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ABSTRACT

Background: Self-rated health (SRH) is a common measure of overall health. However, little is

known about multilevel correlates of physical and mental SRH. **Methods:** Patients attending

primary care clinics completed a survey before their appointment, which we linked to

community data from American Community Survey and other sources (*n*=455). We conducted

multilevel logistic regression to assess correlates of excellent/very good versus good/fair/poor

physical and mental SRH. **Results:** 43.9% of participants had excellent/very good physical

SRH, and 55.2% had excellent/very good mental SRH. Physical SRH was associated with age

(odds ratio[OR]=0.82 per 10 years; 95% confidence interval[CI]=0.72-0.93) and community

correlates, including retail establishment density (OR=0.94, 95% CI=0.90-0.99) and percent of

students eligible for free/reduced lunch (OR=1.60, 95% CI=1.08-2.38) (all *P*<0.05). Mental SRH

was not associated with any characteristics. **Conclusions:** Practitioners in public health, social

work, and medicine could use zip codes to intervene in patients and communities to improve

physical SRH.

Key words: Self-rated health; physical health; mental health; community; population health.

2

Area- and individual-level correlates of self-rated health:

Implications for geographic health disparities

Self-rated health (SRH), or a person's perception of their overall health status, is a

commonly-used measure in health surveys. It has been said that "self-ratings provide a simple,

direct, and global way of capturing perceptions of health using criteria that are as broad and

inclusive as the responding individual chooses to make them."[1] Single-item measures of SRH

have predictive validity and test-retest reliability of overall health among respondents of different

ages, genders, and ethnicity groups.[2-4] Importantly, SRH is predictive of many clinical outcomes;

for example, people with poor SRH have a significantly higher risk of mortality than people with

better SRH.[1,4] Most studies have focused on physical SRH, but mental SRH is a distinct and

important aspect of well-being, as well.[5] Importantly, provision of high-quality primary care is

associated with better SRH.[6] Thus, primary care clinicians and scientists can conceive of SRH as

an *outcome* of clinical care (and other factors) and a *predictor* of clinical outcomes.

A number of individual and community characteristics impact SRH. On an individual

level, older age, pain, and depression correlate with SRH. For example, older adults who are

experiencing pain are more than twice as likely to report poor SRH as other older adults, even

after controlling for clinical health indicators, sociodemographics, and access to medical care.[7]

Depressive symptoms prospectively predict greater decline in SRH in older adults in the United

States.[8] In contrast, individual-level sex is inconsistently associated with SRH.[9,10] In general,

women report poorer SRH than men, but they have longer life expectancies; as a result, SRH has

a weaker correlation with mortality for women than for men.[9]

On a community level, segregation, income inequality, and social capital all correlate

with SRH. Racial residential segregation of blacks and whites is most strongly associated with

poorer SRH for blacks living in high-poverty neighborhoods.[11] Additionally, greater income

inequality has been linked to poorer SRH status.[12] In contrast, higher social capital is associated

with better SRH.[13]

Given the importance of SRH for predicting health outcomes, we need to better

understand how multilevel characteristics work together in their associations with SRH. In this

study, we conducted a multilevel analysis of individual- and zip code-level variables and SRH.

We examined differences in these associations for physical versus mental SRH. These findings

identify community characteristics that may put patients at risk for poorer SRH, highlighting

where we can locate future supportive interventions to address community factors and individual

health.

METHODS

We collected cross-sectional survey data from patients visiting seven primary care

clinics[14] in July 2019. Patients (≥18 years) self-administered an anonymous paper questionnaire.

Of 1,769 adult patients, 464 completed a survey (response rate=26.2%), and 455 provided valid

zip codes.

Measures

Outcome variables. Participants reported physical and mental SRH in response to the

question "In general, would you say that your [physical/mental] health is…" Responses options

were excellent, very good, good, fair, or poor. We dichotomized responses into *excellent or very

good* versus *good, fair, or poor*.[15]

Predictor characteristics (Table 1). Participants reported age, race/ethnicity, sex, marital status, and residential stability.

Insert Table 1 Here

Community characteristics were primarily drawn from 2013-2017 American Community Survey five-year estimates and linked to participants' zip code.[16] These characteristics were median household income; population density; number of retail establishments per 1,000 population; average life expectancy (from 2010-2015 U.S. Small-Area Life Expectancy Estimates Project[17]); percent of population (≥25 years) with at least a high school degree; percent of households whose language is only English; percent of students eligible for free and reduced lunch (from 2018-2019 [redacted] Department of Education report[18]); and percent of residents who are black, Hispanic, without healthcare insurance, and live in the same house as the previous year.

Statistical analysis

We built multilevel models for physical and mental SRH, accounting for clustering of participants by zip code. For each outcome, we ran empty logistic regression models (Model 0). We calculated intraclass correlation (ICC) using the formula[19]:

$$ICC = \frac{\tau_{00}}{\tau_{00} + 3.29}$$

Where τ_{00} is the Model 0 intercept and 3.29 is the level-1 error variance.[19] ICC summarizes the variation in the outcome attributable to level-2 (i.e., zip code) membership.[19]

Then, we calculated bivariate associations between individual- and zip code-level characteristics and each outcome, accounting for clustering. Finally, we constructed multivariable models simultaneously assessing the associations between individual-level

characteristics (Model 1); between zip code-level characteristics (Model 2); and between

individual- and zip code-level characteristics (Model 3) with each outcome.

The [redacted] determined this study was exempt from review. Analyses were conducted

using SAS version 9.4 (Cary, NC), with a two-sided P-value of 0.05.

RESULTS

Participants lived in 75 zip codes (mean=6.1 participants/zip code). On average,

participants were 50.9 years old (standard error[SE]=0.9) and predominantly female (72.2%)

(Table 1). About half had lived in their current residence for <10 years (51.7%). On average,

participants lived in zip codes with a median household income of $61,662 ($SE$=$752.6), with

10.4% black residents (SE=0.6%) and 12.4% Hispanic residents (SE=0.9%).

Physical SRH

Overall, 198 (43.9%) participants reported excellent or very good physical health. The

ICC for physical SRH was 8.05% (t=-2.05, P=0.04), indicating that zip code membership had a

small-to-medium effect on variation in this outcome.[20]

In the final, multilevel, multivariable model (Model 3), physical SRH was inversely

associated with age (odds ratio [OR]=0.82, 95% confidence interval [CI]=0.72-0.93), density of

retail establishments (OR=0.94, 95% CI=0.90-0.99), and percent of residents who were

uninsured (OR=0.07, 95% CI=0.02-0.35) (Table 2). Physical SRH was positively associated with

zip code-level average life expectancy (OR=1.47, 95% CI=1.07-2.01) and percent of students

eligible for free and reduced lunch (OR=1.60, 95% CI=1.08-2.38).

Insert Table 2 Here

Mental SRH

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Overall, 233 (55.2%) participants reported excellent or very good mental health. The ICC for mental SRH was 5.98% (t=2.01, P<0.05), indicating that zip code membership had a small-to-medium effect on variation in this outcome.[20]

In the final, multilevel multivariable model (Model 3), mental SRH was not associated with any of the individual- or zip code-level characteristics (Table 2).

DISCUSSION

This paper investigated the simultaneous associations of individual- and zip code-level characteristics with self-rated physical and mental health. The study was conducted with adult patients at primary care clinics in central Pennsylvania, many of whom came from relatively affluent zip codes. About half of participants reported excellent or very good physical and mental SRH. Better physical SRH was associated with individual-level characteristics (younger age) as well as zip code-level characteristics (lower density of retail establishments, higher average life expectancy, lower prevalence of uninsured population, and higher percent of students eligible for free and reduced lunch). In contrast, mental SRH was not associated with any of the individual- or zip code-level characteristics we measured in the full multivariable, multilevel model.

Physical SRH was inversely associated with individual-level age, which was expected based on previous studies. Older individuals tend to have poorer SRH than younger individuals, perhaps due to increasing prevalence of chronic and other health conditions with age.[7,8] Interestingly, however, the link between clinical health and physical SRH weakens as people age, perhaps because social factors become increasingly influential for health among older adults.[21]

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Physical SRH was also found to be associated with several community characteristics: density of retail establishments, percent uninsured, and percent of students eligible for free and reduced lunch. In terms of density of retail establishments, individuals living in more commercialized communities had poorer physical SRH. Future studies should investigate how the type and mixture of retail establishments moderate this relationship; for example, living near establishments that primarily sell alcohol, tobacco, and/or unhealthy foods could hinder physical health.[22] In terms of percent uninsured, lack of health insurance can hinder access to preventive healthcare services, resulting in poorer long-term health outcomes.[23] Uninsured individuals are also more likely to have low-wage jobs,[24] which can negatively impact physical health through higher consumption of unhealthy foods.[25] Finally, in terms of percent of students eligible for free and reduced lunch, we observed an inverse association with physical SRH in bivariate models, but a positive association in multivariable models. The reasons for these associations deserve more exploration, but one hypothesis is that communities where students are eligible for free and reduced lunch could foster an environment that can reduce food insecurity and obesity rates, resulting in better physical SRH.[26] In summary, physical SRH is responsive to both individual- and community-level characteristics.

In contrast, mental SRH was not associated with any individual- or zip-code level characteristic in the final models. Although the ICC indicated that zip code membership helped to explain 6% of differences in mental SRH, these differences were not significantly related to the multilevel characteristics we examined. This may indicate that characteristics associated with mental SRH are subtler or more nuanced than our models accounted for (e.g., there may be non-linear associations), and/or we did not account for them in our survey. One such individual-level variable is physical activity, as physical activity can increase positive affect.[27] Two related

excluded zip code-level variables are walkability[28] and green space,[29,30] both of which are

associated with physical activity and SRH. Crime rate is another excluded zip code-level

variable, although previous studies have shown that more neighborhood crime is associated with

greater psychological distress,[31] and greater fear of crime is associated with poorer mental

health.[32] In addition, individual- and area-level degree of religiosity interact in their associations

with SRH,[33,34] so future studies could incorporate both of these variables into analyses of mental

SRH. Finally, the demographic makeup of our sample could also impact observed levels and

correlates of mental SRH, as our respondents include a majority of non-Hispanic white women.

Sex and racial/ethnic differences in mental SRH have been demonstrated in previous studies.[35,36]

      Importantly, while various associations were found between the individual- and zip code-

level characteristics and SRH, we found no statistical evidence for a number of associations that

may have been expected, including with race/ethnicity, sex, and high school completion rate.

Previous studies have shown that, compared to NH whites, NH blacks have poorer SRH and

Hispanics have better SRH.[37] In the present study, our sample had low variability in racial/ethnic

composition, with 72.5% of participants reporting NH white race/ethnicity, which is somewhat

higher than the percent of NH whites in Dauphin County, Pennsylvania (64.9%); better

representation of different races/ethnicities may have shown a relationship with SRH.

Additionally, the racial/ethnic compositions are aggregated data at the zip level; regression with

aggregated data is vulnerable to ecological fallacy, which may lead to the discrepancies between

results at the individual level and zip code-level. As described above, the relationship between

SRH and sex is unclear, with some previous studies reporting that women report poorer SRH

than men[9,38] and others reporting no difference.[10] The present study did not show an association

between gender and SRH, which again could be explained by the demographics of our sample

(i.e., 72.2% female). More representation from males could have provided additional power to detect a sex difference in SRH. Studies have shown that individual-level education levels have been positively associated with SRH[13,37-39]; however, our study did not show an association between zip code-level high school completion rate and SRH. Had we asked participants to report their own education, we may have found an association at the individual level.

These findings have implications for public health, clinical practice, and future research. In terms of public health, our findings indicate that we can use zip codes to identify subpopulations that are at-risk for poor physical SRH, including more commercialized areas, with high percentages of uninsured and low percentages of students eligible for free and reduced lunch. Interventions to improve physical SRH, perhaps by increasing physical activity and reducing food insecurity, could be located in these zip codes to reach the most at-risk populations. Similarly, clinical practice could use patient zip code (or zip code-level characteristics) as an indicator that a person may live in a community that is at higher risk for poorer physical SRH; as more attention is paid to social determinants of health in the clinical setting, the environment in which patients live, and how that environment may impact health, will become more important to primary care.[40] Future research should continue to examine in greater depth the multilevel factors that are associated with SRH and other health outcomes, with larger and more diverse samples. In particular, future studies could incorporate additional contextual, zip code-level characteristics such as walkability, green space, and crime, as well as interpersonal factors such as social cohesion and capital to create nuanced, multilevel models that are ecologically valid. Importantly, identifying the individual- and zip code-level characteristics that are associated with mental SRH will have important implications for promoting whole-person health in primary care.[41] However, in all of these instances, it is

important to remember that SRH reflects a person's actual health status as well as their idiosyncratic reporting tendencies[42,43], and as such is an imperfect reflection of health, well-being, and function. This construct can serve dynamically as a patient's retrospective interpretation of clinical and non-clinical health issues[44-46] and/or a prospective marker of future outcomes.[47-49] As a result, stakeholders from public health, clinical medicine, and research need to be explicit about their hypothesized relationships between SRH and outcomes of interest.

Strengths of our study include our respectable response rate for a survey-based study, moderate variability in zip-code level characteristics (k=75), and successful geocoding of 98% of participants (455/464). However, our study does have several limitations including the majority of the respondents identifying as female and white, and geographic location limited to central Pennsylvania, making generalizability of our findings somewhat limited. Ecological fallacy is also important to consider as a limitation; inferences made about groups based on aggregate data cannot be extended to individuals.

CONCLUSIONS

In this cross-sectional survey of adult primary care patients, we found that physical SRH was associated with individual-level age and with zip code-level density of retail establishments, percent uninsured, and percent of students eligible for free and reduced lunch. Public health and clinical practice can use these results to identify and intervene with patients living in communities considered at-risk for poorer physical SRH. Additional research is needed to explore other zip code-level characteristics, particularly as they relate to mental SRH. This area of research can support efforts to improve social determinants of health and whole-person primary healthcare.

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Table 1. Descriptive statistics for individual- and zip code-level characteristics of patients attending primary care clinics in Pennsylvania (*n*=455), 2019.

Characteristic	Definition	Range	Mean	SE
Individual-level characteristics (n=455)[*]				
		Range	*Mean*	*SE*
Age	Age in years	18-91	50.9	0.9
				%
Race/ethnicity	Race/ethnicity			
Non-Hispanic White				72.5
Non-Hispanic Black				12.8
Hispanic				9.2
Other				5.5
Sex	Sex			
Male				27.8
Female				72.2
Marital status	Marital status			
Other				43.2
Married/Living with partner				56.8
Residential stability	Length of time living at current residence			
Lived in current residence <10 years				51.7
Lived in current residence 10+ years				48.3
Zip code-level characteristics (k=75)[†]				
		Range	*Mean*	*SE*
Median household income	Median household income, $1000s	24.9-118.4	61.7	0.7
Population density	People per square mile, 100s	0.3-122.2	23.1	1.4
Retail establishments	Number of retail establishments, per 1000 population	6.2-131.1	23.1	0.5
Life expectancy[‡]	Average number of years a person can expect to live at birth	73.1-82.2	79.3	0.1

High school completion rate	Percent of population (ages 25 years and above) whose highest education is a high school degree, by 10%	1.6%-5.0%	2.3%	0.1%
Percent black	Percent of residents who are black race, by 10%	0.0%-5.7%	1.0%	0.1%
Percent Hispanic	Percent of residents who are Hispanic ethnicity, by 10%	0.0%-7.0%	1.2%	0.1%
Percent uninsured	Percent of residents without healthcare insurance, by 10%	0.0%-2.0%	0.7%	0.1%
Percent English-speaking households	Percent of households whose household language is only English, by 10%	3.7%-9.9%	8.4%	0.1%
Percent living in same house 1 year ago	Percent of residents who lived in the same house as the previous year, by 10%	7.4%-9.8%	8.4%	0.1%
Percent free and reduced lunch§	Percent of school students eligible for free and reduced lunch program, by 10%	1.7%-10.0%	4.7%	0.1%

*Individual-level characteristics were self-reported on the survey.

†Unless otherwise noted, zip code-level characteristics came from the 2013-2017 American Community Survey five-year estimates.[12]

‡Life expectancy estimates came from 2010-2015 U.S. Small-Area Life Expectancy Estimates Project.[13]

§Information on free and reduced lunch program eligibility came from a 2018-2019 Pennsylvania Department of Education report.[14]

Note. SE=standard error.

Table 2. Bivariate and multivariable associations of individual- and zip code-level characteristics with physical self-rated health (top panel) and mental self-rated health (bottom panel) among patients attending primary care clinics in Pennsylvania (*n*=455), 2019.

	Bivariate Models		Model 1 (Individual-level)		Model 2 (Zip code-level)		Model 3 (Multilevel)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
	Physical SRH							
Individual-level characteristics								
Age, by 10 years	0.86	(0.76-0.97)	0.83	(0.72-0.95)			0.82	(0.72-0.93)
Race/ethnicity (ref: NH White)								
Non-Hispanic Black	0.9	(0.49-1.64)	0.8	(0.40-1.59)			1.04	(0.50-2.14)
Hispanic	0.58	(0.32-1.05)	0.5	(0.28-0.90)			0.74	(0.29-1.91)
Other	1.73	(0.70-4.32)	1.34	(0.51-3.50)			1.2	(0.45-3.25)
Sex (ref: Male)								
Female	0.93	(0.64-1.36)	0.83	(0.55-1.24)			0.79	(0.49-1.28)
Marital status (ref: Other)								
Married/Living with partner	1.25	(0.86-1.80)	1.32	(0.94-1.85)			1.38	(0.88-2.16)
Residential stability (ref: <10 years)								
Lived in residence for 10+ years	0.83	(0.61-1.13)	0.89	(0.63-1.25)			0.84	(0.53-1.33)
Zip code-level characteristics								
Median household income, by $1000	1.02	(1.00-1.03)			0.99	(0.96-1.03)	0.98	(0.93-1.03)
Population density, by 100	1	(0.99-1.00)			1.02	(1.01-1.04)	1.02	(1.00-1.04)
Retail establishments, per 1000	1.01	(0.99-1.03)			0.95	(0.93-0.98)	0.94	(0.90-0.99)
Average life expectancy, by 1 year	1.15	(1.05-1.26)			1.42	(1.10-1.83)	1.47	(1.07-2.01)
High school completion, by 10%	0.69	(0.45-1.06)			0.59	(0.28-1.28)	0.53	(0.19-1.49)
Black, by 10%	0.93	(0.74-1.17)			0.79	(0.55-1.13)	0.65	(0.42-1.02)
Hispanic, by 10%	0.89	(0.80-0.98)			0.78	(0.42-1.43)	0.55	(0.19-1.62)
Uninsured, by 10%	0.51	(0.29-0.89)			0.14	(0.05-0.37)	0.07	(0.02-0.35)
English-speaking households, by 10%	1.13	(1.00-1.29)			1.22	(0.58-2.57)	0.85	(0.25-2.91)

	Model 1	Model 2	Model 3	Model 4
Living in same house 1 year ago, by 10%	0.99 (0.66-1.49)		0.47 (0.26-0.83)	0.42 (0.17-1.06)
Students eligible free and reduced lunch, by 10%	0.91 (0.84-0.99)		1.42 (1.02-1.99)	1.6 (1.08-2.38)
	Mental SRH			
Individual-level characteristics				
Age, by 10 years	1.17 (1.05-1.32)	1.14 (1.00-1.30)		1.13 (1.00-1.29)
Race/ethnicity (ref: NH White)				
Non-Hispanic Black	0.7 (0.42-1.16)	0.91 (0.53-1.59)		0.79 (0.37-1.71)
Hispanic	0.57 (0.28-1.16)	0.75 (0.33-1.70)		1 (0.38-2.69)
Other	1.64 (0.73-3.66)	1.96 (0.91-4.24)		1.59 (0.51-5.04)
Sex (ref: Male)				
Female	0.94 (0.66-1.32)	1.01 (0.69-1.49)		1.03 (0.63-1.66)
Marital status (ref: Other)				
Married/Living with partner	1.38 (0.99-1.91)	1.33 (0.94-1.88)		1.4 (0.88-2.21)
Residential stability (ref: <10 years)				
Lived in residence for 10+ years	1.28 (0.94-1.72)	0.97 (0.70-1.36)		0.98 (0.62-1.56)
Zip code-level characteristics				
Median household income, by $1000	1.01 (1.00-1.02)		1 (0.95-1.04)	1 (0.95-1.05)
Population density, by 100	0.99 (0.99-1.00)		0.99 (0.98-1.01)	1 (0.98-1.02)
Retail establishments, per 1000	1.02 (1.00-1.03)		0.98 (0.95-1.02)	0.98 (0.95-1.02)
Average life expectancy, by 1 year	1.09 (1.01-1.19)		1.08 (0.84-1.39)	1.12 (0.84-1.48)
High school completion, by 10%	0.7 (0.46-1.06)		0.4 (0.16-1.02)	0.44 (0.18-1.09)
Black, by 10%	0.97 (0.84-1.12)		0.84 (0.58-1.21)	0.94 (0.60-1.46)
Hispanic, by 10%	0.91 (0.86-0.96)		1.08 (0.47-2.47)	1.06 (0.38-2.96)
Uninsured, by 10%	0.64 (0.41-1.01)		0.48 (0.15-1.61)	0.44 (0.11-1.76)
English-speaking households, by 10%	1.1 (1.01-1.20)		1.37 (0.55-3.42)	1.33 (0.42-4.19)
Living in same house 1 year ago, by 10%	0.85 (0.60-1.20)		0.57 (0.26-1.23)	0.52 (0.23-1.19)
Students eligible free and reduced lunch, by 10%	0.94 (0.88-0.99)		1.22 (0.88-1.70)	1.22 (0.83-1.79)

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Note. The intraclass correlation (ICC) for physical self-rated health was 8.05% ($t = -2.05$, $P = 0.04$; Model 0). The ICC for mental self-rated health was 5.98% ($t = 2.01$, $P < 0.05$; Model 0). Each row in the "Bivariate Models" column indicates the results of a separate bivariate logistic regression. Models adjusted for clustering by zip code. OR=odds ratio; CI=confidence interval