of sedentary, light, and moderate to vigorous physical activity. Physical environments of early childhood education settings were assessed using estimated measures of indoor and outdoor area and the Early Childhood Environment Rating Scale (ECERS). Overall a significant period of time was spent in sedentary activities and males were significantly more active than females. The results showed interesting relationships between physical activity and the various measures of indoor and outdoor space. This study raises issues regarding the amount of time children spent during the early childhood education centre day in sedentary activities. More work needs to be done to understand how this relates to total daily physical activity. How teachers utilise the environment to promote and deliver physical activity for young children in the early childhood education setting requires further investigation.

Introduction

It is well known that all children can benefit from habitual physical activity (PA) (Department of Health, 2004), however it is likely that daily PA levels have declined in children over the last few decades. The levels of habitual physical activity and sedentary activities such as television watching and video games have become major focus for public health outcomes, especially regarding obesity in children. Child obesity, as in most Western countries, is also an issue in New Zealand (NZ). According to the National Children's Nutrition Survey, 21% of NZ children aged 5 to 14 years were overweight, and a further 10% were obese (Ministry of Health, 2003). While this national survey did not include very young children, local (Carter et al., 2005; Gordon et al., 2003) and international surveillance has shown that increasing numbers are overweight/obese (Chinn & Rona, 2001; Gorely, Marshall, & Biddle, 2004).

Young children who are overweight are five times more likely to be overweight at the age of 12. PA is an important modifiable risk factor for obesity and several other health outcomes

including a decrease in the prevalence of CVD risk factors (Broderick, Winter, & Allan, 2006; Strong et al., 2005), increased bone health (Broderick et al., 2006; Strong et al., 2005) improved motor skills development (Irwin, He, Bouck, Tucker, & Pollett, 2005), and higher self esteem/self efficacy (Irwin et al., 2005). Yet little is known about PA and its determinants in the 3 to 5 year old age group. The pilot study reported in this paper sought to extend the present knowledge on physical activity levels and environmental factors in the early childhood centre environment that may influence physical activity of young children.

The early years, prior to attending school, are important for several developmental reasons, and a sufficient quality and quantity of physical activity can play an important role in both physical and psychological development. A group of American experts (National Association for Sport and Physical Education, 2002) has suggested the following guidelines for young children for accumulating physical activity both in the home environment and in early childhood education settings. First, that young children should accumulate at least, but preferably more than, 60 minutes daily of structured physical activity. Second, that young children should engage in at least 60 minutes and up to several hours per day of daily of unstructured physical activity, and should not be sedentary for more than 60 minutes at a time except when sleeping. Finally, that young children should develop competence in movement skills that are building blocks for more complex movement tasks. An active setting rather than a sedentary one would be more beneficial to children's health and possibly also for learning.

One important determinant of physical activity is the physical environment (Westerterp, 2008). Yet little is known about environmental design and PA relationships for children in NZ. Overseas studies by Finn et al. (2002) and Pate et al. (2004) support the importance of the early childhood education environment in the promotion of PA. Although several studies have examined children's school travel behaviours (McMillan, 2007; Schlossberg, Greene, Paulsen Phillips, Johnson, & Parker, 2006; Timperio et al., 2006), only a limited number of studies have related the built environment to children's play and other PA variables (Epstein et al., 2006; Timperio et al., 2006). These latter studies were limited by small sample sizes, reliance on self-report measures, and minimal focus on urban design features. Despite these limitations, associations existed with boys' play and residential density, and park size was negatively related to television viewing (Epstein et al., 2006). The built environmental variables related to children's PA and weight status may be different from those related to adult PA engagement. It is likely that time available for PA, especially free-play, and the more sporadic nature of PA displayed by children will mean that built environment variables associated with increased PA and/or weight status will be different in children and adults. These studies were conducted overseas and focused on the primary school aged children.

In NZ, as in most western countries, the majority of young children attend an early childhood education centre, hence these centres may be considered an important physical environment for these children. In 2004 (the time of data gathering) approximately 185,000 or approximately 70% percent of young children (Ministry of Education Data Management Unit, 2004) were enrolled in centres. Given the dearth of information on physical activity levels of young children and an even smaller body of research looking at how these data are associated with environmental features. The aim of this pilot study was to examine the environmental correlates of objectively-assessed physical activity behaviour of 3-5 year old children in early childhood centres.

Methods

Sample

The children in this study were recruited from seven privately owned and operated education and care centres in the greater Auckland (NZ) area, one of which was a Kohanga Reo. The centres were assessed consecutively as there was one set of researchers to do the data collection, hence the data collection spanned across all the seasons of year. The roll size for each centre was similar, with the largest being 39 children and the smallest 28. The parents of every child over the age of 3 were provided with an information sheet/invitation to read and a consent form for the parent to sign before the child was eligible to participate in the study. Children that participated were those whose parents returned a completed consent form. Approximately 10 children were recruited from each centre, which provided a good representation of the activity at the centre, given the number of children in this age bracket. Some children were enrolled at their centre for a small number of days during the week and/or small number of hours for the day and these parents did not return consent forms due to lack of accessibility to the child and the parent.

On the first day of data collection all the participants were brought together and the researcher explained to them what was to happen, what the belt was for and assent was gained from the children. The teachers identified each child for the record sheet before their height and weight was recorded. The children were shown the accelerometers that were set to start collecting data at a predetermined time and a volunteer to be the first to wear one was sought. Occasionally a child declined to wear the belt initially but often would ask for the belt once the others had their belt on or if one of their teachers fastened the belt. The belts were put on each child when they arrived for the day and the time was recorded and the same information collected at the end of the child's day when the belt was removed. If there were problems with compliance during the day the teacher recorded this on the individual's record sheet. Exclusion to participate was based on the child's inability to move due to a disability, injury or ill health. Ethical approval to conduct this study was granted by the Auckland University of Technology Ethics Committee (AUTEC).

Table 1: Demographics of the sample. Where appropriate means (+/- Standard deviation) are shown.

Gender	Male (N=42)	Female (N=36)
Age (yrs)	4.0 (+0.5)	3.9 (+0.6)
Ethnicity - European	19	20
Maori	17	13
Asian	4	2
Pacific Island	2	1
Height (cm)	106.8 (+5.6)	98.9 (+16.3)
Weight (kg)	18.7 (+2.8)	17.4 (+2.8)
BMI (kg/m2)	16.8 (+2.6)	16.7 (+1.6)
Average accelerometer time (hrs)	21.6 (+2.0)	21.0 (+2.4)

Table 1 shows the demographic characteristics of the children sampled in this study. The sample was well represented by European and Māori with a small number of the Asian and Pacific Island children. The height, weight and BMI means fell within normal ranges for this age group. Height was measured to the nearest centimetre using a portable stadiometer. Weight was measured to the nearest 0.1kg using precision scales. Both height and weight measurements were made without footwear and in light clothing.

Physical Activity Assessment

Each of the participants wore an Actigraph uniaxial accelerometer model 7164, (sourced from MTI Health Services, Fort Walton Beach, Florida) for a minimum of eighteen hours over a minimum of three days while attending their early childhood education centre (see Table 1). The Actigraph accelerometer is compact and unable to be tampered with by the person wearing the device, making it an ideal instrument for the use with children. Accelerometry has been shown to provide valid assessments of physical activity in the preschool age bracket (Fairweather, Reilly, Grant, Whittaker, & Paton, 1999; Ogden, Flegal, Carroll, & Johnson, 2002; Pate, Almeida, McIver, Pfeiffer, & Dowda, 2006; Pate, Pfeiffer, Trost, Ziegler, & Dowda, 2004; Reilly et al., 2003; Sirard, Trost, Pfeiffer, Dowda, & Pate, 2005), especially given the erratic nature of the movement that young children elicit. An accelerometer measures the amount and intensity of activity or movement through activity counts which are the summation of the accelerations measured during a sampling period.

Activity counts are a quantitative measure of activity over a time period which can be related to the intensity of the individuals physical activity during that time. The adjustable, elasticised belt of the accelerometer was clipped on each child so the accelerometer was on the right hip above the femur. The belt was placed on the child on arrival and removed at the time of departure for the day from the centre. The time of arrival and departure for each child was recorded for each of the days the belt was recording data. This provided a double check of recording times in the data sheet. A one minute sampling interval (known as one epoch) was set for the collection of data stored to the memory. Based on the measurement values called cut points used by Montgomery et al. (2004) and Reilly et al. (2003) the raw accelerometer counts were converted into minutes of sedentary, light, and moderate to vigorous physical activity. The three intensity categories used were: sedentary (no trunk movement) <1100 activity counts per minute (cpm), light intensity 1100 - 3200 cpm and moderate to vigorous physical activity >3200 cpm. The Actisoft software package that accompanied the accelerometers was used to perform these calculations.

Physical Environment

Physical environments of each of the sites were assessed using estimated measures of indoor and outdoor area and the more detailed Early Childhood Environment Rating Scale (ECERS-R) (Harms, Clifford, & Cryer, 1998). Estimated indoor and outdoor areas were measured using a Kinglon 50m fibreglass tape measure and these dimensions were recorded. Other features such as amount of grassed areas, types of play equipment and weather conditions were also noted.

Sections of this rating scale (see Table 2) were selected if they reflected the quality of an environmental factor that may influence physical activity. Assuming if the quality of the section was high, that is, close to the top score of 7 it could result in greater promotion of physical activity or in the case of sections that promote relaxation (SF3 = Subscale, space and furnishings, item 3, furnishings for relaxation and comfort) then activity levels should decrease. Therefore items from the seven subscales of ECERS-R were selected to assess

physical activity related factors that maybe influenced by the physical environment. This scale was designed to be used within one room or with one group of children at a time, for children aged between 2 to 5 years of age. The assessors were trained using the ECERS-R training video to ensure validity and reliability. Each site was assessed, using the relevant sections of the ECERS-R score sheet, by two assessors in order to ensure consistency within the rating scores. Each item was expressed on a 7-point scale with descriptors for 1 (inadequate), 3 (minimal), 5 (good) and 7 (excellent).

Table 2: Subscale and Items from ECERS-R used to assess physical environment.

Subscale	Item number	Item name
Space and furnishings	1	Indoor space
	2	Furniture for routine care, play and learning
	3	Furnishings for relaxation and comfort
	4	Room arrangement for play
	7	Space for gross motor play
	8	Gross motor equipment
Activities	21	Music/movement
	24	Dramatic play
	27	Use of TV, video and/or computers
Interaction	29	Supervision of gross motor activities
Program Structure	34	Schedule
	35	Free play

Using the ECERS-R score sheet a mark out of 7 was produced for each section and used in a calculation to produce an overall score out of 7. The score for each section above was also used individually in the statistical analysis. The numerical value obtained from the rating scale was then able to assist in identifying relationships with the actual movement results. The daily programme, including time allocated to free play, was collected from each education centre but not used in the analysis as this information was also obtained through the ECERS-R observation.

Statistical Analyses

The data were entered and coded into Statistical Package for the Social Sciences (SPSS) Version 12.0 for analysis. Descriptive statistics, including measures of association, were used to understand the relationships between social and physical environmental variables and accelerometer-determined physical activity. Accelerometer counts were examined to

determine overall activity per hour in the early childhood education setting. This is acknowledged as an exploratory analysis of a limited number of environmental cases to identify associations between several environmental variables and physical activity.

Results

Physical Activity Levels

Overall the predominant behaviour for both genders was sedentary, with 76% of time spent in sedentary activities, 18% in light and 6% in the moderate to vigorous category (averaged values from Table 3). Males were significantly more active than females ($t=2.56$, $p=0.01$). An equal variance analysis of variance (ANOVA) showed that there were significant differences in sedentary, light and moderate to vigorous PA between sexes. Boys spent less time in sedentary activities than girls and more time in light and moderate to vigorous PA than girls. Despite this gender difference in physical activity, height, weight, BMI and ethnicity were not statistically different between the sexes.

Table 3: Percentage of time spent in different physical activity levels for males and females

Type of activity	Female (n=36) Percent time (SD)	Male (n=42) Percent time (SD)
Sedentary	78.4% (6.4)	73.9% (7.0)
Light	16.9% (4.6)	19.5% (5.0)
Moderate/Vigorous	4.6% (2.8)	6.6% (4.0)

Environmental Correlates

Table 4 shows the means and standard deviations for the environmental measurements undertaken which were derived from the indoor and outdoor physical space measurements, and the ECERS-R scores. For each environmental parameter, Pearson correlation coefficients were calculated to understand the degree of association between that environmental variable and physical activity. There was a moderate positive association ($r=0.52$, $p<0.01$) between indoor space and accelerometer counts/hour, while a weak negative association ($r=-0.28$, $p=0.01$) was evident between outdoor space and accelerometer counts/hour. The only ECERS-R dimension to show a positive association with accelerometer counts was space and furnishings 1 = indoor space ($r=0.31$, $p=0.01$), while space and furnishings 4 = room arrangement showed a negative association with activity ($r=-0.42$ (<0.01).

Table 4: Means (SD) and ranges for Social and Environmental variables

	Mean (SD)	r (p value)
Physical area		
Outdoor area	767.7 (517.3) m2	-0.28 (0.01)*
Indoor area	149.7 (98.9) m2	0.52 (<0.01)*
ECERS domain		
SF1 Indoor space	5.71 (1.33)	0.31 (0.01)*
SF2 Furniture for care, play and learning	6.89 (0.31)	0.14 (0.23)
SF3 Furniture for relaxation	3.83 (2.06)	-0.05 (0.67)
SF4 Room arrangement	5.90 (1.62)	-0.42 (<0.01)*
SF7 Space for gross motor activities	5.83 (1.47)	-0.16 (0.15)
SF8 Gross motor equipment	6.73 (0.86)	0.00 (0.85)
SF Total Space and furnishings total	5.81 (0.58)	-0.16 (0.17)
A21 Music and movement	4.90 (2.26)	0.10 (0.40)
A24 Dramatic play	5.89 (1.13)	0.11 (0.35)
A27 Use of TV, video and/or computers	6.74 (0.85)	0.05 (0.72)
A Total Activities total	5.64 (1.17)	0.07 (0.55)
I29 Interaction - Supervision of gross motor activities	6.78 (0.41)	-0.11 (0.32)
PS34 Schedule	6.47 (1.54)	0.02 (0.83)
PS35 Free play	6.47 (0.94)	0.10 (0.39)
PS Total Program structure total	6.47 (0.82)	0.09 (0.42)

Discussion

Physical Activity

While the long term effects on health of sedentary behaviour is not yet well understood (Sirard et al., 2005), this study raises issues regarding the amount of time spent during the early childhood education day in sedentary activities and hence the possible failure to meet the recommended guidelines for accumulated daily physical activity (Dowda et al., 2004) for this age group. It is likely that reducing sedentary time will have physical health benefits that may track into later life. Based on the findings of this study, the recommendation for centre settings would be to improve adequate amounts of moderate to vigorous PA by adding specific activities that children are keen to participate in that enhance physical activity

levels. However, more research needs to be conducted to understand how these findings relate to total daily physical activity levels, as activity outside the early childhood education environment was not measured.

This study supports findings from international studies that demonstrated that boys are more physically active than girls (Jackson et al., 2003; Janz et al., 2002; Pate et al., 2004, Wilkins, Mallam, Metcalf, Jeffery, & Voss, 2006). Girls tended to spend more time participating in more sedentary activities compare to the boys. However, this study sheds no further light on this difference and certainly more studies need to be conducted in order to understand this further.

Environment

The environmental measures were simple to apply and able to be used to identify features of the early childhood education environment that may be conducive to physical activity. This, combined with the objective measurement of PA using the accelerometers, were a particular strength of this study. A moderate positive association with activity was seen for both the measured area of indoor space and the ECERS-R assessment of the quality of the indoor space. This would suggest that both the quality and area of indoor space play a key role on physical activity levels in the centre environment. Interestingly the ECERS-R room arrangement assessment gave a negative (-0.42 (<0.01)) association with activity. This may be a reflection of the way that some centres arrange their furniture to encourage the children to sit quietly and engage in educational activities. The more organised the room is for educational activities, the less active the children are likely to be and the distance to travel from one learning activity to another is also minimised. Such room organisation around "interest centres" (Harms et al., 1998) may be useful for child learning but may decrease the opportunity to accumulate PA. As the number of interest centres increased, as assessed using ECERS, the level of PA decreased. An effective strategy to increase movement during the day may be to review the amount of free time play available where movement is promoted by teachers and/or to arrange indoor space such that children need to move some distance from one activity to another. However this does not take into account the complexity of considerations for teachers in organising the indoor environment. For example, if a teacher is arranging the environment so it is conducive to children's concentration, then this would likely minimize the amount of movement needed in that space. The amount of free play was not measured except using the ECERS-R assessment. Further studies are required to look at effective arrangement of indoor space and the use of free play.

One would assume that more outdoor space would be associated with increased PA. Yet this study observed a negative association between PA and the measured outdoor space, indicating that the quality of the outdoor space may be the more important variable for children in this age bracket. Young children of this age move sporadically unlike adults where there is often associated purpose of moving to achieve some outcome which results in more sustained movements often lasting for minutes. Whereas young children do not appear to move in this way; instead movements last seconds rather than minutes. As such, the mere presence of space may have little effect on PA. Instead it is the quality of the outdoor area that is important. Further studies need to be conducted to understand how outdoor space quality is associated with PA and children.

NZ government regulations state the indoor and outdoor area per child required at a centre. However there is no indication as to how this area should be utilised except briefly through regulations related to the program of activities that are fundamentally based around the learning and development needs of children. Based on these findings further investigations

are required to determine effective use of both indoor and outdoor space in the centre to support physical activity or movement.

Limitations

Seven centres were included in this sample. Hence the variability across this small sample is not necessarily the variation in environmental variables necessary to understand complex associations. This sample size has limited the type of analysis that was able to be carried out.

The sequential nature of data collection may have been affected by the time of the year and weather conditions. However Auckland, NZ has a temperate climate and variations in weather are not substantial enough to prevent use of outdoor space on most occasions. The data collected on the environmental variables were simple summations of quantity, and to a certain extent quality. It is unlikely that these variables capture the full range of complexity and the between-variable interactions which influence children's physical activity. However, it raises sufficient concern to warrant further larger-scale investigations.

The sampling cycle for accelerometer data collection which was set at a one minute epoch (Jackson et al., 2003; Montgomery et al., 2004) has been used in many overseas studies. However given the transitory nature of preschoolers' PA (Rowlands, Eston, & Ingledew, 1997), further validation studies looking at sampling time would be helpful. The amount of free time and the details of the daily schedule were evaluated for quality using the ECERS-R assessment but were not evaluated based on the time allocated to physical activity. Notwithstanding possible misclassifications, the present study does allow for associations to be drawn with environmental variables and determine sex differences in activity which add to the present literature.

Conclusion

In summary, this small pilot study supported the current overseas literature related to the gender differences in physical activity levels and identified high levels of sedentary activities within the centre day. Understanding the physical activity behaviours of this age group forms a framework for exploring the health benefits of activity and the development of physical activity recommendations. The environmental variables highlighted a moderate positive association between indoor space (both quantity and quality) and PA, while room arrangement had a negative association with PA. These findings may reflect how indoor space is utilised during the day although further investigations are required to clarify these relationships. Regular physical activity is important for the physical health and well being of young children and could help to curb the onset of chronic diseases that track into adulthood. This study also indicates that further research is required to investigate the significance of inactivity in young children's lives.

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References

Broderick, C., Winter, G., & Allan, R. (2006). Sport for special groups. *Medical Journal of Australia, 184*(6), 297-302.

Carter, P., Taylor, B., Jones, S., Williams, S., Taylor, R., & Gerrard, D. (2005). *Physical activity behaviours in Dunedin 3-year old children.* Paper presented at the Royal Australasian College of Physicians Annual Scientific Meeting, Wellington, New Zealand.

Chinn, S., & Rona, R. (2001). Prevalence and trends in overweight and obesity in three cross sectional studies of British Children, 1974-94. *British Medical Journal, 322*, 24-26.

Department of Health, Physical activity, health improvement and prevention. (2004). *At least five a week. Evidence on the impact of physical activity and its relationship to health*. A report from the Chief Medical Officer. London, UK: Department of Health, Physical Activity, Health Improvement and Prevention.

Dowda, M., Pate, R., Trost, S., Almeida, C., Joao, M., & Sirard, J. (2004). Influences of preschool policies and practices on children's physical activity. *Journal of Community Health, 29*(3), 183-196.

Epstein, L., Raja, S., Gold, S., Paluch, R., Pak, Y., & Roemmich, J. (2006). Reducing sedentary behaviour. *Psychological Science, 17*(8), 654 - 659.

Fairweather, S., Reilly, J., Grant, S., Whittaker, A., & Paton, J. Y. (1999). Using the computer science and applications (CSA) activity monitor in preschool children. *Pediatric Exercise Science, 11*, 413-420.

Finn, K., Johannsen, N., & Specker, B. (2002) FActors associated with physical activity in preschool children. *The Journal of Pediatrics,* 140, 81-85.

Gordon, F. K., Ferguson, E. L., Toafa, V., Henry, T., Goulding, A., Grant, A. M., et al. (2003). High levels of childhood obesity observed among 3- to 7-year-old New Zealand Pacific children is a public health concern. *Journal of Nutrition, 133*, 3456-3460.

Gorely, T., Marshall, S., & Biddle, S. (2004). Couch kids: Correlates of television viewing among youth. *International Journal of Behavioural Medicine, 11*(3), 152-163.

Harms, T., Clifford, R. M., & Cryer, D. (1998). *Early childhood environment rating scale* (rev. ed.). New York: Teachers College Press.

Irwin, J., He, M., Bouck, L., Tucker, P., & Pollett, G. (2005). Preschoolers' physical activity behaviours: parents' perspectives. *Canadian Journal of Public Health, 96*(4), 299-303.

Jackson, D., Reilly, J., Kelly, L., Montgomery, C., Grant, S., & Paton, J. Y. (2003). Objectively measured physical activity in a representative sample of 3- to 4-year old children. *Obesity Research, 11*(3), 420-425.

Janz, K. F., Levy, S. M., Burns, T. L., Torner, J. C., Willing, M. C., & Warren, J. J. (2002). Fatness, physical activity, and television viewing in children during the adiposity rebound period: The Iowa Bone Development Study. *Preventive Medicine, 35*, 563-571.

McMillan, T. (2007). The relative influence of urban form on a child's travel mode to school. *Transportation Research, 41*, 69-79.

Ministry of Education Data Management Unit. (2004). Enrolments in early childhood education by type of service and gender at 1 July (Vol. A4 table). Wellington: Ministry of Education.

Ministry of Health. (2003). *NZ food, NZ children. Key results of the 2002 national children's nutrition survey.* Wellington, New Zealand: Author.

Montgomery, C., Reilly, J., Jackson, D., Kelly, L., Slater, C., Paton, J., et al. (2004). Relation between physical activity and energy expenditure in a representative sample of young children. *American Journal of Clinical Nutrition, 80*(3), 591-596.

National Association for Sport and Physical Education. (2002). *Active start: Physical activity for children birth to five years*. Reston, VA: Author.

Ogden, C., Flegal, K., Carroll, M., & Johnson, C. (2002). Prevalence and trends in overweight among US children and adolescents. *Journal of the American Medical Association, 288*, 1728-1732.

Pate, R., Almeida, M., McIver, K., Pfeiffer, K., & Dowda, M. (2006). Validation and calibration of an accelerometer in preschool children. *Obesity (Silver Spring), 14*(11), 2000-2006.

Pate, R., Pfeiffer, K., Trost, S., Ziegler, P., & Dowda, M. (2004). Physical activity among children attending preschools. *Pediatrics, 114*(5), 1258-1264.

Reilly, J., Coyle, J., Kelly, L., Burke, G., Grant, S., & Paton, J. (2003). An objective method for measurement of sedentary behavior on 3- to 4-year olds. *Obesity Research, 11*(10), 1155-1158.

Rowlands, A., Eston, R., & Ingledew, D. (1997). Measurement of physical activity in children with particular reference to the use of heart rate and pedometry. *Sports Medicine, 24*(4), 258-272.

Schlossberg, M., Greene, J., Paulsen Phillips, P., Johnson, B., & Parker, B. (2006). School trips. *Journal of the American Planning Association, 72*(3), 337-346.

Sirard, J., Trost, S., Pfeiffer, K., Dowda, M., & Pate, R. (2005). Calibration and evaluation of an objective measure of physical activity in preschool children. *Journal of physical activity and health, 2*(3), 345-357.

Strong, W., Blimkie, C., Daniels, S., Dishman, R., Gutin, B., Hergenroeder, A., et al. (2005). Evidence based physical activity for school-age youth. *Journal of Pediatrics, 146*(6), 732-737.

Timperio, A., Ball, K., Salmon, J., Roberts, R., Giles-Corti, B., Simmons, D., et al. (2006). Personal, family, social, and environmental correlates of active commuting to school. *American Journal of Preventive Medicine, 30*(1), 45-51

Westerterp, K. (2008). Physical activity as determinant of daily energy expenditure. *Physiology and Behaviour, 93*(4-5), 1039-1043.

Wilkins, T., Mallam, K., Metcalf, B., Jeffery, A., & Voss, L. (2006). Variation in physical activity lies with the child, not his environment: evidence for an 'activitystat' in young children (EarlyBird 16). *International Journal of Obesity* (30), 1050-1055.

ABOUT THE AUTHORS

Patricia Lucas is a senior lecturer at AUT University in the School of Sport and Recreation, and a member of the Centre for Physical Activity and Nutrition. Patricia's interests lie in the areas of physical activity and nutrition, specifically focused on activity patterns of young children and activity interventions with the elderly.

Professor Grant Schofield is Professor of Public Health at AUT University, and Director of the Centre for Physical Activity and Nutrition. Professor Schofield's interests lie in physical activity, lifestyle habits (including nutrition), and obesity. His research is centred firmly around these interests with several large projects including a strong interest in preschool, child and adolescent physical activity measurement, surveillance and intervention, workplace physical activity measurement and intervention, and whole community physical activity health promotion.