



Predictors of mental and physical health: Individual and neighborhood levels of education, social well-being, and ethnicity

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ABSTRACT

This study examines how education benefits health through social well-being in Hawaii where the centrality of community life is underscored. The 2007 Hawaii Health Survey with linked zip-code information was used to investigate the effects of education at both individual and neighborhood levels using mixed-effects models. Geographic Information System was applied to map the geographical distributions of education, social well-being, and health. It was found that individual-level education benefits mental health and its effects are largely mediated by respondents' employment status and their social well-being (social integration, social contribution, social actualization, and social coherence). Both individual and neighborhood-level education promotes physical health and their effects are partially mediated by economic well-being and two indicators of social well-being (social integration and social coherence). Results of this study suggest the independent effects of two levels of education on physical health and the importance of education and social well-being to both mental and physical health in the State of Hawaii.

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1. Introduction

Socioeconomic status (SES) has now been increasingly acknowledged as the “fundamental cause” of disease and mortality because higher SES will lead to a wide range of material and social resources that help to avoid health risks and minimize the consequences of health problems (Link and Phelan, 1995; Phelan et al., 2004). For instance, SES may influence risk factors such as health behaviors, access to health care and psychosocial stress (e.g., Adler et al., 1994; Haan et al., 1987). Among indicators of SES, education forms a unique dimension. It precedes occupation, earning, and wealth, and contributes to a variety of merits such as developing individuals' abilities to accumulate human capitals and psychosocial resources, making it a particularly important determinant of health (e.g., Adler and Newman, 2002; Mirowsky and Ross, 2003, 2005; Phelan and Link, 2005).

While the positive associations between individual-level educational attainment and health have been well documented in the literature (e.g., Feldman et al., 1989; Freedman and Martin, 1999; Lauderdale, 2001), few studies have examined its collective parallel—neighborhood-level education simultaneously to understand their relative importance to individual health. In recent years,

a growing body of the literature have suggested the significant effects of neighborhood characteristics on health outcomes (e.g., Bernard et al., 2007; Hill et al., 2005; Kim, 2010; Mair et al., 2010), yet only a paucity of studies have explored the underlying mechanisms through which particular attributes of neighborhoods affect health (Jackson et al., 2009) and, to the best knowledge of the authors, none of them have involved neighborhood-level education explicitly.

In this study, we propose social well-being as one of the key mediators linking both individual and neighborhood-level education with health. Social well-being or social wellness is defined as the self-perception of “one's circumstance and functioning in society” (Keyes, 1998, p. 122). It is a multi-dimensional concept, including aspects such as social integration, social acceptance, social contribution, social actualization, and social coherence. Social well-being might be an important mediator for the education–health relationship because higher education, at both individual and collective levels, may facilitate an individuals' ability to develop positive perceptions of society, community, family, and interpersonal relationships, and thus affect their health. This might be particularly true in Hawaii, a place having the highest concentration of multi-ethnic individuals and families and underscoring the centrality of community life to the well-being of its people. In the reminder of the text, we begin by summarizing theoretical arguments linking education, social well-being, and health. Relevant hypotheses concerning the relationships between

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education (at both individual and neighborhood levels) in relation to social well-being and health are then proposed and tested. In conclusion, important findings are reviewed and discussed for future research.

2. Theoretical background

2.1. Social well-being

The original idea of social well-being can be traced back to Durkheim (1951). In his work, *Suicide* (1951), Durkheim presented how the most intimate individual acts like suicide could be influenced by social dynamics such as the level of social integration of the group. Recently, some researchers (Larson, 1992, 1996; Keyes, 1998; Keyes and Shapiro, 2004) distinguished between individuals' private versus public life and began to portray well-being as a social phenomenon, emphasizing the fact that individuals are social being and their lives are embedded in and shaped by social structures. Gradually, these concepts and ideas were developed into a much broader multifaceted term—social well-being in contrast to the commonly used well-being in the clinical and psychological traditions that portray well-being as something private.

In his seminal paper, Keyes (1998) proposed the following five dimensions for constructing social well-being measures. The first dimension is social integration, which reflects the quality of one's relationship to his/her society and community. Individuals who are socially integrated feel that they are part of society and occupy social positions that help them cultivate a genuine sense of belonging and attachment. The second dimension is social contribution, which is similar to but above the concept of individual self-efficacy (Bandura, 1986; Gecas, 1989). It refers to an individual's belief that he/she can perform a specific action or accomplish certain goals that are valuable to society. The third dimension is social actualization or one's evaluation of "the potential and the trajectory of society" (Keyes, 1998, p. 123). It is the belief that

society has the potential to become a better place for citizens to live and that the collective has the potential for positive changes. This concept is in contrast to ideas such as powerlessness (Seeman, 1991) and fatalism (Lefcourt, 1982). The fourth dimension is social coherence, which involves one's ability to make sense of a complex world and to understand and predict what is happening around them. Healthy people tend to think and evaluate things rationally and consistently. Social coherence is parallel to sense of personal coherence (Antonovsky, 1994) and sense of meaning (Mirowsky and Ross, 1989; Seeman, 1959) in the private domain. The final dimension is social acceptance, which is a social analogue of self acceptance (Ryff, 1989), meaning a positive view of human nature in general and a feeling of being comfortable with others. All these five aspects of positive psychological functioning and pro-social attitudes or behaviors could be related to or shaped by education and relevant to individual health and well-being as discussed in the following sections.

2.2. Individual-level education, social well-being, and health

Differences in educational attainment are the root cause of health disparity because education indicates human capital (Mirowsky and Ross, 1998, 2003; Ross and Zhang, 2008). Human capital refers to cognitive skills, habits, and abilities that can be used to control and direct one's life. Based on the human capital theory, education can directly and indirectly improve health by triggering and increasing effective functioning within individuals, which helps to develop various psychosocial resources, health habits, and other abilities that are essential for individuals to achieve a better life. Social well-being could be considered as one of such psychosocial resources and abilities that are related to education as well as individual health. Better educated people tend to think logically, rationally, and consistently, see many sides of an issue, thus view individual well-being to be contingent upon the development of society as a whole. Accordingly, they may value more social solidarity, social responsibility, social development, and social coherence, which in turn, may enhance other individual

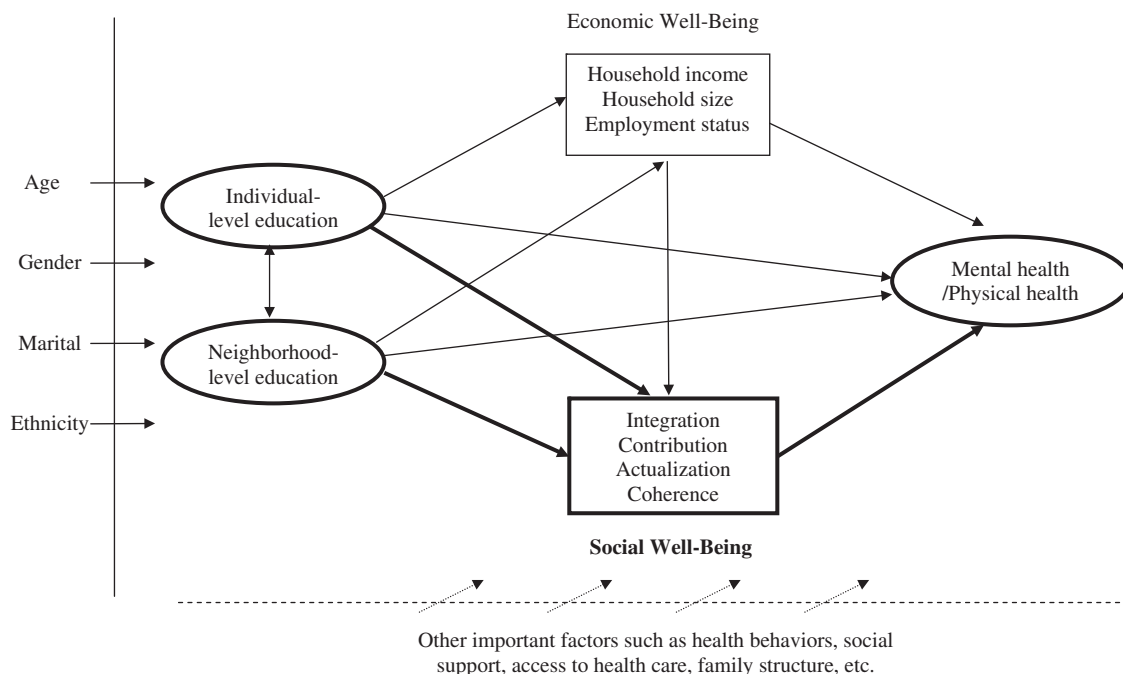


Fig. 1. Conceptual model of proposed relationships among the two levels of education, mediators, and health: key relationships among education, social well-being, and mental/physical health are in bold lines, control variables are next to the solid line, and other important health determinants that are not the focus of this study are underneath the dashed line.

psychological resources and benefit their overall health and well-being. Therefore, one of the aims of this study is to extend prior research by introducing the social domain of well-being that might potentially underlie the relationship between individual-level education and health (Fig. 1).

2.3. Neighborhood-level education, social well-being, and health

While individual-level education suggests human capital, its aggregate parallel—neighborhood-level education may indicate “collective human capital” (Ross and Mirowsky, 2008) and “collective efficiency” (Sampson et al., 1997). For example, if the majority of residents in the neighborhood have higher education, they can successfully communicate with each other, work together to make the best use of information, and mobilize resources to enhance both natural and human environment of the communities. These collective efforts may develop resources and wealth to maintain the value, order, and safety of the communities, therefore, benefiting residents’ health more than the sum of their individual characteristics. Regardless of the theoretical importance of neighborhood-level education, very few studies have explicitly examined its role on health empirically. Using the 2007–2008 Hawaii Health Survey, Zhang et al. (2010) found that neighborhood-level education has independent effects on self-rated health and it partially mediates the between ethnic health disparities. An ecological analysis of 59 neighborhoods in New York City examined the relationship between the distribution of education and health indicators such as homicide rate, infant mortality rate, and cardiovascular disease mortality rate (Galea and Ahern, 2005). Their findings suggested that the presence of highly educated people may be beneficial for all residents, independent of the harmful effects of income maldistribution.

Accordingly, another aim of this study is to examine the extent to which social well-being explains associations of neighborhood-level education with health (Fig. 1). According to Coleman (1988, 1990), the continuity of community structure is essential to the emergence of social capital. A neighborhood with higher concentration of well-educated individuals may suggest a lower rate of residential turnover, which may enforce institutional construction and social networks formation. These healthy traits in the community may help residents develop a strong sense of belonging and make them be willing to contribute their fair parts to the common good. In this sense, neighborhood-level education may benefit individual health through pathways of social well-being such as social integration and social contribution. To summarize, the following hypotheses will be tested.

Hypothesis 1. After controlling for individual characteristics, neighborhood-level education is associated with individual-level health independently of individual-level SES.

Hypothesis 2. Both individual and neighborhood-level education have positive effects on individual health, and their effects tend to be partially mediated by aspects of economic and social well-being.

3. Methods

3.1. Data

In order to test the above hypotheses, the Hawaii Health Survey (HHS) was used. The HHS 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 mental and physical health of residents in Hawaii to provide data to monitor their health status over time, to plan for the availability of health services in the

State, and to evaluate health programs. 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 Niihau, and homeless persons are not represented. Given the disproportionate nature of the sampling design, the 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.

In this study, we used the 2007 version of HHS, which contains a variety of indicators of social well-being. The study population is primarily Hawaiians, Caucasians, and Asian Americans including Japanese, Chinese, and Filipinos. Consistent with prior research (Zhang et al., 2010), respondents’ neighborhood-level data on education (acquired from the 2000 U.S. Census) were linked to the individual-level data (acquired from the 2007 HHS). Without information on respondents’ address, 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. There are a total of 84 zip-code areas in Hawaii with valid neighborhood-level data provided by the 2000 U.S. Census. We applied weighted analysis so that the sample demographics are comparable with those of the population.

3.2. Measurement

3.2.1. Dependent variables

Items from the SF-12 were used to measure mental and physical health. To measure mental health, respondents were asked, “How often do you feel (a) calm and peaceful, (b) downhearted and depressed, (c) energetic, (d) less careful than usual, and (e) accomplished less due to emotional problems?” Response categories for these items were coded such that higher scores reflect better mental health status. The index of mental health is the mean response to these five items, ranging from 1 to 5. Exploratory factor analysis indicated that these items form a single factor and alpha reliability above .72 for all imputations.

To measure physical health, respondents were asked (1) whether or not they had been experiencing limitations in (a) performing moderate activities and (b) in climbing several flights of stairs; (2) how much pain had interfered with their normal work; and (3) how often (a) they had accomplished less than they would like and (b) they had been limited in the kind of work or other activities. Response categories for these items were coded such that higher scores reflect better physical health. The index of physical health is the mean response to these five items, ranging from 1 to 5. Items were adequately explained by a single factor and had loading above .75 and alpha reliability above .83 for all imputations.

3.2.2. Independent variables

Education, the independent variable of major focus, was measured at both individual and neighborhood levels. Individual-level education was coded into a series of dummy variables (less than high school, high school, some college, and college and greater) with college and greater being the reference group. As in some of the previous studies (Ross and Mirowsky, 2008; Zhang et al. 2010), the neighborhood-level education was measured by 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 approximately 3.9–47.5%, with an average value of 26.4%.

3.2.3. Mediating variables

We considered two sets of mediators. Previous studies (e.g., Mirowsky and Ross, 2003; Ross and Wu, 1995) suggest that education may indirectly affect health through economic conditions

such as income and employment status. Hence the first set of mediators in this study are economic well-being including household income ($\leq \$24,999$; $\$25,000$ – $\$49,999$; $\$50,000$ – $\$74,999$; and $\geq \$75,000$) and employment status (*employed*: 0=unemployed, 1=employed). Household size was controlled given that household income may imply different levels of economic well-being with different household sizes. The second set of mediators are social well-being indices that were developed and validated by Keyes (1998). These indices correlate, but do not overlap, with existing measures of psychological and global well-being. Each index consists of several items that were averaged, with response format ranges from 1 (strongly disagree) to 7 (strongly agree). Respondents were asked to respond to each item by evaluating the degree to which the statement represented how they typically feel, think, or behave. Some items have been reversely coded to make positive and negative dimensions consistent such that higher scores indicate higher levels of social well-being.

Social integration is a three item mean index measuring respondents' sense of community. Respondents were presented the following statements: (a) I do not think that I belong to anything that I would call a community; (b) I feel close to other people in my community; and (c) I see my community as a source of comfort. Responses to the first statement were reversely coded. Among 2403 respondents, all items loaded on a single factor above .66 and the alpha reliability is approximately .61 for all imputations. Social contribution is a three item mean index measuring respondents' perception of contribution to the community or society. Respondents were asked to rate the following statements: (a) I have something valuable to give to the world; (b) My daily activities do not produce anything worthwhile for my community; and (c) I have nothing important to contribute to society. Responses to the second and third statements were reversely coded. Exploratory factor analysis suggests that all items loaded on a single factor above .71 and the alpha reliability is approximately .57. Likewise, social actualization is also a three item mean index, which assesses respondents' belief in the growth potential of the society where they reside. The following statements were given to the respondents: (a) the world is becoming a better place for everyone; (b) society has stopped making progress; and (c) society is not improving for people like me. Responses to the last two statements were reversely coded. All three items loaded on a single factor above .62 and alpha reliability is approximately .50. Social coherence is an average response to the following two statements: (a) the world is too complex for me; and (b) I cannot make sense of what's going on in the world. After reversely coding, the alpha reliability is .50. To map the geographical distribution of social well-being, we computed the total well-being score, which is the average response to all the above eleven statements. The alpha reliability for the total well-being is .72. Social acceptance is a three item mean index. Given its lower alpha reliability (.30), this measure is not included in this study.

3.2.4. Control variables

This study controlled for a wide range of demographic factors such as gender (*female*: 0=male, 1=female), age (in years), marital status (0=others, 1=married or cohabitating), and ethnicity (Asian Americans, Hawaiians, Caucasians, and others) with Caucasians being the reference category.

3.3. Analytical strategy

As a tool of exploratory data analysis, Geographical Information System (GIS) technology was used to map the average education, total social well-being, and health (physical and mental) within individual zip-code area and to understand the spatial variability of

education in relation to social well-being and health. Specific regions of Oahu were labeled in the figure so that the results can be easily interpreted.

The missing data analysis suggests that the missingness is not random since the Little's MCAR test is significant at the .001 levels. Therefore, it is not safe to list-wise delete cases with missing values or singly impute missing values. We chose to use multiple imputations to fill in the missing values. There are a total of 23 variables with missing values. The missing values were imputed by constructing either logistic or linear regression models with all other variables as predictors. As multiple imputations will lead to multiple complete samples, pooled results are reported.

To determine the effects of education at the neighborhood-level, the percentage of college degree and higher within each zip-code area was derived from Census 2000 and linked to the survey data. A series of models were estimated to examine the relationship between education, mediators, and health. The first model was estimated to identify the total effect of neighborhood-level education, controlling for the effects of gender, age, marital status, and ethnicity. The second model incorporated individual-level education. The third and fourth models included two sets of mediators: (a) income and employment status, and (b) indices of social well-being to see if and how much they partially mediate the effects of two levels of education on mental or physical health (Tables 2 and 3).

When estimating the effects of neighborhood-level education on individuals' health and social well-being, it is possible that ordinary least squares (OLS) techniques may produce biased standard errors (e.g., Bryk and Raudenbush, 1992; DiPrete and Forristal, 1994; Goldstein, 1995) and create the possibility that a regression residual correlated within aggregates (Ross et al., 2000). To address these problems, we applied mixed-effects modeling. At level 1, the individual-level equation can be summarized as follows: $y_{ij} = \alpha_{0j} + \sum_{k=1}^n \alpha_{kj}x_{kij} + \varepsilon_{ij}$, where y_{ij} stands for the dependent variable for individual i in neighborhood j ; α_{0j} stands for the intercept in neighborhood j ; α_{kj} refers to the slope for variable k in neighborhood j ; and ε_{ij} is the residual for individual i in neighborhood j . At level 2, the neighborhood-level equations can be summarized as follows: $\alpha_{0j} = \alpha_0 + u_{0j}$ and $\alpha_{kj} = \alpha_k + u_{kj}$, $k = 1, 2, \dots, n$, where α_0 and α_k are the fixed effects, whereas u_{0j} and u_{kj} are the random effects.

4. Results

4.1. Geographical distributions of education, social well-being, and health in the state of Hawaii

Fig. 2 summarizes geographical distributions of education in relation to social well-being and health. There are four parallel rows in Fig. 1 and they display the geographical distributions of percentages of college degree or higher, social well-being, mental health and physical health, respectively, by zip-code among surveyed islands in Hawaii. The maps suggest that areas in darker colors (higher educational level) in the first row are found to match quite well with areas in darker colors (higher social well-being) in the second row, which in turn, match even better with darker areas (better mental or physical health) in the last two rows. In particular, focusing on the third and fourth rows of the maps, we see that mental health and physical health are very consistent across islands. This is especially true for islands of Kauai and Hawaii where two health distributions are almost identical.

Taking the island of Oahu as an example, educational distribution is generally consistent with social well-being and health distributions with only a few exceptions. For instance, neighborhoods such as Waialae/Kahala, Nui Valley, AinaHaina, Hawaii Kai,

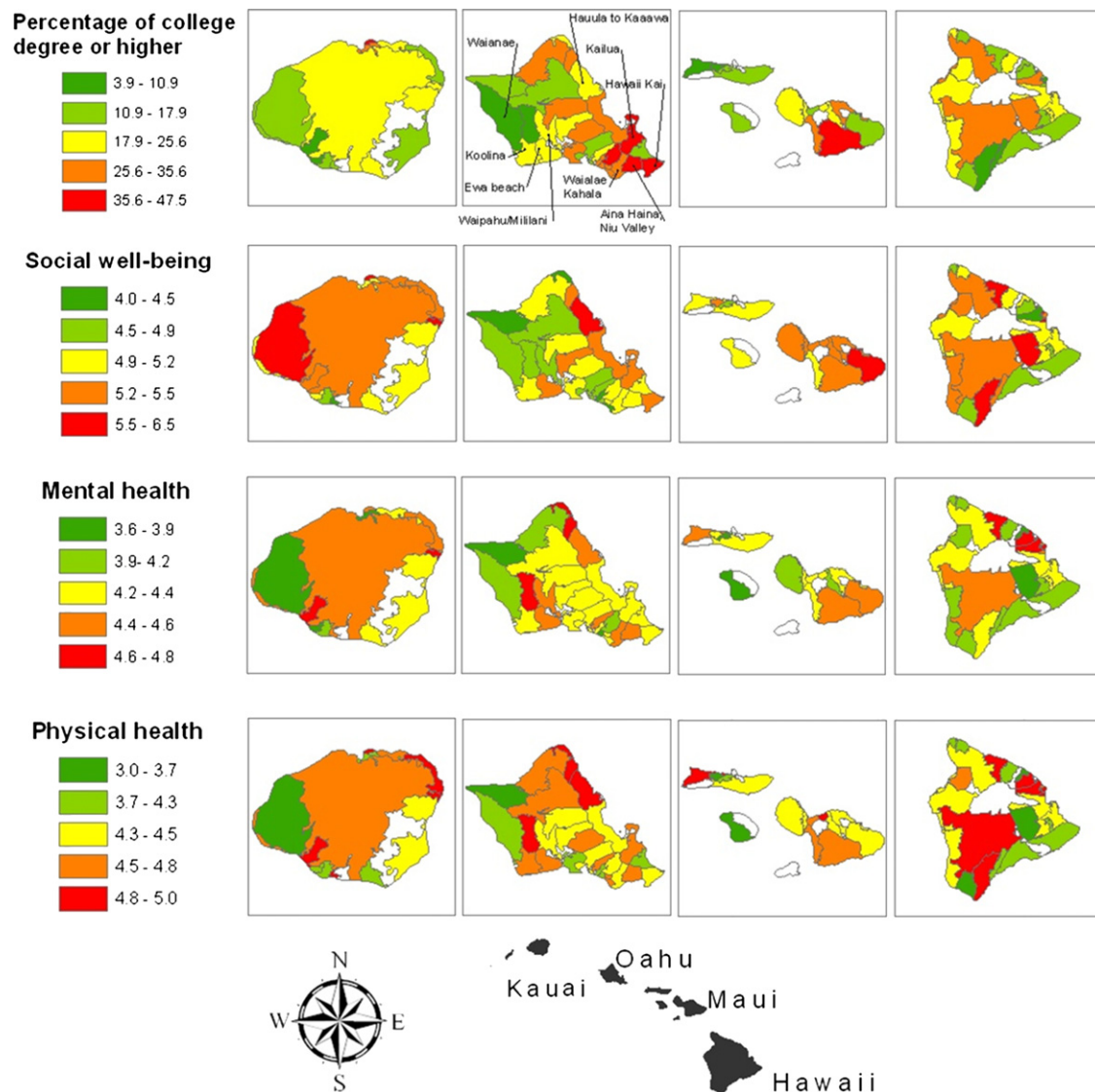


Fig. 2. Geographical distributions of percentages of college degree or higher, social well-being, mental health, and physical health by zip-code in the state of Hawaii: Kauai (first column); Oahu (second column); Molokai, Lanai, and Maui (third column); Hawaii (fourth column).

and Kailua are areas where the percentage of college degree or higher is at higher level (26.6–47.5) and the levels of social well-being and health are also at the middle to higher levels. Similarly, Koolina and Ewa beach are areas where the percentage of college degree or higher is in the middle level (17.9–25.6) and the levels of social well-being and health are also at the middle to higher levels. The Waianae Coast shows the lowest percentage of college degree or higher (3.9–10.9) and has the second to the lowest levels of social well-being (4.5–4.9), mental health (3.9–4.2), and physical health (3.7–4.3).

Collectively, despite a few exceptions such as Kauai, where there are large geographic areas with low levels of college education but fairly high levels of social well-being and health status, the general positive linkages among education, social well-being, and health by islands and zip-codes were exhibited in Fig. 2.

4.2. Distribution of sociodemographics, social well-being, and health

Table 1 summarizes the weighted demographics, SES, and indicators of social well-being and health for the whole sample. Results suggest that there are comparable females and males in the sample. The average age of the respondents is approximately 50

and the majority of them (62.4%) are married or living with their partners. Approximately 60% of the surveyed respondents reported being currently employed. Around 65% of the respondents reported having annual household income of at least \$50,000. Close to 70% of the respondents reported having educational attainment of at least some college. The average levels of social well-being indicators range from 3.3 to 5.9 and the average levels of health indicators range from 3.8 to 4.7. Percentages of missing values for all variables range from 0% to 3.2%.

4.3. Education, social well-being, and mental health

According to Model 1 of Table 2, there is no significant association between mental health and neighborhood-level education after adjusting for demographics. For covariates, females reported significant lower levels ($b = -.120$, $S.E. = .024$, $p < .001$) of mental health compared with males. Married and cohabitating respondents exhibited significant better ($b = .153$, $S.E. = .038$, $p < .001$) mental health compared with others. When contrasted with Caucasians, ethnic differences were noted with Asians ($b = .090$, $S.E. = .030$, $p < .01$) and Hawaiians ($b = .074$, $S.E. = .039$, $p < .1$) reporting better mental health.

Table 1
Weighted means, percents, and standard deviations for all study variables: 2007 Hawaii health survey.

	Statistics	Missing cases
Neighborhood-level education		
Average percentage of college degree of higher	26.5 (9.7)	77 (3.2%)
Individual-level education		
Less than high school	3.3	0 (0.0%)
High school graduate	28.0	0 (0.0%)
Some college	30.5	0 (0.0%)
College or higher	38.3	0 (0.0%)
Mediators: economic well-being		
Household income (\$)	–	0 (0.0%)
≤ 24,999	11.8	–
25,000–49,999	22.5	–
50,000–74,999	23.8	–
≥ 75,000	41.9	–
Household size	3.0 (1.7)	0 (0.0%)
Employment status	–	1 (0.1%)
Employed	59.5	–
Others	40.5	–
Mediators: social well-being		
<i>Social integration (SIN)</i>		
SIN1	5.7 (1.8)	53 (2.2%)
SIN2	5.3 (1.7)	15 (0.6%)
SIN3	5.2 (1.8)	36 (1.5%)
<i>Social contribution (SCT)</i>		
SCT1	5.5 (1.8)	57 (2.4%)
SCT2	5.3 (2.0)	49 (2.0%)
SCT3	5.9 (1.7)	34 (1.4%)
<i>Social actualization (SAC)</i>		
SAC1	3.3 (1.9)	34 (1.4%)
SAC2	4.9 (1.9)	65 (2.7%)
SAC3	4.8 (2.0)	77 (3.2%)
<i>Social coherence (SCH)</i>		
SCH1	5.1 (2.0)	34 (1.4%)
SCH2	4.9 (2.1)	26 (1.1%)
Demographic characteristics		
Gender	–	0 (0.0%)
Male	48.1	–
Female	51.9	–
Average Age (years)	49.6 (17.5)	0 (0.0%)
Marital Status	–	4 (0.2%)
Married and cohabiting	62.4	–
Others	37.6	–
Health		
<i>Mental health (MH)</i>		
MH1	4.5 (0.8)	0 (0.0%)
MH2	3.8 (0.9)	2 (0.1%)
MH3	3.9 (0.9)	2 (0.1%)
MH4	4.7 (0.8)	10 (0.4%)
MH5	4.7 (0.8)	2 (0.1%)
<i>Physical health (PH)</i>		
PH1	4.6 (1.0)	4 (0.2%)
PH2	4.6 (1.0)	5 (0.2%)
PH3	4.4 (1.0)	3 (0.1%)
PH4	4.3 (1.2)	13 (0.6%)
PH5	4.5 (1.0)	3 (0.1%)

Note: Except for rounding error, percentages sum to 100.0%; standard deviations are in parentheses; SIN1–SIN3 are indicators of social integration; SCT1–SCT3 are indicators of social contribution; SAC1–SAC3 are indicators of social actualization; SCH1 and SCH2 are indicators of social coherence; MH1–MH5 are indicators of mental health; and PH1–PH5 are indicators of physical health. Please refer to the measurement section for detailed contents of those indicators.

A series of dummy variables on individual-level education were added in Model 2 of Table 2. Compared with respondents with college and higher level of education, respondents with less than

high school ($b = -.256$, $S.E. = .074$, $p < .001$) and some college ($b = -.104$, $S.E. = .030$, $p < .001$) levels of education reported significantly worse mental health. No significant difference in mental health was found for respondents with high school and college and higher levels of education. When indicators of economic well-being—household income (adjusting for household size) and employment status were included in Model 3, the educational differences in mental health were greatly reduced. After a set of indices of social well-being were introduced in Model 4, another substantial portion of educational differences in mental health was explained. However, household income and household size were found to have random effects in Model 4 whereas they only have fixed effects in Model 3. Given that Models 3 and 4 are not strictly nested, Model 4a (a model without random effects of household income and household size) was estimated. Coefficients and significance levels for all the social well-being indices in Model 4a are similar to those of Model 4, indicating that they are still significant mediators in the relationship between individual-level education and mental health.

All the indices of social well-being are positively associated with mental health, with the effects of social coherence being the most salient, followed by social integration, social contribution, and social actualization. Interestingly, after adjusting for all the socio-demographic factors and mediators, the effects of ethnicity became significant and more pronounced in Model 4. This suggests that when keeping all the covariates as constant, Asians and Hawaiians tend to report much better mental health. In other words, the mental health advantages of Asians and Hawaiians were suppressed, to some extent, due to their lower levels of SES and social well-being when compared with Caucasians. The significant random effects of age, marital status, and household income along with household size suggest that their relationships with mental health tend to vary across neighborhoods.

4.4. Education, social well-being, and physical health

Table 3 summarizes the relationship between education, social well-being, and physical health. In contrast to the data presented in Table 2, the effects of neighborhood-level education on physical health remain significant after adjusting for individual background demographics (Model 1), SES (Model 2–3), and social well-being (Model 4). These findings indicate that about 45% ($(.011-.006)/.011 \approx .45\%$) of the effect of neighborhood-level education is due to individual SES and social characteristics of the residents who live there. However, despite this 45% compositional effect, our results suggest that the neighborhood-level education still has certain amount of independent effect on individual physical health, which is likely to be over and above respondents' own socioeconomic characteristics. Similarly, although economic well-being (Model 3) and social well-being (Model 4) partially mediated the effects of individual-level education, their effects remain significant in Model 4. In another word, the physical health disadvantages of respondents with lower levels of education compared with those with college and higher level of education are not fully explained by their socioeconomic differences.

In terms of the proposed mediators, both household income and employment status are significant. All indices of social well-being are positively related to physical health, but the effects of social integration are the strongest, followed by social coherence. For covariates, no gender differences are found. As expected, age is negatively associated with physical health. Compared with Caucasians, ethnic differences were observed with Asians reporting better whereas Hawaiians reporting worse physical health. The decreasing effects of Hawaiians with the sequential inclusion of mediators suggest that the Hawaiian–Caucasian differences in

Table 2

Unstandardized coefficients from the regression of mental health on neighborhood and individual characteristics: 2007 Hawaii health survey.

Independent variables	Model 1	Model 2	Model 3	Model 4	Model 4a
Neighborhood-level education					
% of college degree or higher	.001 (.002)	.000 (.002)	.000 (.002)	.000 (.002)	.000 (.005)
Individual-level education					
Degree (College and greater ^a)					
Less than high school		-.256 (.074)***	-.174 (.075)*	-.098 (.074)	-.096 (.071)
High school		-.038 (.032)	.004 (.033)	.059 (.033) [†]	.048 (.031)
Some college		-.104 (.030)***	-.086 (.030)**	-.062 (.029)*	-.053 (.028) [†]
Mediators: income and employment					
Household Income Levels			.019 (.013)	.030 (.020)	.012 (.013)
Household size			-.025 (.009)**	-.020 (.011)[†]	-.029 (.008)***
Employment status (Others ^a)					
Employed			.119 (.028)***	.120 (.028)***	.118 (.027)***
Mediators: social well-being indices					
Social integration				.032 (.010)**	.033 (.010)***
Social contribution				.018 (.011) [†]	.019 (.010) [†]
Social actualization				.016 (.010) [†]	.018 (.009) [†]
Social coherence				.047 (.008)***	.050 (.008)***
Demographic characteristics					
Gender (Male ^a)					
Female	-.120 (.024)***	-.111 (.024)***	-.096 (.024)***	-.082 (.024)***	-.090 (.023)***
Age	-.001 (.001)	-.001 (.001)	.000 (.001)	.002 (.001)	.001 (.010)
Marital status (Others ^a)					
Married and cohabiting	.153 (.038)***	.138 (.038)**	.139 (.041)**	.117 (.033)**	.162 (.054)**
Ethnicity (Caucasian ^a)					
Asians	.090 (.030)**	.098 (.030)***	.105 (.030)***	.115 (.029)***	.123 (.029)***
Hawaiian	.074 (.039) [†]	.085 (.040)*	.106 (.040)**	.128 (.040)***	.135 (.039)***
Others	-.001 (.039)	.010 (.039)	.018 (.039)	.024 (.038)	.045 (.037)
Constant	4.216	4.279	4.160	3.449	3.467

Note: Numbers in parentheses are standard errors; N=2403.

Variables in bold are variables that have random effects.

^a Reference group.[†] $p < .1$.* $p < .05$.** $p < .01$.*** $p < .001$.

physical health can be partially interpreted by their differences in education, economic, and social well-being. Finally, the significant random effects of age, household income, household size, and social actualization indicate that their relationships with physical health tend to vary across neighborhoods.

Taken together, findings for mental and physical health are similar in general with a couple of major disparities. For physical health, the independent effects of both levels of education are identified and the proposed mediators partially explained the effects of two levels of education. For mental health, no significant effects of neighborhood-level education were found and the proposed mediators largely explained the effects of individual-level education. As a result, both Hypothesis 1 and Hypothesis 2 are partially supported by the data.

5. Discussion

In this study, we examined the roles of two levels of education and four aspects of social well-being in predicting individual mental and physical health in Hawaii. The major findings are: (1) for mental health, only individual-level education has positive effects and its effects are partially mediated by all aspects of social well-being; (2) for physical health, both individual and neighborhood-level education have positive effects and their effects are partially mediated by two aspects of social well-being—social integration and social coherence; and (3) when all mediators such as social-welling, income, and employment status are included,

there are still independent effects of both levels of education on physical health, but not on mental health.

When GIS was used to describe the geographical distributions of education and health, the island of Kauai shows an interesting pattern. The neighborhood-level education in Kauai was found to be generally low, yet its mental and physical health distributions were much better than its educational profile. This is similar to a relevant study by Zhang et al. (2010) who found relatively high self-related health in Kauai. To explain this education and health discrepancy, they suggested that some contextual factors such as collective identity, social cohesion, sense of place, and independent spirit embedded in the history of this island (Werner and Smith, 2001) may play significant roles in distinguishing Kauai from other places in Hawaii and helping to promote the exceptionally good health of its residents. Focusing on social well-being, this study provides empirical evidences supporting this explanation. Despite the low levels of education in Kauai, Fig. 2 suggests that its total social well-being is relatively high, which partially contributes to the generally good mental and physical health in Kauai. This finding implies the health promoting functions of social well-being in the absence of higher levels of collective education in local communities.

This study also reveals independent effects of neighborhood-level education on physical health, which is over and above individual SES, demographic characteristics, and indices of social well-being. The well-educated neighbors tend to share information with each other, take care of each other when necessary, and effectively mobilize the available resources to enhance the recreational, educational, health as well as daily living facilities in the

Table 3

Unstandardized coefficients from the regression of physical health on neighborhood and individual characteristics: 2007 Hawaii health survey.

Independent Variables	Model 1	Model 2	Model 3	Model 4
Neighborhood-level education				
% of college degree or higher	.011 (.002)***	.008 (.002)***	.006 (.002) [†]	.005 (.002) [†]
Individual-level education				
Degree (College and greater ^a)				-.288 (.096)**
Less than high school		-.457 (.095)***	-.308 (.097)**	-.079 (.043) [†]
High school		-.181 (.041)***	-.100 (.042) [†]	-.090 (.038) [†]
Some college		-.127 (.038)***	-.097 (.038) [†]	
Mediators: income and employment				
Household Income Levels			.062 (.026) [†]	.055 (.024) [†]
Household size			-.030 (.016) [†]	-.029 (.015) [†]
Employment status (Others ^a)				
Employed			.226 (.036)***	.220 (.036)***
Mediators: social well-being indices				
Social integration				.022 (.013) [†]
Social contribution				.006 (.014)
Social actualization				.027 (.019)
Social coherence				.019 (.010) [†]
Demographic characteristics				
Gender (Male ^a)				
Female	-.045 (.032)	-.029 (.032)	-.014 (.032)	-.014 (.032)
Age	-.013 (.001)***	-.013 (.001)***	-.010 (.001)***	-.010 (.001)***
Marital status (Others ^a)				
Married and cohabiting	.146 (.033)***	.115 (.033)***	.076 (.035) [†]	.062 (.035) [†]
Ethnicity (Caucasian ^a)				
Asians	.078 (.038) [†]	.098 (.038)**	.071 (.038) [†]	.080 (.039) [†]
Hawaiian	-.090 (.050) [†]	-.046 (.051)	-.009 (.053)	.005 (.052)
Others	-.013 (.050)	.022 (.050)	.001 (.051)	.004 (.050)
Intercept	4.776	4.923	4.621	4.281

Note: Numbers in parentheses are standard errors; N=2403

Variables in bold are variables that have random effects.

^a Reference group.[†] $p < .1$.* $p < .05$.** $p < .01$.*** $p < .001$.

communities. All these collective efforts will improve residents' physical health by providing a safe, convenient, green, and friendly neighborhood environment. The positive relationship between neighborhood quality and health has been documented in several studies. For example, Sugiyama et al. (2008) discloses the associations of neighborhood greenness with physical and mental health and recreational walking partially explains the relationships. A recent study by Stronegger et al. (2010) found a significant association between the perception of better residential environment and higher level of leisure time physical activity and self-rated health. Interestingly, in this study although neighborhood education was found to affect physical health, it is insignificantly related to mental health. These divergent findings suggest the possibilities of people relying on their social network of friends instead of neighbors for their problems. For instance, one usually would not talk to a neighbor about marital problems, but would be likely to talk to a good friend, who does not necessarily live in the same zip-code area, about these problems.

How education improves health is also found to be slightly different for mental health than for physical health. For mental health, only individual-level education has positive effects and its effects can be largely explained by two sets of mediators (income and employment status combined with the dimensions of social well-being). In contrast, for physical health, both individual-level and neighborhood-level education have positive effects. Moreover, both sets of mediators only partially explain the effects of education, leaving certain amount of its effects unexplained. These findings have at least five implications. First, they underscore

the importance of the proposed mediators in explaining the effects of education on mental health. Second, they suggest the independent effects of education on physical health. Third, the unexplained variance in physical health indicates the desirability of including other potential mediators such as health lifestyles, eating, and exercise habits that were not included in this investigation. Fourth, the data reveal two discernable patterns related to health outcomes. Mental health appears to be shaped by the combined contributions of social processes involving social mediators and related processes inclusive of employment status, aspects of social well-being as well as gender, age, marital status, and ethnicity. In contrast, physical health appears to be shaped by the individual competencies (involving combined contributions of neighborhood and individual levels of education), social capital of income, employment, and social well-being dimensions of integration and coherence, as well as age, marital status and Asian ancestry. Finally, the findings suggest the importance of ethnicity and culture, for both Asians (across both mental and physical health), and Hawaiians in the case of mental health. However, how ethnicity and culture come to determine health outcomes remains to be examined in greater depth in future studies.

Furthermore, this study extends previous theoretical explanations on why higher levels of education are associated with better health by introducing a concept of social well-being, which resembles individual psychological well-being, but has unique social components. According to the human capital theory, one fundamental way that education promotes health is because the well-educated people are more likely to develop beliefs that their

actions and choices can affect outcomes (Mirowsky and Ross, 2003). These positive learned expectations, also called sense of personal control, are likely to go beyond enhancing one's health-related behaviors (Ross and Wu, 1995). Their beneficial effects can be well extended into developing a sense of determination and judgment, which can be used to objectively evaluate one's circumstances and functioning in society. For instance, well-educated and psychologically healthier people tend to view themselves as essential parts of community and society, contribute their fair parts to the commonwealth, and objectively evaluate the trajectory of social development. In this study, various aspects of social well-being, the newly proposed mechanisms linking education and health are empirically tested and supported by the data. Therefore, educational attainment benefits health, not only because it determines other aspects of SES, enhances individual psychosocial resources, and helps to develop healthy lifestyles, but also because it shapes individuals' various aspects of social well-being.

The results of this investigation also underscore its limitations. First, just like any cross-sectional study design, this work is limited in its abilities to establish causal relationship. There are increasing evidences in the literature (e.g., Goesling, 2007; Martin et al., 2007; Mirowsky and Ross, 2008) suggesting the possible changing patterns of educational differences in relation to health among the general population in the United States. For instance, Lynch (2006) pointed out the importance of treating the education and health relationship as time-variant. He found that the indirect effect of education through income is strengthening across cohorts. In the future, using longitudinal data or pooled repeated cross-sectional data, it will be interesting to examine whether and how education and health relationship has been changing over decades across various cohorts in the State of Hawaii, an island community that is geographically, ethnically and culturally unique in comparison with the rest of the United States.

In addition, those widely used mediators linking education and health such as individual psychosocial factors (e.g. various types of social support and sense of personal control) and indicators of health lifestyles (e.g. exercising, eating, drinking, and smoking behaviors) should be included in further surveys in order to (a) to further disentangle the total effects of education on health, (b) to compare their relative importance with dimensions of social well-being, and (c) to examine the underlying ethnic, multi-ethnic and cultural factors in explaining the education and health relationship (McCubbin et al., 2010; Tashiro, 2010).

Moreover, this study used zip-code area as an approximation of neighborhoods. Previous studies suggest that zip-code is a fine proxy of neighborhood SES. For instance, Geronimus and Bound (1998) found that the correlation between SES measures at the zip-code level tends to be generally consistent with SES measures at the census tract level. However, it will always be desirable to use finer scale census tract, the commonly used local geographic areas with visible boundaries and residents sharing similar socioeconomic characteristics (e.g., Rehkopf et al., 2006; Ross and Mirowsky, 2008). With information on respondents' addresses in future surveys, census tracts should be used because smaller geographical units tend to have larger inter-neighborhood SES variation, which allows for a wide range of comparisons and may lead to more significant and substantial effects of the contextual characteristics.

Despite the above limitations, this study contributes to prior research in the field of SES, neighborhood, and health in at least two major ways. First, using the 2007 HHS with linked census information and applied mixed-effects modeling, this study examined the effects of neighborhood-level education, one of the most important neighborhood attributes, on mental and physical health in addition to individual-level educational attainment. Second, it proposed and tested one possible process or mechanism—social well-being, through which two levels of education affect health.

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