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The relationship between the body mass index and daily activity of children and their parents

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Abstract
Boys accumulate thousands of more steps per school year than girls equating to hundreds of miles. As well, girls averaged a higher obesity level than boys, while female parents were much less physically active than male parents during the weekdays. Since female parents are role models to their daughters, and as the female parent's BMI increases, their child's BMI is likely to increase, immediate attention must be given to the overweight and obese girls and their mothers. Excellent programs need to be developed and implemented where children and parents can be physically active together in an urban environment. Parents of elementary aged children should receive more information on the importance of regular, daily physical activity for their child. The parents should be encouraged to participate in the physical activities with their child whereby both parent and child together would be reaping the benefits of an active lifestyle. Increasing physical education duration and frequency can have a substantial positive impact on helping overweight and obese children become more physically active, which will help alleviate the obesity problem faced by so many children today.

Keywords: Body mass index, daily activity, children, parents etc.

Introduction
Obesity is a problem that many American adults and children are facing today as nearly 34% of U.S. adults and 17% of U.S. children aged 2-17 years are obese (Centers for Disease Control and Prevention, 201 ld; CDC, 201 le) [10]. An association has been found between a parent's weight and their child's weight. If at least one parent is obese, their child is at an increased risk for becoming obese (Davison & Birch, 2002; Panagiotakos *et al.*, 2008; Fogelholm, Nuutinen; Pasanen, Myohanen, & Saaleta, 1999) [13]. A lack ofphysical activity can be a major contributor in a person's obesity (CDC, 201 lf). Obese adults and children have health risks. An obese adult has an increased health risk oftype II diabetes, hypertension, cardiovascular disease, stroke, and certain types of cancers, while an obese child has many health risks, as compared to a
normal weight child (CDC, 201 la). These include an early onset of type II diabetes, respiratory issues including asthma, liver disease, high blood pressure, female menstrual problems, the early onset of puberty, and depression (CDC, 201 la; National Institutes of Health [NIH], 2007).

Since obese people have health risks, it is important to know how to determine an adult or child's weight category. The CDC has determined formulas for classifying people in categories of a healthy or normal weight, overweight, and obese weight. For adults, overweight is defined as having a body mass index (BMI) of 25-29.9, while 1 obesity is defined as having a BMI of 30 or greater (CDC, 201 le). BMI is calculated by taking the person's weight in kilograms and dividing it by their height in meters squared. For children, overweight is defined as being in the g5th _ 94th percentile. Obesity is defined as being in the 95th percentile or higher. Percentiles are determined based on the CDC growth charts for gender and age (CDC, 2010a). This research examines the relationship of parent and child physical activity levels and BMI, therefor, for the sake of comparison, a child's weight status will be converted to normal/healthy, overweight, or obese, instead of referring to percentiles. When relating BMI to physical activity, Hands and Parker (2008) reported that if a child has a high BMI, there is a high likelihood the child is not very physically active.

When looking at the relationship of a parent's BMI and physical activity level to that oftheir child's BMI and physical activity level, a parent's socio-economic level can have an impact on their child's BMI. Lamerz *et al*. (2005) studied 1,979 parents and their children on parental social class, education, and obesity prevalence of their children. They reported that 5% of the children having a high socio-economic level had a BMI equal to or greater than the 90th percentile. For children having a low socio-economic level, 15% had a BMI equal to or greater than the 90th percentile (Lamerz *et al*., 2005). As can be seen, the lower socio-economic level children were three times more likely to have an unhealthy BMI than the high socio-economic children. Parents play a role in their child's physical activity as socio-economic status impacts available resources (Johnson, Brusseau, Darst, Kulinna, & White-Taylor, 2010) [5]. It is possible that a family with low socio-economic status will not have the disposable income available to spend on resources for their child's physical activity as compared to a middle or high income family. Therefore, the child may not be exposed to a wide variety of physical activity choices outside of school.

Child Obesity Health Risks

Obese adults and children have a higher risk for many types of diseases than adults and children maintaining a healthy weight (CDC, 201 ld). As noted, an obese adult has increased health risks. Children suffering from obesity are also at risk for many health problems (CDC, 201 lf). Some of these risks are similar to adult obesity risks, while some are more age specific. Obese children and youth who regularly consume unhealthy amounts of foods high in sugar and saturated fat are at risk for developing insulin resistance and diabetes (U.S. Department of Health and Human Services [DHHS], 2007). While physical inactivity in children can contribute to obesity leading to type II diabetes, physical activity on a regular basis can contribute to a child's healthy BMI, which helps to reduce the risk of getting type II diabetes (CDC, 2011d). Besides type II diabetes, obese children have an increased risk of developing respiratory problems such as asthma. In a study by Gennuso, Epstein, Paluch, and Cerny (1998), the authors researched 85 children with asthma and 86 children without asthma aged 4-16 years. They noted that 30.6% of the children with asthma had BMI's above the 95th percentile, classifying them as very obese, while only 12% of the non-obese children had asthma (Gennuso *et al*., 1998). By participating in regular physical activity at a moderate intensity, children can reduce their risk of developing 3 an obese BMI (CDC, 2010b). In addition to type II diabetes and respiratory problems, children and youth that are obese have an increased risk for getting non-alcoholic fatty liver disease (NAFLD) (Dunn & Schwimmer, 2008) [14]. NAFLD affects the liver in that healthy cells break down and become diseased with the presence of fat inside the cell, which can gradually lead to cirrhosis. The current treatment is an increase in physical activity and a change in diet, so that the child is consuming healthy foods, in order to achieve the goal of weight loss (Dunn & Schwimmer, 2008) [14]. Hypertension is yet another health condition that can affect obese children. Virdis *et al*. (2009) reported hypertension to be the main cardiovascular risk factor connecting obesity to cardiovascular disease. Unfortunately, obese children and youth can begin to develop atherosclerosis. When this condition is accompanied with hypertension, children are at an increased risk of cardiac mortality in adulthood if they remain obese (Virdis *et al*., 2009). The CDC (201 lc) reported that maintaining a healthy BMI helps sustain a person's blood pressure at a healthy level. Diabetes, asthma, NAFLD, and hypertension are just a few of the health issues an obese child can face. These and other health issues, such as female menstrual problems, early onset of puberty, and depression can all contribute to a reduced quality of life for an obese child (CDC, 201 la; NIH, 2007). Physical inactivity can contribute to a child's obesity, while an active child that participates in regular physical activity has an increased chance of achieving and maintaining a healthy BMI (CDC, 201 lg).

Physical Activity Benefits for Adults

fu addition to the notion that physical activity contributes to a healthy BMI, there are also other advantages. Physically active adults have a reduced risk of contracting certain diseases (CDC, 201 ld). The 1996 Surgeon General's Report on Physical Activity and Health stated that if adults exercise regularly they significantly reduce their risk for heart diseases, diabetes, and colon cancer. Regular physical activity in adults also can reduce depression and anxiety, improve emotional health, increase an overall feeling of well-being, lower high blood pressure, increase or maintain bone density, maintain healthy joints, increase muscle mass, and is instrumental in contributing to maintaining a healthy body weight (CDC, 2011:t).

Physical Activity Benefits for Children

The CDC (2010b) reported that in 2007 in the United States, 38% of children aged 9-13 years, participated in organized physical activity during out of school hours, while 67% participated in unorganized physical activity. Only 17% of high school aged children participated in at least one hour of physical activity a day. These statistics suggest that children spend less time in physical activity as they mature (CDC, 2010b). Some of the benefits of regular physical activity for children are improvement in bone mineral density, prevention of child onset type II diabetes, a reduction in the incidence of attention deficit hyperactivity disorder (ADHD), and prevention of obesity (CDC, 201 la). When girls are 11-14 years of age, and when boys are 14-16 years of age, there are quick increases in bone mass (Gracia-Marco *et al*., 2010). At these ages, participation in weight bearing activity can increase their bone density, which sets the stage for a healthy bone density level in adulthood (Gracia-Marco *et al*., 2010).

Methods

In this section, participants, instruments, and procedures will be described. The data collection and data treatment/analysis will also be explained.

Participants

For this study, 36 children (14 males and 18 females) and 23 of their parent(s) or guardian(s) (5 males and 18 females) agreed to participate by wearing a pedometer throughout the day for seven consecutive days. All of the children attended one of United States. The school used in this investigation was chosen based on its location along with the excellent rapport that had been developed with the administrators and educators. When looking at the elementary school as a whole, 85% of the children were eligible for the free or reduced breakfast/lunch program at school for the 2009/2010 school year. The ethnic/racial background for the children in the study was 78% African American, 14% Hispanic, and 8%

Caucasian.

Letters were sent to the parents/guardians of 39 children explaining the study. By the first day of the study, 36 children and 23 parents had agreed to participate. By the last day of the study there were 36 children (16 males and 20 females) and18 parents (3 males and 15 females) who had provided usable BMI data. Also, on the last day of the study there were 32 children (14 males and 18 females) and 11 parents (4 males and 7 females) who had provided usable step count data. Four children (2 males and 2 females), and 12 parents (1 male and 11 females) were given a podometry yet edometer yet never reported any step counts. The mean age of the children was 10.5 years with a standard deviation of For the parents, the mean age of the females was 35.5 years with a standard deviation of 8.297, and the mean age of the males was 34 years with a standard deviation of 8.124. Of the 17 adult females reporting their ethnicity, 70% were African American, 18% Hispanic, and 12% Caucasian. For the five adult males reporting their ethnicity, 60% were African American, 20% Hispanic, and 20% Caucasian. For the 12 adult females listing their occupation, eight were employed, two were homemakers, and two were either retired or disabled. For adult males, three listed themselves as employed. For the 17 adult females reporting their marital status, 59% were single, 35% married, and 6% divorced. For the five adult males reporting their marital status, 60% were single and 40% married. The data obtained from this study were for research purposes only, and kept in a locked filing cabinet for three years. At the end of three years, the data will be shredded with the exception of a spreadsheet and coding list, which could be used in future research if needed. A subject's data was not shared with any other person, with the exception of the primary researcher. Informed consent was obtained from the parent or guardian of each child. Each child filled out a child assent form. Each parent or guardian also filled out an informed consent for their own participation in the study. The school principal, physical education teacher, and additional homeroom teachers also gave their approval and permission to come into their school and classrooms between January and May, 2012. The informed consent for child participation, child assent form, adult informed consent form, adult daily step count 38 log sheet (parent data collection form), and the adult and child demographics forms are contained in appendixes A, B, C, D, E, and F. Institutional Review Board approval was obtained from the State University of New York College at Brockport, in February of 2012.

Instruments

In this study, one goal was to capture a direct measurement ofhow active the subjects were on a daily basis. This was done by having the subjects wear a pedometer that recorded daily step counts. The Yamax Digiwalker SW-200pedometer was used for all adults while the Yamax Digiwalker CW-600 was used for all children. The CW-600 is exactly like the SW-200 except that it is a newer version nwith added features that include a clock and seven day recall function. Both the SW-200 and the CW-600 models of the Yamax pedometer are research grade pedometers. The SW-200 has been used in other pedometer based physical activity studies (Brusseau, *et al*., 2011; Tudor-Locke *et al*., 2009) [6]. Both Yamax pedometers are small, discrete monitors worn on the waist band of clothing. The SW-200 is 5 cm in width x 4 cm in height (without the clip) and the CW-600 is 6 cm in width x 4.5 cm in height. These pedometers are very lightweight and count each step that is taken through a lever arm action. The SW-200 was found to be valid and reliable in the adult population (Tudor-Locke *et al*., 2009), and in the pediatric population (Tudor-Locke, McClain, Hart, Sisson, and Washington, 2009b).

Data Collection

The parent or guardian was given a demographics questionnaire to fill out. Questions regarding a subject's age, race, ethnic background, profession, and marital status were asked on this form. A sample questionnaire can be found in appendix D. The adults recorded their daily step counts on a log sheet. A sample log sheet can found in appendix C. The demographics form and log sheet for adults, and the demographics form for children was included in the informational materials sent home with each child. The children recorded their daily step counts (for the previous day) at the start of each school day, in the presence of the researchers. On the last day of data collection for the children (Monday morning), they recorded their Friday, Saturday, and Sunday step counts.

Results

The purpose of this study was to investigate and compare fifth grade children's BMI and daily physical activity levels to their parents' BMI and daily physical activity levels. It was important to investigate this relationship because parents influence their child's physical activity levels and because of the prevalence of obesity among elementary aged children and adults, particularly those of a low socio-economic status, minority ethnic background, and living in an urban area (Bauer *et al*., 2008; Timperio *et al*., 2008; MCDPH, 2008; MCDPH, 2011) [3]. This chapter will describe the relationship between parent and child physical activity, parent and child BMI, and BMI differences in children by gender and ethnicity. Differences in step counts were examined with regard to a five day week, the weekend, and the seven day week. Differences with regard to gender, ethnicity, and BMI differences in children, and between physical education and non-physical education days were, as well, examined. A power analysis was not used to determine the sample size. Determination of the means, standard deviations, paired *t* tests scores, independent samples *t* tests scores, analysis of variance scores, and Pearson correlations was calculated. These tests were calculated because their results gave insight into the fifth grade children's BMI and daily physical activity level as they related to their parent's BMI and daily physical activity level.

Parent-Child Physical Activity

The means and standard deviations depicting the physical activity of the parents and children are shown in table 4.1. The mean steps per day in the seven day week for children= 9,535 (SD=2,594), female parents= 5,209 (SD=2,832), and male parents= 10,161 (SD=7,010). The increment of change in scores from children to female parents was *f::.* = 4,326, children to male parents was *f::.* = -626, and from female parents to male parents was *f::.* = -4,952. A Pearson correlation examining the relationship between children and female parents across the seven day week step count was not significant (r = .19,p = .65), but indicated a weak relationship. The relationship between children and their male parents was not significant (r = -.47,p = .53). This score indicated a moderate inverse relationship (Holcomb, 2006).

Table 1: Parent-child physical activity by weekday, weekend, and the seven day week

	Weekday Mean	Weekday SD	Weekend Mean	Weekend SD	Seven day Week Mean	Seven day week SD
Children	9,951	2,747	7,557	4,337	9,535	2,594
Female parents	4,333	2,781	7,252	3,594	5,209	2,832
Male parents	11,026	7,348	8,358	6,349	10,161	7,010

Note: For children and female parents, the Pearson correlation wasp = .8 for weekday, *p* = .97 for weekend, and *p* = .65 for the seven day week. For children and male parents, the Pearson correlation *wasp = .83* for weekday, *p* = .9 for weekend, and *p* = .53 for the seven day week. 'rr=32.*bn=7.`n*=4.

Table 1 aired samples t-tests were conducted on these data to determine if there were significant differences. When analyzing children and female parent seven day week step counts the results [t(7) = 2.8, *p* =.03] demonstrated a significant difference. For children and their male parent seven day week step counts the results [t(3) = -.44, *p* =.69] indicated that there was not a significant difference. The mean weekday steps for children was 9,951 (SD=2,747), female parents 4,333 (SD=2,781), and male parents 11,026 (SD=7,348). When analyzing the data for weekday step counts, the correlation between children and female parents was not significant (r = .1, *p* = .8), which indicated a weak relationship. The correlation between children and their male parents was not significant (r = -.17,p = .83) and indicated a weak inverse relationship (Holcomb, 2006). Paired samples *t-tests* were performed to determine if there were significant differences. When analyzing children and female parent weekday step counts the results [t(7) = 3.98,p = .00] indicated that there was a significant difference. For children and their male parent weekday step counts the results [t(3) = -*.56,p* = 62] indicated that there was not a significant difference. The mean weekend steps per day for children was 7,557 (SD=4,337), female parents, 7,252 (SD=3,594), and male parents, 8,358 (SD=6,349). The weekend step count correlation for children and female parents was not significant as the results (r = -.02, *p* = .97) indicated a weak inverse relationship. The correlation between children and their male parents was, as well, not significant as the results (r = .16, *p* = .9) indicated a weak relationship (Holcomb, 2006). Paired samples *t-tests* were conducted to determine if there were significant differences. When analyzing children and female parent weekend step counts the results [t(6) = -*.69,p* = .52] indicated that there was not a significant difference. For children and their male parent weekend step counts the results [t(2) = -.98,p = .43] indicated that there was not a significant difference.

Weekday and Weekend Step Counts in Children

Statistical analyses were performed for weekday and weekend step counts of the children. Step count means on the weekday was 10,090 (SD=2,939), and on the weekend 7,557 (SD=4,337), with an increment of change of *Ii*= 2,533. A paired samples t-test was performed to determine if there were differences. The t-test revealed t(16)=2.38,p =.03, which indicated there was a significant difference.

Gender Differences in Step Counts of Children

The means and standard deviations for the weekday, weekend, and seven day week step counts for the children examined by gender are illustrated in figure 4.1. The differences in step counts between boys and girls for weekdays was 1,756, weekends 681, and seven day week 1,409 with boys having more steps in each case. An independent samples *t-test* was conducted for children's weekday, weekend, and seven day week step counts based on gender. For the weekday steps [t(30)= 1.86,p =.07], and for the weekend steps [t(15)= .31,p =.76], and for the seven day week steps [t(30)= 1.56, *p* =.13] the results revealed that there was not a significant difference in the step counts between boys and girls

Ethnic Differences in Step Counts of Children

The means and standard deviations for the step counts of the children based on ethnicity are shown in table 4.2. A one-way ANOVA was conducted on children's weekday, weekend, and seven day step counts based on their ethnicity (African American, Caucasian, or Hispanic). For the weekday [F(2,29)= .77,p = .47],the weekend [F(2,14)= 1,p = .39] and the seven day week [F(2,29)= .98,p = .39] the differences were not statistically significant at the .05 level

Table 2: Children's Step Counts based on Ethnicity

Ethnicity	Weekday Mean	Weekday SD	Weekend Mean	Weekend SD	Seven day Mean	Seven day SD
African American[a]	9,637	2,986	7,672	3,559	9,188	2,638
Cattcasian[b]	11,599	1,148	8,937	7,460	11,166	2,911
Hispanic[c]	10,469	1,891	1,918[4]	O[d]	10,220	2,141

Note: A one-way ANOVA showed the differences in step counts based on ethnicity were not statistically significant at the .05 level. = 24. [b]u = 3. *un* = 5. Reflects results of only one child who turned in weekend data

Physical Education and Non-Physical Education Days

Statistical analysis was performed for step counts of children on physical education and non-physical education days. For physical education days, the mean number of steps was 10,610 (SD=2,842) and on non-physical education days, the mean number of steps was 8,338 (SD=2,802), with an increment of change of /j,,= 2,272. A paired samples *t-test* was performed to determine if there were differences. The *t-test* [t(30)=4.7, p =.00] indicated that there was a significant difference for children on physical education and non-physical education days. Regarding gender, the mean for boys on physical education days was 11,633 (SD=2,405), and for girls, 10,176 (SD=3,356), with an increment of change of /j,, = 1,457. The mean for boys on non-physical education days was 8,982 (SD=2,990), and for girls, 7,873 (SD=2,645) with an increment of change of /j,, = 1,109. The change in the step count for boys, from physical education days to non-physical education days, was /j,, = 2,651. The 52change in the step count for girls, from physical education to non-physical education days, was *1:1* = 2,303. An independent samples t-test was done to determine differences between physical education and non-physical education day step counts by gender. For physical education days [t(30)= 1.37,p = .18], and for non-physical education days [t(29)= *1.09,p* = .29] the results indicated that there was not a significant difference in step counts based on gender for physical education and nonphysical education days.

Parent BMI and Physical Activity

Parent BMI, the percentages for each BMI category, and step counts are summarized in table 4.3 change in the step count for girls, from physical education to non-physical education days, was *1:1* = 2,303. An independent samples t-test was done to determine differences between physical education and non-physical education day step counts by gender. For physical education days [t(30)= 1.37,p = .18], and for non-physical education days [t(29)= *1.09,p* = .29] the results indicated that there was not a significant difference in step counts based on gender for physical education and nonphysical education days.

Parent BMI and Physical Activity

Parent BMI, the percentages for each BMI category, and step counts are summarized in table 3.

Table 3: Parent BM and Step Counts

	BMI (A4)	Normal Weight (%)	Overweight (%)	Obese (%)	Step Count (W)
Female Parents'	29.1	27	33	40	5,209
Male Parents"	26.8	33	67	0	10,161
All Parents'	27.2	26	42	32	7,010

Conclusions

In conclusion, data was obtained on children and their parents' physical activity and BMI in February and March, 2012. At-test showed that children were significantly more active than their female parents. The correlation between children and their female parents' BMI revealed a moderately strong relationship. Boys took more steps than girls during the seven day week, weekdays, and on the weekends. Caucasian children took more steps during the seven day week, weekdays, and on the weekends than African American and Hispanic children. Children in the healthy BMI category took more steps in the seven day week than children in the overweight or 56 obese BMI categories. Children took significantly more steps on physical education days than on non-physical education days indicating that children are more active on physical education days than non-physical education days.

Conclusions

The children involved in this study averaged considerably less steps per weekday and on the weekend than other children their age across the United States. Boys accumulated hundreds of thousands of more steps per school year than girls equating to hundreds of miles. As well, girls averaged a higher obesity level than boys, while female parents were much less physically active than male parents during the weekdays. Since female parents are role models to their daughters, and as the female parent's BMI increases, their child's BMI is likely to increase, immediate attention must be given to the overweight and obese girls and their mothers. Excellent programs need to be developed and implemented where children and parents can be physically active together in an urban environment. Parents of elementary aged children should receive more information on the importance of regular, daily physical activity for their child. The parents should be encouraged to participate in the physical activities with their child whereby both parent and child together would be reaping 79 the benefits of an active lifestyle. Increasing physical education duration and frequency can have a substantial positive impact on helping overweight and obese children become more physically active, which will help alleviate the obesity problem faced by so many children today

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