



Age-Friendly Features in Home and Community and the Self-Reported Health and Functional Limitation of Older Adults: the Role of Supportive Environments

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Published online: 30 June 2020
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Abstract This study aims to identify age-friendly community features that are associated with better health for older adults. This cross-sectional study utilized the 2015 AARP Age-Friendly Communities (AFC) Survey, which includes 66 home and community features that fall within the eight domains specified by the World Health Organization (WHO)'s age-friendly cities guidelines. Two measures of health (self-rated health and functional limitations) were examined using multi-level linear and logistic regressions. Both a greater perceived availability of age-friendly features in communities and a good person-environment fit were associated with better self-rated health and a lower likelihood of reporting functional limitations. The domains of outdoor spaces and buildings, transportation, and social participation and inclusion were consistently associated with these outcomes. Promoting age-friendliness in outdoor spaces and buildings, transportation, and social participation and inclusion domains by providing green spaces, neighborhood safety programs, transportation options, and social opportunities may be the most effective way to support healthy and active aging.

Keywords Age-friendly · Community assessment · Person-environment fit · Outdoor spaces and buildings · Transportation · Social participation and inclusion

Introduction

Health and physical functioning has been identified as key elements of successful aging as autonomy and independence of older adults cannot be maintained without good health and high levels of physical functioning [1, 2]. Health and physical functioning may also be essential to achieve other aspects of successful aging, including psychosocial health and well-being [3–5]. A growing number of studies have explored risk factors for poor health and functional limitations at the level of home and neighborhood because understanding environmental factors is essential to improve older adults' health and achieve successful aging, considering the significant amount of time that older adults spend in their home and community and the greater influence of environment on older adults [6–8].

Age-Friendly Environments and Health

According to the US Census Bureau, the number of community-dwelling older adults has continuously increased; over 96% of the older population were living in the community in 2010 [9]. The rising number of community-dwelling older adults is a global trend. In response to the trend, the World Health Organization (WHO) introduced the concept of age-friendly cities to guide the designs of physical and social environments in eight domains (i.e., housing, outdoor spaces and buildings, transportation, health and wellness, social participation and inclusion, volunteering and civic engagement, job opportunities, and community information) in order

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to promote healthy and active aging and improve older residents' quality of life, emphasizing the importance of a comprehensive approach [10, 11]. By promoting age-friendly environments in this way, the WHO sent the message that the speed of the decline of functional capacity may be influenced and even reversed.

Theories and empirical evidences suggest that supportive environments, including age-friendly communities, can enhance opportunities for aging well, while poor environment may impose significant constraints [12, 13]. For example, living in accessible or modified homes, which can be considered to be supportive features, prevented a decline in physical functioning and helped with maintaining independence [14–18]. Menec and Nowicki also reported that older adults who were living in a community with more age-friendly features, including parks and walking trails, affordable housing, neighborhood safety, parking spaces, and transportation for older adults with disabilities, had better self-perceived health [19].

On the other hand, the incongruence between personal characteristics, personal preferences, and environmental characteristics (or a poor person-environment (P-E) fit) was associated with negative health outcomes. Factors, such as living in an unsafe neighborhood, housing and neighborhood disorders (e.g., traffic, noise, crime, trash and litter, lighting), and physical environmental barriers (e.g., parking spaces, stairs, housing conditions), were associated with poor health, functional decline, and higher mortality [18, 20–26]. Living in disadvantaged neighborhoods (e.g., low SES) or lacking desirable services also increased the risk of poor health and functional limitations [27, 28]. In addition, Iwarsson found that more physical environmental barriers (e.g., parking space, stairs, housing conditions) or the increase of P-E fit problems results in more functional decline among frail older adults [15].

However, existing literature has several limitations. Previous studies often used “unidimensional measures of neighborhoods,” with few looking at multiple factors impacting the physical health of older adults [29]. Existing studies have often merely explored certain aspects of environmental characteristics, such as housing quality and maintenance, home modification, and neighborhood safety [16, 25, 30]. The generalizability of previous studies is another limitation of the existing literature. Most studies are based on specific geographic areas or foreign samples, so the effect of age-friendly environments on older Americans' health is unclear. Most importantly,

most previous studies have used the existence of or the actual number of community features or services as a measure of person-environment fit, which does not reflect the (in)congruence between personal needs/preferences and environmental features. Therefore, in an effort to identify environmental factors that can support healthy and independent aging, this study aims to examine the relationship between age-friendly community features and older adults' self-rated health and functional limitations by using the AARP Age-Friendly Community (AFC) Survey that includes a randomly selected sample of older adults in 14 US communities. The AARP AFC includes information on the availability of 66 age-friendly features in home and community that fall within the eight domains specified by the WHO's age-friendly cities guidelines as well as respondents' perceived importance of each feature. The unique features of the data will allow the application of the P-E fit theory, which was not available in previous studies.

In addition to theoretical and empirical contributions, this study will provide implications for policy. Efforts to promote age-friendliness of communities have been made mostly through small scale programs and activities. However, for well-balanced development of age-friendly communities, a large-scale projects or long-term system change at the community, state, and federal level, including housing policies (e.g., affordable housing, home modification, in-home supports), employment policies (e.g., age discrimination, flexible working hours, workplace accommodations), and age-friendly city planning and development to increase infrastructure and improve environments for older adults (e.g., road condition and connectivity, transportation options, medical services), are essential [31–33]. Considering limited resources, one of the priorities to foster age-friendly communities is to identify a specific area of development [31]. By using summarized measures for each domain rather than individual age-friendly features, findings of this study will help identify a priority area of development and provide implications to improve health and physical functioning of older adults.

Methods

Data and Sampling

This study involved secondary data analyses using the 2015 AARP Age-Friendly Community (AFC) Survey, which is publicly available upon request. Since it was

founded in 1958, AARP has been providing various services for improving the quality of life of the age 50+ population and conducting research on issues and topics of concern for this population, such as economic security, health and health care, life and leisure, long-term care, politics and government, and technology (see <http://www.aarp.org/research/topics/>). Promoting livable communities or age-friendly communities is one of AARP's key areas of focus.

The WHO's Global Age-Friendly Cities and Communities initiative was created "to help cities prepare for the rapid aging of populations and the increase in urbanization" by targeting the environmental, social, and economic factors that influence the health and well-being of older adults [34]. "AARP and the WHO are working together with communities across the USA to encourage and promote age-friendly planning and policies that will allow communities to become places where adults can successfully age in place." [34] As a part of this effort, AARP State Research partnered with Education and Outreach to develop a survey—the 2015 AARP Age-Friendly Community Survey (AARP AFC)—to assess the eight domains of age-friendliness and livability identified by the WHO, which have been widely utilized in foreign countries [19, 35, 36]. AARP has been publishing annual reports on older adults' needs and availability of age-friendly features based on the data collected using the survey. However, it has not been used within peer-reviewed studies.

This study used a two-stage cluster sampling approach [37, 38]. In the first stage, AARP identified 14 communities across the USA that range in size and demographic makeup (convenience sampling): Atlanta, GA; Bangor, ME; Brownsville, TX; Dallas, TX; Fort Worth, TX; Houston, TX; Lansing, MI; Charlotte, NC; Philadelphia, PA; Phoenix, AZ; San Antonio, TX; Tallahassee, FL; Washington County, OR; and West Sacramento, CA. Five of these communities were in Texas, due to Texas's high-profile work on age-friendly communities and its high volume of AARP members. Among the 14 communities, a half of them (i.e., Atlanta, GA; Bangor, ME; Dallas, TX; Fort Worth, TX; San Antonio, TX; Tallahassee, FL; Sacramento, CA) has action plans to address communities' needs and to develop age-friendly communities.

There were two sampling approaches used within these 14 communities. In Atlanta, GA; Dallas, TX; Fort Worth, TX; and Houston, TX, a random sample of 2000 AARP members (aged over 50) for each community

was selected from AARP's membership database. In Bangor, ME; Brownsville, TX; Lansing, MI; Charlotte, NC; Philadelphia, PA; Phoenix, AZ; San Antonio, TX; Tallahassee, FL; Washington County, OR; and West Sacramento, CA, a 3000-person sample was recruited from each community from the listed address database of Survey Sampling International (SSI), a data solution provider for survey research (<https://www.surveysampling.com/>).

This survey was conducted by mail between June and October 2015. Respondents received the following pieces of mail from AARP: [1] pre-notification postcard, [2] survey, [3] reminder postcard, and [4] second survey copy. In each community, data collection was done over 4–8 weeks. The response rate ranged from 9.9 in Brownville, Texas to 31% in Fort Worth, Texas.

After collecting the surveys, VuPoint Research, a data service provider, entered the data. VuPoint Research weighted the sample by age, gender, and AARP membership to reflect the actual age and gender distribution as well as AARP membership in each community. The 2015 AARP membership database and the 2015 Nielsen Pop Facts Advanced demographic data were used for the weighting.

The 2015 AARP AFC Survey includes 5999 survey respondents, 5465 of whom were aged 50 and older. Among the age-eligible respondents, approximately 33% had missing values for at least one of the included variables. After excluding those with missing values, the analytic sample included 3650 respondents. Little's test of missing completely at random confirmed that the missing data are missing at random.

Measures

Dependent Variables AARP AFC includes two variables measuring participants' health status, self-rated health (SRH), and functional limitations. SRH was assessed using a single question: "In general, when compared to most people your age, how would you rate your health?" Respondents were asked to rate their overall health on a five-point Likert scale, on which 0 indicated *poor* and 4 indicated *excellent*. This variable was treated as a continuous variable (skewness = $- .42$). A single item self-reported health measure is a commonly used approach to assess overall health status due to its simplicity and effectiveness [39–41]. As a simple and reliable indicator of health status, self-reported health has been included in large-scale surveys, including

General Social Survey, Health and Retirement Study, National Health Interview Survey, and World Health Survey.

To measure functional limitations or chronic conditions that prevents older adults from performing activities, respondents were asked if they have any disability, handicap, or chronic disease that kept them from fully participating in work, school, housework, or other activities, with the response options 0 = *no* and 1 = *yes*. This measure has been used to assess disability or chronic diseases, activity limitations, and mobility in previous studies [42–44].

Independent Variables Adapting the WHO's age-friendly cities guidelines [11], the AARP AFC Survey included information on the availability of 66 age-friendly features in home and community under the eight domains (see Appendix Table 8) and respondents' perceived importance of each feature. Using the information, the perceived availability indices, which reflect respondents' awareness of age-friendly features available within the given home or community domain, and the person-environment fit indices, which captures congruence between perceived importance of (or personal needs) and perceived availability of the given home or community feature for each of the eight domains, were created.

For the perceived availability indices, the 66 age-friendly features were coded as 0 = *no/do not know* and 1 = *yes* so that an affirmative response essentially reflects perceived availability of the specified community feature by the respondent. For each of the eight domains, an average score of the *yes* responses was created, where higher scores indicate a greater perceived availability of age-friendly features within the home or community domain. The Cronbach's alpha for each domain to test reliability and internal consistency ranged from .75 to .91 (see Table 1).

For the person-environment fit indices, respondents' perceived importance was incorporated. No availability of an age-friendly feature when respondents' perceived importance of the feature is high was coded as 0 = *poor P-E fit* and the availability of an age-friendly feature when respondents' perceived importance of the feature is high was coded as 1 = *good P-E fit* to reflect different levels of person-environment fit. Regardless of its availability, low importance of age-friendly features was categorized as neutral P-E fit. The Cronbach's alpha for each domain to test reliability and internal consistency ranged from .77 to .90 (see Table 1).

Table 1 Reliability (Cronbach's alpha) of the perceived availability of age-friendly features indices and person-environment fit indices

Domain	Number of items	Perceived availability	Person-environment fit
Housing	7	0.78	0.79
Outdoor spaces and buildings	7	0.75	0.77
Transportation	14	0.86	0.85
Health and wellness	14	0.91	0.90
Social participation and inclusion	10	0.90	0.89
Volunteering and civic engagement	5	0.86	0.85
Job opportunities	3	0.85	0.83
Community information	6	0.80	0.82

Covariates

Sociodemographic characteristics include age (in years), gender (male (reference group), female), marital status (married/partnered (reference group), separated/divorced/widowed, never married), employment status (not working (reference group), working), race/ethnicity (non-Hispanic White/other (reference group), non-Hispanic Black, Hispanic), education (0 = K–12th grade (no diploma) to 6 = graduate or professional degree(s)), total household income (0 = less than \$10,000 to 7 = \$150,000 or more), social interaction (0 = less than once a week to 4 = more than once a day), and the length of time spent in the current community (0 = less than 5 years to 5 = 45 years or more).

Analysis Plan

First, descriptive information on the analytic sample was presented to provide an overview of the sample. Bivariate analyses were then conducted to assess the correlations between key variables. Lastly, multivariate analyses were conducted to examine the relationship between age-friendly community features and the self-reported health of older adults. Two-level null models were estimated, revealing that there was a statistically significant amount of variance to be explained at the neighborhood level for the health outcomes. Therefore, to adjust for the dependency of respondents due to clustering in the data, multi-level regression models (random intercept models) were estimated where individuals (level-1) are

nested within communities (level-2). Based on the press-competence model or environmental docility hypothesis [7], which argues that the influence of environments or resources are greater for individuals with low competence or less ability, stratified models by age were also estimated to test if respondents with older age are more influenced by the environments.

Results

Descriptive Statistics

Table 2 presents descriptive information on the analytic sample. The mean self-rated health score for the sample was 2.65 (SD = 0.98), which was between *good* and *very good*. Regarding physical limitation, 25.23% of respondents reported that they have physical limitations.

The average perceived availability of age-friendly features for most domains was between .15 and .58, meaning that, on average, respondents were aware of between 14% and 58% of the age-friendly features in the given domain that were available in their own community. The mean scores of transportation and health and wellness were .58 (SD = 0.29) and .51 (SD = 0.32), respectively, suggesting a relatively high perceived availability of age-friendly features in these domains. The mean values of volunteering and civic engagement, job opportunities, and community information were below .30. It is particularly noteworthy that the average for job opportunities was .14, which indicates a very low perceived availability.

Similarly, the average P-E fit score ranged from .29 to .59. Transportation ($M = .59$; $SD = 0.27$) and health and wellness ($M = .53$; $SD = 0.30$) had the highest P-E fit scores, while the average P-E fit scores of volunteering and civic engagement, job opportunities, and community information were .37 (SD = 0.31), .26 (SD = 0.30), and .34 (SD = 0.34) respectively, suggesting older adults' needs were not met in those domains.

Regarding sociodemographic characteristics, the majority of the sample was female (58.55%), married or partnered (47.87%), not working (59.93%), and non-Hispanic White/other (62.80%). The average age of respondents was 69.15 (SD = 10.10); the average education was 3.08 (SD = 1.97), which is about 2 years of college; the average income was 3.28 (SD = 1.91), which is about \$30,000–\$49,999; the average social interaction was 2.64 (SD = 1.31), which is between

Table 2 Descriptive information on the analytic sample

	M(SD)/%
Self-reported health (range 0–4)	2.65(0.98)
Physical limitation	
No physical limitation	72.81%
Physical limitation	25.23%
Perceived availability of age-friendly features (range 0–1)	
Housing	0.41(0.31)
Outdoor spaces and buildings	0.44(0.31)
Transportation	0.58(0.29)
Health and wellness	0.51(0.32)
Social participation and inclusion	0.41(0.36)
Volunteering and civic engagement	0.27(0.35)
Job opportunities	0.15(0.31)
Community information	0.24(0.28)
Person-environment fit (range 0–1)	
Housing	0.45(0.28)
Outdoor spaces and buildings	0.47(0.28)
Transportation	0.59(0.27)
Health and wellness	0.53(0.30)
Social participation and inclusion	0.50(0.29)
Volunteering and civic engagement	0.37(0.31)
Job opportunities	0.26(0.30)
Community information	0.34(0.34)
Age (in years) (range 65–101)	69.15(10.10)
Gender	
Male	41.02%
Female	58.55%
Marital status	
Married	47.87%
Separated/divorced/widowed	42.27%
Never married	9.06%
Work status	
Not working	59.93%
Working	31.25%
Race/ethnicity	
Non-Hispanic White/other	62.80%
Non-Hispanic Black	16.47%
Hispanic	9.24%
Education (range 0–6)	3.08(1.97)
Total household income (range 0–7)	3.28(1.71)
Social interaction (range 0–4)	2.64(1.31)
Length of time spent in the current community	2.69(1.67)

Higher value indicates better health, greater availability of age-friendly features, higher education, higher total household income, and more social interactions

several times a week and once a day; and the average length of time spent in the current community was 2.69 (SD = 1.67), which is between 15 and 35 years.

Bivariate Results

Table 3 presents pair-wise correlation analysis results among key variables. Correlations are in the expected direction. The eight domains of home and neighborhood environments were positively correlated with SRH and negatively correlated with functional limitations. The eight domains were also correlated with each other although the level of strength varied. Housing and outdoor spaces and buildings were strongly positively correlated with each other when it was measured using the perceived availability indices ($r = .64, p < .001$). Correlation between social participation and inclusion and volunteering and civic engagement was also strong (the perceived availability indices $r = .73, p < .001$; the person-environment fit indices $r = .62, p < .001$). Overall, correlations among domains were stronger when it was measured using the person-environment fit indices.

Multivariate Results

Perceived Availability of Age-Friendly Features and Self-Rated Health Table 4 presents the results of the multi-level linear regression models for the association between the perceived availability of age-friendly

features and self-reported health. A greater perceived availability of the features in the outdoor spaces and buildings ($b = 0.34, SE = 0.06, p < .001$) and transportation ($b = 0.16, SE = 0.07, p < .05$) domains was significantly associated with better self-rated health. However, the perceived availability of other domains was not associated with the outcome at a statistically significant level.

Sociodemographic factors, including being female, working, higher education, higher income, and frequent social interaction, were associated with better self-rated health, while being non-Hispanic Black and being Hispanic were negatively associated with the outcome.

Perceived Availability of Age-Friendly Features and Functional Limitations

The results of the mixed-level logistic regression models for the association between the perceived availability of age-friendly features and functional limitations are shown in Table 5. A unit increase in the perceived availability of age-friendly features in the housing domain was associated with a 60% increase in the odds of having functional limitations (OR = 1.60; SE = 0.27; $p < .01$). However, for a one-unit increase in the perceived availability of age-friendly features in the outdoor spaces and buildings, transportation, and social participation and inclusion domains, the odds of having functional limitations decreased by 53% (OR = 0.47; SE = 0.09; $p < .001$), 32% (OR = 0.68; SE = 0.14; $p < .10$), and 33% (OR = 0.67;

Table 3 Pairwise correlation

	1	2	3	4	5	6	7	8	9	10
1. Self-reported health		−0.45***	0.09***	0.16***	0.10***	0.08***	0.15***	0.09***	0.03	0.04**
2. Functional limitation	−0.45***		−0.02	−0.11***	−0.07***	−0.04**	−0.10***	−0.05***	−0.05	−0.02
3. Housing	−0.07***	0.04**		0.45***	0.42***	0.44***	0.43***	0.36***	0.28***	0.33***
4. Outdoor spaces and buildings	−0.08***	0.06***	0.64***		0.53***	0.44***	0.46***	0.39***	0.29***	0.36***
5. Transportation	−0.06***	0.04**	0.38***	0.44***		0.52***	0.42***	0.34***	0.25***	0.32***
6. Health and wellness	−0.05***	0.03*	0.33***	0.38***	0.45***		0.60***	0.48***	0.31***	0.41***
7. Social participation and inclusion	−0.05***	0.05***	0.27***	0.31***	0.35***	0.37***		0.62***	0.35***	0.44***
8. Volunteering and civic engagement	−0.04**	0.04**	0.26***	0.30***	0.33***	0.38***	0.73***		0.46***	0.50***
9. Job opportunities	−0.05***	0.05***	0.20***	0.22***	0.26***	0.28***	0.29***	0.33***		0.45***
10. Community information	−0.04**	0.03	0.25***	0.25***	0.30***	0.35***	0.36***	0.40***	0.56***	

Perceived availability (below diagonal) and person-environment fit (above diagonal)

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 4 Multi-level regression results explaining the association between the perceived availability of age-friendly community features and self-reported health

	Whole sample			Young-old			Old-old		
	<i>b</i>	(SE)		<i>b</i>	(SE)		<i>b</i>	(SE)	
Housing	−0.09	(0.06)		−0.05	(0.07)		−0.22	(0.12)	†
Outdoor spaces and buildings	0.34	(0.06)	***	0.28	(0.07)	***	0.53	(0.12)	***
Transportation	0.17	(0.07)	*	0.18	(0.08)	*	0.23	(0.14)	†
Health and wellness	−0.10	(0.07)		−0.10	(0.08)		−0.20	(0.14)	
Social participation and inclusion	0.11	(0.07)		0.13	(0.08)		0.05	(0.14)	
Volunteering and civic engagement	0.07	(0.07)		0.10	(0.07)		−0.07	(0.14)	
Job opportunities	−0.08	(0.06)		−0.06	(0.07)		−0.12	(0.13)	
Community information	−0.01	(0.07)		−0.03	(0.08)		0.13	(0.14)	
Age	0.00	(0.00)		0.02	(0.00)	***	−0.02	(0.01)	*
Gender (ref: male)									
Female	0.13	(0.03)	***	0.14	(0.04)	***	0.06	(0.07)	
Marital status (ref: married/partnered)									
Separated/divorced/widowed	0.06	(0.04)		0.01	(0.04)		0.20	(0.08)	**
Never married	0.01	(0.05)		−0.00	(0.06)		0.16	(0.19)	
Working status (ref: not working)									
Working	0.26	(0.04)	***	0.30	(0.04)	***	0.17	(0.11)	
Race/ethnicity (ref: non-Hispanic White)									
Non-Hispanic Black	−0.14	(0.04)	***	−0.09	(0.04)	*	−0.38	(0.09)	***
Hispanic	−0.07	(0.08)		−0.11	(0.09)		0.09	(0.20)	
Educational attainment	0.05	(0.01)	***	0.05	(0.01)	***	0.05	(0.02)	**
Total household income	0.11	(0.01)	***	0.12	(0.01)	***	0.09	(0.02)	***
Social interaction	0.06	(0.01)	***	0.05	(0.01)	***	0.09	(0.03)	***
Length in the current community	−0.01	(0.01)		−0.02	(0.01)		−0.00	(0.02)	
Constant	1.45	(0.14)	***	0.59	(0.21)	**	2.85	(0.52)	***
<i>N</i>	3650			2788			862		

† $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

SE = 0.13; $p < .05$), respectively. The perceived availability of the other domains was not associated with the outcome at a statistically significant level.

Sociodemographic factors, including working, higher education, and higher income, were associated with increased odds of having functional limitations, and older age was associated with decreased odds of having functional limitations.

Person-Environment Fit and Self-Rated Health Table 6 shows the results of the multi-level linear regression models for the association between P-E fit and self-reported health. A better P-E fit in the outdoor spaces and buildings ($b = 0.33$, SE = 0.07, $p < .001$) and transportation ($b = 0.21$, SE = 0.07, $p < .01$) domains was

significantly associated with better self-rated health. However, the perceived availability of other domains was not associated with the outcome at a statistically significant level.

Sociodemographic factors, including being female, working, higher education, higher income, and frequent social interaction, were associated with better self-rated health, while being non-Hispanic Black was negatively associated with the outcome.

Person-Environment Fit and Functional Limitations Table 7 presents the results of the multi-level logistic regression models for the association between P-E fit and functional limitation. A unit increase in the P-E fit score in the housing

Table 5 Multi-level regression results explaining the association between the perceived availability of age-friendly community features and functional limitation

	Whole sample			Young-old			Old-old		
	OR	(SE)		OR	(SE)		OR	(SE)	
Housing	1.60	(0.27)	**	1.66	(0.35)	*	1.41	(0.44)	
Outdoor spaces and buildings	0.47	(0.09)	***	0.56	(0.13)	*	0.34	(0.11)	**
Transportation	0.68	(0.13)	†	0.63	(0.16)	†	0.59	(0.21)	
Health and wellness	1.22	(0.24)		0.45	(0.35)		1.06	(0.39)	
Social participation and inclusion	0.67	(0.13)	*	0.51	(0.13)	**	1.26	(0.46)	
Volunteering and civic engagement	1.03	(0.20)		1.04	(0.25)		0.86	(0.31)	
Job opportunities	1.00	(0.18)		1.03	(0.21)		1.10	(0.37)	
Community information	1.33	(0.27)		1.31	(0.32)		1.04	(0.40)	
Age	0.99	(0.01)	*	0.95	(0.01)	***	1.07	(0.02)	***
Gender (ref: male)									
Female	0.92	(0.09)		0.96	(0.11)		0.90	(0.16)	
Marital status (ref: married/partnered)									
Separated/divorced/widowed	0.98	(0.10)		1.03	(0.13)		0.90	(0.18)	
Never married	0.83	(0.13)		0.80	(0.14)		0.83	(0.46)	
Working status (ref: not working)									
Working	0.22	(0.03)	***	0.16	(0.02)	***	0.53	(0.18)	†
Race/ethnicity (ref: non-Hispanic White)									
Non-Hispanic Black	0.93	(0.11)		0.90	(0.12)		1.22	(0.28)	
Hispanic	0.89	(0.14)		1.29	(0.35)		0.45	(0.29)	
Educational attainment	0.95	(0.02)	†	0.96	(0.03)		0.92	(0.04)	†
Total household income	0.74	(0.02)	***	0.72	(0.03)	***	0.86	(0.05)	*
Social interaction	1.00	(0.03)		1.08	(0.04)	†	0.81	(0.05)	**
Length in the current community	0.99	(0.03)		0.98	(0.03)		0.98	(0.05)	
<i>N</i>	3650			2788			862		

† $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

domain was associated with a 39% increase in the odds of having functional limitations (OR = 1.39; SE = 0.26; $p < .10$), although marginally significant. However, for a one-unit increase in the P-E fit score in the outdoor spaces and buildings, transportation, and social participation and inclusion domains, the odds of having functional limitations decreased by 48% (OR = 0.52; SE = 0.10; $p < .01$), 32% (OR = 0.68; SE = 0.14; $p < .10$), and 37% (OR = 0.63; SE = 0.14; $p < .05$), respectively. The perceived availability of the other domains was not associated with the outcome at a statistically significant level.

Sociodemographic factors, including working, higher education, and higher income, were associated with increased odds of having functional limitations.

Age Differences

Stratified models by age (the young-old (age 50–74 years) vs. the old-old (age 75 and above)) were estimated to test whether respondents with older age are more influenced by the environments. Overall, the results of stratified models showed similar patterns although the impact of the environments was greater among the old-old. For example, a greater perceived availability of age-friendly features in outdoor spaces and buildings was associated with 44% decrease in odds of having functional limitation among the young-old (OR = 0.56; SE = 0.13; $p < .05$), while the odds decreased by 66% among the old-old (OR = 0.34; SE = 0.11; $p < .01$).

Table 6 Multi-level regression results explaining the association between the person-environment fit and self-reported health

	Whole sample			Young-old			Old-old		
	<i>b</i>	(SE)		<i>b</i>	(SE)		<i>b</i>	(SE)	
Housing	−0.01	(0.07)		0.03	(0.08)		−0.11	(0.14)	
Outdoor spaces and buildings	0.33	(0.07)	***	0.29	(0.08)	***	0.51	(0.14)	***
Transportation	0.21	(0.07)	**	0.21	(0.08)	*	0.29	(0.15)	†
Health and wellness	−0.07	(0.07)		−0.04	(0.08)		−0.23	(0.15)	
Social participation and inclusion	0.12	(0.08)		0.12	(0.08)		0.06	(0.16)	
Volunteering and civic engagement	−0.01	(0.07)		−0.01	(0.08)		−0.09	(0.15)	
Job opportunities	−0.03	(0.06)		−0.04	(0.07)		−0.00	(0.13)	
Community information	−0.03	(0.07)		−0.05	(0.08)		0.15	(0.15)	
Age	0.00	(0.00)		0.02	(0.00)	***	−0.02	(0.01)	**
Gender (ref: male)									
Female	0.13	(0.03)	***	0.13	(0.04)	***	0.08	(0.07)	
Marital status (ref: married/partnered)									
Separated/divorced/widowed	0.07	(0.04)		0.01	(0.04)		0.24	(0.08)	**
Never married	0.02	(0.05)		−0.00	(0.06)		0.18	(0.19)	
Working status (ref: not working)									
Working	0.26	(0.04)	***	0.30	(0.04)	***	0.17	(0.11)	
Race/ethnicity (ref: non-Hispanic White)									
Non-Hispanic Black	−0.15	(0.04)	***	−0.10	(0.04)	*	−0.38	(0.09)	*
Hispanic	−0.09	(0.08)		−0.12	(0.09)		0.10	(0.20)	
Educational attainment	0.05	(0.01)	***	0.06	(0.01)	***	0.05	(0.02)	**
Total household income	0.11	(0.01)	***	0.12	(0.01)	***	0.09	(0.02)	***
Social interaction	0.06	(0.01)	***	0.05	(0.01)	***	0.08	(0.03)	**
Length in the current community	−0.01	(0.01)		−0.02	(0.01)		−0.00	(0.02)	
Constant	1.41	(0.14)	***	0.53	(0.21)	*	2.83	(0.53)	***
<i>N</i>	3650			2788			862		

† $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

Secondary Analysis

The results may be biased because one third of the sample was lost due to missing answers to at least one variable included in this study (see the “Data and Sampling” section). Missing data can cause problems, such as reduced statistical power and the representativeness of the sample as well as bias in the results [45]. To remove the potential bias and confirm the findings, additional analyses were conducted using twenty complete data sets that were created using multiple imputation by chained equations. The results using the imputed data were similar to the results presented in this study. The results of the secondary analyses are not shown here but are available upon request.

Discussion

There is a growing interest in fostering age-friendly environments to promote older adults’ health and well-being. This study investigated the importance of age-friendly community features or P-E fit in relation to health of older adults and provided more comprehensive evidence by using a multi-dimensional approach (i.e., the WHO’s eight environmental domains). Overall, the perceived availability awareness indices and the P-E fit indices and their association with SRH and functional limitations showed similar patterns, suggesting age-friendly environments—measured either as perceived availability of age-friendly features or P-E fit—play an important role in improving older adults’ health. Based on this finding, an availability or an existence of age-

Table 7 Multi-level regression results explaining the association between the person-environment fit and functional limitation

	Whole sample			Young-old			Old-old		
	OR	(SE)		OR	(SE)		OR	(SE)	
Housing	1.39	(0.26)	†	1.38	(0.32)		1.31	(0.47)	
Outdoor spaces and buildings	0.52	(0.10)	**	0.54	(0.13)	*	0.42	(0.16)	*
Transportation	0.68	(0.14)	†	0.65	(0.17)	†	0.59	(0.23)	
Health and wellness	1.03	(0.21)		1.13	(0.28)		1.00	(0.38)	
Social participation and inclusion	0.63	(0.14)	*	0.53	(0.14)	*	0.95	(0.40)	
Volunteering and civic engagement	1.28	(0.26)		1.38	(0.33)		1.11	(0.44)	
Job opportunities	1.04	(0.18)		1.13	(0.23)		1.10	(0.37)	
Community information	1.00	(0.21)		1.17	(0.30)		1.07	(0.02)	
Age	0.99	(0.01)		0.95	(0.01)	***	0.45	(0.18)	*
Gender (ref: male)									
Female	0.91	(0.91)		0.97	(0.11)		0.86	(0.16)	
Marital status (ref: married/partnered)									
Separated/divorced/widowed	1.00	(0.11)		1.04	(0.13)		0.93	(0.19)	
Never married	0.84	(0.14)		0.79	(0.14)		0.92	(0.51)	
Working status (ref: not working)									
Working	0.21	(0.03)	***	0.17	(0.02)	***	0.47	(0.17)	*
Race/ethnicity (ref: non-Hispanic White)									
Non-Hispanic Black	0.97	(0.12)		0.91	(0.13)		1.12	(0.28)	
Hispanic	1.07	(0.27)		1.38	(0.38)		0.27	(0.20)	†
Educational attainment	0.95	(0.02)	*	0.95	(0.03)		0.93	(0.04)	
Total household income	0.74	(0.02)	***	0.72	(0.03)	***	0.87	(0.05)	*
Social interaction	1.00	(0.03)		1.09	(0.04)	*	0.81	(0.05)	**
Length in the current community	0.98	(0.03)		0.98	(0.03)		0.97	(0.05)	
<i>N</i>	3650			2788			862		

† $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

friendly features could be used as an alternative to P-E fit if chosen carefully considering older adults' needs.

In this study, both a greater perceived availability of age-friendly features and a good P-E fit in the outdoor spaces and buildings domain were consistently associated at a statistically significant level with better self-rated health and a decreased risk of having functional limitations, which is consistent with the existing literature [18, 19, 28]. Physical activity, which has been identified as a protective factor in physical health [46–49], could be an explanation of this association. The outdoor spaces and buildings domain includes items asking the walkability of the neighborhood, such as green space, rest areas, neighborhood safety programs, and road conditions. Previous studies have found that high walkability in neighborhoods (e.g., park proximity, park quality, and neighborhood safety) is

associated with improved health-related behaviors, including physical activity [50–54].

Transportation, which includes transportation options and driving environments, was also associated with both self-rated health and functional limitations. Numerous studies have reported similar results on the association of transportation options and driving environments with older adults' health [19, 55, 56]. This may be because transportation allows older adults to access numerous essential services and activities, including health services [57, 58], nutrition sources [59, 60], and social participation [61–63].

In the stratified model, the old-old were more impacted by the age-friendliness of the outdoor spaces and buildings and transportation, compared with the young-old. This finding supports the press-competence model or environmental docility hypothesis, which asserts that

the influence of environments is greater for individuals with low competence or less ability. Individuals' competence or ability may be decreased due to changes that they experience as age, such as reduced income, limited mobility, and loss of close relationships, and it may prevent them from participating in physical activities or accessing needed resources in less supportive environments. Therefore, promoting built environments and providing transportation options for older adults, especially for the old-old, may help them to maintain their health and stay active and independent.

Social participation and inclusion, which includes items assessing accessibility (e.g., location and information) and affordability as well as variety of social activities and events in the community, was significantly associated with a decreased risk of having functional limitations. Previous studies have also reported a positive association between social participation and physical health, including self-perceived health and disability [64–66]. Social networks and relationships built through social participation may be a potential reason for this result as they are valuable resources in later life that provide instrumental supports [67].

Unlike other domains, a greater availability of age-friendly features in the housing domain was associated with a greater risk of having functional limitations. The housing domain includes items involving the condition, accessibility, and affordability of housing as well as related services (e.g., repair, lawn work, snow removal). This result may occur because older adults with functional limitations prefer to live in a community that has more age-friendly features in the housing domain or are more aware of the age-friendly features (so they have a greater perceived availability) compared with others without such conditions, since these features can help complement their loss of functionality [68, 69]. A longitudinal analysis should be conducted to clarify the relationship.

Other domains were not significantly associated with the outcomes. However, this does not mean that these domains are less importance. Since the WHO's age-friendly cities guidelines were developed to improve health and well-being, domains that were not significantly associated with health may be associated with other indicators of well-being, such as psychological health, residential satisfaction, and social participation. The impact of the eight domains on other well-being outcomes was not examined in this study due to the unavailability of the information in the AARP AFC data. Further research investigating the association would be necessary

for the holistic understanding and the comprehensive development of age-friendly communities.

Limitations

Although the inclusion of various items assessing age-friendly community features is a unique advantage of the AARP AFC, there are several limitations to the data. The AARP AFC used a cross-sectional design, which limited our ability to assess the causality of the association.

For example, it is possible that healthy older adults tend to live in the communities with more age-friendly feature rather than the opposite. Most previous studies, including this study, have been cross-sectional primarily due to the lack of longitudinal data with information on age-friendly environments. There are several longitudinal studies available, such as the American Housing Survey and the Health and Retirement Survey, but a number of variables that assess home and community environments in these studies are limited. Therefore, the development of longitudinal data with comprehensive environmental information is crucial towards confirming the causal relationship between age-friendly environments and older adults' health and well-being.

Another limitation of this study is generalizability. Although the AARP AFC data were weighted to reflect the demographic characteristics of each community, the sample of this study is not representative of the entire US population. Therefore, additional research must be conducted to confirm if the findings can be applied to older adults in other communities.

Conclusion

This study is among the first to examine an association between age-friendly environments and the health of older Americans by using a multi-dimensional approach. Living in supportive environments—or communities with a greater availability of age-friendly features and a good person-environment fit—was associated with improved health. These findings add to the growing evidence that age-friendly environments influence healthy aging. They also highlight the importance of age-friendly features in the outdoor spaces and buildings, transportation, and social participation and inclusion domains when fostering age-friendly environments that support the health and independence of older adults.

Based on the findings, adopting age-friendly policies and city planning in those domains may be the most effective and efficient way to promote age-friendliness of a community and health of older residents.

Acknowledgements This study is a part of the author's doctoral dissertation at Boston College and the author would like to thank dissertation committee members: Drs Christina Mats, James Lubben, and Sara M. Moorman. The author is especially grateful for Dr Christina Mats who provided wonderful guidance on developing and writing the earlier draft of this manuscript. The author also would like to thank Dr Eileen M. Crimmins for reviewing the current version of the manuscript.

Funding information This work was supported by the National Institute on Aging [T32-AG000037].

Appendix

Table 8 Age-friendly home and community features

Domain 1: housing
a. Home repair contractors who are trustworthy, do quality work, and are affordable
b. Well-maintained homes and properties
c. A home repair service for low-income and older adults that helps with things like roof or window repairs
d. Seasonal services such as lawn work or snow removal for low-income and older adults
e. Affordable home options for adults of varying income levels such as older active adult communities, assisted living, and communities with shared facilities and outdoor spaces
f. Homes that are equipped with things like a no step entrance, wider doorways, grab bars in bathrooms, and first floor bedrooms and bathrooms
g. Well-maintained and safe low-income housing
Domain 2: outdoor spaces and buildings
a. Well-maintained and safe parks that are within walking distance of your home
b. Public parks with enough benches
c. Sidewalks that are in good condition, free from obstruction, and are safe for pedestrian use and accessible for wheelchairs or other assistive mobility devices
d. Well-maintained public buildings and facilities that are accessible to people of different physical abilities
e. Separate pathways for bicyclists and pedestrians
f. Well-maintained public restrooms that are accessible to people of different physical abilities
g. Neighborhood watch programs

Table 8 (continued)

Domain 3: transportation
a. Accessible and convenient public transportation
b. Affordable public transportation
c. Well-maintained public transportation vehicles
d. Reliable public transportation
e. Safe public transportation stops or areas
f. Special transportation services for people with disabilities and older adults
g. Well-maintained streets
h. Easy to read traffic signs
i. Enforced speed limits
j. Public parking lots, spaces, and areas to park
k. Affordable public parking
l. Well-lit, safe streets and intersections for all users (pedestrians, bicyclists, drivers)
m. Audio/visual pedestrian crossings
n. Driver education/refresher courses
Domain 4: health and wellness
a. Health and wellness programs and classes in areas such as nutrition, smoking cessation, and weight control
b. Fitness activities specifically geared towards older adults
c. Conveniently located health and social services
d. A service that helps seniors find and access health and supportive services
e. Conveniently located emergency care centers
f. Easy to find information on local health and supportive services
g. Home care services including health, personal care, and housekeeping
h. Well-trained certified home health care providers
i. Affordable home health care providers
j. Well-maintained hospitals and health care facilities
k. A variety of health care professionals including specialists
l. Health care professionals who speak different languages
m. Easily understandable and helpful local hospital or clinic answering services
n. Respectful and helpful hospital and clinic staff
Domain 5: social participation and inclusion
a. Conveniently located venues for entertainment
b. Activities specifically geared towards older adults
c. Activities that offer senior discounts
d. Activities that are affordable to all residents
e. Activities that involve both younger and older people
f. Accurate and widely publicized information about social activities
g. A variety of cultural activities for diverse populations
h. Local schools that involve older adults in events and activities
i. Continuing education classes
j. Social clubs such as book, gardening, craft, or hobby
Domain 6: volunteering and civic engagement
a. A range of volunteer activities to choose from
b. Volunteer training opportunities to help people perform better in their volunteer roles
c. Opportunities for older adults to participate in decision-making bodies such as community councils or committees
d. Easy to find information on available local volunteer opportunities
e. Transportation to and from volunteer activities for those who need it

Table 8 (continued)

Domain 7: job opportunities

- A range of flexible job opportunities for older adults
- Job training opportunities for older adults who want to learn new job skills within their job or get training in a different field of work
- Jobs that are adapted to meet the needs of people with disabilities

Domain 8: community information

- Access to community information in one central source
- Clearly displayed printed community information with large lettering
- An automated community information source that is easy to understand like a toll-free telephone number
- Free access to computers and the Internet in public places such as the library, senior centers, or government buildings
- Community information that is delivered in person to people who may have difficulty or may not be able to leave their home
- Community information that is available in a number of different languages

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