

Body mass index, weekday and weekend days step counts for Fifth grade Costa Rican children

Índice de Masa Corporal y la cantidad de pasos durante la semana y los fines de semana en estudiantes de quinto grado de escuela en Costa Rica

María Morera¹, Mary E. Rudisill², Danielle D. Wadsworth²

¹ School of Human Movement and Quality of Life. National University. Costa Rica.

² School of Kinesiology. Auburn University. USA.

CORRESPONDENCIA:

María Morera

mmore@una.cr

Recepción: mayo 2013 • Aceptación: julio 2013

Abstract

The purpose of this study was to determine the differences in physical activity levels (pedometer step count) over a seven day period between normal weight and overweight/obese fifth grade Costa Rican boys and girls. Children's ($n = 188$) weight and height were measured. Each child wore an Omron HJ-720 ITC pedometer for one week to assess step count. Participants were placed into one of two groups (Obese/Overweight or Normal weight) based on *BMI*. A 2 (Sex) \times 2 (*BMI* Groups) \times 2 (Week/Weekend) mixed model ANOVA revealed no interactions among variables. However, there were statistically significant differences for the within-subjects effect, with average step counts for weekdays and weekend days, $F = 19.421$, $p < .001$, and statistically significant between-subjects effects for step counts and *BMI* groups, $F = 4.09$, $p = .044$, and Sex, $F = 6.80$, $p = .010$. All children engaged in more daily steps during the weekdays than the weekend days. Daily step counts for children in the Obese/Overweight *BMI* group were lower than children in the Normal *BMI* group. Boys engaged in more daily steps than girls all days of the week. Interventions to provide weekend physical activity should be promoted based on these findings, particularly for girls and children with high *BMI*s.

Key words: Children, physical activity, body mass index, pedometer, health.

Resumen

El propósito de este estudio fue determinar las diferencias en los niveles de actividad física (cantidad de pasos) durante un período de siete días en niños y niñas de quinto grado con peso normal y sobrepeso/obesidad en Costa Rica. Se midieron ($n = 188$) el peso y la talla de cada participante. Cada niño/a utilizó un podómetro Omron HJ-720ITC durante una semana completa para contabilizar la cantidad de sus pasos. Las personas participantes fueron agrupadas según su IMC (obesidad/sobrepeso o peso normal). El ANOVA de modelo mixto 2 (sexo) \times 2 (IMC Groups) \times 2 (semana / fin de semana) reveló que no existe interacción entre las variables. Sin embargo, sí existen diferencias estadísticamente significativas en el efecto intra-sujetos de la cantidad de pasos que se toman durante los días entre semana y los fin de semana, $F = 19.421$, $p < .001$. Además, se encontraron diferencias estadísticamente significativas en el efecto inter-sujetos entre la cantidad de pasos y los grupos de IMC, $F = 4.09$, $p = 0.044$; y la cantidad de pasos y el sexo $F = 6.80$, $p = 0.010$. Se concluye que los niños/as en esta investigación realizan mayor cantidad de pasos durante la semana que durante los fines de semana, así como que la cantidad de pasos en los niños/as del grupo Obesidad/Sobrepeso fueron más bajos que en los niños/as del grupo Peso Normal. Los niños realizan mayor cantidad de pasos que las niñas durante todos los días de la semana. De acuerdo a los resultados obtenidos es importante el desarrollo de intervenciones que promuevan actividad física durante los fines de semana, particularmente en niñas y entre la población infantil con alto IMC.

Palabras clave: Niños/as, actividad física, índice de masa corporal, podómetros, salud.

Introduction

In the last decade, a public health crisis associated with obesity has been the focus for many nations around the world. Globally, obesity has reached epidemic proportions and has increased in almost 43 countries according to Wang & Lobstein (2006). An estimated 22 million children under 5 years of age are overweight (Malecka-Tendera & Mazur, 2006) and between 15 to 20% of school-age children have been classified as overweight/obese (Sundblom, Petzold, Rasmussen, Callmer, & Lissner, 2008). Childhood obesity rates are dramatically changing at an alarming rate in many countries (International Association for the Study of Obesity [IASO], 2012; Sharma, 2007). Latin American and the Caribbean countries are among those reporting increases in obesity. In Chile, 29% of 6-year-old boys and 27% of girls were obese. In 2006, the prevalence of overweight among 5 to 17 year old children from Mexico was 28.1% in boys and 29% in girls, and from 10-year-old Argentina boys were 32.1% and girls 27.5% (IASO, 2012). Similar trends have been observed in Canada, the United Kingdom and Europe (IASO, 2012). Costa Rica is not an exception to this epidemic. The overall prevalence of overweight and obesity in school-aged children in 2004 were 20.9% and 20.6% respectively (Estado de la Nación en Desarrollo Humano Sostenible, 2008). In Costa Rica, the overall prevalence of overweight and obesity in school children from urban and rural areas (7 to 12 years of age) were 34.5% and 26.2%, respectively (Núñez-Rivas, Monge-Rojas, León, & Roselló, 2003).

World efforts are being made to improve and protect children's health. Research has shown that there are a number of variables associated with this obesity epidemic (i.e., poor nutritional habits, genetics, and low socioeconomic status) (Li & Hooker, 2010) and that physical inactivity is a strong contributor (Hands & Parker, 2008).

Physical activity has been identified as an important factor in combating the obesity crisis (Pangrazi, Beighle, Vehige, & Vack, 2009) and plays a critical role in setting healthy lifestyle habits (Janssen & LeBlanc, 2010). Research suggests that an active lifestyle during childhood reduces the risk of health problems later in life (Sallis, Prochaska, & Taylor, 2000) and helps children develop social skills, improve mental health and reduce risk-taking behaviors (e.g. tobacco/alcohol/substance use, violence and unhealthy diet) (Taras, 2005). Physical activity is positively related to good health, happiness, and vitality in young children (Miles, 2007). Physical activity has been associated with improved psychological wellbeing, gaining

more self-confidence and higher self-esteem, raising HDL cholesterol, and reducing the risk of diabetes and some types of cancers later in life (American Heart Association, 2012). Physical activity has been associated with beneficial changes in triglycerides, insulin resistance and adiposity in children (Ekelund et al., 2007). In addition, children with asthma who are physically active experience decreased severity of asthma symptoms (Lang, Butz, Duggan, & Serwint, 2007).

A review of the evidence relating physical activity to health concluded that children should spend at least 60 min in moderate to vigorous physical activity (MVPA) each day, in order to promote a broad range of health improvements. However, despite all the benefits associated with physical activity engagement, children are not accumulating enough physical activity to reap these health benefits. There still a lack of information in Latin-America about children's physical activity levels (measured with an objective assessment) and the relationship with body mass index. Beets, Bornestein, Beighle, Cardinal, & Morgan (2010), found that from 43 studies of pedometer-measured physical activity patterns in children the majority where from the U.S.A (17), Europe (15); Western Pacific (7), Canada (1) and China and Saudi Arabia (3), confirming the need for physical activity patterns among Costa Rican children. Furthermore, according to the Social Ecological Model multiple domains affect physical activity participation, meaning children need to be assessed in more than one microsystem (i.e. school and home; Brownson, 2006). Therefore, the purpose of this study was to determine differences in physical activity levels (pedometer step count) over seven days between normal weight and overweight/obese (based on BMI) 5th grade Costa Rican children. It was hypothesized that children with BMIs categorized, as overweight/obese, would accumulate fewer steps on weekdays and weekend days than children with BMIs within the normal range. It was also speculated that boys would accumulate more step counts than girls regardless of BMI. This hypothesis is based on research that shows that males accumulate more steps than females (Johnson, Brusseau, Graser, Darst, & Kulinna, 2010; Purslow, Hill, Saxton, Corder, & Wardle, 2008).

Method

Participants

Fifth grade students enrolled in three elementary schools located in the province of San Jose, Costa Rica were invited to participate in this study. This region

offers a large range of social classes, nationalities, physical features of neighborhoods and public schools which represent the heterogeneous population of residents in Costa Rica. From the list of public schools (sampling frame) developed by the Costa Rican Ministry of Public Education, and using probability sampling a total of three schools were selected to participate in this study.

Of the 403 possible participants, a total sample of 223 (55%) fifth graders received parental consent to participate in this study. Of these participants, 195 (87%) completed all components of the study. To be included in the data analysis, participants must have worn the pedometer at least eight consecutive hours per day for three or more weekdays and 1 or more weekend day (Kang et al., 2009). Seven participants (4%) were eliminated from data analysis due to missing pedometer data. A total of 188 children (boys 80, girls 108), ages between 10 to 13 years, were included in the final analyses. Participant demographics can be found in Table 1 and Table 2.

Measures

Body Mass Index (BMI). Height was measured using a standard tape measure. Children were asked to stand with their back against a wall and height was measured to the nearest centimeter. Each child also stood on a standard scale to measure their weight in kilogram. Body Mass Index was calculated from the height and weight measures using the formula weight (kg) divided by height (m²). Due to small numbers in the obese category (n = 13), overweight (n = 37) and obese groups were combined (n = 50). Participants were placed into two groups based on their BMI, Group one (Normal weight) and Group two (Obese/Overweight) using the international cut off points for body mass index for overweight and obesity children made by Cole, Bellizini, Flegal, and Dietz (2000). From the total 188 children analyzed, 138 children (61 boys, and 77 girls) were included in the Group one (Normal weight) and, 50 children (19 boys and 31 girls) formed Group 2 (Obese/Overweight).

Physical activity. Children's daily step count was measured using the Omron HJ-720 ITC pedometer. This device records and stores information in its memory for 42 days, resets automatically at midnight, and cannot be zeroed manually. Tudor-Locke, MaClain, Hart, Sisson, and Washington (2009b) have recommended steps per day as the most appropriate metric choice to measure children youth physical activity. Correlations between .73 and .79 for 3 to 4 days of monitoring have been reported for this instrument (Hands & Larkin,

Table 1. Participant height and weight means and standard deviations by age and sex.

| Age | Sex | n | Height (cm) | | Weight (lbs) | |
|-------|-----|-----|-------------|-------|--------------|-------|
| | | | M | SD | M | SD |
| 10 | F | 47 | 141.28 | 8.62 | 87.54 | 24.22 |
| | M | 30 | 137.06 | 5.02 | 74.39 | 14.80 |
| 11 | F | 36 | 144.73 | 6.32 | 89.72 | 23.13 |
| | M | 29 | 139.60 | 6.27 | 79.24 | 17.11 |
| 12 | F | 17 | 148.31 | 8.20 | 93.67 | 21.20 |
| | M | 13 | 146.92 | 5.81 | 94.35 | 23.84 |
| 13 | F | 8 | 146.74 | 4.98 | 89.57 | 15.42 |
| | M | 8 | 158.50 | 11.40 | 123.72 | 35.47 |
| Total | F | 108 | 143.94 | 7.98 | 89.38 | 22.68 |
| | M | 80 | 141.73 | 9.10 | 84.34 | 24.55 |

Table 2. Weekdays and weekend days average step count means and standard deviations for boys and girls according with their BMI.

| | Sex | BMI | n | M | SD |
|-----------------|-------|-----------------|---------|------|---------|
| | | | | | |
| Overweigh/obese | 19 | 9703 | 2596.29 | | |
| Total | 80 | 11261 | 3989.69 | | |
| Weekday | Girls | Normal | 77 | 9544 | 2839.60 |
| | | Overweigh/obese | 31 | 9239 | 2495.28 |
| | | Total | 188 | 9456 | 2737.17 |
| Weekend day | Boys | Normal | 61 | 9644 | 4813.49 |
| | | Overweigh/obese | 19 | 8669 | 3683.36 |
| | | Total | 80 | 9413 | 4567.59 |
| Weekend day | Girls | Normal | 77 | 8235 | 3789.90 |
| | | Overweigh/obese | 31 | 7449 | 2635.59 |
| | | Total | 188 | 8009 | 3503.84 |

2006). This pedometer is an accurate measure of step count (Giannakidou et al., 2012) and established validity and reliability in prescribed and self-paced walking conditions and demonstrates an absolute percent error of < 3.0% and < 2.1%, respectively (Holbrook, Barreira, & Kang, 2009). The Omron HJ-720 ITC pedometer also demonstrated acceptable validity and reliability as a measure of step counts in children (Lee et al., 2012; Peters, Heelan, & Abbey, 2013). A 20-step field test validated that the pedometers worked appropriately in this study. Measurement error was computed and the range of error was explored (100 pedometers did not exceed ± 5% error [i.e., 1 step in either direction]). The pedometer was calibrated based on children's stride length and weight in accordance with the manufactory instructions. Each participant was given verbal and written instructions regarding how

to wear the pedometer on the waistband of the pant or skirt (i.e., right side of the body, in line with the mid-line of the thigh and approximately 5-7 cm from the umbilicus) and how and when (i.e. waking hours) to wear and remove the pedometer (i.e., only during showering, bathing, swimming or sleeping time).

Procedure

Approval was received from the Institutional Review Board for Research Involving Human Subjects at Auburn University and the Ministry of Public Education in Costa Rica. Informed parental consent and child assent were also obtained. The researcher measured children's stride length, weight and height. A pedometer was then distributed to each child and asked that he or she wear it for one full week (Monday through Sunday) during waking hours. At the end of the week the researcher collected the pedometers.

Data Analysis

Data was subjected to a 2 (Sex) x 2 (BMI Groups) x 2 (Week/Weekend) mixed model ANOVA with alpha set a priori at .05. Prior to conducting the analyses, frequencies were run on all data to screen for data errors or outliers. Daily step count outliers were set (i.e., below 1,000 and above 30,000 steps per day) and were eliminated based on the cut-off points made by Rowe, Mahar, Raedeke, and Lore (2004). Seven children's data were not included in the analyses due to missing data or because they did not meet the pedometer inclusion criteria. The final sample size that was included for data analysis was 188 children. A G* Power 3.1.7 was used to determine the power of the statistic test analysis.

Results

Descriptive statistics of children's height and weight by age and sex can be found in Table 1. Means and standard deviations for males and females for weekdays and weekend days average step count based on their BMI are provided in Table 2.

A Post Hoc Power Analysis was computed, with a result of power (1-b error probability) = 0.99. The sample size of this research was larger enough to reject the null hypothesis.

The 2 (Sex) x 2 (BMI Groups) x 2 (Week/Weekend) mixed model ANOVA showed no statistically significant interaction between variables. The results for between-subjects revealed statistically significant main

effects for step counts and BMI groups, $F(1,184) = 4.09$, $\eta^2 = .022$, $p = .044$, (Figure 1) and Sex, $F(1,184) = 6.80$, $\eta^2 = .036$, $p = .010$. Daily step counts for children in the Normal BMI group were higher than children in the Obese/Overweight BMI group (See Table 2). Also, boys engaged in more daily steps than girls for all days of the week. A significant within-subjects effect for average step counts for weekdays and weekend days was also found, $F(1,184) = 19.421$, $\eta^2 = .095$, $p < .001$. The fifth graders engaged in more daily steps over the weekdays than the weekend days.

Discussion

This study was conducted to determine differences in physical activity levels (pedometer step count) over seven days between normal weight and overweight/obese 5th grade Costa Rican boys and girls. It was speculated that children who accumulated higher daily step count would have lower BMI regardless of sex and the day of the week.

The findings supported the hypothesis that children with lower BMI accumulate higher daily step count for weekdays and weekend days. These results support previous findings that have shown differences in physical activity between overweight/obesity and non-obese children with lower levels of physical activity in obese children (Page et al., 2005; Riddoch et al., 2007). Duncan, Schofield, and Duncan (2006) reported a stronger association between physical activity measured by pedometers and percentage body fatness (BMI) in New Zealand children. An international study using American, Australian, and Swedish children conducted by Tudor-Locke and colleagues (2004) established steps per day recommendations related to body mass index (BMI). The selected cutoff points for steps per day for 6 to 12 year olds were 12,000 steps for girls and 15,000 steps for boys, if the goal is maintenance of a healthy BMI. In this study, 15% of girls met this recommendation for weekdays and a 12% met the recommendation for weekend days. Twenty percent of boys met the step count recommended to maintain a healthy BMI for weekdays and 14% met the recommendations for weekend days. These findings have implications for the health of Costa Rican children. Policies should be developed to reduce and prevent the epidemic of obesity and on promoting children's physical activity engagement.

A secondary hypothesis proposed that boys would demonstrate a higher daily step count during weekdays and weekends compared to girls. This hypothesis was supported, boys engaged in more daily steps than

girls all days of the week. Several studies have found similar differences between the two sexes (Trost, Rosenkranz, & Dzewaltowski, 2008; Tudor-Locke, Johnson, & Katzmarzyk, 2010). In New Zealand, boys were significantly more active than girls, and in Australia boys were on average significantly ($p < 0.01$) more active than girls (Spinks, Macpherson, Bain, & McClure, 2006).

A significant difference was found in this study for children average step counts between the weekdays and the weekend days. This result supports previous findings that suggest that children are more active during weekdays than weekend days (Riddoch et al., 2007; Duncan, Al-Nakeeb, Woodfield, & Lyons, 2007). Tudor-Locke, MaClain, Hart, Sisson, and Washington (2009a) suggest that during weekday's boys take approximately 12,000 to 16,000 steps per day, and girls accumulate between 10,000 to 14,000 steps per day. In contrast, boys take 12,000 to 13,000 steps per day and girls take 10,000 to 12,000 steps per day on weekend days. In this study boys took an average of 11261.21 steps on weekdays and 9412.71 steps on the weekend days. In contrast, girls achieved 9456.30 steps on weekdays and 8009.23 on weekend days.

One possible explanation for these results is a lack of facilities or safe environments to play outdoors. The Social Ecological model proposes that children's physical activity may be influenced by their access to safe places to play, their friendship groups, and local policy regarding physical activity (Veitch, Bagley, Ball, & Salmon, 2005). Moore et al. (2010) showed decrease in physical activity due to parental fear of criminal activity against their children, and lack of safety. Studies also have reported that structural and conditional aspects such as access to sport, outdoor school environments and recreation facilities, and sidewalks have been identified as important determinants that influence children's physical activity opportunities and choices (Giles-Corti, Kelty, Zubrick, & Villanueva, 2009; Haug, Torsheim, Sallis, & Samdal, 2010). On weekdays Costa Rican children spend half of the day or more at their school, which allows the opportunity to have a safe environment to play and be more active. It could be that over the weekend days Costa Rica children do not have safe environments to go outside and play. Measurement of the environment was outside the scope of this study, but should be explored in relation to physical activity rates of children residing in Costa Rica.

Another potentially contributing factor for the significant findings of the differences of average step count for weekend days and week days may be attributed to the fact that children received recess and

physical education while attending school. In Costa Rica most of the schools have a mixed schedule, which means children go to the school half of the day (i.e., three days during the morning and two days during the afternoon). During that time they have at least 30 minutes per day of recess to engage in unstructured free physical activity and 80 minutes per week of physical education. The three schools in this study provided physical education classes to their fifth grade students. Studies suggest that physical education class (13-14% of daily steps) and recess (8-9% of daily steps) promote engagement in more daily step count (Brusseu et al., 2011). And it could be an equivalent of 1800-1890 steps in a 30-min physical education (Scruggs et al., 2003).

Another viable explanation for why the average step count was lower over the weekend is that the children were not walking or cycling to school on those days. Although not measured, researchers observed, during data collection that most of the Costa Rican children used "active transportation", such as walking, bicycling or public transportation to travel to the school, instead of being delivered in a car. Studies have found that children who use active transportation to and from school result in higher levels of physical activity compared to those who travel to school by no active transportation (i.e. motorized transport, car, bus) (Loucaides & Jago, 2008; Pabayo et al., 2012).

Parental involvement may be one of the factors associated with Costa Rican children's physical activity on the weekends. Studies suggest that parents influence childhood behavior. These mechanisms of influence can be either by providing support, through modeling or an interaction of both (Ferreira et al., 2007). Likewise, parental opportunities to participate, supervise and spend time in playing with their children have decreased considerably (Karsten, 2005; Page, Cooper, Griew, Davis, & Hillsdon, 2009). Ginsburg (2007) suggested that the decrease of children physical activity in play is associated with television and digital media, lack of parent's time to play with their children, and increase attention to academics. Studies have found that children whose parents are physically active reported to be nearly six times more active than children whose parents are both inactive (Ferreira et al., 2007).

In conclusion, obese children exhibited significantly fewer daily steps than children with a normal BMI, regardless of the day of the week. Boys were more active than girls all days of the week and there were a higher percentage of overweight and obese girls than boys. This finding suggests the need for effective interventions with children who are overweight and obese, particularly for girls. Additionally, the results of

the study showed that Costa Rican children achieved significantly more steps over the weekdays than the weekend days. According to Dietz (2006) opportunities for spontaneous play may be the only requirement that young children need to increase their physical activity. Those may be a key to promote physical activ-

ity over the weekend days. Children's physical activity over the weekend days should be a high concern for parents, communities, and the government in Costa Rica to ensure that children meet the recommended amount of physical activity to avoid obesity and promote healthy lifestyles.

REFERENCES

- American Heart Association (2012). *Physical activity and Children*. Retrieved from http://www.heart.org/HEARTORG/GettingHealthy/Physical-Activity-and-Children_UCM_304053_Article.jsp
- Beets, M. W., Bornestein, D. B., Beighle, A., Cardinal, B. J., & Morgan, C. F. (2010). Pedometer-measured physical activity patterns of youth: A 13 country review. *American Journal of Preventive Medicine, 38*(2), 208-216.
- Brownson, R. C., Haire-Joshu, D., & Luke, D. A. (2006). Shaping the context of health: A review of environmental and policy approaches in the prevention of chronic diseases. *Annual Review of Public Health, 27*, 341-370.
- Brusseau, T. A., Kulinna, P. H., Tudor-Locke, C., Ferry, M., van der Mars, H., & Darst, P. W. (2011). Pedometer-determined segmented physical activity patterns of fourth- and fifth-grade children. *Journal of Physical Activity and Health, 8*, 279-286.
- Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for children overweight and obesity worldwide: International survey. *British Medical Journal, 320*(7244), 1240-1243.
- Dietz, W. (2006). *Exchange every day*. Retrieved from <http://www.child-careexchange.com/eed/issue.php?id=1440>
- Duncan, J. S., Scholfield, G., & Duncan, E. K. (2006). Pedometer-determined physical activity and body composition in New Zealand children. *Medicine and Science in Sports and Exercise, 38*(8), 1402-1409.
- Duncan, J. M., Al-Nakeeb, Y., Woodfield, L., & Lyons, M. (2007). Pedometer determined physical activity levels in primary school children from central England. *Preventive Medicine, 44*(5), 416-420.
- Ekelund, U., Anderssen, S. A., Froberg, K., Sardinha, L. B., Andersen, L. B., & Brage, S. (2007). Independent associations of physical activity and cardiorespiratory fitness with metabolic risk factors in children: The European youth heart study. *Diabetologia, 50*, 1832-1840. doi: 10.1007/s00125-007-0762-5
- Estado de la Nación (2008). En Desarrollo Humano Sostenible. *Decimocuarto informe: Bienestar Subjetivo en Costa Rica* [Fourteenth Report: Subjective Wellness in Costa Rica]. FLACSO-Mexico y OPAEP. Recuperado de: http://www.estadonacion.or.cr/files/biblioteca_virtual/014/Bienestar-subjetivo-Rojas-2008.pdf
- Ferreira, I., van der Horst, K., Wendel-Vos, W., Kremers, S., van Lenthe, F., & Brug, J. (2007). Environmental correlates of physical activity in youth – a review and update. *Obesity Reviews, 8*(2), 129-154.
- Giles-Corti, B., Kelty, S. F., Zubrick, S. R., & Villanueva, K. P. (2009). Encouraging walking for transport and physical activity in children and adolescents: How important is the built environment? *Sports Medicine, 39*(12), 995-1009.
- Ginsburg, K. (2007). The importance of play in promoting healthy child development and maintaining strong parent-child bonds. *American Academy of Pediatrics, 119*(1), 182. doi: 10.1542/peds.2006-2697
- Hands, B., & Larkin, D. (2006). Physical activity measurement methods for young children: A comparative study. *Measurement in Physical Education & Exercise Science, 10*(3), 203-214.
- Hands, B., & Parker, H. (2008). Pedometer-determined physical activity, BMI, and waist girth in 7- to 16-year-old children and adolescents. *Journal of Physical Activity & Health, 5*(Suppl. 1), 153-165.
- Haug, E., Torsheim, T., Sallis, J. F., & Samdal, O. (2010). The characteristics of the outdoor school environment associated with physical activity. *Health Education Research, 25*(2), 248-256.
- Holbrook, E. A., Barreira, T. V., & Kang, M. (2009). Validity and reliability of Omron pedometers prescribed and self-paced walking. *American College of Sports Medicine, 41*(3) 669-673.
- International Association for the study of Obesity [IASO] (2010). *IASO prevalence data: Children & Adolescents*. Retrieved from http://www.iaso.org/site_media/library/resource_images/Global_Childhood_Overweight_25th_September_2012.pdf
- Janssen, I., & LeBlanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral, Nutrition and Physical Activity, 7*, 40.
- Johnson, T. G., Brusseau, T. A., Graser, S. V., Darst, P. W., & Kulinna, P. H. (2010). Step counts of 10- to 11-year-old children by ethnicity and metropolitan status. *Journal of Physical Activity and Health, 7*(3), 355-363.
- Kang, M., Bassett, D. R., Barreira, T. V., Tudor-Locke, C., Ainsworth, B., Reis, J. P., Strath, S., & Swartz, A. (2009). How many days are enough? A study of 365 days of pedometer monitoring. *Research Quarterly for Exercise and Sport, 80*(3), 445-453.
- Karsten, L. (2005). It all used to be better? Different generations on continuity and change in urban children's daily use of space. *Children's Geographies, 3*(3), 275-290.
- Lang, D. M., Butz, A. M., Duggan, A. K., & Serwint, J. R. (2007). Physical activity in urban school-aged children with asthma. *Pediatrics, 113*(4), 341-346.
- Lee, M., Lee, D., Park, C., Park, G., Lee, D., Kim, S., & Kim, Y. (2012). Validity evidence of Omron pedometer HJ-720ITC for Korean children: A preliminary study. *Journal of Science and Medicine in Sport, 15*(Suppl. 1), 297.
- Li, J., & Hooker, N. H. (2010). Childhood obesity and schools: Evidence from the National Survey of children's health. *Journal of School Health, 80*(2), 96-103.
- Loucaides, C. A., & Jago, R. (2008). Differences in physical activity by gender, weight status and travel mode to school in Cypriot children. *Preventive Medicine, 47*(1), 107-111.
- Malecka-Tendera, E., & Mazur, A. (2006). Childhood obesity: A pandemic of the twenty-first century. *International Journal of Obesity, 30*, 1-3.
- Miles, L. (2007). Physical activity and health. *Nutrition Bulletin, 32*(4), 314-363.
- Moore, J. B., Jilcott, S. B., Shores, K. A., Evenson, K. R., Brownson, R. C., & Novick, L. F. (2010). A qualitative examination of perceived barriers and facilitators of physical activity for urban and rural youth. *Health Education Research, 25*(1), 355-367.
- Núñez-Rivas, H., Monge-Rojas, R., León, H., & Roselló, M. (2003). Prevalence of overweight and obesity among Costa Rican elementary school children. *Revista Panamericana de la Salud Pública/Pan American Journal of Public Health, 13*(1), 25-32.
- Pabayon, R., Maximova, K., Spence, J. C., Ploeg, K. V., Wu, B., & Veuglers, P. J. (2012). The importance of active transportation to and from school for daily physical activity among children. *Preventive Medicine, 55*(3), 196-200.
- Pangrazi, R., Beighle, A., Vehige, T., & Vack, C. (2009). Impact of Promoting Lifestyle Activity for Youth (PLAY) on children's physical activity. *Journal of School Health, 73*(8), 317-321.
- Page, A. S., Cooper, A. R., Griew, P., Davis, L., & Hillsdon, M. (2009). Independent mobility in relation to weekday and weekends physical activity in children aged 10-11 years: The PEACH project. *International Journal of Behavioral Nutrition and Physical Activity, 6*, 2.

- Page, A., Cooper, A. R., Stamatakis, E., Foster, L. J., Crowne E. C., Sabin, M., & Shield, J. P. (2005). Physical activity patterns in nonobese and obese children assessed using minute-by-minute accelerometry. *International Journal of Obesity*, 29(9), 1070-1076.
- Peters, B. P., Heelan, K. A., & Abbey, B. M. (2013). Validation of Omron™ Pedometers using MTI accelerometers for use with children. *International Journal of Exercise Science*, 6(2), 106-113.
- Purslow, L.R., Hill, C., Saxton, J., Corder, K., & Wardle, J. (2008). Differences in physical activity and sedentary time in relation to weight in 8-9 year old children. *International Journal of Behavioral Nutrition and Physical Activity*, 5, 67.
- Riddoch, C. J., Mattocks, C., Deere, K., Sounders, J., Kirkby, J., Tilling, K., Leary, S. D., Blair, S. N., & Ness, A. R. (2007). Objective measurement of levels and patterns of physical activity. *Archives of Disease in Childhood*, 92, 963-969.
- Rowe, D. A., Mahar, M. T., Raedeke, T. D., & Lore, J. (2004). Measuring physical activity in children with pedometers: Reliability, reactivity, and replacement of missing data. *Pediatric Exercise Science*, 16(4), 343-354.
- Sallis, J. E., Prochaska, J. J., & Taylor, W. C. (2000). A review of correlates of physical activity and adolescents. *Medicine and Science in Sports and Exercise*, 32(5), 963-975.
- Scruggs, P. W., Beveridge, S. K., Eisenman, P. A., Watson, D. L., Shultz, B. B., & Ransdell, L. B. (2003). Quantifying physical activity via pedometry in elementary physical education. *Medicine and Science in Sports and Exercise*, 35(6), 1065-1071.
- Sharma, M. (2007). International school-based interventions for preventing obesity in children. *Obesity Reviews*, 8(2), 155-167.
- Spinks, A., Macpherson, A., Bain, C., & McClure, R. (2006). Determinants of sufficient daily activity in Australian primary school children. *Journal of Paediatrics & Child Health*, 42(11), 674-679.
- Sundblom, E., Petzold, M., Rasmussen, E., Callmer, E., & Lissner, L. (2008). Childhood overweight and obesity prevalences leveling off in Stockholm but socioeconomic differences persist. *International Journal of Obesity*, 32, 1525-1530.
- Taras, H. (2005). Physical activity and student performance at school. *Journal of School Health*, 75(6), 214-218.
- Trost, S. G., Rosenkranz, R. R., & Dziewaltowski, D. (2008). Physical activity levels among children attending after-school programs. *Medicine & Science in Sports & Exercise*, 40(4), 622-629.
- Tudor-Locke, C., Johnson, W. D., & Katzmarzyk, P. T. (2010). Accelerometer-determined steps per day in US children and youth. *Medicine & Science in Sports & Exercise*, 42(12), 2244-2250.
- Tudor-Locke, C., McClain, J. J., Hart, T. L., Sisson S. B., & Washington T. L. (2009b). Pedometry methods for assessing free-living youth. *Research Quarterly for Exercise and Sport*, 80(2), 175-184.
- Tudor-Locke, C., McClain, J. J., Hart, T. L., Sisson S. B., & Washington T. L. (2009a). Expected values for pedometer-determined physical activity in youth. *Research Quarterly for Exercise and Sport*, 80(2), 164-174.
- Tudor-Locke, C., Pangrazi, R. P., Corbin, C. B., Rutherford, W. J., Vincent, S. D., & Cuddihy, T. F. (2004). BMI-referenced standards for recommended pedometer-determined steps/day in children. *Preventive Medicine*, 38, 857-864.
- Veitch, J., Bagley, S., Ball, K., & Salmon, J. (2005). Where do children usually play? A qualitative study of parent's perceptions of influences on children's active free-play. *Health and Place*, 12(4), 383-393.
- Wang, Y., & Lobstein (2006). Trends of obesity in children overweight and obesity. *International Journal of Pediatric Obesity*, 1(1), 11-25.