



Examining the Association Between Different Aspects of Socioeconomic Status, Race, and Disability in Hawaii

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Abstract

Socioeconomic status and race/ethnicity are known to be associated with health disparities. This study used data (2010–2014) from the American Community Survey. Respondents over age 30 from Hawaii were included ($n = 44,921$). Outcome variables were self-reported disability in vision, hearing, ambulatory function, self-care, independent living, or cognitive function. Four measures of socioeconomic status were personal income, average income for the area, income inequality for area, and education. This study used multivariable logistic regression to predict disability by race/ethnicity and socioeconomic status, controlling for age and gender. All four measures of socioeconomic status were significant predictors of at least one type of disability after adjustment for age, gender, and other measures of socioeconomic status. Higher education was significantly related to having every type of disability. Similarly, people with high personal income were less likely to have each type of disability than those with middle income, and those with low income were more likely to have all disabilities except hearing. Income inequality was significantly associated with half the disabilities. Low area income was significantly associated with increased vision-related disability, while high income was associated with less likelihood of hearing-related disability. Native Hawaiians were significantly more likely to report having a disability than Filipinos and Chinese for all six types of disability, Japanese for four, and whites for two, after adjustment. These results suggest that in order to reduce health disparities for Native Hawaiians, as well as other ethnic groups, a range of socioeconomic factors need to be addressed.

Keywords People with disabilities · Socioeconomic status

Introduction

One of the strongest and most consistent predictors of health is a person's socioeconomic status. Socioeconomic status is defined by the American Psychiatric Association as “the social standing or class of an individual or group. It is often measured as a combination of education, income and occupation.” [1] Low socioeconomic status is associated with lower ratings of quality of life and self-perceived health and life satisfaction [2, 3]. Prior studies have shown that socioeconomic status, measured in a variety of ways including personal income, area income, income inequality, and education, has been consistently and significantly associated with a range of health outcomes [4, 5]. For instance, low personal income and low area income have been independently linked to major depressive

disorders [6]. Income inequality has been linked to an increased risk of mental disorders such as schizophrenia [7] and depression [8], and European countries with high income inequality tend to have poorer average health [9]. There is also evidence that there is a threshold for income inequality. When income inequality exceeds this threshold, adverse health effects begin to emerge [10]. Additionally, low education is associated with an increase in risk factors for non-communicable diseases [11]. One of the strengths of this manuscript is the inclusion of measures of socioeconomic status at the individual and area level, including area income inequality. Each measure is thought to have a different underlying mechanisms related to their association with health. Personal income is thought to affect health-related behaviors including diet and exercise as well as access to care. Mechanisms for income inequality are thought to include underinvestment in social goods, diminished social cohesion, and social capital, as well as the psychological effects brought upon by known inequities [12].

Health disparities are also prevalent among racial/ethnic minorities. Previous studies have shown that Native

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Hawaiians experience health disparities in many areas including a higher incidence of diabetes, heart disease, and stroke [13–15]. These differences are often hard to distinguish from disparities related to socioeconomic status, as Native Hawaiians, on average, have a lower socioeconomic status than other ethnic groups [16].

In Hawaii, Japanese and Chinese tend to have relatively strong health profiles, including lower rates of diabetes and stroke and increased life expectancy [17, 18]. In contrast, Filipinos tend to have health disparities similar to Native Hawaiians across a variety of health outcome variables [15, 18].

One commonly used measure of health is disability. Disability can be measured in a variety of ways including cognitive disability [19], physical disability [20], and self-care disability [21]. Disability status has been linked to low socioeconomic status even after controlling for gender, age, and ethnicity [19–21]. Native Hawaiians have been shown to have higher rates of disability than other ethnic groups in Hawaii [22].

The goal of this paper was to examine the impact of several aspects of socioeconomic status, as well as race/ethnicity, on disability rates in Hawaii. The strength of our approach is the inclusion of a number of different measures of socioeconomic status, both at the individual and at the area level, which will provide a more comprehensive assessment of an individual's socioeconomic status. This will allow us to assert more definitively whether racial/ethnic disparities remain after controlling for socioeconomic status.

Methods

This study used a 5-year (2010–2014) dataset from the American Community Survey, which is an annual national survey conducted by the Census Bureau via the mail with in-person and telephone follow-ups. The study population ($n = 44,921$) consists of people living in the state of Hawaii who were over the age of 30 at the time of the survey. In the American Community Survey, the state of Hawaii is broken into 10 distinct Public Use Microdata Areas (PUMAs), meant to capture approximately the same number of people in each section. PUMAs are non-overlapping areas that break each state into contiguous geographic units containing at least 100,000 people. The survey was weighted to reflect the sampling design.

Race/Ethnicity

American Community Survey data has detailed race/ethnicity information, breaking out individual Asian and Pacific Islander subgroups. We have examined disparities for the five largest groups in Hawaii (Whites, Japanese, Filipinos, Native

Hawaiians, Chinese). If someone was of mixed race, we categorized them as “mixed race.” Mixed race was included in the model, but results are not presented in this manuscript. The exception was Native Hawaiians, who were considered Native Hawaiian if they were part Native Hawaiian. This is commonly done because there are extremely few people who are 100% Native Hawaiian.

Socioeconomic Status

We considered four measures of socioeconomic status: (1) personal household income, (2) mean income for a person's PUMA, (3) level of income inequality for a person's PUMA, and (4) education level. Personal household income was self-reported on the survey, and 2010 to 2013 data was adjusted for inflation to constant 2014 dollars. Mean income for the individual's PUMA was calculated by taking the weighted average of personal income for each resident in the PUMA and was also adjusted for inflation. To measure income inequality, we divided the 75th percentile of income by the 25th percentile for each PUMA. We also calculated a Gini coefficient for each racial or ethnic group. A Gini coefficient of zero signifies perfect equality (i.e., everyone has the same income), while a Gini coefficient of 1 expresses maximal inequality (i.e., one person has all the income) [22]. Education was categorized as less than high school, high school graduate, some college, college graduate, and graduate degree.

For analysis, personal income and mean PUMA income were categorized as low (1st quartile), medium (middle 50%), or high (4th quartile). PUMA-level income inequality was specified as a continuous variable.

Disability

Outcome variables were aspects of disability measured for six separate domains: hearing, vision, self-care, ambulatory function, cognitive function, and independent living. We created a dichotomous outcome variable for each disability, which was “yes” if the individual reported having the disability, and “no” if the individual did not report having the disability. To be included in the study, participants needed to respond to all six of the disability questions.

Statistical Analysis

Respondent demographic characteristics and disability rates were summarized by race/ethnicity and compared using t tests and Chi-squared tests, as appropriate. Initially, multivariable logistic regression models were estimated to examine the relationship between race/ethnicity and disability, controlling for age and gender. Subsequently, socioeconomic factors were added to the model to examine the extent to which racial/ethnic disparities persisted after controlling for education

and income. For analysis, categorical variables were used for personal income and mean area income, comparing low and high income to middle income for each. All analyses were conducted using R statistical software. Institutional Review Board approval was not required.

Results

Characteristics of the Study Population:

Native Hawaiians had the lowest average age and the second highest rate of disability after Japanese (17 versus 19%); however, Japanese were 10 years older on average when compared to Native Hawaiians. As age might be a potential confounder, the multivariable analysis controlled for age as well as gender. Native Hawaiians had the lowest percentage with a college degree or higher at 16%, compared to 41% of Whites, 39% of Japanese, 29% of Chinese, and 20% of Filipinos. At about 20%, Chinese and Filipinos had the highest rate of not having completed a high school education (Table 1).

Income by Race/Ethnicity:

Whites had the highest mean income followed by Chinese, Japanese, Native Hawaiians, and Filipinos (Fig. 1). The mean income of Native Hawaiians and Filipinos was significantly less than the mean income of any other ethnic group. The mean income of Whites was also significantly greater than that of Japanese but not different from that of Chinese.

Income Inequality by Race/Ethnicity

Income inequality was highest in Chinese and Whites where the Gini coefficient of both was 0.54 (Fig. 2). In Native Hawaiians, the Gini coefficient was 0.49, while Japanese

and Filipinos had the lowest levels of income inequality with coefficients of 0.45 and 0.44, respectively.

Disability Related to Socioeconomic Status and Race, Adjusted for Age and Gender

Relative to Native Hawaiians, every other race/ethnic groups had significantly lower disability rates for every type of disability, after controlling only for age and sex. For whites, the reduction was approximately a 15–30% decrease in odds of disability, with the greatest difference in the area of ambulatory disability [OR = 0.60, 95%CI (0.53, 0.69) Table 2]. For Filipinos, the largest difference was for self-care, with approximately a 40% reduced odds of disability compared to Native Hawaiians. For Japanese, the reduced odds of disability ranged from approximately 30% to more than 50% in the area of ambulatory disability. Relative to Native Hawaiians, Chinese tended to be least likely to have a disability. The largest differences were also in ambulatory disability [OR = 0.43, 95%CI (0.34, 0.55)].

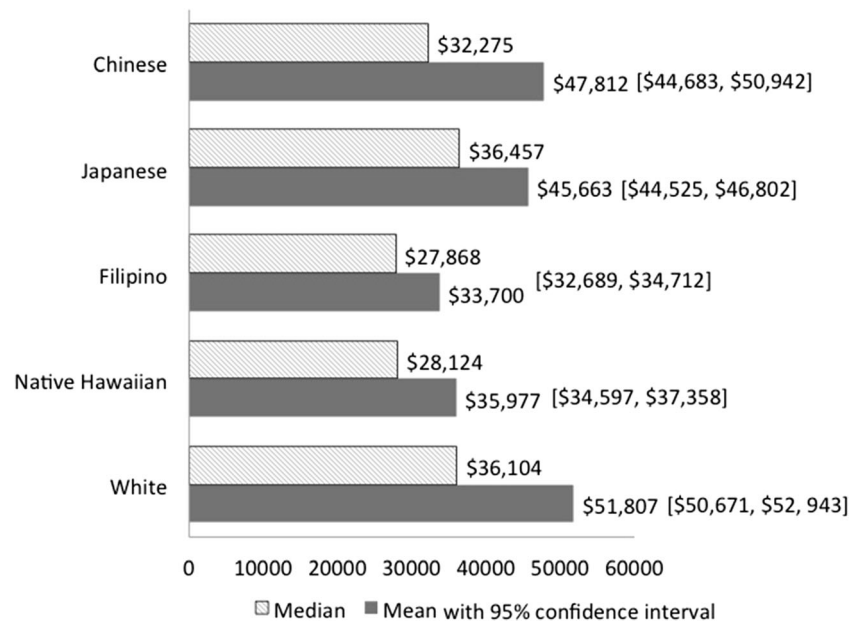
Low socioeconomic status was also significantly associated with higher rates of disability after controlling for age and sex (Table 2). After adjusting for age and sex, people with a high school education, some college education, or a college degree had significantly lower rates of disability in each of the six categories than people with less than a high school education. Additionally, low area income was significantly linked with higher rates of disability in every category, with odds ratios ranging from approximately 16% higher for cognitive disability to over 40% in the area of vision. Compared to middle level income, low personal income was significantly linked with higher rates of disability in every category except hearing, with the largest decreased odds for cognitive disability [OR = 1.68, 95%CI (1.46, 1.92)]. After adjusting for age and sex, income inequality was

Table 1 Characteristics of the study population

	White (n = 13,098)	Native Hawaiian (n = 7330)	Filipino (n = 6079)	Japanese (n = 8740)	Chinese (n = 2224)	P value
Age [mean, SE]	55.1 (15.1)	51.7 (14.1)	54.5 (15.0)	62.5 (16.6)	60.1 (15.8)	< 0.001
Female (%)	46.2%	50.5%	54.1%	55.4%	53.5%	< 0.001
Education						< 0.001
< High school	4.6%	9.3%	19.5%	5.8%	20.0%	
High school grad	18.0%	40.2%	28.2%	24.3%	18.3%	
Some college	36.1%	34.9%	32.3%	32.3%	22.4%	
College grad	41.4%	15.7%	20.0%	38.7%	29.3%	
% with disability	15.3%	17.2%	13.6%	19.0%	14.2%	< 0.001

Note: Mixed race (2019) and other race (5431) not displayed

Fig. 1 Mean and median income by race/ethnicity



significantly associated with every type of disability with the largest odds for ambulatory and self-care disabilities.

Logistic Model Adjusted for Age, Sex, Race, and Socioeconomic Factors

After adjusting for race and socioeconomic status, some of the ethnic differences in disability status lost their significance, including hearing and cognitive function for Japanese and self-care, hearing, vision, and cognitive disability for Whites (Table 3). The rest of the ethnic differences remained significant. In fact, Chinese and Filipino ethnicity was associated with decreased likelihood of disability in every category, compared to Native Hawaiians.

For our measures of socioeconomic status, every category of education remained significantly associated with every disability (Table 3). Additionally, even after controlling for age,

sex, race, and other socioeconomic factors, high personal income was inversely related to every type of disability, and low personal income remained significantly associated with each disability except for hearing (Table 3). Low area income remained significantly associated with vision disability, while high area income was associated with hearing disability. Area income inequality remained significantly associated with vision, ambulatory, and independent living disability.

Discussion

The purpose of this study was to examine the relationship between socioeconomic factors, race/ethnicity, and rates of disability in the state of Hawaii. In this random sample of close to 45,000 individuals, we found that Native Hawaiians had higher rates of disability than all other racial/ethnic groups examined (Whites, Chinese, Japanese, and Filipinos) after controlling for age, sex, and socioeconomic factors. Consistent with the literature, almost all of the indicators for low socioeconomic status were significantly associated with higher rates of disability.

In this study, all four of our measures of socioeconomic status were shown to be independently and significantly related to at least one category of disability. Personal income is known to be correlated with health, as people with low income may experience barriers to care, have less healthy behaviors, or experience increased stress [4]. The significance of area income suggests that health is related to environment.

In terms of area income, income inequality was more strongly and consistently related to disability than level of area income. The correlation between income inequality and health is especially relevant today with income inequality on the rise

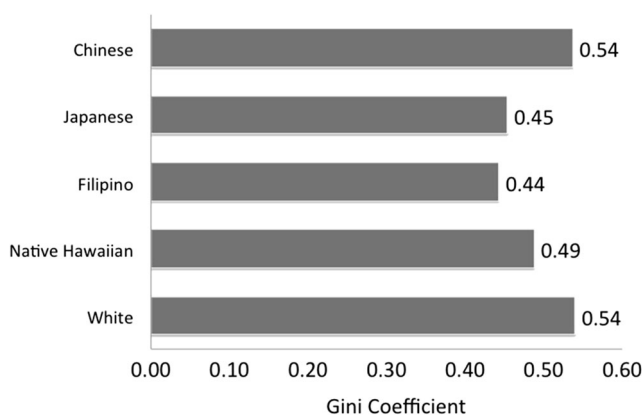


Fig. 2 Gini coefficient by race/ethnicity

Table 2 Odds ratio of disability by type related to demographic characteristics, adjusted for age and sex

	Self-care	Hearing	Vision	Ambulatory	Cognitive	Independent living
Race/ethnicity						
Native Hawaiian	1	1	1	1	1	1
White	0.72 [0.57,0.89]	0.85 [0.72,0.99]	0.77 [0.61,0.97]	0.60 [0.53,0.69]	0.83 [0.69,0.98]	0.64 [0.54,0.85]
Filipino	0.59 [0.46,0.75]	0.81 [0.67,0.99]	0.66 [0.50,0.87]	0.61 [0.51,0.73]	0.65 [0.53,0.79]	0.68 [0.55,0.85]
Japanese	0.61 [0.48,0.76]	0.74 [0.62,0.90]	0.54 [0.43,0.69]	0.49 [0.42,0.57]	0.64 [0.53,0.78]	0.55 [0.46,0.66]
Chinese	0.59 [0.42,0.82]	0.61 [0.46,0.81]	0.47 [0.32,0.68]	0.43 [0.34,0.55]	0.52 [0.39,0.69]	0.51 [0.40,0.55]
Education						
< high school	1	1	1	1	1	1
High school grad	0.81 [0.67,0.97]	0.84 [0.71,0.99]	0.60 [0.50,0.73]	0.75 [0.66,0.84]	0.57 [0.49,0.67]	0.59 [0.52,0.68]
Some college	0.54 [0.44,0.67]	0.71 [0.60,0.84]	0.66 [0.51,0.84]	0.60 [0.52,0.68]	0.42 [0.36,0.50]	0.40 [0.34,0.47]
College graduate	0.64 [0.51,0.81]	0.77 [0.66,0.90]	0.58 [0.47,0.71]	0.58 [0.50,0.66]	0.57 [0.48,0.67]	0.65 [0.56,0.76]
Personal income low	1.50 [1.27,1.78]	1.15 [0.98,1.36]	1.33 [1.10,1.62]	1.37 [1.20,1.56]	1.68 [1.46,1.92]	1.66 [1.36,1.79]
Personal income midrange	1	1	1	1	1	1
Personal income high	0.35 [0.28,0.43]	0.68 [0.60,0.78]	0.57 [0.47,0.70]	0.43 [0.38,0.48]	0.27 [0.22,0.31]	0.33 [0.29,0.39]
PUMA income inequality	1.54 [1.28,1.84]	1.18 [1.04,1.34]	1.21 [1.01,1.45]	1.64 [1.46,1.84]	1.31 [1.14,1.51]	1.47 [1.30,1.65]
PUMA income low	1.34 [1.25,1.58]	1.36 [1.19,1.55]	1.46 [1.22,1.75]	1.24 [1.11,1.40]	1.16 [1.02,1.32]	1.20 [1.05,1.37]
PUMA income midrange	1	1	1	1	1	1
PUMA income high	0.73 [0.61,0.88]	0.97 [0.83,1.12]	0.95 [0.77,1.18]	0.77 [0.69,0.85]	0.77 [0.66,0.90]	0.81 [0.72,0.92]

in the USA [5]. This suggests that it is not only the mean level of area income that is important but its distribution is also relevant. A large-scale causal review of income inequality and health conducted by Pickett and Wilkinson concluded that there is strong evidence of a relationship between high levels of income inequality and worse health outcomes. For the minority of studies that did not find an association, a methodological flaw could be found in almost all of them [23]. Kawachi and Kennedy attempt to explain the difference between the health effects of area income and income inequality in another article. While area income affects the availability of resources, income inequality results in residential isolation and a lack of social cohesion. This can reduce social mobility, impede productivity and economic growth, and increase crime and violence [24].

Education is important not only because higher education tends to lead to higher income, but also because educated people are more likely to understand health information and make informed decisions regarding their health [25]. Our findings that every category of education was significantly

associated with every type of disability suggest that effective interventions could be made at any level of education, from increasing the high school graduation rate to increasing scholarships and funding for graduate school. Moreover, improving educational attainment is also likely to increase other measures of socioeconomic status, such as personal income. The fact that adding socioeconomic variables to the model reduces the odds ratios of disability in at least one category for Whites, Japanese, Chinese, and Filipinos relative to Native Hawaiians indicates that part of the difference in disability rates between these groups is related to socioeconomic status.

In general, the results did not differ greatly between the disabilities. Each disability category was significantly linked to at least one measure of socioeconomic status beyond education. This result provides further evidence that when trying to address the relationship between socioeconomic status and the general health of a population, a variety of socioeconomic factors need to be taken into consideration.

Even after controlling for age, sex, and socioeconomic status, Native Hawaiians had a significantly higher rate of

Table 3 Odds ratios of disability related to demographic characteristics, adjusted for age, sex, and socioeconomic status

	Self-care	Hearing	Vision	Ambulatory	Cognitive	Independent living
Race/ethnicity						
Native Hawaiian	1	1	1	1	1	1
White	0.97 [0.77,1.21]	0.99 [0.85,1.16]	0.91 [0.71,1.17]	0.76 [0.66,0.87]	1.14 [0.96,1.36]	0.89 [0.79,0.99]
Filipino	0.54 [0.42,0.70]	0.78 [0.64,0.96]	0.62 [0.46,0.84]	0.55 [0.39,0.63]	0.55 [0.44,0.68]	0.56 [0.48,0.66]
Japanese	0.77 [0.61,0.97]	0.87 [0.72,1.05]	0.65 [0.51,0.84]	0.60 [0.51,0.71]	0.84 [0.68,1.03]	0.70 [0.58,0.84]
Chinese	0.69 [0.49,0.97]	0.71 [0.54,0.94]	0.52 [0.35,0.78]	0.50 [0.39,0.63]	0.56 [0.42,0.75]	0.47 [0.38,0.57]
Education						
< high school	1	1	1	1	1	1
High school grad	0.82 [0.68,0.98]	0.83 [0.71,0.98]	0.60 [0.48,0.74]	0.77 [0.68,0.87]	0.58 [0.49,0.67]	0.64 [0.57,0.72]
Some college	0.59 [0.48,0.73]	0.72 [0.61,0.84]	0.68 [0.53,0.87]	0.67 [0.58,0.78]	0.46 [0.40,0.54]	0.58 [0.52,0.65]
College grad	0.77 [0.61,0.98]	0.83 [0.71,0.97]	0.65 [0.52,0.87]	0.69 [0.60,0.79]	0.70 [0.59,0.83]	0.70 [0.63,0.79]
Personal income low	1.42 [1.21,1.67]	1.12 [0.95,1.31]	1.26 [1.03,1.53]	1.28 [1.13,1.46]	1.55 [1.35,1.77]	1.39 [1.24,1.56]
Personal income midrange	1	1	1	1	1	1
Personal income high	0.41 [0.33,0.52]	0.76 [0.67,0.87]	0.67 [0.54,0.82]	0.51 [0.46,0.58]	0.31 [0.26,0.38]	0.55 [0.51,0.59]
PUMA inequality high	1.31 [1.04,1.66]	1.00 [0.85,1.18]	0.96 [0.76,1.22]	1.48 [1.30,1.69]	1.18 [0.98,1.42]	1.18 [1.06,1.32]
PUMA income low	1.04 [0.86,1.27]	1.12 [0.95,1.30]	1.30 [1.03,1.62]	0.92 [0.81,1.04]	0.89 [0.76,1.05]	1.05 [0.95,1.17]
PUMA income midrange	1	1	1	1	1	1
PUMA income high	0.85 [0.70,1.04]	0.76 [0.67,0.87]	1.04 [0.83,1.32]	0.93 [0.84,1.04]	0.91 [0.78,1.07]	0.98 [0.89,1.08]

disability than other ethnicities in most of the disability categories. These results suggest that there are health disparities for Native Hawaiians unrelated to socioeconomic factors such as income and education. In the effort to eradicate health disparities for ethnic minorities in the USA, the scope should be widened to include underlying cultural or other circumstantial variables.

Chinese and Filipinos had the lowest rates of disability, after adjustment. As Chinese are known to have the highest life expectancy and low rates of obesity, this finding was expected; however, it was somewhat surprising that Filipinos had lower rates of every disability considering the significant health disparities for Filipinos noted in the literature. It is possible that these health disparities are simply not captured by the disability variables used in the ACS.

One issue with using disability as an outcome variable is that all of the questions are self-reported and somewhat subjective. The participants may be unable to accurately diagnose themselves with certain disabilities or they may purposely misrepresent their health status. One of the questions asks if

the participant has any difficulty concentrating, remembering, or making decisions. While this question might seem straightforward, people have different ideas of what it means to have difficulty. Some people might be embarrassed about their disabilities and would be less inclined to admit them on a survey, even if it is anonymous. Non-response bias is also present in the dataset because not everyone answered all of the questions. Additionally, there are many possible causes for each disability, and people with vastly different health statuses could be grouped together because there is no indication of severity. Multicollinearity might be factor as the measures of socioeconomic status are related to each other; however, because for most variables, at least three categories were created, our analysis attempted to minimize the impact. Moreover, our results suggest that all aspects of socioeconomic status are significant, which indicates that multicollinearity was not a major issue in our study. Another limitation is that since this is a cross-sectional observational study, there are concerns about directionality, and it is possible that disability predicts SES and not the other way around. Future studies using

longitudinal data are needed to further sort out the timing of the relationship.

We believe that one of the strengths of our analysis is the comprehensive approach to our definitions of both socioeconomic status and disability. Socioeconomic status is complex and could not be sufficiently represented by education or income alone. There are also many different forms of disability, and we believe that our use of six separate disability categories provided our analysis with an effective measure of an individual's overall health profile. Moreover, the detailed racial/ethnic categories available in this dataset were also a major strength.

In conclusion, disability is significantly associated with socioeconomic factors such as education, income, and income inequality. Additionally, Native Hawaiians have existing health disparities even after controlling for socioeconomic status. In order to reduce health disparities, socioeconomic factors need to be addressed; however, further research is required to determine the other sources of higher disability rates for Native Hawaiians and other disadvantaged groups. Any public health intervention aimed at reducing disability should take into consideration the socioeconomic qualities of the target area, as we have shown that disability status and socioeconomic status are closely related.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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