IDENTIFYING DISPARITIES IN PHYSICAL ACTIVITY AND BODY MASS INDEX IN AN UNDERSTUDIED GROUP OF ADOLESCENTS

A THESIS SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAI‘I IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN

KINESIOLOGY AND LEISURE SCIENCE

DECEMBER 2006

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We certify that we have read this thesis and that, in our opinion, it is satisfactory in quality as a thesis for the degree of Master of Science in Kinesiology and Leisure Science.

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ACKNOWLEDGEMENTS

I’d like to thank my committee members, Dr. Morgan, Dr. Murata, and Dr. Maeda, for your professionalism and assistance every step of the way. There was not one barrier or frustration I experienced from any of you. Your constructive input, knowledge, and sincerity have served to make this research study to reach its potential.

My heartfelt thanks goes out to my chairperson, Dr. Morgan. His encouragement, enthusiasm, and dedication have been the driving force behind this process. I would have not re-entered the program if it wasn’t for your ideas, encouragement, and belief that this will make a positive impact for West Oahu. I hope to inspire my students in the same way.

I’d like to thank the faculty, staff of Waianae Intermediate School. I always fold my hands over my heart when I describe your support and help. To the principal, Mr. John Vannatta. Thank you for the support and for recognizing to dire need to research these students. To the teachers who helped me: Ms. Gerrity, Mr. Matsumoto, Ms. Maruyama, Mr. Takamori, Mr. Sabado, Mr. Song, Ms. Cole, and Ms. Delima, thank you for allowing me to disrupt your homeroom classes during this time. Special thanks to: Ms. Hiranaka, Mr. Harris, Ms. Nagata, Ms. Benson, Ms. Tarumi, Ms. Darling, Ms. Ginoza, and Ms. Sue. I would have not survived if it weren’t for you. You all took on added headaches and responsibilities and asked for nothing in return. It is just one testament of your devotion and work ethic.

Thank you to the KLS undergraduate students who made the commute to help me collect data. I couldn’t have done it by myself.

Lastly, to the participants of this study, thank you for helping me for nothing in return. You are the reason why my heart and loyalties will always be with you. I hope that our efforts in this study will give you the attention and help that you deserve. I love you all.
Abstract

Purpose: The objectives of this study were to provide descriptive data on body mass index (BMI) and pedometer-determined physical activity in a sample of Pacific Islander (PI) adolescents. Methods: A multiethnic sample of adolescents, a total of 171 (78 boys and 93 girls), in grades seven and eight, wore sealed pedometers for 6-8 weekdays. The ethnic composition of the sample was 64% PI (Native Hawaiian, Part Native Hawaiian, and Samoan) and 36% Non-Pacific Islander (Filipino, Black, Japanese, Portuguese, White, American Indian, Hispanic, Chinese, Indo-Chinese, and other). BMI was determined from height and weight. Participants were classified as normal, at-risk, or overweight using CDC BMI-for-age growth charts to obtain percentile ranking. Greater than or equal to the 95th percentile of BMI for each age and sex group was used to classify overweight participants. Results: The total sample (N=171) accumulated 10,663 ± 4,200 steps/day. Boys (12,360 ± 4,271) accumulated approximately 3,000 more steps/day than girls (9,241 ± 3,583) (p=.001) and 8th grade (11,623 ±4,280) accumulated approximately 1,800 more steps/day than 7th grade (9,800 ±3,953) (p=.01). PI (10,649±4,377) and Non-PI (10,689±3,895) accumulated similar steps/day. No significant differences were found on BMI between sex and grades. There were also no significant ethnic differences in BMI, however, 33.4% of the PI adolescents were classified as overweight compared to 23% of the Non-PI adolescents. Conclusion: Boys and girls were less active than U.S. counterparts, with the exception of 8th grade boys. The overweight prevalence among PI adolescents (33%) was more than double the national average (15%). Clearly, interventions are needed to reduce the prevalence of overweight in this population.
# Table of Contents

Acknowledgement ........................................................................ iii

Abstract .................................................................................... iv

List of Tables .............................................................................. vi

List of Figures .............................................................................. vii

Introduction ................................................................................. 1

Methods ...................................................................................... 4

Results ........................................................................................ 7

Discussion .................................................................................... 8

Conclusion .................................................................................. 14

Reference .................................................................................... 15

Appendix A: Literature Review

Appendix B: Daily Questionnaire

Appendix C: Principal Letter of Approval
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Steps/Day and Body Mass Index Means (Standard Deviations)</td>
<td>17</td>
</tr>
<tr>
<td>for Total, Gender, Grade, and Ethnicity</td>
<td></td>
</tr>
<tr>
<td>2. Frequency of CDC BMI-For-Age Categories by Total, Pacific Islander</td>
<td>18</td>
</tr>
<tr>
<td>Pacific Islander, and Non-Pacific Islander</td>
<td></td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pedometer-Determined Physical Activity of Boys Compared to National Studies</td>
<td>19</td>
</tr>
<tr>
<td>2. Pedometer-Determined Physical Activity of Girls Compared to National Studies</td>
<td>20</td>
</tr>
</tbody>
</table>
IDENTIFYING DISPARITIES IN PHYSICAL ACTIVITY AND BODY MASS INDEX IN UNDERSTUDIED GROUP OF ADOLESCENTS
Introduction

There are more American adolescents who are overweight compared to 14 other industrialized nations such as Austria, Czech Republic, France, and Portugal (Lissau et al., 2004). Despite having the highest general population of overweight adolescents in the United States, notable health disparities exist within American ethnic populations. Ethnic minorities consistently have a higher prevalence of overweight youth than White children within each age and gender group. Most notably, Mexican-American and non-Hispanic black youth ranked higher and showed greater increases in recent decades compared to their White counterparts ages 6 to 19 years-old (Kumanyika & Grier, 2006; Ogden, Flegal, Carroll, & Johnson, 2002; Strauss & Pollack, 2001).

Disparities exist within low-income communities regardless of ethnicity as well. Poorer children are more likely to be overweight compared to middle and or upper class children (Kumanyika & Grier, 2006). In general, overweight prevalence decreases as socioeconomic status (SES) increases and vice versa. However, anomalies exist because the relationship between income, overweight, and ethnicity is complex and varies across ethnicities. For example, data collected from the National Longitudinal Study of Adolescent Health (ADD Health) found that the overweight prevalence trends were identified among socioeconomic status (SES), gender, and ethnic groups (Gordon-Larsen, Adair, & Popkin, 2003). In the highest SES groups, there was little disparity in overweight prevalence among White, Hispanic, and Asian females. In contrast, as SES increased for African-American females, so did the prevalence of overweight increase.

Chai et al (2003) used multiple anthropometric measurements and reported disparities between Native Hawaiian youth and the National Health and Nutrition Examination Survey III (NHANES III). The authors compared overweight prevalence to NHANES-III statistics and
found that the Native Hawaiian youth more than doubled the national overweight rates in all ages and for both genders.

Disparities in physical activity levels exist among population groups too. Anderson, Crespo, Bartlett, Cheskin, and Pratt (1998) found that non-Hispanic Black and Mexican American children were less likely to participate in vigorous physical activity than non-Hispanic Whites. Physical inactivity is consistently higher among minority youth (children and adolescents) compared to White youth in all national surveillance systems regardless of the year (Crespo, 2005). Unfortunately, national surveillance systems have focused on two minority groups: non-Hispanic Blacks and Mexican-Americans. Little evidence exists on physical activity of Pacific Islander youth. Pacific Islanders are defined by the U.S. Census as people having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands (US Census, 2000).

Physical activity levels of Pacific Islander youth have not been investigated despite having some of the highest prevalence of overweight among U.S. adolescents. All physical activity data from the Youth Risk Behavior Surveillance System (YRBSS) was determined to be statistically unreliable for Native Hawaiian and other Pacific Islander populations under the age of 18 (CDC, 1998). According to the U.S.Census 2000, those who identify only as Native Hawaiian or Pacific Islander comprise 0.1 percent of the American population, or almost 400,000 individuals.

In a New Zealand study, pedometer-determined physical activity revealed that Polynesian (composed of Pacific Islander and Maori descent) children were the most active group on weekdays and the second most active group on weekends. Despite higher mean steps/day counts, Polynesian children were significantly heavier and had a greater BMI and waist circumferences than European and Asian children (Duncan, Schofield, & Duncan, 2006). To our knowledge, no studies have objectively measured physical activity levels in Pacific Islander adolescents. The
objectives of this study were to provide descriptive data on body mass index (BMI) and pedometer-determined physical activity in a sample of Pacific Islander (Pl) adolescents.

Method

Setting and Participants

Approximately 450 students from a Title I publicly accredited middle school (grades 7 & 8) were solicited to participate in the study during the spring of 2006. One hundred eighty five students volunteered to participate in the study and written informed consent and assent was obtained. The school was selected specifically for its large Native Hawaiian population and low socioeconomic status. The demographics for the 2004-2005 school year consisted of 59.1% Hawaiian or Part-Hawaiian, 10.7% Filipino, 6.1% Samoan, 5.2% Caucasian, 2.3% Hispanic, 2.2% Portuguese, and 1.3% Black. The ethnic distribution in the study was similar to the distribution of the school and included Samoan (n=10), Hawaiian (n=23), Part-Hawaiian (n=77), American-Indian (n=3), Black (n=6), Chinese (n=1), Filipino (n=26), Japanese (n=5), Portuguese (n=4), Non-black Hispanics (n=2), White (n=4), Indo-Chinese (n=1), and other (n=9). The area that comprises the school boundaries has been classified as a low socioeconomic (SES) area based on the 2000 U.S. Census data (Bureau, 2000). Approximately 24.5% of households receive public assistance income and 17.2% of families are living below the poverty level. Participation was voluntary and participants were allowed to stop at anytime without consequence or question. Approval to conduct the study was obtained from school principal and the University's Institutional Review Board.

Data Collection

The procedures used in the current study were similar to other published studies that have measured pedometer-determined physical activity in youth. A week prior to the study, participants were introduced to the pedometers and were allowed to wear them during a
homeroom activity. On the first week of the study, pedometers were distributed on a Monday during their homeroom period. Homeroom on Mondays and Tuesday was 11:34-12:04 for eighth graders and 12:07-12:37 for seventh graders respectively. Thus, there was an unavoidable 31-minute difference between the homerooms on Wednesdays and Thursdays compared to the rest of the weekdays.

*Physical Activity*

Pedometers are a valid way to measure adolescent physical activity (Rowlands, Eston, & Ingledew, 1999). In a study in which eighty-seven boy scouts ages 11 to 15 wore pedometers during walking, fast walking, and jogging, the pedometers provided an accurate step count assessment (Jago et al., 2006).

The pedometers were secured with a zip-tie to avoid accidental erasure of the data. Pedometers were also engraved with an identifying number and issued to the students. For eight consecutive weekdays, students wore the pedometers during waking hours. Participants were instructed to go about their usual activity patterns without regard to the pedometer. Tuesday through Friday, during homeroom class, research assistants collected the pedometers and recorded steps from the previous 24 hours. Data was not recorded if the student forgot the pedometer or returned with it after the 24-hour period. Participants were then instructed to wear it again for the next 24-hour period.

Research assistants assisted in the data collection. They were trained on the data collection procedures 2 weeks prior to the study during one 2-hour session. Each assistant was also given written instructions on the procedures. Research assistants were assigned to the same classroom during the entire study. On each day of data collection, the research assistants met with the lead investigator to ensure the procedures were being conducted smoothly.

*Pedometer questionnaire*
Participants completed a “pedometer questionnaire” for each day they wore the pedometer. This was implemented to account for activity without the pedometer or to clarify atypical step counts, below 5,000 or above 20,000 steps/day. Questions included information about mode of transportation to school, if they participated in activities on wheels or in the water (i.e. riding a bike or surfing), and if they wore the pedometer the entire time.

*Body Mass Index Assessment*

Body mass index (BMI) was used to screen for overweight. BMI is based on height and weight and is age and gender-specific. BMI is calculated by dividing a participant’s weight in kilograms by height in meters squared (kg/m²). Normal, at-risk for overweight, and overweight categories were based on the Centers for Disease Control (CDC) BMI-for-age growth charts. Participants between the 85th and 95th percentile were classified as at-risk for becoming overweight. Greater than or equal to the 95th percentile were considered overweight (CDC).

Although BMI does not measure percent of body fat, it is considered an effective tool with large sample sizes and is the measurement of choice for many obesity researchers and health professionals. It has also been used internationally to classify overweight and obesity of adolescents (Cole, Bellizzi, & Dietz, 1999).

Each participant was measured outside of the classroom by research assistants, away from the sight of peers, for privacy. Participants were required to remove their shoes, and all measurements and results were kept confidential. An electronic scale (Seca 884, Hamburg, Germany) was used to weigh participants to the nearest tenth in kilograms, and a portable stadiometer (Model Seca 214, Hamburg, Germany) was used to measure height to the nearest centimeter (http://apps.nccd.cdc.gov/dnpabmi/Calculator.aspx?CalculatorType=Metric).
Data Analysis.

Data were analyzed using SPSS version 13.0 for Windows (SPSS Inc., Chicago, IL). Mean steps/day were calculated on 171 of 184 participants with 3 to 8 days of pedometer data. Thirteen participants (7%) were excluded from analysis due to incomplete data \( n = 12 \) or failure to follow testing protocol correctly \( n = 1 \). A pair of analysis of variance (ANOVA) procedures were conducted to determine group differences on mean steps/day and BMI respectively. The between subjects factors included gender, grade \( (7, 8) \), and ethnicity. For the purposes of this analysis, two ethnic groups were formed to be consistent with US Census Bureau definitions (US Census, 2000). The Pacific Islander (PI) group included Samoan (5.8%), Hawaiian (13.5%), and Part-Hawaiian (45%) and was the subject majority (64.3%). The Non-Pacific Islander (NPI) included American-Indian (1.8%), Black (3.5%), Chinese (0.6%), Filipino (15.2%), Japanese (2.9%), Portuguese (2.3%), Non-black Hispanics (3.5%), White (2.3%), Indo-Chinese (0.6%), and other (5.3%) and comprised 35.7% of the sample. A p value \( \leq .05 \) was used to indicate statistical significance.

Results

Physical Activity

Significant differences were found on mean steps/day between gender, \( F(1, 163) = 21.78, \ p < .001 \), partial \( \eta^2 = .12 \), and grade, \( F(1, 163) = 7.76, \ p < .01 \), partial \( \eta^2 = .05 \). Boys accumulated approximately 3,100 (25%) more steps/day than girls and eighth graders accumulated approximately 1,800 (16%) more steps/day than 7th graders. No significant differences were found between the Pacific Islanders and Non-Pacific Islanders \( F(1, 163) = .02, \ p = .90 \) and on any of the 4 associated interaction terms. Means (Standard Deviations) are displayed in Table 1.

Body Mass Index
No significant differences were found on BMI between gender, $F(1, 163) = .08, p = .78$, grade, $F(1, 163) = 3.57, p = .06$, and ethnic groups, $F(1, 163) = 3.13, p = .08$. Significant differences were not found on any of the associated interactions terms. Means (Standard Deviations) are displayed in Table 1. Frequencies for BMI classification for Pacific Islanders, Non Pacific Islander, and the entire sample are displayed in Table 2.

Discussion

Physical Activity

Gender differences. This was the first study to objectively measure daily physical activity in Pacific Islander adolescents. Boys accumulated approximately 3,100 (25%) more steps/day than girls. This is consistent with numerous studies of youth physical activity that have found boys are more active than girls. A New Zealand study of children with similar ethnicities found that boys accumulated approximately 2,000 (12%) more steps/day than girls (Duncan, Schofield, & Duncan, 2006). Two U.S. studies of junior high youth reported that seventh and eighth grade boys accumulated approximately 500 – 2,000 (5-19%) more steps/day than girls in the same grades (G.C. Le Masurier et al., 2005; G.C. Le Masurier & Corbin, 2006). It appears there may be a larger disparity in physical activity levels between boys and girls in this sample, an estimated 3,000 steps/day difference. It is possible that more boys than girls choose physical education elective classes over other elective classes such as keyboarding. Furthermore, boys were the majority of the elective PE classes such as team sports and body conditioning. "Spring conditioning" was a precursor to junior varsity football try-outs and was offered to the eighth grade boys, not girls. All of these factors could partly explain the greater gender disparity of our participants.

Grade Differences. Eighth graders accumulated approximately 1,800 (16%) more steps/day than 7th graders which is not consistent with pedometer-determined studies of junior
high aged adolescents. Le Masurier et al (2005) and Le Masurier and Corbin (2006) did not find significant grade differences between the seventh and eighth grades. The eighth graders in this study may have been more active because they had more scheduled physical activities. The unequivocal comparisons may be partially explained by the preferential option of selecting elective physical education (PE) classes, offered in the eighth grade only. Studies have found that middle school students who participated in PE and extracurricular sports accumulated significantly more steps/day than those who did not (K. R. Anderson, Spink, & Humpbert, 2003; Flohr & Todd, 2003). In addition to the standard PE class, elective variations of PE classes (i.e. team sports and body conditioning) were offered to the eighth graders and not to the seventh graders. Hence, an eighth grader could have had one PE class and another elective PE class too. Seventh graders were allocated only a trimester, one third of the school year, of PE at best. Many 7th grade participants may not have had PE during this study. Activity done during school hours by the 7th graders was discretionary and, for the most part, done during two recess and lunch breaks (15 and 30 minutes each). An eighth grader in PE, or a variation thereof, may have accumulated 225 more minutes (3.75 hours) of physical activity per week. In addition, during this study, “spring conditioning” was held two times per week. Practice sessions were an hour and a half each practice session. “Spring conditioning” was not offered to the seventh graders. More scheduled physical activity for the eighth graders may explain the steps/day difference between the seventh and eighth grade participants. Thus, it supports that offering more physical activity during and after school can greatly increase physical activity.

Ethnic Differences. Although significant gender and grade differences existed, there were no significant ethnic differences in steps/day. To our knowledge, pedometer-determined physical activity has not been measured on PI adolescents in the United States. Self-reported data, via national surveillance systems, such as the Youth Risk Behavioral Factor Survey (YRBSS), have measured and tracked physical activity by measuring “no leisure time physical activity”. Results
were divided into three basic groups: White, non-Hispanic Black, and Mexican-American. It is well documented that ethnic disparities among these minority groups exist. Ethnic minorities, especially non-Hispanic Black and Mexican-American children, consistently showed lower levels of no leisure time physical activity (R. E. Anderson, Crespo, Bartlett, Cheskin, & Pratt, 1998; Crespo, 2005). Physical activity levels of Native Hawaiian and or PI adolescents have not been reported. Data collected on Pacific Islanders were determined to be statistically unreliable (CDC, 1998). Further research is necessary to investigate why ethnic disparities in physical activity were not significant in this study.

Comparison to National Standards. We compared pedometer-determined physical activity in the current sample to other studies by gender and grade (Figures 1 & 2). Compared to national data, mean steps/day in the current study were not similar to other studies of American adolescents (G.C. Le Masurier et al., 2005; G.C. Le Masurier & Corbin, 2006). Eighth grade boys accumulated approximately 13,000 steps/day, 2,000 - 2,200 (18 - 20%) more steps/day than the eighth grade boys in the American studies. In contrast, 7th grade boys accumulated approximately 11,500 steps/day, 100 - 700 (2 - 6%) less steps/day than 7th grade boys in the American studies. Girls accumulated fewer steps than their contiguous counterparts in both grades. Specifically, seventh grade girls accumulated approximately 9,000 steps/day, almost 1,000 steps/day fewer than the comparison groups. The 8th grade girls accumulated approximately 10,000 steps/day, 100 - 700 (2 - 6%) steps fewer than the comparison groups in the same grade. Although most of the participants in this study had lower mean step counts than U.S. national averages, it does not pardon the sedentary lifestyle of U.S. adolescents who are some of the least active adolescents of all industrial nations.

Comparison to International Study. To our knowledge, only one other study collected steps/day for a similar ethnic group living in New Zealand. Duncan et al (2006) collected steps/day data on a large multi-ethnic sample that included 30% Polynesian children (Pacific
Islander and Maori) children ages 5-12 years. We did not directly compare our PI adolescents to this study because they were children, however it should be noted that the Polynesian children were the most active group on the weekdays, averaging 15,747 steps/day, approximately 5,000 more steps/day than the PI adolescents in our study.

Overweight Status

Comparison to National Standards. Studies report that ethnic minorities consistently have a significantly higher prevalence of overweight than White youth within each age and gender group (Kumanyika & Grier, 2006; Ogden, Flegal, Carroll, & Johnson, 2002; Strauss & Pollack, 2001). The results of our study supported this disparity as well. The prevalence of overweight and at-risk for overweight of participants in this predominately ethnic minority sample was approximately 50% (Table 2). This more than tripled the NHANES '00-'02 report of overweight White counterparts (14%). Furthermore, the prevalence of overweight PI (33.6%) exceeded Non-Hispanic Black (21%), Mexican-American (23%), and White (14%) adolescents. The prevalence of overweight among the Non-PI group (21.3%) was similar to the Non-Hispanic Blacks and Mexican-Americans (CDC, 1999-2002). In sum, we found the largest overweight disparity between Pacific Islander adolescents and U.S. mainland adolescents. We also found that Non-PI adolescents have a similar overweight prevalence as two other US ethnic minorities.

The results of this study supported Chai et al (2003) findings that there may be more overweight adolescents of Native Hawaiian ancestry. Chai et al (2003) was the only anthropometric measurement study conducted on Native Hawaiian youth. Using the CDC BMI 95th percentile cut-off point to define overweight, the authors reported that 25.5% of Native Hawaiian adolescents were overweight. We found an even higher prevalence of overweight Pacific Islanders in this current study (33.6%) suggesting that this problem is not isolated to one particular island and that the prevalence of overweight may be increasing (+8%).
There were no significant differences in BMI between gender, grades, and ethnic groups. Chai et al (2003), on the other hand, found significant differences in BMI between Native Hawaiians and Non-Hawaiian counterparts in age groups 6-11 and 12-19. The ethnic difference in the current study was approaching significance ($p = .08$) with PI BMI (24.4) 1.5 units higher than Non-PI (22.9). The comparisons made between our study and Chai et al should be interrupted cautiously. Our study used BMI as the only anthropometric measurement whereas as Chai et al used waist and hip circumferences, sum of skinfolds, waist/hip circumference ratios in addition to BMI.

**Steps/day and Body Mass Index**

When BMI data were compared to Le Masurier and Corbin (2006), BMI means for both genders in this study were higher. The mean BMI values of boys and girls in this study were 2.7 and 3.9 units higher respectively, than Le Masurier and Corbin’s results. One might assume that since the BMI values in this study were higher, participants would have been less active. This was not the case. Mean steps/day of this study was not lower than the results of Le Masurier and Corbin (2006). Hence, the prevalence of overweight among our participants cannot be solely due to insufficient physical activity. More physical activity and BMI baseline data collected on PI adolescents from various SES communities may help to answer if disparities are largely based on living conditions.

**Comparison to International Study.** Duncan et al.(2006) examined the associations among step counts and body fatness in a multiethnic sample of children in New Zealand. Polynesian children (56% PI and 44% Maori) ages 5-12 years-old were the most active than the other ethnic groups and still had the highest BMI and waist circumference (WC) means. Results from this study compared to the present study suggest that further investigation is needed to understand why PI are equally or more active but have higher BMI values.

**Limitations**
This study is limited by the exclusion of weekend activity and energy intake. Research has shown large differences between weekday and weekend step counts (Duncan, Schofield, & Duncan, 2006; Trost, Pate, Freedson, Sallis, & Taylor, 2000) and including weekend data increases reliability. In Duncan et al. (2006), weekday and weekend steps/day was 25,085 ±3,711 and 11,886 ±4,733 respectively. We did not account for energy intake either. People living in poverty have less access to healthy food (Broussard, 1995) and greater access to fast-food restaurants (Block, 2004).

The inherent limitations of BMI, its inferior sensitivity, as a tool for measuring overweight may have incorrectly characterized participants. BMI alone doesn’t account for variations in percent body fat (%BF) among adolescents of different ethnic backgrounds (Deurenberg, 2003). The PI group of this study had slightly higher BMI for both genders compared to the NPI group, 1.2 and 0.6 higher for girls and boys respectively. A possible reason is Polynesian children tend to have more fat free mass and less fat mass at a given BMI compared to European children (Rush, Puniani, Valencia, Davies, & Plank, 2003). Percent body fat is a better indicator of childhood obesity.

Environmental issues were not assessed either. For example, reduced access to parks and recreational facilities are more typical of lower-SES communities (Bennett, Wolin, Puleo, & Emmons, 2006; Block, 2004; Gordon-Larsen, Nelson, Page, & Popkin, 2006). Data attrition may have been due to voluntary participation. We may not have had a representative sample of an activity spectrum from sedentary to active participants. Participants may have been more active than average. Attrition and not addressing weekend physical activity may have influenced the result.

In the current study, ethnicity was self-reported and no attempt was made to determine the precise percentage of Pacific Islander ancestry. Hence, the role of genetics and ethnicity is difficult to determine. None the less, the role of ethnicity and genetics in obesity is considered
secondary to non-genetic factors since the rate of overweight increase is faster than the rate of genetic composition change (Hill & Trowbridge, 1998). We also did not tally the number of participants who had scheduled physical activities during and after school hours. Having this information may have explained the large steps/day differences between genders and grades.

Conclusion

This study provided the first objectively measured data in Pacific Islanders adolescents living in a low SES community. Findings of this study replicated Chai et al (2003) findings of the high prevalence of overweight in the PI population. PI mean steps/day count was similar, but BMI mean values were higher when compared to national and international values. Hence, physical activity differences did not seem to be proportional to the overweight prevalence. Dietary intake, social- and environmental-determinants are factors that should be considered in future research. Clearly, there is a dire need for intervention to eliminate the serious health disparity of Pacific Islander youth.
REFERENCES


Table 1.

Steps/Day and Body Mass Index Means (Standard Deviations) for Total, Gender, Grade, and Ethnicity

<table>
<thead>
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<th>N</th>
<th>Steps/Day</th>
<th>BMI</th>
</tr>
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<tbody>
<tr>
<td>Total</td>
<td>171</td>
<td>10,664 (4,199)</td>
<td>23.8 (5.77)</td>
</tr>
<tr>
<td>Gender†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>78</td>
<td>12,360 (4,271)</td>
<td>23.9 (6.13)</td>
</tr>
<tr>
<td>Female</td>
<td>93</td>
<td>9,241 (3,583)</td>
<td>23.8 (5.48)</td>
</tr>
<tr>
<td>Grade‡</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7th Grade</td>
<td>90</td>
<td>9,800 (3,953)</td>
<td>23.1 (5.33)</td>
</tr>
<tr>
<td>8th Grade</td>
<td>81</td>
<td>11,623 (4,280)</td>
<td>24.7 (6.14)</td>
</tr>
<tr>
<td>Ethnicity</td>
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<td></td>
</tr>
<tr>
<td>Pacific Islander</td>
<td>110</td>
<td>10,649 (4,377)</td>
<td>24.4 (5.76)</td>
</tr>
<tr>
<td>Non Pacific Islander</td>
<td>61</td>
<td>10,689 (3,895)</td>
<td>22.9 (5.72)</td>
</tr>
</tbody>
</table>

Note. †Significant steps/day gender difference (p<.001), ‡significant steps/day grade difference (p<.01).
Table 2. 

Frequency of CDC BMI-For-Age Categories by Total, Pacific Islander, and Non Pacific Islander

<table>
<thead>
<tr>
<th>Category</th>
<th>Total</th>
<th></th>
<th>Pacific Islander</th>
<th></th>
<th>Non Pacific Islander</th>
<th></th>
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<td></td>
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<td>Percentage</td>
<td>N</td>
<td>Percentage</td>
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<td>Percentage</td>
</tr>
<tr>
<td>Lean</td>
<td>2</td>
<td>1.2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3.3</td>
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<tr>
<td>Healthy</td>
<td>85</td>
<td>49.7</td>
<td>54</td>
<td>49.1</td>
<td>31</td>
<td>50.8</td>
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<tr>
<td>At-Risk</td>
<td>34</td>
<td>19.9</td>
<td>19</td>
<td>17.3</td>
<td>15</td>
<td>24.6</td>
</tr>
<tr>
<td>Overweight</td>
<td>50</td>
<td>29.2</td>
<td>37</td>
<td>33.6</td>
<td>13</td>
<td>21.3</td>
</tr>
</tbody>
</table>
Figure 1.

**Pedometer-Determined Physical Activity of Boys Compared to National Studies**
Figure 2.

Pedometer-Determined Physical Activity of Girls Compared to National Studies

The graph shows the comparison of pedometer-determined physical activity of girls in 7th and 8th grades, presented in steps. The data points are based on studies by Le Masurier et al. 2005 and Le Masurier and Corbin 2006.
APPENDICES

Appendix A: Extended Literature Review

Eliminating Health Disparities

One of the two goals of the Healthy People 2010 national public health agenda is to eliminate health disparities which exist among populations in the United States (*Healthy People 2010*, 2000). The health disparities include obesity, hypertension, heart disease, type 2 diabetes, and stroke. Populations have been categorized by race/ethnicity, gender, education level, socioeconomic status, and geographic location of residence, and disparities exist among all of these population groups.

Overall, there are marked differences in health disparities between whites and minorities (Flegal, Carroll, Ogden, & Johnson, 2002; Liburd, Jack. L., Williams, & Tucker, 2005; Mensah, Mokdad, Ford, Greenland, & Croft, 2005). In 2000, heart disease was the leading cause of death in the United States. Cerebrovascular diseases and type 2 diabetes ranked third and sixth, respectively, as the leading cause of death and disability. Minority communities (Blacks, Hispanics, Native Americans, Alaska Natives, Asian and Pacific Islanders) suffered disproportionately from these chronic diseases (Liburd, Jack. L., Williams, & Tucker, 2005). Deaths from cardiovascular diseases tend to be the highest in blacks at all ages.

The life expectancy is higher in women than men and higher in whites than blacks by approximately five years (Mensah, Mokdad, Ford, Greenland, & Croft, 2005). Persons with less than a high school education tend to have higher rates of CVD and its risk factors regardless of race and ethnicity (Mensah, Mokdad, Ford, Greenland, & Croft, 2005).

Obesity is most prevalent among blacks, Hispanic/Mexican Americans, and persons with low socioeconomic status (Mensah, Mokdad, Ford, Greenland, & Croft, 2005). In men, the highest prevalence of obesity was found in Mexican Americans (29.2%) who had completed a high school education. In women, Black women, regardless of education, had the highest prevalence of obesity (47.3%). In another study, the number of overweight or obese Black women was estimated to be even higher. It estimated 77.3% Non-Hispanic Black women were overweight or obese. This was 20% more than overweight or obese Non-Hispanic White women (57.3%) (Flegal, Carroll, Ogden, & Johnson,
Despite differences between final estimates of overweight and obese populations, results consistently show that racial and ethnic minorities, especially minority women, have higher overweight rates than Whites in the United States.

Increase in Sedentary Related Diseases

Anthropometric measurements taken between 1999 and 2002 estimated that 65.1% adults over 20 years of age in the U.S. were overweight or obese. 31% of individuals between 6 and 19 years of age were at risk of becoming overweight. 16% were overweight (Hedley et al., 2004). These findings indicate alarming public health issues since the number of obese and overweight individuals continue to rise sharply for all ages.

Increase in Obesity Prevalence

The prevalence of overweight American youth has increased at an alarming rate in the last two decades. Children ages 6 to 11 years old increased twofold from an estimated 7% in 1980 to 15% in 2000. For adolescents ages 12 to 19, the prevalence of overweight tripled from 5% to 15% in the same twenty years (Ogden, Flegal, Carroll, & Johnson, 2002). There is no indication that the prevalence of overweight children and obese adults will decrease either (Hedley et al., 2004).

The obesity epidemic is not isolated to America. It is a global issue for all ages. It is estimated that there are over 1 billion overweight adults; 300 million of them are obese. In some countries, overweight adults are the majority. For example, 75% of urban Samoa was overweight. An estimated 22 million children under five are estimated to be overweight worldwide (WHO, 2006). Although adulthood obesity has serious health and economic implications, childhood obesity is of greater concern since overweight children will more likely become overweight adults (Gordon-Larsen, Adair, Nelson, & Popkin, 2004; Serdula et al., 1993; Whitaker & Wright, 1997).

Childhood obesity and its prevalence have grown at alarming rates in almost every corner of the world. Based on the international BMI (body mass index) percentile curves and cut-off points recently established, an estimated 26.3% of Greek school-aged children are classified as overweight or obese (Krassas et al., 2004). The prevalence of overweight adolescents in Dublin, Ireland increased threefold
from 1.9% in 1990 to 6% in 2004 (Griffin, Younger, & Flynn, 2004). In northeast Brazil, overweight adolescent rates tripled as well from 1975 to 1997 (da Veiga, da Cunha, & Sichieri, 2004). In Mexico, an estimated 30.8% of boys and 29.7% of girls are overweight and obese (del Rio-Navarro et al., 2004). In just two years, obese Thai children, ages 5 to 12, rose from 12.2% to 15%. Increases in overweight and obese adolescents have been noted in other areas of the world such as Sweden, the United Kingdom, and China (Neovius, Janson, & Rossner, 2006; WHO, 2006).

The childhood obesity trends foretell that the numbers will continue to rise. Generally, overweight kids grow-up to become overweight or obese adults. In a study that tracked 854 subjects, 75% of the overweight children with BMI greater than the 85th percentile became obese adults (Whitaker & Wright, 1997).

Disparities in Physical Activity

Virtually all individuals benefit from physical activity. Regular physical activity is associated with lower mortality rates. Regular moderate physical activity has been shown to lower the risk of developing diseases such as heart disease, non-insulin-dependent diabetes mellitus, hypertension, osteoporosis, and obesity. Physical activity also appears to improve mental health. Individuals with active lifestyles appear to suffer less from stress, anxiety, and depression. In addition, health-related quality of life appears to be more favorable. Active people are physically able to be more independent and are able to participate in activities without being compromised by poor health. (CDC, 1996; LaCroix, Guralnik, Berkman, & al., 1993). Research has determined a high correlation between low physical activity, obesity, and disease. People who are sedentary are more likely to become overweight or obese; hence, they are at a higher risk to die from diseases at an earlier age.

Despite the benefits of physical activity, most people living in rural and urban areas are not active enough. The World Health Organization estimates that at least 60% of global population fails to achieve 30 minutes of moderate physical activity. The proportion of adults who are sedentary or nearly so ranges from 60 to 85% (WHO, 2006).
Disparities in levels of physical activity exist among population groups. Older populations report less physical activity than younger population. This problem is exacerbated since low activity levels are prevalent for all ages. Children and adolescents are less physically active than recommended. In 2003, the Youth Risk Behavior Surveillance System reported that 33.4% of adolescents did not participate in sufficient physical activity (Grunbaum et al., 2004). Nearly half of Americans between the ages of twelve and twenty-one are not vigorously active on a regular basis. In addition, about 14% of youth reported no recent physical activity (CDC, 1996).

Physical activity declines as age increases (CDC, 1998; Pate, 1994). In three separate surveys, the National Health Interview Survey (NHIS), the Behavioral Risk Factor Surveillance System (BRFSS), and the Third National Health and Nutrition Examination Survey (NHANES III), about one-fourth of the U.S. adults do not engage in any leisure-time activity. In older groups, one in three men and one in two women over 74 years of age were inactive.

Leisure-time physical activity is higher among affluent populations than the less affluent, higher among persons with higher levels of education than those with lower levels of education. Notable differences also occur between ethnicities. Reported leisure-time physical activity is higher among whites than African Americans and Hispanics (CDC, 1999-2002; Crespo, 2005).

Disparities in Factors that Influence Physical Activity

There are several factors that contribute to obesity and inactivity. Genetics, metabolism, behavior, environment, culture, and socioeconomic status are factors that cause overweight and obesity (CDC, 2001). In rural areas, sedentary past times such as watching television, is a common reason for inactivity. In urban areas, crowding, poverty, crime, traffic, pollution, and a lack of parks and recreation facilities, and sidewalks make physical activity difficult (WHO, 2006).

Physical activity disparities exist among minorities and low socioeconomic groups. In a study done by Gordon-Larsen, et al (2006), geographic and social distribution of recreational facilities was assessed. The objective was to investigate how disparity in access to recreational facilities might underlie population-level physical activity and overweight patterns. The results showed that higher socioeconomic
groups had significantly greater odds of having 1 or more facilities. Whereas, low socioeconomic groups and high-minority block groups were less likely to have facilities. Hence, it was concluded that inequality in availability of physical activity facilities may contribute to ethnic and socioeconomic disparities in physical activity and overweight patterns (Gordon-Larsen, Nelson, Page, & Popkin, 2006).

Physical self-perception is another factor that influences physical activity. There is a positive correlation between participation in extra-curricular activities and positive self-perceptions. In other words, a person with a high self-perception is more likely to engage in physical activity than a person with low self-perceptions (Daley & Leahy, 2003).

Due to the multifactored nature of obesity, it is difficult to make adequate associations between body fatness and physical activity. Income, ethnicity, age, maturation, gender, SES, energy intake, environment, and occupational status, physical self-perceptions all have been shown to be contributing factors of body composition. These multiple factors more than likely contributed to the perplexing results. The magnitude of impact, or contribution, of each factor is still debatable and also requires further investigation.

Hawaiians and Pacific Islanders and Sedentary Related Diseases

The mortality rate for Native Hawaiians is 34% higher than the total US population. Death from heart disease is 44% greater; cancer is 39% greater; cerebrovascular disease is 31% greater; and diabetes mellitus is 22% greater (Current health status and population projections of Native Hawaiians living in Hawaii, 1987).

The Native Hawaiian population suffers from a high prevalence of overweight and obesity. A 1985 study that measured 257 Native Hawaiians of a small rural community determined that 63.6% of the adults were overweight. 44.6% were classified as being severely obese (Aluli, 1991). The Hawaii Health Risk Behaviors Survey (HHRBS), based on self-reported weight, of 1987 showed that the overall Native Hawaiian prevalence rate for overweight was 2.3 times greater than the overall prevalence rate for the state. 41.9% Native Hawaiians were overweight compared to 18.1% for all other races in Hawaii combined (Hawaii's Health Risk Behaviors 1987, 1988).
Children and adolescents of Hawaiian ancestry also have one of the highest rates of overweight and obesity in the nation. The BMI values of children and adolescents of Hawaiian descent ranked in the 75th %ile of the NHANES III (Chai et al., 2003). It has been noted that a significant correlation exists between %ages of Polynesian ancestry and body composition (i.e. fatness) among children (Brown DE, 1991).

Despite the dire health conditions for the Hawaiian population, insufficient attention has been given to study the reasons for inactivity, overweight, and its relationship. Most of the data collected is subjective, self-reported surveys, or considered unreliable, or combined with another ethnicity (i.e. Asian/Pacific Islander). In Healthy People 2010, the National Health Interview survey reported 41% of Native Hawaiians and or Pacific Islanders ages 18 or over reported no leisure-time physical activity. However, physical activity data for ages less than 18 was considered statistically unreliable.

Little data collection has been collected for the Hawaiian or Pacific Islander population alone. Data from the Racial and Ethnic Approaches to Community Health (REACH) 2010 Risk Factor Survey is misleading because it combined Asians and Pacific Islanders. It reported one of the lowest prevalence of obesity with only 2.9% and 3.6% of Asian/Pacific Islander men and women, respectively (Mensah, Mokdad, Ford, Greenlund, & Croft, 2005). Clearly, there is a need to objectively measure physical activity for the Pacific Islander population. Associations between physical activity and body fatness can then be investigated rather than making assumptions.
Appendix B: Daily Questionnaire

Today’s Date:____________________  Name:_____________________________________ Ped #:_______

1. How did you get to school today?   walk   bike   rode to school (bus or car)
2. Did you do any of the following activities yesterday:
   - play an after school sport: Yes   No
   - ride your bike: Yes   No
   - roller blade: Yes   No
   - swim or surf: Yes   No
   - Other (describe): ____________________________________________________________
3. How long did you do that activity? _____________________________________________
4. Did you take the pedometer off before going to sleep? Yes   No
5. Did you put the pedometer on when you got dressed this morning? Yes   No
6. Did you wear the pedometer the entire time? Yes   No
Appendix C: Approval Letter by School Principal

March 29, 2006

To: Jan Combs, Graduate Student
University of Hawaii- Manoa

From: John Vannatta, Principal

Subject: Research Study

Aloha! Thank you very much for your interest in conducting your research study at our school. I support your efforts to bring new knowledge and attention to our rising problem of childhood obesity here in West Oahu.

Please accept this letter as approval at the school level to conduct your study during the month of April. Your methods have been reviewed and will suffice.

If there is any way that we may further help you, you may contact me or one of the assistant administrators at 697-7121.

Sincerely,

John Vannatta
Waianae Intermediate Principal