Published in final edited form as:

Asia Pac J Public Health. 2015 March ; 27(2): NP288–NP298. doi:10.1177/1010539512440593.

Access to environmental resources and physical activity levels of adults in Hawaii

KS Geller¹, CR Nigg², NJ Ollberding³, RW Motl⁴, C Horwath⁵, and RK Dishman⁶

¹Department of Kinesiology and Health, Miami University, Oxford, OH, gellerks@muohio.edu

²Department of Public Health Sciences, John A. Burns School of Medicine, University of Hawaii, Honolulu, HI, cnigg@hawaii.edu

³University of Hawaii Cancer Center, Honolulu, HI, nollberding@cc.hawaii.edu

⁴Department of Kinesiology and Community Health, University of Illinois at Urbana-Champaign, Urbana, IL, robmotl@illinois.edu

⁵Department of Human Nutrition, University of Otago, Dunedin, New Zealand, caroline.matthaei@otago.ac.nz

⁶Department of Kinesiology, University of Georgia, Athens, GA, rdishman@uga.edu

Abstract

Purpose—Examine associations between physical activity (PA) and spatial accessibility to environmental PA resources in Hawaii.

Methods—Metabolic equivalents (METs) of mild, moderate, and strenuous PA were compared for accessibility to environmental PA resources within a population-based sample of Hawaiian adults ($n=381$). Multiple linear regression estimated differences in PA levels for residing further from a PA resource or residing in an area with a greater number of resources.

Results—No associations were found in the total sample. Analyses within subsamples stratified by ethnicity revealed that greater spatial accessibility to a PA resource was positively associated with strenuous PA among Caucasians ($p=0.04$), but negatively associated with moderate PA among Native Hawaiians ($p=0.00$).

Conclusion—The lack of association in the total sample may be a consequence of Hawaii's unique environment. Results of stratified sample analyses are unique, providing groundwork for future examinations within parallel environments and among similar ethnic groups.

The US has experienced a dramatic rise in obesity¹ and research reports a disproportionate rate of obesity among certain Hawaiian populations². Moreover, obesity-related illnesses have demonstrated a disproportionately negative influence on minority subgroups (Native Hawaiian/Other Pacific Islander (NHOPI), Asian Americans)³. Regular physical activity (PA) has been demonstrated to aid in the prevention of overweight/obesity and related illnesses^{4–6}. Despite this benefit, 39% of adults are completely sedentary⁷, and evidence

suggests that minority ethnic populations are disproportionately less likely to engage in healthy levels of PA⁸. Investigations of individual-level risk factors (e.g., income) report only partial associations that do not fully explain this disparity⁹, and research aimed at elucidating the processes that lead to such ethnic differences remain under-researched¹⁰. The current study examined the influence of certain environmental-level factors on the PA of a highly understudied ethnic population.

Proximity or nearness to PA resources from one's residence is a primary characteristic of environmental resources that support active transport¹¹ and increased PA¹². Density, or the number of PA resources within a certain distance of one's home, has been documented a significant contributor to increased PA¹² and overweight/obesity¹³. Research has also revealed significantly lower accessibility to PA environmental resources within minority communities relative to ethnic majority communities^{14–16}; and limited accessibility associates strongly with decreased PA and increased overweight among minority ethnic groups¹⁴. Although suggesting an ethnic disparity in PA resource accessibility, such evidence cannot be directly generalized across ethnic minority populations. Similar research targeting additional ethnically diverse populations is of high interest¹⁴, and analyses stratified by race/ethnicity are advised¹¹.

The primary aim of the current study was to investigate the relationship of spatial accessibility to environmental PA resources with the activity levels Hawaiian adults. A second aim was to examine disparities in PA across ethnic groups and the level of variability explained by spatial access to environmental PA resources. Based on previous reports, we hypothesized that greater density and closer proximity to PA resources would be associated with increased activity levels. Given limited data on disparities in PA relevant to spatial access to relevant resources, analyses were considered exploratory and no a priori hypotheses were specified.

Methods

Adults living in Hawaii were recruited via random digit dialling. Following informed consent, participants completed a 30-minute phone interview with trained interviewers. Questionnaire items were programmed into a computer assisted telephone interview (CATI) system. All procedures were approved by the University Human Subjects Committee. More detailed information regarding recruitment procedures have been described previously^{17–18}.

Measurement

Spatial modeling of the PA environment was constructed via ArcGIS 9.3.1 software (ESRI, Redlands, CA) using participants' place of residence and the addresses for both free and paid PA resources located in the Hawaiian Islands. Free access resources included swimming pools, exercise paths, parks, public beaches, and athletic courts/fields. Paid access resources included fitness centers, golf courses, and dance/martial art studios. Proximity was operationalized as the distance from participants' residence to the nearest PA resource and examined by 0.5 km radial increments. Density represented the number of PA resources counted within 10 km from participants' place of residence.

Participants' PA was assessed using the Godin Leisure-Time Exercise Questionnaire (GLTEQ) ¹⁹. The GLTEQ is a 3-item self-report measure that assesses the frequency of mild, moderate, and strenuous exercise done for at least 30 min per session during a typical week. Strenuous PA was defined to participants as an activity causing a rapid heart rate and sweating (e.g., running, soccer, vigorous swimming, heavy weight training, etc.). Moderate PA was defined as not exhausting with light sweating, such as fast walking, baseball, volleyball, hula dancing, etc. Mild PA included minimal effort without sweating (e.g., easy walking, yoga, archery, fishing, golf, etc.). Each level of PA frequency was weighted by its associated metabolic equivalent (MET) value. MET units represent the metabolic equivalent of PA in multiples of resting oxygen consumption using the following calculations: (Strenuous $\times$ 9), (Moderate $\times$ 5), and (Mild $\times$ 3). Previous research has deemed the GLTEQ highly reliable¹⁹ and valid²⁰.

Statistical Analysis

Data analyses were performed using PASW Statistics 18.0 (2009, Chicago IL). Descriptive statistics characterized the sample and described participants' accessibility to PA resources. ANOVA F-test was used to test for differences in mean METs of mild, moderate, and strenuous PA between demographic groups. Differences between groups with >2 categories were tested via Least Significant Differences (LSD) post hoc analyses. Groups with >3 categories were adjusted for type I error using the Bonferroni correction (0.05/*n*).

Mean METs of mild, moderate, and strenuous PA were calculated for each 0.5 km interval and tested for differences between distances were using ANOVA F-test. Similarly, differences in PA METs based on the density of PA resources were also examined via ANOVA. Confounding variables were initially identified via linear regression and modeled as independent variables, including age, gender, ethnicity, education-level, body mass index (BMI), and perceived health (5-point Likert scale; 1= excellent to 5=poor). Confounding effects were accounted for by calculating both unadjusted and adjusted means. Four participants had missing data on covariates included in the calculation of adjusted means; therefore, these same data were also excluded from unadjusted mean calculations.

Multiple linear regression was used to estimate mean differences in mild, moderate, and strenuous METs for participants residing further from a PA resource or in an area with added resources. Models examined both unadjusted and adjusted associations, controlling for covariates that were found to predict PA levels and effect model estimates (i.e., age, gender, ethnicity, education, and perceived health). Parallel analyses examined the potential for disparity in accessibility to PA resources relative to PA behavior within subsamples stratified by ethnicity (Caucasian, Asian American, and NHOPI). Adjusted R square (R^2_{adj}) was used to calculate the proportion of variation in PA accounted for by the included independent and confounding variables.

Results

Descriptive statistics and mean METs of mild, moderate, and strenuous PA for study participants are presented in Table 1. Participants were predominantly female (62%) with a mean age of 46.45 (standard deviation (SD) =17.13). The majority of participants self-

identified as Caucasian (34%), Asian American (33%) or NHOPI (23%). As shown, the total mean METs of mild PA demonstrated statistically significant differences between groups based on age ($p<0.05$), ethnicity ($p<0.008$), income ($p<0.05$), and perceived health ($p<0.005$). For age, the 56+ year-olds were significantly higher than both the 18 to 35 year-olds (mean difference (MD)=2.22, standard error of the mean (SEM)=0.99) and the 36 to 55 year-olds (MD=2.39, SEM=0.92). Caucasians reported significantly more mild PA METs than both Asian Americans (MD=3.96, SEM=0.92) and Other/Mixed participants (MD=3.77, SEM=1.30). Participants reporting “very good” health were higher than participants reporting “good” (MD=3.34, SEM=0.93). Finally, participants with an annual income $< \$30,000$ reported significantly less mild METs than those with an annual income between \$30,000 and \$50,999 (MD=3.06, SEM=1.01) and participants with an income $\geq \$60,000$ (MD=2.14, SEM=0.98).

The mean METs of moderate PA for the total sample was 18.66 ± 0.61 , demonstrating significant subgroup differences based on age ($p<0.05$), ethnicity ($p<0.008$), and income ($p<0.05$). LSD post hoc analyses revealed lower moderate PA METs among 36 to 55 year-olds compared to both 18 to 35 year-olds (MD=3.62, SEM=1.46) and 55+ year-olds (MD=3.09, SEM=1.46). Caucasians were higher compared to Asian Americans (MD=6.89, SEM=1.46); and participants with a \$30,000 to \$50,999 annual income were significantly higher compared to those reporting $< \$30,000$ (MD=6.13, SEM=1.59) and $\geq \$60,000$ (MD=3.52, SEM=1.51).

The mean METs of strenuous PA for the total sample was 21.10 ± 1.00 with differences based on gender ($p<0.05$), ethnicity ($p<0.008$), income ($p<0.05$), and perceived health ($p<0.005$). LSD post hoc analyses demonstrated higher moderate METs among participants reporting a \$30,000 to \$50,999 annual income, compared to those with an income $< \$30,000$ (MD=6.59, SEM=2.69). Participants reporting “excellent” health were higher in strenuous METs compared to those perceiving “good” (MD=12.04, SEM=3.00), “fair” (MD=10.54, SEM=3.60), and “poor” health (MD=18.23, SEM=4.84); and, “very good” health participants were higher than those reporting “good” (MD=7.95, SEM=2.41) and “poor” health (MD=14.14, SEM=4.50).

Physical Activity by Environmental Accessibility to Resources

Table 2 presents the mean METs of PA levels by proximity to PA resources. The majority of study participants (69%) lived within 2.5 km of a PA resource; however, 14% of participants remained without access within a distance of 4.5 km from their residence. There was a fairly equal distribution across 0.5 km buffers, ranging from 3% of study participants with a PA resource within 4.5 km to 19% with a resource within 1.0 km. In both the unadjusted and adjusted model, no difference was detected at any level of PA based on closest proximity to a PA resource.

Table 3 presents the mean METs of PA by the density of resources accessible between 0.5 and 10 km of participant residence. The total number of PA resources ranged from 1 to 32 with the largest proportion of participants (14%) having access to between 21 and 25 resources within 10 km of their place of residence. Conversely, a similar proportion of participants (12%) had access to only one PA resource within a 10km distance. No

differences were detected for any level of PA between density subgroups, when categorized by sample size for a balanced comparison (Table 3).

Association of Physical Activity and Environmental Accessibility to Resources

Multiple regression outcomes are presented in Table 4, which examined the influence of proximity and density on study participants' mean METs of mild, moderate, and strenuous PA. As seen, residing 0.5 km nearer to PA environmental resources was not associated with PA at any level, nor was it associated with having access to additional PA resources in both the unadjusted and adjusted models. Gender was significantly associated with participants' strenuous PA METs ($p=0.05$), with males demonstrating a higher mean (24.63) compared to females (19.44). Perceived health was significantly associated with the mean METs at all levels of PA, demonstrating increased METs among those perceiving better health. Finally, ethnicity was significantly associated with mean METs of both mild and moderate PA.

Table 5 presents the results of multiple regression analysis performed in samples stratified by ethnic categorization. The density of PA resources demonstrated varying degrees of influence on participants' PA, depending on ethnicity and level of PA. Specifically, living 0.5 km nearer to a PA resource was positively associated with strenuous PA among Caucasians ($n=126$; $\beta=0.19$, $p=0.04$, $R^2_{adj}=0.03$), negatively associated with NHOPI's moderate PA ($n=84$; $\beta=-0.34$, $p=0.00$, $R^2_{adj}=0.10$), but had no association with PA among Asian Americans ($n=119$). Proximity to the nearest resource was only influential for moderate PA among NHOPI participants, demonstrating a negative association ($\beta=-0.25$, $p=0.03$, $R^2_{adj}=0.05$). Interestingly, the demographic variables controlled for in the regression models demonstrated variable influence between ethnic subsamples. Perceived health was negatively associated with strenuous PA among Caucasians ($\beta=-0.28$, $p=0.00$) and Asian American ($\beta=-0.26$, $p=0.01$); however, there was no confounding effect found among NHOPI participants. Further, gender only influenced the strenuous PA of NHOPI participants ($p=0.00$); and age was only negatively associated with Asian Americans' PA at both the moderate ($\beta=-0.20$, $p=0.04$) and strenuous levels ($\beta=-0.25$, $p=0.01$).

Discussion

The current study examined the relationship between spatial access to environmental PA resources on adults' mild, moderate, and strenuous activity; additionally examining the relationship in stratified samples based on ethnic categorization (Caucasian, Native Hawaiian, and Asian American). In a diverse sample of adults living in Hawaii, there were no differences detected in PA by spatial access to supportive PA resources. Similarly, accessibility was not a significant predictor of PA at any level; however, associations were detected when examined in specified ethnic subsamples. Specifically, greater access to PA resources using a measure of density was associated with higher levels of strenuous PA among Caucasians. Conversely, density and proximity of PA resources were both negatively associated with NHOPI participants' moderate PA.

First, greater accessibility to PA resources had no influence on participants' PA, which is contrary to the study hypothesis and previous research. Out of 13 review articles summarized by Bauman and Bull¹², 11 reported a consistent positive relationship between

adults' activity levels and both proximity to PA resources and greater resource density. To our knowledge the current study is the first to examine spatial accessibility and PA in Hawaii, which is home to many unique environmental factors that may be contributing to this inconsistency. The small size of the Hawaiian Islands relative to the mainland US may lessen the importance of proximity, such that islanders focus more on their travel intention rather than the distance to their destination. Further, only 8 study participants had zero PA resource opportunities within 10 km and over half (51%) had 7 or more; hence, the environmental opportunities for PA in Hawaii are highly dense and fairly balanced. In light of Hawaii's natural proximity and dense source of PA resources, study participants may be desensitized to the influence of spatial accessibility; therefore, having limited influence on their PA. Secondly, the 51% of participants residing on the island of Oahu are provided with excellent opportunities for public transport. The Honolulu Rapid Transit has an annual ridership of approximately 70.6 million passengers on a fleet of 532 buses²¹, minimizing distance as a potential barrier to PA resource accessibility.

Similarly, the 29% of participants living in the city of Honolulu may be surrounded by numerous PA resource options; however, many facilities may require membership fees that are not affordable for many. Likewise, high accessibility may be irrelevant to low income individuals who work multiple jobs and lack the time and/or resources to participate in the activities offered by their surrounding environment. The perceived safety of certain resources is another factor requiring consideration. For example, a certain PA resource within one's neighborhood may not be viewed as a safe gathering place due to drug- and/or sex-related crime. Also, due to the compact nature of the Hawaiian Islands, walking to a PA resource may require traveling through unsafe neighborhoods or high traffic areas that are not walk friendly. In general, the lack of detail relative to the types of PA resources in the current analysis makes data interpretation difficult and should be considered in the future.

The ethnic diversity of the current study population revealed interesting differences that require consideration in future investigations. Unlike previous research, current analyses detected no disparity in PA resource accessibility. Instead, outcomes demonstrated equality in spatial accessibility across ethnicities, differing from previous reports. For instance, two nationally representative cohort studies documented significantly lower accessibility to PA resources among high-minority groups and communities^{12, 16}. Further, a longitudinal investigation reported that parents of non-Hispanic Black youth perceived significantly higher activity barriers compared to parents of white youth, including transportation problems, lack of participation opportunities, high expense, and safety²². Given the uniqueness of the Hawaiian Islands, direct comparison to other areas may be inappropriate. Moreover, the ethnic groups experiencing disparity on the mainland US differ greatly from those in Hawaii, potentially facing distinct barriers to PA resource accessibility. Accordingly, the current lack of ethnic disparity is a novel finding and potential consequence of Hawaii's unique population and environment.

Stratification of the current population-based sample generated homogeneous subsamples based on ethnicity, facilitating lower within-group variation and more accurate outcome interpretation. First, a higher density of PA resources was significantly associated with increased strenuous PA among Caucasians, which supports our hypothesis and previous

research^{11–13}. Contrary to this, greater accessibility (both density and proximity) to PA resources was negatively associated with the moderate PA of NHOPI participants. Previous research examining the influence of resource accessibility on PA between ethnicities has been mixed^{23–25}, with little to no specific examinations among NHOPI; therefore, the following inferences are only suggestive. First, many NHOPI families living on or near the beach; which may mask beach parks as an opportunity to be physically active and represent more of a gathering place for friends and family. Secondly, NHOPI individuals perceive family involvement as essential for adopting and sustaining healthy behaviors²⁶; which may involve more group-based activities that are not perceived as PA or at a level less (or more) than moderate. Also, NHOPI may feel stigmatized from gyms or other recreational facilities with primarily Caucasian members. Lastly, the NHOPI ethnicity category includes multiple groups (e.g., Micronesian, Samoan) that differ significantly in their beliefs and lifestyles. This is similar to the Asian American categorization, including Japanese, Chinese, and Korean. In order to fully understand the environmental influence on PA, future research must consider the uniqueness between the ethnic subgroups within these larger categories.

There are specific strengths and limitations of the current study that should be noted. Similar to previous research, the current study used simple measures of accessibility that did not account for the characteristics or quality of the resources (e.g., safety, cost, etc.). There is further difficulty in operationalizing accessibility as the existence of a PA resource within a geographic unit of aggregation (e.g., zip code, neighborhood, etc.)⁹. For instance, an individual may live across from a public pool that is located within a different zip code and not counted. Finally, the current cross sectional study design prevents causal inferences and cannot fully account for the potential bias of individuals self-selecting into neighborhoods that support their behavioral choices. Study strengths include research among a highly diverse and understudied population; spatial accessibility examined as both proximity and density; and analyses at multiple distances and densities. This is the first study of spatial accessibility in relation to PA to be reported in the Hawaiian Islands, providing groundwork for future research in parallel environments.

Conclusion

The current study is among the first to examine spatial accessibility and PA in Hawaii, which includes unique environmental characteristics. Additional research is warranted that specifically examines PA levels based on differing environmental characteristics (e.g., urban, suburban, and rural), which may help to illuminate the mechanisms by which accessibility to resources influences PA levels. Given the projected increase of minority populations and their increased risk for obesity-related diseases, it is critical to understand the environmental factors that promote PA across a broader population. Such information may help to inform policy makers and urban planners regarding how environmental modifications can better facilitate PA, reduce obesity and related diseases, and eliminate health disparities.

Acknowledgements

This project was funded by the National Cancer Institute grant R01 CA109941. KSG and NJO were supported by a postdoctoral fellowship on grant R25 CA90956 from the National Cancer Institute.

References

1. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among US adults 1999–2008. *JAMA*. 2010; 303(3):235–241. [PubMed: 20071471]
2. Florentina, RS.; Nguyen, DH.; Liang, S. [cited 2011 Jan 26] State of Hawaii by demographic characteristics behavioral risk factor surveillance system [Internet]. Available from: <http://hawaii.gov/health/about/statistics/brfss/brfss2008/2008/demo08/bmi.html>.
3. Smith SC, Clark LT, Cooper RS, et al. Discovering the Full Spectrum of Cardiovascular Disease Minority Health Summit 2003, Report of the Obesity, Metabolic Syndrome, and Hypertension Writing Group. *Circulation*. 2005; 111:e134–e139. [PubMed: 15769755]
4. Albright A, Franz M, Hornsby G, Kriska A, Marrero D, Ullrich I, et al. American College of Sports Medicine position stand. Exercise and type 2 diabetes. *Med Sci Sports Exerc*. 2000; 32(7):1345–1360. [PubMed: 10912903]
5. Allison DB, Fontaine KR, Manson JE, Stevens J, VanItallie TB. Annual deaths attributable to obesity in the United States. *JAMA*. 1999; 282(16):1530–1538. [PubMed: 10546692]
6. Grundy SM, Blackburn G, Higgins M, Lauer R, Perri MG, Ryan D. Physical activity in the prevention and treatment of obesity and its comorbidities: evidence report of independent panel to assess the role of physical activity in the treatment of obesity and its comorbidities. *Med Sci Sports Exerc*. 1999; 31(11):1493–1500. [PubMed: 10589848]
7. Pleis JR, Lucas JW. Summary health statistics for U.S. adults: National Health Interview Survey, 2007. *Vital and Health Statistics Series*. 2009; 10:1–159.
8. Behavioral Risk Factor Surveillance System [Internet]. Atlanta (GA): Centers for Disease Control and Prevention; 2009. Available from: <http://www.cdc.gov/brfss>. [cited 2011 Jan 3]
9. Maroko AR, Maantay JA, Sohler NL, Grady KL, Arno PS. The complexities of measuring access to parks and physical activity sites in New York City: a quantitative and qualitative approach. *International Journal of Health Geographics*. 2009; 8(34):1–23. [PubMed: 19149870]
10. Javier JR, Huffman LC, Mendoza FS. Filipino child health in the United States: do health and health care disparities exist? *Prev Chronic Dis*. 2007; 4(2):1–20.
11. Sallis JF, Glanz K. Physical activity and food environments: solutions to the obesity epidemic. *The Milbank Quarterly*. 2009; 87(1):123–154. [PubMed: 19298418]
12. Bauman, AE.; Bull, FC. Environmental Correlates of Physical Activity and Walking in Adults and Children: A Review of Reviews. London: National Institute of Health and Clinical Excellence; 2007. [Internet]. Available from: <http://www.nice.org.uk/guidance/index.jsp?action=download&o=34740> [cited 2011 Jan 8]
13. Papas MA, Alberg AJ, Ewing R, Helzsouer KJ, Gary TL, Klassen AC. The built environment and obesity. *Epidemiologic Reviews*. 2007; 29:129–143. [PubMed: 17533172]
14. Gordon-Larsen P, Nelson MC, Page P, Popkin BM. Inequality in the built environment underlies key health disparities in physical activity and obesity. *Pediatrics*. 2006; 117:417–424. [PubMed: 16452361]
15. Moore LV, Diez RA, Evenson KR, McGinn A, Brines S. Availability of recreational resources in minority and low socioeconomic status areas. *AJPM*. 2008 Jan; 34(1):16–22.
16. Powell LM, Slater S, Chaloupka FJ, Harper D. Availability of physical activity-related facilities and neighborhood demographic and socioeconomic characteristics: a national study. *AJPH*. 2006; 96:1676–1680.
17. Nigg CR, McCurdy DK, McGee KA, et al. Relations Among Temptations, Self-Efficacy, and Physical Activity. *International Journal of Sport and Exercise Psychology*. 2009; 7:230–243.
18. Paxton RJ, Nigg CR, Motl RW, et al. Are constructs of the transtheoretical model for physical activity measured equivalently between sexes, age groups, and ethnicities? *Ann Behav Med*. 2008 Jun; 35(3):308–318. [PubMed: 18607667]
19. Godin G, Shepherd R. A simple method to assess exercise behavior in the community. *Canadian Journal of Applied Sport Sciences*. 1985; 10:141–146.
20. Jacobs DR, Ainsworth BE, Hartman TJ, Leon AS. A simultaneous evaluation of 10 commonly used physical activity questionnaires. *Med Sci Sports Exerc*. 1993; 25:81–91. [PubMed: 8423759]

21. [cited 2011 Jan 3] City and County of Honolulu Department of Transportation Service (DTS) Agency Profile. National Transit Database [Internet]. 2009. Available from: http://www.ntdprogram.gov/ntdprogram/pubs/profiles/2008/agency_profiles/9002.pdf.
22. Centers for Disease Control and Prevention. Physical activity levels among children aged 9–13 years. United States. 2002. MMWR Morb Mortal Wkly Rep. 2003; 52:785–788. [PubMed: 12931076]
23. Diez RA, Everson K, McGinn A, Brown D, Moore L, Brines S, Jacobs D. Availability of recreational resources and physical activity in adults. AJPH. 2007; 97:493–499.
24. Frank LD, Schmid TL, Sallis JF, Chapman J, Saelens BE. Linking Objectively Measured Physical Activity with Objectively Measured Urban Form. Findings from SMARTRAO. AJPM. 2005; 28(2S2):117–125.
25. Zhu X, Lee C. Walkability and Safety around Elementary Schools: Economic and Ethnic Disparities. AJPM. 2008; 34:282–290.
26. Kaholokula J. Culturally informed smoking cessation strategies for Native Hawaiians. Nicotine Tob Res. 2008; 10(4):671–681. [PubMed: 19301474]

Table 1
Descriptives and mean metabolic equivalent of mild, moderate, and strenuous physical activity

Sample Characteristics	n	(%)	Mild METs Mean (SEM)	p	Moderate METs Mean (SEM)	p	Strenuous METs Mean (SEM)	p
Total	381	100	13.50 (0.38)		18.66 (0.61)		21.40 (1.00)	
Age in Years								
18-35	112	29.4	12.91 (0.73)	0.02	20.31 (0.99)	0.02	23.63 (1.81)	0.12
36-55	157	41.2	12.75 (0.61)		16.69 (0.95)		21.96 (1.61)	
56+	112	29.4	15.13 (0.63)		19.78 (1.21)		18.40 (1.78)	
Gender								0.01
Male	144	37.8	12.73 (0.63)	0.12	19.41 (0.97)	0.34	24.63 (1.68)	
Female	237	62.2	13.96 (0.48)		18.21 (0.78)		19.44 (1.23)	
Ethnicity								0.03
Caucasian	129	33.9	15.84 (0.61)	0.00	22.05 (1.04)	0.00	24.49 (1.79)	
Asian American	124	32.5	11.90 (0.82)		15.16 (1.07)		17.35 (1.72)	
NHOPI	86	22.6	12.98 (0.68)		19.24 (1.18)		22.92 (2.06)	
Other or Mixed	42	11.0	12.07 (1.10)		17.38 (1.69)		20.79 (2.73)	
Education								0.62
< High School	16	4.2	13.69 (2.12)	0.29	18.44 (3.41)	0.52	24.75 (5.90)	
High School	116	30.4	12.44 (0.73)		18.36 (1.09)		22.42 (1.88)	
Some College	206	54.1	13.84 (0.51)		19.32 (0.84)		21.19 (1.35)	
College Graduate	43	11.3	14.65 (1.10)		16.40 (1.68)		18.42 (2.66)	
Annual Individual Income								0.05
< 30,000	103	27.0	11.59 (0.74)	0.01	15.39 (1.07)	0.00	18.00 (1.88)	
30,000-50,999	112	29.4	14.65 (0.66)		21.52 (1.08)		24.59 (1.91)	
60k	125	32.8	13.73 (0.68)		18.00 (1.11)		22.54 (1.79)	
Missing	41	10.8						
Body Mass Index (kg/m ²)								0.52
Underweight (<18.5)	9	2.4	13.33 (2.13)	0.57	16.11 (4.15)	0.54	19.00 (6.61)	
Normal (18.5-24.9)	179	47.0	14.06 (0.56)		19.16 (0.90)		22.32 (1.44)	
Overweight (25-29.9)	115	30.2	12.86 (0.69)		17.52 (1.10)		22.07 (1.89)	
Obese (≥ 30)	78	20.5	13.15 (0.88)		19.49 (1.32)		18.58 (2.17)	
Perceived Health								0.00
Excellent	57	15.0	15.05 (0.96)	0.00	21.14 (1.56)	0.05	29.37 (2.55)	
Very good	115	30.2	15.21 (0.61)		20.43 (1.07)		25.28 (1.81)	

Sample Characteristics	n	(%)	Mild METs Mean (SEM)	p	Moderate METs Mean (SEM)	p	Strenuous METs Mean (SEM)	p
Good	134	35.2	11.87 (0.67)		17.08 (1.03)		17.33 (1.55)	
Fair	54	14.2	13.33 (1.04)		17.31 (1.62)		18.83 (2.87)	
Poor	21	5.5	10.71 (1.78)		15.71 (2.77)		11.14 (3.62)	

METs= metabolic equivalents; SEM=standard error of the mean; NHOPI=Native Hawaiian/Other Pacific Islander;
p-value from ANOVA for differences in mean METs
Bolded=statistically significant at p-values <0.5, <0.008 (ethnicity), and <0.005 (perceived health)

Table 2

Unadjusted and adjusted mean metabolic equivalents of mild, moderate, and strenuous physical activity by proximity to resources

Proximity	n (%)	Mild METs			Moderate METs			Strenuous METs		
		Unadjusted		Adjusted [‡]	Unadjusted		Adjusted [‡]	Unadjusted		Adjusted [‡]
		Mean (SEM)	p [§]	Mean (SEM)	Mean (SEM)	p [§]	Mean (SEM)	Mean (SEM)	p [§]	Mean (SEM)
0.5	55 (14.7)	14.24 (1.01)	0.59	13.76 (1.00)	19.18 (1.60)	0.62	19.19 (1.58)	21.93 (2.64)	0.42	22.12 (2.55)
1.0	72 (18.9)	13.50 (0.88)		13.47 (0.87)	18.26 (1.40)		17.87 (1.36)	22.75 (2.31)		22.11 (2.21)
1.5	60 (15.7)	12.70 (0.97)		12.89 (0.95)	19.42 (1.53)		19.88 (1.49)	20.55 (2.53)		21.42 (2.42)
2.0	39 (10.2)	13.62 (1.20)		13.91 (1.18)	17.82 (1.90)		18.24 (1.85)	24.00 (3.14)		24.81 (3.00)
2.5	36 (9.4)	14.08 (1.25)		14.17 (1.24)	18.06 (1.97)		17.44 (1.95)	24.50 (3.26)		22.70 (3.15)
3.0	19 (5.0)	15.16 (1.72)		14.60 (1.69)	16.32 (2.72)		15.52 (2.65)	18.95 (4.49)		18.56 (4.30)
3.5	21 (5.5)	10.14 (1.64)		10.67 (1.62)	18.33 (2.58)		18.33 (2.54)	28.29 (4.27)		26.62 (4.11)
4.0	19 (5.0)	13.74 (1.72)		13.89 (1.69)	12.90 (2.72)		13.33 (2.64)	17.05 (4.49)		18.01 (4.29)
4.5	12 (3.1)	15.00 (2.17)		14.78 (2.13)	20.83 (3.42)		21.02 (3.34)	15.75 (5.65)		15.99 (5.42)
5.0–10.0	40 (10.5)	12.75 (1.19)		12.79 (1.16)	20.38 (1.87)		20.64 (1.83)	16.65 (3.10)		17.60 (2.97)

METs=metabolic equivalent; SEM=standard error of the mean; Proximity= distance (km) to nearest physical activity resource by 0.5 km buffer distances

[‡] Adjusted for gender, age, ethnicity, education, perceived health, and BMI

[§] P-value from ANOVA F-test, examining mean differences between distances

Table 3

Unadjusted and adjusted mean metabolic equivalents of mild, moderate, and strenuous physical activity by density of resources

Density	n (%)	Mild METs			Moderate METs			Strenuous METs		
		Unadjusted		Adjusted [‡]	Unadjusted		Adjusted [‡]	Unadjusted		Adjusted [‡]
		Mean (SEM)	p [§]	Mean (SEM)	Mean (SEM)	p [§]	Mean (SEM)	Mean (SEM)	p [§]	Mean (SEM)
1	45 (12.1)	14.87 (1.12)	0.83	14.72 (1.10)	18.78 (1.75)	0.19	18.74 (1.71)	19.80 (2.93)	0.63	20.00 (2.79)
2-3	20 (5.4)	12.60 (1.68)		12.34 (1.64)	23.25 (2.63)		22.91 (2.56)	18.45 (4.39)		18.39 (4.18)
4	37 (9.9)	13.87 (1.24)		13.96 (1.21)	20.14 (1.93)		20.04 (1.89)	21.16 (3.23)		21.47 (3.08)
5	32 (8.6)	13.41 (1.33)		13.64 (1.31)	18.75 (2.08)		19.20 (2.04)	18.84 (3.47)		18.67 (3.34)
6	50 (13.4)	13.56 (1.07)		13.77 (1.04)	20.40 (1.66)		20.71 (1.63)	25.92 (2.78)		26.09 (2.65)
7-10	48 (12.9)	11.81 (1.09)		11.61 (1.06)	14.58 (1.70)		14.16 (1.65)	19.88 (2.84)		19.29 (2.70)
11-15	20 (5.4)	13.80 (1.68)		13.38 (1.66)	20.00 (2.63)		18.58 (2.59)	26.55 (4.39)		25.29 (4.24)
16-20	30 (8.0)	13.60 (1.37)		13.45 (1.34)	18.50 (2.15)		18.56 (2.09)	21.60 (3.59)		22.16 (3.42)
21-25	51 (13.7)	12.77 (1.05)		12.96 (1.03)	16.47 (1.65)		16.97 (1.62)	19.24 (2.75)		19.94 (2.64)
>25	40 (10.7)	14.10 (1.19)		14.18 (1.16)	17.88 (1.86)		17.96 (1.81)	24.30 (3.11)		23.77 (2.96)

METs=metabolic equivalents; SEM=standard error of the mean; Density= total physical activity resources within 10 km of participants' residences

[‡] Adjusted for gender, age, ethnicity, education, perceived health, and BMI[§] P-value from ANOVA F-test, examining mean differences between groups characterized by resource density

Table 4

Association of accessibility to resources with mean metabolic equivalents of mild, moderate, and strenuous physical activity

<i>n</i> = 373	Mild METs		Moderate METs		Strenuous METs	
	β (SEM)	<i>p</i>	β (SEM)	<i>p</i>	β (SEM)	<i>p</i>
Proximity	-0.03 (0.14)	0.63	-0.03 (0.22)	0.63	-0.07 (0.36)	0.20
Density	-0.02 (0.05)	0.78	-0.07 (0.07)	0.21	0.00 (0.12)	0.99
Gender	0.07 (0.80)	0.16	-0.04 (1.26)	0.41	-0.10 (2.03)	0.05
Age	0.05 (0.02)	0.29	-0.08 (0.04)	0.13	-0.15 (0.06)	0.00
Ethnicity	-0.18 (0.38)	0.00	-0.20 (0.59)	0.00	-0.10 (0.96)	0.06
Education	0.02 (0.55)	0.68	-0.04 (0.87)	0.43	-0.10 (1.40)	0.07
Perceived Health	-0.11 (0.39)	0.04	-0.12 (0.61)	0.04	-0.24 (0.99)	0.00
BMI	-0.01 (0.07)	0.90	0.06 (0.12)	0.31	-0.02 (0.19)	0.78

METs=metabolic equivalents; SEM=standard mean error; BMI=body mass index; β =standardized coefficient; Proximity= distance (km) to nearest physical activity resource by 0.5 km buffer distances; Density= total physical activity resources within 10 km of participants' residences
 Bolded=statistically significant at *p*-values <0.5

Table 5

Association of accessibility to resources with mean metabolic equivalents of mild, moderate, and strenuous physical activity by ethnic categorization

		Mild PA METs		Moderate PA METs		Strenuous PA METs		
	Mean (SD)	β (SEM)	p	β (SEM)	p	β (SEM)	p	
Caucasian n= 126	Proximity	4.49 (3.03)	0.04 (0.23)	0.66	0.03 (0.39)	0.75	-0.11 (0.62)	0.26
	Density	10.05 (8.85)	0.06 (0.08)	0.58	0.02 (0.13)	0.82	0.19 (0.21)	0.04
	Gender		0.11 (1.32)	0.21	0.07 (2.26)	0.45	0.10 (3.62)	0.24
	Age		-0.05 (0.04)	0.56	0.04 (0.07)	0.70	0.06 (0.11)	0.53
	Education		0.14 (1.01)	0.14	-0.14 (1.74)	0.14	-0.10 (2.78)	0.27
	Perceived Health		-0.06 (0.66)	0.51	-0.10 (1.13)	0.29	-0.28 (1.81)	0.00
	BMI		-0.07 (0.12)	0.48	-0.01 (0.21)	0.95	0.07 (0.33)	0.46
Asian American n= 119	Proximity	4.28 (2.84)	-0.01 (0.27)	0.95	-0.03 (0.42)	0.78	0.00 (0.65)	0.97
	Density	11.52 (9.41)	0.08 (0.08)	0.46	0.04 (0.13)	0.72	-0.07 (0.20)	0.48
	Gender		0.04 (1.49)	0.68	-0.12 (2.28)	0.22	-0.16 (3.51)	0.08
	Age		0.15 (0.04)	0.12	-0.20 (0.06)	0.04	-0.25 (0.10)	0.01
	Education		0.02 (1.01)	0.87	-0.03 (1.56)	0.73	-0.03 (2.39)	0.74
	Perceived Health		-0.08 (0.75)	0.42	-0.05 (1.15)	0.60	-0.26 (1.76)	0.01
	BMI		0.07 (0.15)	0.49	-0.00 (0.23)	0.97	-0.05 (0.35)	0.57
NHOPI n= 84	Proximity	4.13 (2.76)	-0.12 (0.33)	0.31	-0.25 (0.45)	0.03	-0.15 (0.76)	0.18
	Density	11.62 (9.15)	-0.22 (0.10)	0.06	-0.34 (0.13)	0.00	-0.14 (0.23)	0.19
	Gender		0.13 (1.78)	0.25	-0.06 (2.46)	0.57	-0.32 (4.11)	0.00
	Age		0.09 (0.05)	0.47	0.06 (0.07)	0.59	-0.14 (0.12)	0.20
	Education		-0.09 (1.30)	0.44	-0.09 (1.81)	0.42	-0.17 (3.03)	0.11
	Perceived Health		-0.14 (0.88)	0.21	-0.14 (1.22)	0.23	-0.06 (2.04)	0.54
	BMI		0.06 (0.16)	0.64	0.01 (0.22)	0.96	-0.16 (0.37)	0.15

METs=metabolic equivalent; SD=standard deviation; β =standardized coefficient; SEM=standard mean error; BMI=body mass index; Proximity= distance (km) to nearest physical activity resource by 0.5 km buffer distances; Density= total physical activity resources within 10 km of participants' residences
 Bolded=statistically significant at p-values <0.5