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Examination of Changes in Youth Diet and Physical Activity Over the Summer Vacation Period

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ABSTRACT
Purpose: The purpose of this study was to examine weight, diet, and physical activity (PA) changes in youth over summer vacation. **Methods:** Thirty healthy subjects (19 male, 11 female; mean age $\pm$ SEM 10.0$\pm$0.1 yrs) were assessed before the end of the 2009/2010 school year (baseline), and prior to the start of the 2010/2011 school year (post-test). **Results:** Significant ($p<0.05$) increases in height, weight, body mass index (BMI), and BMI percentile-for-age were observed. Percent time spent in light ($p=0.002$) and moderate ($p=0.014$) PA intensities both decreased, while time spent being sedentary significantly ($p=0.006$) increased. No significant diet changes were reported. **Conclusion:** This healthy youth population increased time spent being sedentary at the expense of light and moderate PA over summer vacation. The result was an increase in BMI and BMI percentile-for-age. Future studies are needed to examine ways to prevent this decline in PA in youth over summer vacation.

INTRODUCTION
The prevalence of obesity among United States school children 6- to 11-years of age has tripled from 5 to 15% over the last two decades.[1] There are a number of possible factors contributing to the increase in childhood obesity. Schools are often linked to the policies and practices regarding food options, physical activity, and physical education.[2-5] However, schools are not the only culprit; researchers have identified a number of influences outside the school setting that may also play a role in the childhood obesity epidemic. Some of these external factors include 1) consumption of fast food and calorically dense products, 2) lack of sidewalks and recreation areas and increased television viewing time, and 3) less daytime supervision over the summer months as compared to their school-schedule routine. [6-11]

A recent study from our laboratory examined the role of exercise on measures of cardiovascular function in overweight children and adolescents.[4] An increase in body weight and a decline in cardiovascular function were observed among adolescents who did not participate in a supervised exercise program during the summer vacation period. However, those students who participated in a planned exercise program maintained their body weight and improved measures of cardiovascular function.[4] Von Hippel et al. recently reported an increase in body weight and body mass index (BMI) that was faster and more variable during the summer vacation period than during the actual school year in adolescents.[12] The reason for the rapid increase in adolescent body mass over summer vacation is unknown; however, several possible factors exist.
One cause could be that diet and eating patterns change during summer vacation. While children have a regimented eating schedule that revolves around their school schedule during the school year, their schedule for eating meals and snacks is less

regimented during the summer vacation period. In addition, children may have greater access to food during the summer months, especially if both parents are employed and there is a lack of daytime supervision. A second potential cause may be a reduction in physical activity (PA). During the summer vacation period, children may have a number of options to occupy their free-time, such as video and computer games, internet, etc.

Additional research is needed to obtain an understanding into the underlying causes of potential weight gain over the course of summer vacation. Therefore, the purpose of the present study was to examine body weight, diet, and PA changes over the summer vacation period in youth between the ages of 9-11 yrs.

METHODS

The study protocol was reviewed and approved by the University of Minnesota Institutional Review Board (IRB). Additionally, the procedures followed in the study adhered to the University of Minnesota's IRB and the Health Insurance Portability and Accountability Act (HIPAA) guidelines.

Study Population

Thirty-five healthy children (22 males, 13 females) between the ages of 9-11 yrs were examined one-week prior to the end of their 2009/2010 school year (baseline), as well as one-week prior to the start of their 2010/2011 school year (post-test). All subjects submitted written informed assent and consent was obtained from a parent/guardian prior to participation in the study. Subjects attended a rural elementary school in east-central Minnesota, and were otherwise considered healthy individuals. A total of thirty children (19 males, 11 females; mean age 10.0±0.1 yrs) completed all study components required for inclusion in the final analysis.

Measurements

Anthropometric and Blood Pressure Assessments

Height (cm) and weight (kg) were obtained using a standard stadiometer (Ayrton, Model S100, Prior Lake, MN, USA) and electronic scale (ST Scale-Tronix, Serial No. 5002-8893, White Plains, NY, USA), respectively. Body Mass Index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Waist circumference was measured using a Gulick measuring tape. Subjects were told to relax and breathe normally and a horizontal measure was taken at the level of the umbilicus, recorded to the nearest millimeter (mm). Seated blood pressure (BP) was obtained on the right arm using a manual sphygmomanometer BP unit (American Diagnostic Corporation, Hauppauge, NY, USA) after 5 minutes of quiet rest. Duplicate measures of BP were obtained and the mean values were reported. All measures were obtained by trained research staff.

Physical Activity Assessment

Physical activity was assessed at both baseline and post-test via ActiGraph accelerometry (ActiGraph, Pensacola FL, USA)[13-15] The ActiGraph has been shown to be a valid device for measuring physical activity in children.[13-15] Subjects were instructed to wear the ActiGraph over a 7-consecutive day period. ActiGraph data were reduced using a custom developed software program using Visual Basic Version 6.0.[16,17] All data that were reduced contained the time frame from when the monitor was initialized until exactly 7 days later (end time).

Exclusion criteria were established to determine days and times with valid accelerometer data. Blocks of time incorporating at least 20 continuous minutes of "0" output from the ActiGraph were considered to be times when the subject was not wearing the monitor, and thus not a valid representation of their activity level. These data points were eliminated and not used in any summary variable calculations. Also, days with less than 10 hours of data were eliminated from data reduction to account for unrepresentative days of activity data. Only participants who recorded ≥4 days of ActiGraph data were included for ActiGraph analysis.[18] Fourteen of the 30 participants (9 males, 5 females) wore the accelerometers for the required time period for both baseline and post-measurements. An independent t-test was utilized to compare BMI at post-test and BMI percentile-for-age at post-test of those whose accelerometer data were included, and those whose data was excluded. Accelerometer data were reduced to the time (in mean minutes per day) spent in sedentary, light, moderate, moderate-to-vigorous physical activity (MVPA) and vigorous physical activity (VPA), and also as the percent of total wear time per day (i.e., mean percent of time spent in activity intensity category per day).

Diet Assessment

Changes in diet and eating patterns between the school year and the summer vacation period were assessed using the Youth/Adolescent Questionnaire (YAQ), a self-reported food frequency questionnaire.[19] This questionnaire has been shown to be both valid and reproducible to assess diet in adolescents.[19,20] YAQ data was coded by the Nutrition Questionnaire Service Center at the Harvard School of Public Health.

Statistical Analysis

SPSS Statistics 19.0 (SPSS, Chicago, IL, USA) was used for statistical analyses. Results are expressed as mean ± standard error of the mean (SEM). A paired-samples t-test was used to compare baseline and post-test measurements. An alpha value of 0.05 was used to signify statistical significance.

RESULTS

Physical characteristics for the 30 participants (19 males, 11 females) are displayed in Table 1. A significant ($p<0.05$) increase in weight, height, BMI, and BMI percentile-for-age was reported between baseline and post-periods. Waist circumference was not significantly different between baseline and post-period testing (68.0±1.5 vs. 67.3±1.3 cm, respectively, p=0.41). Systolic BP did not significantly change (111±1 vs. 110±1 mmHg, p=0.52). However, there was a significant (p=0.05) increase in diastolic BP reported from baseline to post-test periods (61±1 vs. 64±1 mmHg, respectively).

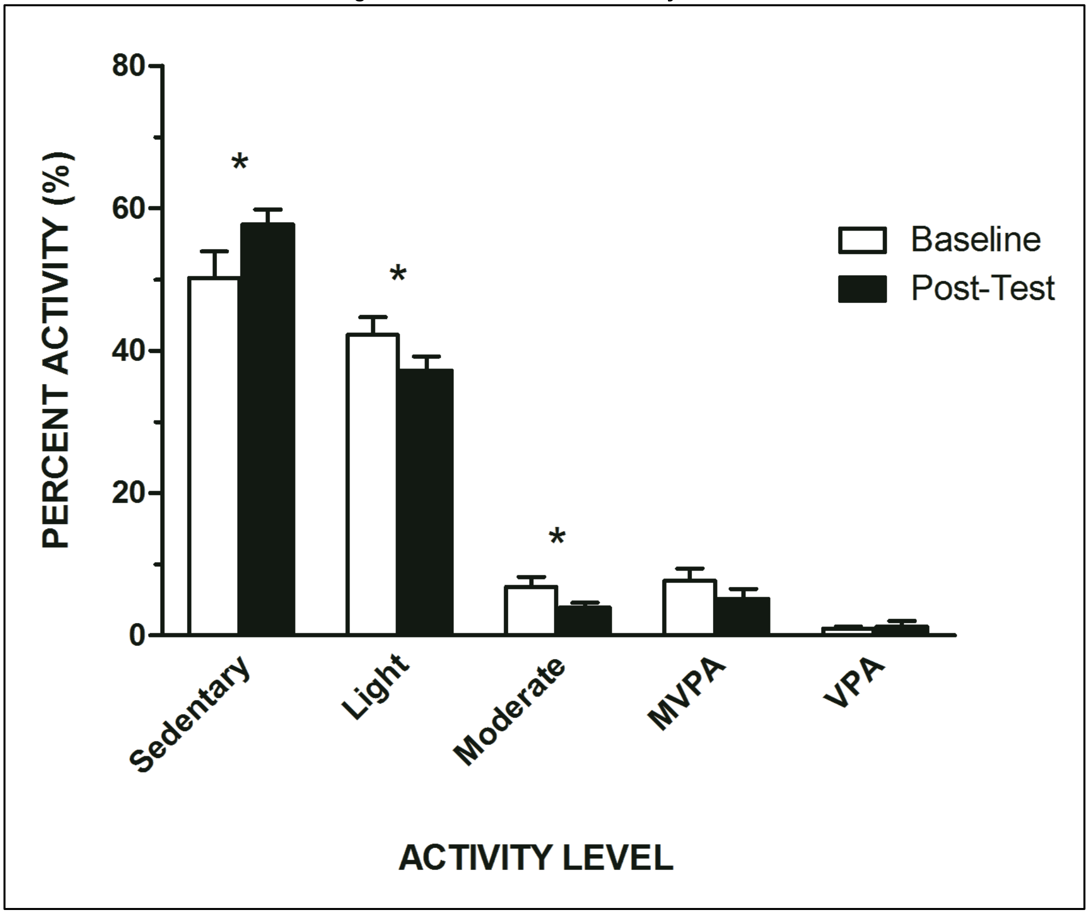
Table 1. Mean (± Standard Error of the Mean) Physical Characteristics

	Baseline (n=30)	Post-test (n=30)	*P*-value
Age (yrs)	10.0 ± 0.1	10.2 ± 0.1	0.012
Weight (kg)	38.7 ± 1.7	39.9 ± 1.7	< 0.001
Height (cm)	144.6 ± 1.7	145.4 ± 1.7	< 0.001
Waist Circumference (cm)	68.0 ± 1.5	67.3 ± 1.3	0.41
BMI (kg/m^2)	18.2 ± 0.5	18.6 ± 0.5	0.001
BMI Percentile-for-Age (%)	57.8 ± 5.2	60.7 ± 5.2	0.029
SBP (mmHg)	111 ± 1	110 ± 1	0.52
DBP (mmHg)	61 ± 1	64 ± 1	0.05

*BMI (body mass index); SBP (systolic blood pressure); DBP (diastolic blood pressure)

Independent t-tests run on the participants' physical activity levels indicated that participants whose data were excluded displayed higher BMI at post-test (19.8 vs 17.8, p=0.05) and higher BMI percentile for age at post-test (73.7 vs 51.2, p=0.03) than those who were not excluded. There was a significant difference in the amount of time the ActiGraphs were worn per day between baseline and post-testing phases (59.9±2.3 vs. 48.8±3.0 %, p=0.02); therefore, data were expressed as percent of time wearing the ActiGraph. Percent of time spent at specific activity levels are displayed in Figure 1. The percent of time spent being sedentary significantly increased from baseline to post-test (50±7 vs. 58±2 %, p=0.006), while percent of time spent in light (42±2 vs. 37±2 %, p=0.002) and moderate (7±1 vs. 4±1 %, p=0.014) intensity PA levels both decreased (Figure 1). No change was detected in percent of time spent in MVPA (8±2 vs. 5±1 %, p=0.151) or in VPA (0.9±0.3 vs. 1.2±0.8 %, p=0.697). No significant change was observed in total calories (1,562±131 vs. 1,663±188 kcal, p=0.415), protein (65±6 vs. 74±9 g, p=0.24), total fat (53±5 vs. 56±7 g, p=0.563), or carbohydrate (215±20 vs. 221±24 g, p=0.621) intake between baseline and post-test periods.

Figure 1. Percent Time in Activity Levels



MVPA (moderate-to-vigorous physical activity); VPA (vigorous physical activity)
*****Significant at *P*<0.05 level; Sedentary (*P*=0.006), Light (*P*=0.002), Moderate (*P*=0.014)

DISCUSSION/CONCLUSION

In the present study, we reported that over the course of summer vacation, 9- to 11-year old youth significantly increased their percent of time per day spent being sedentary. This increase in sedentary time corresponded to an increase in BMI, BMI percentile, and diastolic BP. One would expect youth in this age group to continue growing during this time period, as represented by the change in height in the present study. However, the increase in height was disproportionate to the increase in body weight, indicated by the increase in BMI and BMI percentile-for-age during this time period. The increase in the percent of sedentary time occurred at the expense of light and moderate PA as percent of time spent at these activity levels decreased. Contrary to our initial hypothesis, we did not observe a decrease in time spent in MVPA or VPA from baseline to post-analysis.

Similar to the results of the present study, von Hippel et al. also reported an increase in adolescent BMI during the summer vacation period.[12] These changes in BMI were also paralleled by an increase in diastolic BP. Findings of the present study suggest that children are increasing their amount of sedentary time at the expense of light and moderate physical activity over the course of summer vacation, and the result is an increase in BP, total body weight, and BMI.

The reasons for the reduction in PA during the summer months in the present study are not clear. One factor that may play a role in the increase in childhood obesity is increased screen time.[21,22] During summer vacation, children may have a less-structured routine, and potentially less supervision throughout the day as compared to their school schedule.[11,21] Nelson et al. reported that there has been a significant increase in leisure-time computer use among middle-school aged boys and girls.[22] Their results indicated that as leisure-time computer usage increased, PA decreased. Findings from a large (n=9,155), nationally representative, longitudinal cohort reported that weekly hours of screen time during adolescence independently and significantly predicted incident obesity in early adulthood by over 40% among females and over 20% among males.[21] Furthermore, sedentary activities such as television watching, video games, and computers have been found to be associated with increased levels of body fatness.[24]

Recently, Gillis et al. reported that overweight adolescents gain significantly more weight during the months of July-August compared to January-February ($p<0.004$), March-April ($p<0.04$), May-June ($p<0.001$), and September-October ($p<0.04$).[11] Sixty-six percent of participants gained weight during summer vacation, and their weight gain was nearly 3% of ideal body weight.[11] Whereas results in the present study indicate statistically different changes only occurring within PA parameters, Gillis et al. reported increased diet and altered eating patterns occur over summer months, as well.[11] These researchers noted potential factors contributing to the observed weight gain may have included less self-monitoring of diet and PA, as well as an increase in sedentary time, increase in situations that cause overeating, increase in availability of higher calorie foods, and under-arousal leading to overeating.

There are some limitations of the present study that must be considered. The small sample size is one limitation. Additionally, the majority of our subjects were Caucasian; thus, the results may not be generalizable to other racial and ethnic groups. Using a study design that examines only one-week before the start of the next school year is another potential limitation. It is possible that a one-week measurement may not accurately portray measures of PA and diet throughout the entire summer; however, it must be understood that the observed weight gain and BMI both coincide with the PA observations.

Clearly, additional research is needed in larger and more diverse populations to replicate these findings and to determine the exact cause for the reported increases in sedentary time and decreases in light and moderate PA in youth over summer vacation. Interventions that focus on decreasing sedentary time during the summer in adolescents and youth populations are needed to help prevent excess weight gain that can carry over to adulthood and have long lasting negative health effects. Finally, strategies promoting the importance of maintaining a healthy diet and PA habits over summer vacation need to be developed.

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