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Education and self-rated health: An individual and neighborhood level analysis of Asian Americans, Hawaiians, and Caucasians in Hawaii

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ABSTRACT

Focusing on Asian Americans, Hawaiians, and Caucasians in Hawaii, this study contributes to the literature by examining (1) the geographical distributions of education in relation to self-rated general health at neighborhood levels, and (2) the individual variations in self-rated health by ethnicity and education at both individual and neighborhood levels. Using the 2007 Hawaii Health Survey with linked zip-code information, and applying GIS (Geographic Information System) and binary logistic regression models, this study found that (1) there are significant between ethnic differences in self-rated health in Hawaii, with Hawaiians being the most disadvantaged population compared to Japanese, Chinese, and Caucasians; (2) individual socioeconomic characteristics are all related to self-rated health, and education (in particular) mediates the Japanese vs. Hawaiian and Chinese vs. Hawaiian health differences; (3) the neighborhood level of education has an independent effect on self-rated health over and above individual characteristics for the whole sample and it partially mediates the between ethnic health differences; and (4) the relative importance of education to self-rated health is more significant and salient for Caucasians and Japanese/Chinese than for Filipinos and Hawaiians. In sum, this study not only demonstrates a geographical profile of health and education distributions in Hawaii, but also reveals significant mediating effects of education, at both individual and neighborhood levels, in explaining the between and within ethnic differentials in self-rated health.

Introduction

During the past decade, Asian Americans have been increasingly acknowledged as one of the fastest growing racial minorities in the United States (Barnes & Bennett, 2002; Kitano & Daniels, 1995). Therefore their health and well-being compared to other ethnic groups has been increasingly capturing scholarly attention (e.g., Frisbie, Cho, & Hummer, 2001; Lauderdale & Kestenbaum, 2002; Mutchler, Prakash, & Burr, 2007). Hawaii, a place with 40% of the population being Asian Americans (compared with 4% in the U.S. as a whole) according to the 2000 U.S. Census data, becomes an ideal place to examine the health and well-being of Asian Americans in comparison with other ethnic groups such as Hawaiians and Caucasians. Using the 2007 Hawaii Health Survey, this study intends to (1) describe the geographical distribution of self-rated general health in relation to education across six islands in Hawaii, (2) examine the between and within ethnic differences in self-rated general health among Asian Americans (including Japanese, Chinese, and Filipinos), Hawaiians, and Caucasians, and (3) explore whether education, at both individual and neighborhood (aggregate) levels, explains the ethnic health disparities.

This study focuses on self-rated general health because it has both construct and criterion validity (Patrick & Erickson, 1993). It is a robust indicator of individual health that predicts morbidity, mortality, subsequent disability, and health care utilization (Benyamini & Idler, 1999; Ferraro, Farmer, & Wybraniec, 1997; Idler & Benyamini, 1997; Idler & Kasl, 1995; Malmstrom, Sundquist, & Johansson, 1999; Mossey & Shapiro, 1982; Wilson & Kaplan, 1995). To explain ethnic differences in self-rated general health, the role of education is especially emphasized in this study. It is well documented that education forms a distinct dimension of social status. It precedes occupation, earning, and wealth, and has a variety of merits that make it a particularly important determinant of health (e.g., Adler & Newman, 2002; Mirowsky & Ross, 2003; Phelan & Link, 2005).

This paper begins by summarizing theoretical arguments linking education and self-rated health. Relevant hypotheses concerning the relationships between education, at both individual

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and neighborhood levels, in relation to self-rated health, are then described and tested using GIS (Geographic Information System) and binary logistic regression models. Finally, the findings are reviewed and their implications are discussed for future research.

Theoretical background

The association between education and health is well established (e.g., Mirowsky & Ross, 2003), but whether the association holds for Asian Americans (i.e., Japanese, Chinese, and Filipinos) and Hawaiians has not been explicitly explored. In this study, we examine whether education, at both individual and neighborhood levels, is associated with self-rated general health among different ethnic groups in Hawaii; and whether two levels of education explain the between, as well as within, ethnic differences in health.

Individual level education and health

According to Mirowsky and Ross (2003), education is the root cause of health disparity because it indicates human capital – cognitive skills and abilities that can be used to control and direct one's own life and provide resources beyond economic gains. Those cognitive skills and abilities learned in school cannot be taken away by others as external social ties, jobs, or assets, and can help individuals continuously: (1) improve reading comprehensions, writing and communication skills; (2) develop abilities such as observing, synthesizing, interpreting, classifying, and reasoning; and (3) form values and attitudes such as motivation, effort, trust, confidence, and future-planning (Mirowsky & Ross, 2003; Ross & Zhang, 2008). In addition to these internalized skills and abilities, highly educated individuals are also more likely to engage in healthy lifestyles such as exercising, maintaining a healthy weight, drinking moderately, and abstaining from smoking (Ross & Wu, 1995).

Given the increasing complexity of disease causes, health knowledge, and information to which individuals are now exposed, education may become even more of an asset for the well-educated than for the less-educated ones. To explain the rising importance of education for health disparities in the U.S., Goesling (2007) summarized three major reasons – the increasing socioeconomic inequality since the 1980s, the growing educational disparities in health-promoting behaviors, and the access to and utilization of health services and medical technology. Empirical evidence in recent literature has also started to document trends toward widening gaps in self-rated health by educational levels over time among various U.S. cohorts (Goesling, 2007; Liu & Hummer, 2008; Lynch, 2003; Mirowsky & Ross, 2008).

Despite the substantial and increasing significance of education for health, an important question on racial and ethnic differences remains unclear. Relatively smaller proportions of Asian Americans compared to non-Hispanic whites and blacks in nationally representative samples in the U.S. often leads to the exclusion of Asian Americans (with a great deal of within-group heterogeneity) from analysis. Focusing on Hawaii, the western-most state in the U.S. with the highest Asian American concentration (The 2000 U.S. Census), this study intends to examine the relative importance of education among Japanese, Chinese, Filipino, Hawaiians, and Caucasians, and whether educational attainment at an individual level helps explain the between and within ethnic health disparities.

Neighborhood level education and health

If individual educational attainment indicates human capital, neighborhood level of education may indicate "collective human capital" and employ "collective watch" (Ross & Mirowsky, 2008), which may derive recourses and wealth that maintain the order of community and benefit individual health more than the sum of individual socioeconomic status (SES). For instance, individuals living in a neighborhood with higher average level of education may be especially likely to work together to make most use of information and resources to enhance the natural as well as human environment and the safety of their community. In a similar vein, Sampson, Morenoff, and Earls (1999) developed the concept of "collective efficacy" to distinguish neighborhood level social cohesion from individual level social networks. They emphasized mutual trust and solidarity among local residents (social cohesion) and expectations for action (informal social control) in explaining the impact of aggregate level social connection on individual well-being.

Using multilevel analyses to link individual level data with contextual information, recent studies in the U.S. have started to test the independent effect of neighborhood SES net of personal characteristics. Although results remain mixed and inconclusive due to diverse measures of neighborhood attributes (e.g., Browning & Cagney, 2003; Mair, Diez-Roux, & Galea, 2008; Robert, 1998; Winkleby, Cubbin, & Ahn, 2006), most research suggests the positive association between neighborhood SES and health. For instance, Diez-Roux, Nieto, Muntaner, Tyroler, and Comstock (1997) found that neighborhood economic deprivation is associated with the onset of heart disease in the United States A study by LeClere, Rogers, and Peters (1998) suggested that neighborhood characteristics (as indicated by public assistance, poverty rate, low median income, and female headship rates) predict women's heart disease mortality. Similarly, Waitzman and Smith (1998) found that residence in a poor area (as defined by proportions of families with low income, substandard housing, children in single-headed households, unskilled males in the labor force, and adults with low educational attainment) is associated with significantly elevated mortality risk among adults aged 25 through 54 years, after adjustment for individual and household characteristics. Another study in Illinois by Ross and Mirowsky (2001) found that neighborhood disadvantage (as measured by poverty, lone parent households, few college educated adults, and low home ownership) is associated with poor health, adjusting for individual educational attainment, employment status, and household income.

To date, however, only a few studies have explicitly examined the role of aggregate level of education, an important factor that may have an independent effect on personal health, over and above other neighborhood economic factors and individual SES. An ecological analysis of New York City neighborhoods indicated that the presence of highly educated people in a neighborhood may be beneficial for all residents, independent of the potentially deleterious consequences of income maldistribution (Galea & Ahern, 2005). One recent study by Ross and Mirowsky (2008) created a macro-level SES index (measured as home ownership, college educated adults, and poverty) and found approximately 40% of the association between neighborhood SES and individual health is contextual whereas 60% is compositional. Given the relatively higher housing prices, lower owner occupied housing rates, larger variation of housing values and household size, and smaller variation of family poverty rates in Hawaii compared to the U.S. as a whole (The 2000 U.S. Census), it is proposed that collective education (measured by the percentage of college graduate adults in the neighborhood) may be the most relevant and stable indicator of neighborhood SES in Hawaii.

According to the above theoretical arguments, the following hypotheses will be tested in this study.

Hypothesis 1: there are geographical differences in education and self-rated general health such that neighborhoods with a higher percentage of college educated adults are more likely to display a higher percentage of very good to excellent general health.

Hypothesis 2: adjusting for demographic characteristics, individual differences in self-rated health can be explained by ethnicity and neighborhood level of education as well as individual level of education and other socioeconomic characteristics such as household income and employment status.

Hypothesis 3: differences in self-rated health *within* each ethnic group after adjusting for demographic characteristics can also be explained by the neighborhood level of education as well as individual level of education and other socioeconomic characteristics such as household income and employment status.

Methods

Data

To test the proposed hypotheses, we used The Hawaii Health Survey (HHS), which is a statewide household survey conducted annually by the Hawaii Department of Health (DOH) and Office of Health Status Monitoring (OHSM). The HHS measures demographic characteristics as well as the health status of Hawaii's residents to provide data to monitor health status in Hawaii, to plan for the availability of health services in the State, and to evaluate health programs. Modeled after the National Health Information Survey, the HHS has been, and now remains, one of the most important data sources collected by government in the State of Hawaii. The survey population is all persons residing in households with residential land-line telephone service in the State of Hawaii. Persons residing in group quarters, those residing in households without telephones, persons residing on the island of Ni'ihau, and homeless persons are not represented. The sample design is disproportionate by geography, and survey data are statistically adjusted to match the geographic location and number of telephone lines, size of households, and the age and gender of all household members.

For this study, the 2007 version of HHS was used and the study population is Asian Americans (including Japanese, Chinese, and Filipinos), Hawaiians, and Caucasians. Respondents' neighborhood level data (acquired from the 2000 U.S. Census) were linked to the individual level data. Without information on respondents' addresses, from which census tract (a smaller neighborhood unit compared to zip-codes) can be derived, zip-codes were used as the best objective approximation of neighborhoods in this study. There are 84 zip-code areas in Hawaii with valid neighborhood level data provided by the 2000 U.S. Census.

Measurement

Dependent variable

The dependent variable for this study is self-rated general health. Respondents were asked, "How would you rate your general health – excellent, very good, good, fair, or poor?" Given that the purpose of this study is to examine education in relation to outstanding self-rated health, this measure was collapsed into two categories: (1) poor, fair, and good; and (2) very good and excellent. Of the valid sample, over 49% of the respondents reported having very good to excellent health.

Independent variables

Education, the focal independent variable of this study, was measured at both individual and neighborhood levels. Individual educational attainment was coded into four categories (less than high school, high school, some college, and college and greater) with college and greater being the reference group.

The neighborhood SES was measured with the 2000 U.S. Census data aggregated at the zip-code level. Two indicators of neighborhood SES were used: education and poverty. Neighborhood level of education was measured as the percentage of the population over the age of 24 with a college degree or higher in the respondent's zip-code area. The sample rates range from 3.9 to 47.5%, with an average value of 22%. Poverty is measured as the percentage of families below the Federal poverty line in the respondent's zip-code area. The poverty rates by zip-code range from 0 to 37.5%, with an average value of slightly over 10%. There are a total of 84 valid zip-code areas in which respondents live. This allows for a large range of comparisons. Approximately 3.6% of a total of 5250 respondents were missing zip-code level data, thus, were excluded. As a result, the analytical sample is reduced to 5062.

Ethnicity was measured by asking respondents, "What race do you consider yourself to be? And anything else?" Respondents were allowed to claim up to four ethnic groups to which they belong. To facilitate group comparisons, respondents were classified into the ethnic group that they first selected. For instance, respondents were considered Japanese if they mentioned Japanese as their first choice. Of the valid sample, there are 1099 Japanese (1003 are pure Japanese and 96 are mixed Japanese), 253 Chinese (180 are pure Chinese and 73 are mixed Chinese), 664 Filipinos (553 are pure Filipinos and 111 are mixed Filipinos), 841 Hawaiians (214 are pure Hawaiians and 627 are mixed Hawaiians), and 2205 Caucasians (1982 are pure Caucasians and 223 are mixed Caucasians). Given the small sample sizes of mixed ethnicity, the pure and mixed respondents were grouped into a single category for each ethnic group.

This study controlled for demographic factors such as gender (*female*: 0 = male, 1 = female), age groups (18–24, 25–34, 35–49, 50–64, ≥65), and other socioeconomic factors such as household income (≤$24,999; $25,000–$49,999; $50,000–$74,999; and ≥$75,000) and employment status (*employed*: 0 = unemployed, 1 = employed).

Analytical strategy

To describe the geographical distributions of education in relation to self-rated general health across neighborhoods in the State of Hawaii, ArcGIS (ESRI, Redlands, CA) was used to map by zip-code the percentages of the population with a college degree or higher level of education and the percentages with very good to excellent health in Fig. 1. The maps of self-rated health and neighborhood level of education are listed for each island side by side. Specific areas of Oahu are labeled to make the results easier to interpret.

The sample characteristics by ethnicity were summarized in Table 1. To determine the independent effects of education at both individual and neighborhood levels requires multilevel data, in which the unit of analysis is individual, and characteristics of the respondent's neighborhood are linked to individual survey data. A series of binary logistic regression models were estimated in Table 2 to examine the relationship between ethnicity, education, and self-rated health. The first model of Table 2 was estimated to identify at the individual level the between ethnic differences in self-rated general health with Hawaiian being the reference category (In the Appendix, Caucasian was used as the reference category), controlling for the effects of gender and age group. The second model incorporated neighborhood level of education and poverty to test if they partially mediate the between ethnic differences in self-rated health. The third model included individual level income and employment status. The purpose of Model 3 is to isolate the effect of these other individual socioeconomic factors, so that the independent effect of individual level education can be identified in Model 4. In order to examine the independent effect of individual

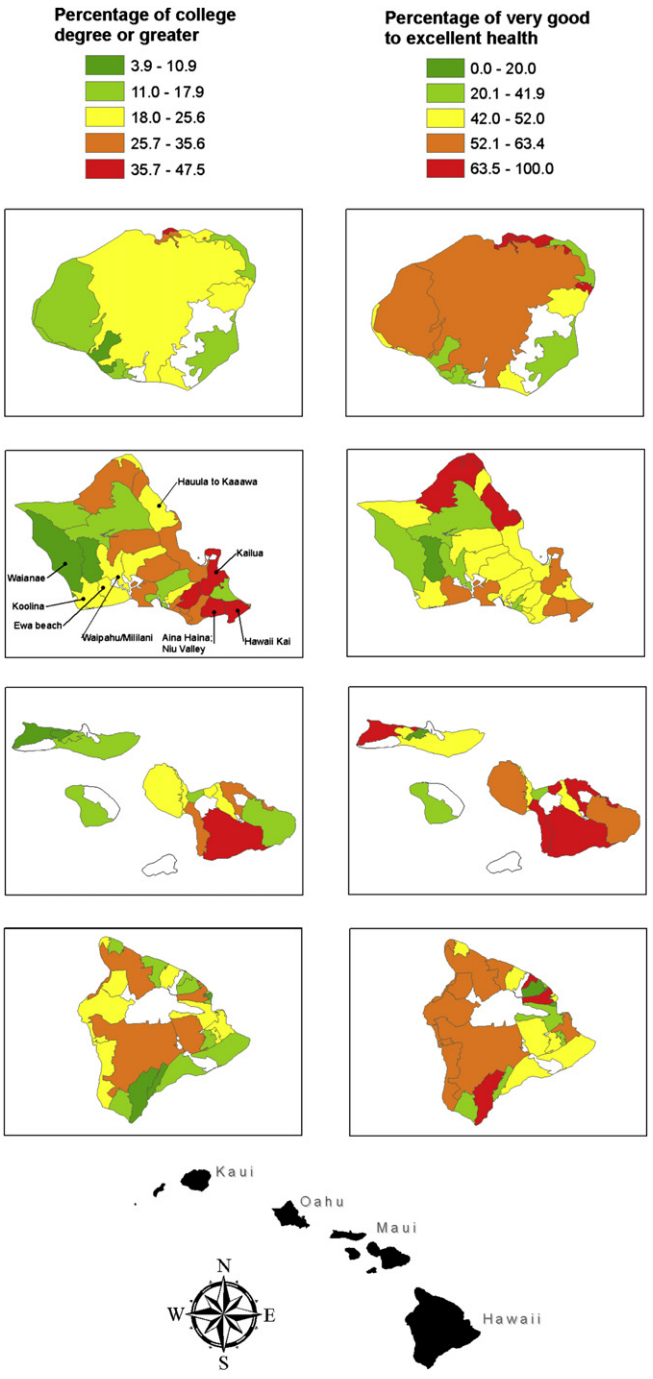

Fig. 1. Geographical distributions of percentages of college degree or greater and very good to excellent health by zip-code in the state of Hawaii: Kauai (first row); Oahu (second row); Molokai, Lanai, and Maui (third row); Hawaii (fourth row).

level of education in explaining the between ethnic differences in self-rated health, a series of dummy variables on individual educational attainment were separately added in the final model.

To examine the within ethnic health variations in relation to education, the analysis was performed separately for different ethnic groups: Japanese, Chinese, Filipino, Hawaiian, and Caucasian. A preliminary figure (Fig. 2) describing the relationship between mean levels of self-rated health and individual educational attainment was created first. Following this, the same modeling strategies as applied in Table 2 were used for the five ethnic groups. Only the results of the full models are reported (See Table 3).

Table 1
Distributions of sociodemographic characteristics and self-rated general health of adults by ethnicity: 2007 Hawaii Health survey,

	Japanese	Chinese	Filipino	Hawaiian	Caucasians
Demographic characteristics					
Gender					
Male	35.5	37.2	33.4	31.6	39.1
Female	64.5	62.8	66.6	68.4	60.9
Age (years)					
18–24	1.8	4.7	5.7	7.8	2.3
25–34	5.0	7.9	15.7	14.1	7.8
35–49	19.5	23.3	30.1	31.4	24.8
50–64	38.2	31.2	29.1	29.0	42.4
≥65	35.5	32.8	19.4	17.6	22.6
Individual level socioeconomic characteristics					
Household income ($)					
≤24,999	11.5	12.6	13.3	14.1	14.5
25,000–49,999	24.0	16.6	23.2	25.1	22.1
50,000–74,999	23.6	24.5	23.6	23.3	23.7
≥75,000	40.9	46.2	39.9	37.5	39.7
Employment status					
Employed	48.9	53.0	65.8	57.3	56.0
Others	51.1	47.0	34.2	42.7	44.0
Education at an individual level					
Less than high school	2.8	1.6	8.7	6.2	1.8
High school graduate	24.0	23.3	37.0	45.4	18.3
Some college	33.8	30.0	34.2	27.2	32.4
College or higher	39.3	45.1	20.0	21.2	47.5
Neighborhood level socioeconomic characteristics					
Average percentage of college degree or higher	26.6 (8.9)	29.0 (10.0)	21.3 (7.1)	22.2 (8.6)	25.2 (8.6)
Average percentage of family in poverty	7.8 (4.1)	7.0 (4.0)	8.6 (4.6)	10.0 (5.7)	8.9 (5.5)
Self-rated general health					
Good/fair/poor	58.1	58.1	58.6	62.1	38.4
Very good/excellent	41.9	41.9	41.4	37.9	61.6
All persons (no.)	1099	253	664	841	2205

Note: $N = 5062$; percentages are reported; except for rounding error, percentages sum to 100.0%; for neighborhood level socioeconomic characteristics, means are reported. Standard deviations are in parentheses.

Results

Geographical distributions of education and self-rated general health in the State of Hawaii

The first column in Fig. 1 exhibits the geographical distribution of percentages of college degree or higher, and the second column displays the geographical distribution of percentages of very good to excellent self-rated health by zip-code. Comparing the four pairs of figures, it can be seen that areas in darker colors (i.e., higher educational level) in the first column match well with areas in darker colors (i.e., higher self-rated health) in the second column.

To focus on the maps of Oahu, the educational distribution is found to be generally consistent with the health distribution. For instance, Nui Valley, Aina Haina, Hawaii Kai, and Kailua are areas on Oahu where the percentage of college degree or higher is at the highest level (35.7–47.5) and the percentage of very good to excellent health is also at the higher levels. The Waianae Coast shows the lowest percentage of college degree or higher (3.9–10.9) and has the second to lowest level of percentage of very good to excellent health (20.1–41.9).

However, there are several exceptions; for example, these four different communities: Hauula to Kaaawa, Ewa Beach, Koolina, and Waipahu/Mililani all have the same level of education (18.0–25.6)

Table 2
Self-rated very good to excellent health[b] on demographics and ethnicity (Model 1), neighborhood level socioeconomic characteristics (Model 2), household income and employment status (Model 3), and individual level education (Model 4): 2007 Hawaii Health survey.

	Model 1	Model 2	Model 3	Model 4
	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Demographic characteristics				
Gender (male[a])				
Female	1.03 [0.92, 1.16]	1.03 [0.91, 1.16]	1.09 [0.97, 1.23]	1.11 [0.98, 1.26]†
Age (yr)(18–24[a])				
25–34	0.80 [0.56, 1.13]	0.79 [0.56, 1.13]	0.71 [0.50, 1.02]†	0.62 [0.43, 0.89]**
35–49	0.70 [0.51, 0.96]*	0.69 [0.50, 0.95]*	0.60 [0.43, 0.83]**	0.52 [0.38, 0.73]***
50–64	0.53 [0.39, 0.73]***	0.52 [0.38, 0.72]***	0.50 [0.36, 0.69]***	0.43 [0.31, 0.59]***
≥65	0.37 [0.27, 0.52]***	0.37 [0.26, 0.50]***	0.47 [0.34, 0.65]***	0.41 [0.30, 0.58]***
Ethnicity (Hawaiian[a])				
Japanese	1.41 [1.16, 1.70]***	1.32 [1.09, 1.60]**	1.29 [1.06, 1.57]**	1.15 [0.94, 1.40]
Chinese	1.34 [1.00, 1.79]*	1.21 [0.90, 1.62]	1.17 [0.87, 1.58]	1.02 [0.75, 1.38]
Filipino	1.18 [0.96, 1.46]	1.19 [0.97, 1.48]	1.15 [0.93, 1.43]	1.16 [0.94, 1.45]
Caucasian	2.95 [2.49, 3.49]***	2.83 [2.39, 3.36]***	2.90 [2.44, 3.44]***	2.48 [2.08, 2.96]***
Neighborhood level socioeconomic characteristics				
Percentage of college degree or higher		1.02 [1.01, 1.02]***	1.01 [1.00, 1.02]**	1.01 [1.00, 1.02]†
Percentage of family in poverty		0.99 [0.98, 1.01]	1.01 [0.99, 1.02]	1.01 [0.99, 1.02]
Individual level socioeconomic characteristics				
Household income (≥$75,000[a])				
≤$24,999			0.45 [0.37, 0.55]***	0.52 [0.43, 0.64]***
$25,000–$49,999			0.64 [0.54, 0.74]***	0.69 [0.59, 0.81]***
$50,000–$74,999			0.80 [0.69, 0.93]**	0.83 [0.71, 0.97]*
Employment status (others[a])				
Employed			1.45 [1.26, 1.66]***	1.38 [1.19, 1.59]***
Education (college or higher[a])				
Less than high school				0.30 [0.20, 0.44]***
High school graduate				0.56 [0.48, 0.65]***
Some college				0.72 [0.62, 0.83]***
χ^2/df	312.81/9	333.49/11	456.96/15	535.98/18
Pseudo R^2	0.08	0.09	0.12	0.13
$\Delta\chi^2/\Delta$df	–	20.68/2	123.47/4	79.02/3
p: $\Delta\chi^2 = 0$	–	***	***	***

Note: $N = 5062$; $^{\dagger}p < 0.1$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$; OR = odds ratio; CI = confidence interval.
[a] Reference group.
[b] Reference group for self-rated very good to excellent health (good/fair/poor).

but each area has slightly different levels of health in a descending order: Hauula to Kaaawa has the highest level (63.5–100.0), then Ewa Beach (52.1–63.4), Koolina (42.0–52.0), and Waipahu/Mililani have the second to lowest level (20.1–41.9).

In summary, the mapping of higher education (college degree or higher) and health status (very good to excellent) revealed the clusters of education and health by islands/zip-codes, but does not perfectly confirm the convergence of the two. For some places, the concentrations of more educated respondents appear to vary slightly in their health status across geographical locations, whereas for other places such as Kauai, there are large geographic areas with low levels of college education but fairly high levels of self-rated health.

Distribution of sociodemographics and self-rated general health by ethnicity

Table 1 shows noticeable diversity in demographics, SES, and self-rated general health among five major ethnic groups in Hawaii. In general, there are more females than males in our sample and this is especially true for Hawaiians and Filipinos. Japanese and Chinese are older, whereas Filipinos and Hawaiians are relatively younger in our sample. Among five ethnic groups, Chinese reported the highest proportion (46.2%) of annual household income as $75,000 or higher, whereas Caucasians reported the highest proportion of education as a college degree or higher (47.5%). For employment status, Filipinos were most likely to be employed (65.8%), followed by Hawaiians (57.3%). At the neighborhood level, the average percentage of college degree or higher is found to be the highest among Chinese (29.0%), followed by Japanese (26.6%) and Caucasians (25.2%). In terms of self-rated general health, approximately 62% of Caucasians reported very good to excellent health. In contrast, less than 38% of Hawaiians reported very good to excellent health. Japanese, Chinese, and Filipinos are similar in the percentages of very good to excellent health, ranging from 41.4% for Filipinos to 41.9% for Chinese and Japanese.

Education and self-rated general health: between ethnic variations

According to Model 1 of Table 2, there are significant differences in self-rated general health by ethnicity, after adjusting for gender and age. Compared to Hawaiians, Japanese (odds ratio [OR] = 1.41, $p < 0.001$), Chinese (OR = 1.34, $p < 0.05$), and Caucasians (OR = 2.95, $p < 0.001$) reported significantly higher odds of very good to excellent health. As expected, there was a monotonic decrease in the odds ratios for self-rated general health (OR = 0.80, OR = 0.70, OR = 0.53, OR = 0.37) as age of the respondents increased from 25–34, 35–49, 50–64, to 65 years or older, respectively.

Model 2 of Table 2 shows the effect of neighborhood SES on self-rated general health adjusting for individual background demographics and ethnicity. The logistic regression coefficient for

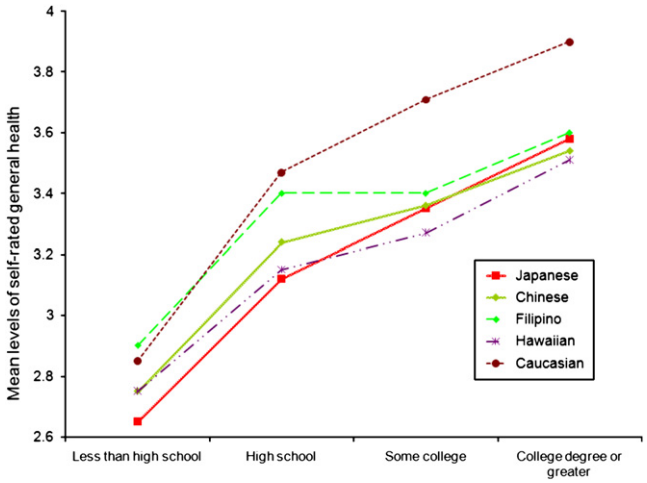

Fig. 2. Mean levels of self-rated general health by levels of individual educational attainment.

education is 0.02 (logistic regression coefficient = $\log_e$(odds ratio) = $\log_e$(1.02) ≈ 0.02), which is significant at the $p < 0.001$ level. That is, in neighborhoods with more college graduate adults, individuals report better self-rated general health. The logistic regression coefficients associated with Japanese and Chinese are reduced from 0.34 ($\log_e$(odds ratio) = $\log_e$(1.41) ≈ 0.34) and 0.29 ($\log_e$(odds ratio) = $\log_e$(1.34) ≈ 0.29) to 0.28 ($\log_e$(odds ratio) = $\log_e$(1.32) ≈ 0.28) and 0.19 ($\log_e$(odds ratio) = $\log_e$(1.21) ≈ 0.19), respectively, suggesting that approximately 18% ((0.34 − 0.28)/0.34 ≈ 0.18) of the Japanese vs. Hawaiian and 34% ((0.29 − 0.19)/0.29 ≈ 0.34) of the Chinese vs. Hawaiian health disparities are due to education at the neighborhood level. Another indicator of neighborhood SES – poverty is not significant.

When a series of household income dummy variables and employment status were added in Model 3, the Chinese vs. Hawaiian and Japanese vs. Hawaiian differences in self-rated health reduced only a small amount. The Caucasian vs. Hawaiian health difference remained substantial and significant at the 0.001 level. The results also showed that compared with others, the employed were significantly more likely to report their health was very good to excellent (OR = 1.45, $p < 0.001$).

After individual level education was incorporated in Model 4, the logistic regression coefficients of Japanese and Chinese on self-rated general health were reduced substantially once again, indicating that the Chinese vs. Hawaiian and Japanese vs. Hawaiian differences in health were greatly mediated by their differences in education at an individual level. However, the Caucasian vs. Hawaiian health difference remained significant and substantial despite a noticeable decrease in the effect associated with Caucasian (OR = 2.48, $p < 0.001$).

In the last Model, with all personal SES included, the logistic regression coefficient associated with neighborhood level of education reduced to 0.01 ($\log_e$(odds ratio) = $\log_e$(1.01) ≈ 0.01), yet it is still significant at the 0.1 level ($p = 0.08$). These findings suggest that about 50% ((0.02 − 0.01)/0.02 = 0.50) of the effect of neighborhood level education is due to individual SES characteristics of the residents who live there. However, despite this 50% compositional effect, our results suggest that the neighborhood level of education still has a certain amount of independent effect on individual health, which is likely to be over and above respondents' own socioeconomic characteristics.

Education and self-rated general health: within ethnic variations

To examine the preliminary patterns of within ethnic variations, Fig. 2 was constructed to display how the crude means of self-rated

Table 3
Self-rated very good to excellent health[b] on neighborhood and individual levels of education by ethnicity: 2007 Hawaii Health survey.

	Japanese/Chinese	Filipino	Hawaiian	Caucasian
	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Demographic characteristics				
Gender (male[a])				
Female	1.10 [0.87, 1.40]	0.85 [0.60, 1.20]	0.84 [0.61, 1.14]	1.33 [1.10, 1.60]**
Age (yr)(18–24[a])				
25–34	0.95 [0.40, 2.25]	0.86 [0.39, 1.90]	0.40 [0.21, 0.76]**	0.74 [0.37, 1.46]
35–49	0.56 [0.26, 1.21]	0.55 [0.26, 1.17]	0.39 [0.22, 0.70]***	0.77 [0.41, 1.46]
50–64	0.46 [0.22, 0.97]*	0.45 [0.22, 0.96]*	0.28 [0.15, 0.50]***	0.63 [0.34, 1.18]
≥65	0.51 [0.24, 1.08]†	0.53 [0.24, 1.16]	0.37 [0.20, 0.71]**	0.51 [0.27, 0.97]*
Neighborhood level socioeconomic characteristics				
Percentage of college degree or higher	1.01 [0.99, 1.02]	1.02 [0.99, 1.05]	1.01 [0.99, 1.04]	1.00 [0.99, 1.02]
Percentage of family in poverty	0.98 [0.95, 1.02]	1.03 [0.98, 1.07]	1.00 [0.96, 1.03]	1.01 [0.99, 1.04]
Individual level socioeconomic characteristics				
Household income (≥$75,000[a])				
≤$24,999	0.69 [0.46, 1.05]†	0.73 [0.41, 1.29]	0.66 [0.40, 1.09]	0.38 [0.29, 0.51]***
$25,000–$49,999	0.72 [0.53, 0.98]*	0.72 [0.46, 1.11]	0.61 [0.42, 0.89]*	0.69 [0.54, 0.88]**
$50,000–$74,999	0.81 [0.61, 1.09]	1.02 [0.68, 1.54]	0.71 [0.48, 1.03]†	0.82 [0.65, 1.04]
Employment status (others[a])				
Employed	1.23 [0.91, 1.65]	2.00 [1.29, 3.08]**	1.33 [0.94, 1.88]	1.38 [1.12, 1.70]**
Education (college or higher[a])				
Less than high school	0.16 [0.06, 0.47]***	0.36 [0.17, 0.76]**	0.47 [0.22, 0.97]*	0.19 [0.09, 0.40]***
High school graduate	0.47 [0.35, 0.65]***	0.62 [0.39, 0.98]*	0.57 [0.39, 0.84]**	0.52 [0.41, 0.67]***
Some college	0.74 [0.57, 0.96]*	0.55 [0.35, 0.87]**	0.71 [0.47, 1.08]	0.72 [0.59, 0.89]**
All persons (no.)	1352	664	841	2205

Note: $N = 5062$; †$p < 0.1$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; OR = odds ratio; CI = confidence interval.
[a] Reference group.
[b] Reference group for self-rated very good to excellent health (good/fair/poor).

health has changed as levels of education increase for the five major ethnic groups. With the exception of Filipinos, Fig. 2 suggests no significant deviation from linearity in the association between education and mean levels of self-rated health for Caucasians, Japanese, Chinese, and Hawaiians. At every level of education, Caucasians displayed much higher mean levels self-rated health compared to others. And the health gains of education are the most salient for Caucasians, followed by three Asian American groups whose educational gaps in health became narrower at higher levels of education. The Hawaiians reported the lowest mean level of self-rated general health, however, at "some college" or higher level of education, the health gap between Hawaiians and Asian Americans decreases.

Following Fig. 2, the relative importance of education to different ethnic groups is then examined by stratifying the total sample into four sub-groups. Given the small sample size of Chinese and the similarities of Japanese and Chinese on many sociodemographic characteristics, the Japanese and Chinese respondents are combined and relabeled Japanese/Chinese in the analysis. Only the results of the full models with all sociodemographs are reported (See Table 3). According to Table 3, although the percentage of college graduate adults (the neighborhood level of education) is associated with slightly better self-rated health for Japanese/Chinese, Filipinos, and Hawaiians, the association is not statistically significant. However, individual educational attainment is significant for all the ethnic groups that were examined. The health benefits of college or higher education, compared to lower levels of education, are more significant and substantial for Caucasians and Japanese/Chinese than for Filipinos and Hawaiians. Collectively, our results fully support hypothesis 1–2 and partially support hypothesis 3.

Discussion

Using the 2007 Hawaii Health survey with linked zip-code area information, and focusing on Asian Americans, Hawaiians, and Caucasians, this study examines the geographical distributions of education and self-rated health in the State of Hawaii. It also examines how individual self-rated general health depends on ethnicity and education at both individual and neighborhood levels. Major findings of this study include: (1) there are significant between ethnic differences in self-rated health in Hawaii, with Hawaiians being the most disadvantaged population compared to Japanese, Chinese, and Caucasians; (2) individual socioeconomic characteristics are all related to self-rated general health, and education (in particular) mediates the Japanese vs. Hawaiian and Chinese vs. Hawaiian health differences; (3) the neighborhood level of education has an independent effect on self-rated health over and above individual characteristics for the whole sample and it partially mediates the between ethnic health differences; and (4) the relative importance of education to self-rated health is more significant and salient for Caucasians and Japanese/Chinese than for Filipinos and Hawaiians.

First of all, GIS was applied in this study to present two columns of maps visualizing the geographical distributions of education and self-rated health in the State of Hawaii across Kauai, Oahu, Molokai, Lanai, Maui, and Hawaii. The neighborhood level of education is found to be generally consistent with health distribution with several noticeable deviations. Identifying these deviations has substantial policy implications and practical significance. For instance, Kauai, a more rural area compared to parts of Oahu, appears to have large areas with low levels of education yet high levels of self-rated health. This paradox finding suggests that some contextual factors of communities other than their SES might play significant roles in promoting the health of their residents. For instance, one possible characteristic that distinguishes Kauai from other islands is its collective identify and social cohesion, embedded in the history of the island. In their book, Werner and Smith (2001, p. 16) mentioned that, "The ancient Hawaiians named it Kauai-a-manoka-lani-po, 'the fountainhead of many waters from on high and bubbling up from below' as the oldest of the Hawaiian Islands and the last of the independent Hawaiian kingdoms, its history and legends reflect a certain maverick quality and independence of spirit that have come to characterize its people." Another important index of this is the Island's collective strength in defying and repelling invaders including the efforts of King Kamehameha the 1st to conquer the island and place it under his rule. Over time, this collective spirit has persisted with a sense of pride and self-affirmation. In sum, this finding places the linkage between the sense of place or collectivism and the health of residents in the community.

In addition, while a substantial proportion of Japanese vs. Hawaiian and Chinese vs. Hawaiian health disparities are explained by college educated adults in the neighborhood and individual SES, the Caucasian vs. Hawaiian health disparity remains substantial and significant despite the inclusion of controls and mediators. In the Appendix, we had Caucasians as the reference group and compared their health with others. Findings indicate that the health advantages of Caucasians over any other ethnic groups are substantial and persistent. The universal and unexplained health advantages of Caucasians could be largely due to factors that are not included in our models. Education indicates human capital. In a broad sense, the human capital component of education encompasses social-psychological resources (i.e., sense of control and social support) and health behaviors (Mirowsky & Ross, 2003; Ross & Wu, 1995), which may collectively and independently explain a greater proportion of the total effect of education than the

Table 4
Effect of neighborhood and individual level of education on alternative dependent variables adjusting for all the sociodemographic controls: 2007 Hawaii Health survey.

	Alternative dependent variables			
	OLS Regression	Logistic regressions OR [95% CI]		
	General health	Excellent health	Very good health	Good health
Neighborhood level of education	0.032†	1.01 [1.00, 1.02]*	1.01 [1.00, 1.02]†	1.00 [0.99, 1.01]
Individual level of education				
Education (college or higher[a])				
Less than high school	−0.11***	0.43 [0.25, 0.74]**	0.30 [0.20, 0.44]***	0.32 [0.22, 0.46]***
High school graduate	−0.13***	0.62 [0.51, 0.76]***	0.56 [0.48, 0.65]***	0.54 [0.43, 0.68]***
Some college	−0.08***	0.76 [0.64, 0.90]***	0.72 [0.62, 0.83]***	0.68 [0.54, 0.84]***

Notes: $N = 5062$; $^{\dagger}p < 0.1$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$; OR = odds ratio; CI = confidence interval.

[a] Reference group. For OLS regression, standardized coefficients are reported; to save space, only parts of full models are shown. "General health" is a continuous variable (1–5) with higher value indicating better health; "excellent health" is a dichotomous variable to contrast excellent health (1) to others (0); "very good health" is a dichotomous variable to contrast very good and excellent health to others; "good health" is a dichotomous variable to contrast good, very good, and excellent health to others.

translation of schooling into economic returns. Accordingly, our findings may suggest that while the Asian vs. Hawaiian health differences may be primarily due to the direct physiological effect of education and its translation into economic returns, the Caucasian vs. Hawaiian and Asian Americans health differences may be largely due to the indirect effect of education such as socio-psychological resources and health behaviors that are not considered in our models.

Moreover, the aggregate level of education (as indicated by the percentage of college graduate adults in the neighborhood) is found to be significant at the 0.1 level with adjustment for individual characteristics. This finding suggests the independent effect of collective human capital and its effect on individual health, is over and above personal SES. The presence of more educated people in the community may lead to the possible "spillover" benefits generated by the actions of those with high educational attainment. For instance, well-educated neighbors may effectively mobilize their resources to make their community a better one, which affects individual health by providing a safe, convenient, and friendly micro-environment. The Chinese–Hawaiian health differences are also largely explained by the neighborhood level of education.

Furthermore, individual educational attainment is found to be differently related to self-rated health in different ethnic groups with the health benefits of education being the most salient for Japanese and Caucasians (in particular). For most ethnic groups, high school graduation is a cutting-off point, before which the health gains are substantial, and after which the health gains increase less significantly and follow an approximate linear pattern. However, there is a noticeable advantage in health for college education among Filipinos and Hawaiians. This finding suggests the possible ethnic disparities in return to educational attainment between Caucasians and Hawaiians or Filipinos, which can be explored in future studies.

Like Goesling (2007), the robustness of the results was checked applying alternative coding strategies for the dependent variables (See Table 4). Results were found to be quite similar with one exception. The effect of neighborhood level of education is significant in the full model for the first three coding strategies (self-rated health as a continuous variable; excellent health vs. others; very good to excellent health vs. others), but insignificant for the fourth coding strategy (good to excellent health vs. others). This may indicate that the effect of neighborhood level of education may be beneficial only for those who have good or better health.

The results of this investigation are interesting however, much remains to be explored. First, the possible variations in self-rated health data among respondents of different ethnicity and immigration status need to be addressed in future studies. Are the health disparities reflecting the real ethnic differentials or cultural differences in health expectation or both? Are there significant differences in self-reporting by immigration status? One study by Chen, Lee, and Stevenson (1995) found that Chinese and Japanese students were more likely to select midpoints on general scales compared to their U.S. and Canadian counterparts due to their emphasis on self-criticism in collectivism cultures. Accordingly, it can be reasonably argued that Asian Americans, especially those recent immigrants, are less likely to endorse the extreme categories of the self-rated health scale compared to Caucasians. In terms of variation by immigration status, there is fair amount of work showing that self-rated health measures by non-English speaking, immigrant Latinos are systematically lower than those of more acculturated Latinos (Finch & Vega, 2003; Franzini & Fernandez-Esquer, 2004). Another study by Finch, Hummer, Reindl, and Vega (2002) found that self-rated health is a relatively stronger predictor of mortality among long-term immigrants and native-born Hispanic respondents than among recent Hispanic immigrants, which suggests that the interpretation of a given level of health may differ by one's nativity and length of residence. However, one recent study (Erosheva, Walton, & Takeuchi, 2007) does not find significant differences between foreign- and U.S.-born Asian Americans in reporting self-rated physical and mental health on the 5-category scales from "excellent" to "poor." Regardless of these inconsistent findings, information on respondents' immigration status such as nativity, length of residence in the U.S., and English proficiency should be included in future surveys to explicitly examine the cultural variation in self-rated health.

As with all cross-sectional research, this study is limited in its efforts to establish causal direction. There is evidence in recent literature suggesting the changing patterns of educational differences in health among the general population in the U.S. over several decades (Goesling, 2007; Liu & Hummer, 2008; Martin, Schoeni, Freedman, & Andreski, 2007). Whether the significance of education is rising or declining over time in Hawaii, a place very different from the rest of the U.S., deserves further exploration in the future by using the pooled repeated cross-sectional data and longitudinal data.

In addition, individual socio-psychological factors, believed to be important mediators linking education and health, need to be included in future surveys to further disentangle the total effect of education on health by ethnicity. Besides individual level mediators, the concept of "collective human capital" and "collective watch" proposed by Ross and Mirowsky (2008) and the concept of "collective efficacy" developed by Sampson, Raudenbush, and Earls (1997) needs to be operationalized and adjusted to the indigenous collectivism cultures in Hawaii such that the mechanisms linking neighborhood levels of education and individual health can be studied empirically.

Due to another limitation of the data, the analysis did not consider finer scale census tracts, which are the commonly used local geographic areas with visible boundaries and residents sharing similar socioeconomic characteristics (e.g., Rehkopf et al., 2006; Ross & Mirowsky, 2008). Smaller geographical units with larger inter-neighborhood SES variation as opposed to intra-neighborhood variation, allow for a large range of comparisons and may lead to a more significant and substantial effect of the contextual characteristics. However, although zip-code areas are not optimal approximations of neighborhoods, previous studies suggest that the correlation between SES measures at the zip-code level and SES measures at the census-tract area, tend to be moderate to high and differences between zip-code and census-tract level measures of SES in terms of their effects on individual health, tend to be small (Geronimus & Bound, 1998).

Regardless of these and other limitations, this study contributes to the literature on education and health in at least three ways. First, using multilevel data, this study simultaneously considered the effect of individual educational attainment as well as neighborhood levels of education on individual health. Second, it described and explained between, as well as within, ethnic differences in self-rated health. Third, this study also demonstrates the geographical distribution of self-rated health in relation to the geographical distribution of collective education.

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Appendix

Full model using Caucasian as reference group[b]: 2007 Hawaii Health survey.

	Model 4
	OR [95% CI]
Demographic characteristics	
Gender (male[a])	
Female	1.11 [0.98, 1.26]†
Age (yr)(18–24[a])	
25–34	0.62 [0.43, 0.89]**
35–49	0.52 [0.38, 0.73]***
50–64	0.43 [0.31, 0.59]***
≥65	0.41 [0.30, 0.58]***
Ethnicity (Caucasian[a])	
Japanese	0.46 [0.40, 0.54]***
Chinese	0.41 [0.31, 0.54]***
Filipino	0.47 [0.39, 0.57]***
Hawaiian	0.40 [0.34, 0.48]***
Neighborhood level socioeconomic characteristics	
Percentage of college degree or higher	1.01 [1.00, 1.02]†
Percentage of family in poverty	1.01 [0.99, 1.02]
Individual level socioeconomic characteristics	
Household income (≥$75,000[a])	
≤$24,999	0.52 [0.43, 0.64]***
$25,000–$49,999	0.69 [0.59, 0.81]***
$50,000–$74,999	0.83 [0.71, 0.97]*
Employment status (others[a])	
Employed	1.38 [1.19, 1.59]***
Education (college or higher[a])	
Less than high school	0.30 [0.20, 0.44]***
High school graduate	0.56 [0.48, 0.65]***
Some college	0.72 [0.62, 0.83]***

Note: $N = 5062$; †$p < 0.1$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; OR = odds ratio; CI = confidence interval.

[a] Reference group.

[b] Reference group for self-rated very good to excellent health (good/fair/poor).

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