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Patterns of cancer-related health behaviors among middle-aged and older adults: Individual- and area-level socioeconomic disparities

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Abstract

Multiple health behaviors could have greater impact on chronic diseases than single behaviors, but correlates of behavioral clusters are relatively understudied. Using data from NIH-AARP Diet and Health Study (initiated in 1995) for 324,522 participants from the U.S. (age 50–71), we conducted exploratory factor analysis to identify clusters of adherence to eight cancer prevention behaviors. Poisson regressions examined associations between cluster scores and neighborhood socioeconomic deprivation, measured with census block group (1) poverty and (2) low education. Four clusters emerged: Movement (adequate physical activity/less TV); Abstinence (never smoked/less alcohol); Weight control (healthy body mass index/high fruits and vegetables); and Other (adequate sleep/receiving cancer screenings). Scores on all clusters were lower for participants in neighborhoods with the highest poverty (most deprived quintile versus least deprived: relative risk [RR]=0.95 (95% confidence interval[CI]=0.94–0.96) for Movement, 0.98 (95% CI=0.97–0.99) for Abstinence, 0.94 (95% CI=0.92–0.95) for Weight control, and 0.94 (95% CI=0.93–0.95) for Other; all p<.001). Scores on three clusters were lower for participants in neighborhoods with the lowest education (RR=0.88 (95% CI=0.87–0.89) for Movement, 0.89 (95% CI=0.88–0.90) for Weight control, and 0.90 (95% CI=0.89–0.91) for Other; all p<.001). Health behaviors among older adults demonstrated four clusters. Neighborhood deprivation was associated with lower scores on clusters, suggesting that interventions to reduce concentrated deprivation may be an efficient approach for improving multiple behaviors simultaneously.

Keywords

Cancer; cancer prevention; multiple health behaviors; area socioeconomic status; socioeconomic deprivation; older adults

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The National Cancer Institute estimated that the 2016 cancer incidence rate was 454 per 100,000 people per year (Howlader et al., 2016) in the United States. Many of these cases will be detected in adults ages 65 years of older (Howlader et al., 2016). However, up to 50% of cancer cases could be prevented through behavior change (Song and Giovannucci, 2016), including avoiding smoking, limiting alcohol use, consuming a healthy diet, and maintaining a physically active lifestyle.

Many Americans fail to meet these guidelines and remain at excess risk of cancer (Kabat et al., 2015; Song and Giovannucci, 2016; Warren Andersen et al., 2016). Epidemiologic research has evaluated correlates of cancer prevention behaviors, finding consistent differences by factors such as race/ethnicity (Wang and Beydoun, 2007; Williams and Collins, 1995) and individual- or area-level socioeconomic status (Braveman et al., 2010; Wang and Beydoun, 2007; Williams and Collins, 1995). Less research has examined how behaviors overlap with one another, but evidence suggests that individuals who engage in one prevention behavior are more likely to engage in others (Berrigan et al., 2003; Kabat et al., 2015; Patterson et al., 1994; Pronk et al., 2004). For example, individuals who routinely consume high numbers of fruits and vegetables are more likely to be physically active and individuals who smoke are more likely to be heavy drinkers (Berrigan et al., 2003; Patterson et al., 1994). To date, most research on clusters of health behaviors have focused on individual-level correlates, with less analysis of area-level correlates.

Intervening to affect overlapping clusters of health behaviors may be more efficient than single-behavior interventions for resource allocation and impact on public health (Noar et al., 2008; Prochaska et al., 2008). A better understanding of the prevalence of these clusters as well as their individual- and area-level correlates could inform interventions aiming to change multiple health behaviors with the goal of reducing cancer risk.

In this study, we leveraged data from a cohort study including more than half a million participants, the National Institutes of Health (NIH)-AARP Diet and Health Study (Schatzkin et al., 2001) (formerly, the American Association of Retired Persons (AARP)), to understand the epidemiology of clusters of health behaviors related to cancer risk, examining intrapersonal and neighborhood correlates of these clusters. The findings from this analysis could inform future interventions aiming to improve cancer prevention behaviors among middle-aged and older adults.

Methods

Data source

The NIH-AARP Diet and Health Study is a prospective study of individuals who were members of AARP, focusing on the relationship between dietary factors and health among middle-aged and older adults (Schatzkin et al., 2001). Eligible participants were ages 50–71 years (selected to optimize analysis of cancer outcomes) and lived in selected states and metropolitan areas (California; Florida; Pennsylvania; New Jersey; North Carolina; Louisiana; Atlanta, Georgia; or Detroit, Michigan). In 1995–1996, NIH-AARP sent baseline questionnaires (primarily asking about diet and lifestyle factors related to health) to 3.5 million AARP members, and 567,169 eligible participants returned

completed questionnaires (~18% response rate). In 1996–1997, NIH-AARP sent additional questionnaires focused on risk behaviors to the baseline cohort. Data collection for NIH-AARP was approved by the institutional review board of the National Cancer Institute. More details on the design and administration of NIH-AARP are available (Schatzkin et al., 2001).

Analytic Sample

The current analysis draws upon data from participants who completed both the baseline and risk factor questionnaires (n=334,921). Additional exclusion criteria included having a proxy respondent on either questionnaire (i.e., if another person filled out the questionnaire on behalf of the participant), not providing an address at baseline, and having a cancer diagnosed before completing the baseline questionnaire. Thus, the analytic sample comprised 324,522 participants.

Measures

Cancer prevention behaviors.—Behavioral variables of interest in the present study included adherence or non-adherence to several guidelines from national organizations (when available) or recent scientific research about cancer risk reduction (Song and Giovannucci, 2016). We created dichotomous indicators of whether participants had never smoked (U. S. Department of Health Human Services, 2014); had a body mass index (BMI) of $<25 kg/m^2$ at baseline (NHLBI Obesity Education Initiative, 2010); consumed ≥2 fruits and 3 vegetables per day (Department of Health and Human Services, 2015); engaged in ≥60 minutes of physical activity per week (Office of Disease Prevention and Health Promotion, 2008); consumed ≤2 servings of alcohol per day (Department of Health and Human Services, 2015); slept ≥7 hours per night (Office of Disease Prevention and Health Promotion, 2018); spent ≤2 hours per day watching television (Keadle et al., 2015; Matthews et al., 2008; Patel et al., 2010); and had received selected cancer screenings in the past 3 years (males: received screenings for colorectal and prostate cancer; females: received screenings for colorectal, breast, and ovarian cancer) (Centers for Disease Control and Prevention, 2012). Complete details about item wording are available through the NIH-AARP Diet and Health Study website (www.dietandhealth.cancer.gov). Each variable was coded such that *1* indicated that the participant engaged in the behavior and *0* indicated that the participant had not engaged in the behavior.

Socioeconomic factors.—Each participant's residential address at baseline was linked to census block groups (99% of participants in the analytic sample were matched), which we used as a proxy for participants' neighborhood. Using data from the 2000 U.S. Census, neighborhood socioeconomic deprivation was estimated with two measures (Krieger et al., 2002): (1) the percent of residents (all ages) in each census block group living below the federal poverty line, and (2) the percent of adults (ages 18+ years) in each census block group with less than a high school degree. Data were divided into quintiles based on the distribution of the sample, with 20% of participants in each quintile. Quintiles were scored such that the first quintile was the least socioeconomically deprived while the fifth quintile was the most deprived.

Covariates.—We controlled for individual-level sociodemographic and health information. Sociodemographic covariates were sex (male or female); age category at baseline (<65 years or 65+ years); race/ethnicity (non-Hispanic white or other, due to small sample sizes in the non-white categories (Schatzkin et al., 2001)); marital status (married/living as married or other); and educational attainment (high school degree or less, or more than high school degree). We used self-reported health status (less than very good, or excellent or very good) to summarize baseline health.

Statistical analysis

First, we conducted a descriptive analysis of participants' health behaviors. We estimated the prevalence of engaging in each behavior and generated a phi correlation matrix of the correlations among each pair of behaviors (Stokes et al., 2012). The phi correlation coefficient summarizes correlations between dichotomous variables and theoretically ranges from −1 to +1. Then, we conducted an exploratory factor analysis to determine which behaviors clustered together. Specifically, we implemented a principal component analysis with an oblique promax rotation (Kim and Mueller, 1978) for all eight behaviors. We retained factors with eigenvalues greater than 1 (n=4) and examined which factor each of the behaviors loaded on most strongly. We created factor scores by summing (with equal weights) participants' responses on the behaviors that loaded on each factor. We examined the associations between scores on each factor and the socioeconomic factors and covariates by conducting chi-square tests.

Next, we examined the associations between neighborhood socioeconomic deprivation and scores on the factors. Using multivariable Poisson regression to model the "count" scores on each factor, we modeled the association between participants' poverty or education quintile and each health behavior score, adjusting for covariates. We had greater than 90% power to detect an association between neighborhood SES quintile and the dependent variables, assuming an alpha of .05 and based on the observed distribution of health behavior factors scores.

Finally, we examined the cross-level interactions between socioeconomic deprivation and covariates with health behavior scores. We repeated the Poisson regressions with multiplicative interaction terms for the product of neighborhood poverty or education quintile and each covariate. Wald chi-square tests analyzed whether each interactions term contributed significantly to the model. If so, we probed the interactions by stratifying models across levels of the covariates.

Supplementary analyses included alternate combinations of behaviors. We examined the associations between neighborhood socioeconomic deprivation and (1) an *a priori* factor summing participants' scores on four behavioral recommendations from the American Cancer Society (ACS) (Kabat et al., 2015; Kushi et al., 2012) (having a healthy BMI, engaging in frequent physical activity, high fruit and vegetable consumption, and low alcohol consumption) and (2) an additive index of all eight health behaviors. In addition, we examined the associations between neighborhood poverty and education (simultaneously) with health behavior scores. All analyses were conducted using SAS version 9.3 (Cary, NC).

Statistical tests used a two-sided *p* value of .05. The present analysis was approved by the NIH-AARP Diet and Health Study Steering Committee.

Results

Of 324,522 participants, 58.0% were male and 42.0% were female. Most participants were non-Hispanic white (92.5%) and had attained more than a high school degree (64.1%).

Engagement in prevention behaviors ranged from 35.1% (low television watching) to 88.6% (low alcohol consumption) (Table 1), and almost all behaviors were significantly correlated with each other. Only four pairs of behaviors had phi coefficients ≥0.100: never smoked with low alcohol consumption (φ=0.136); healthy BMI with high physical activity (φ=0.103); healthy BMI with low television watching (φ=0.107); and high fruit and vegetable consumption with high physical activity (φ=0.135) (all $p<.001$) (Table 1).

Health behavior factor analysis

Four health behavior factors emerged. Two health behaviors loaded on the first factor, which we described as “Movement”: high physical activity (standardized factor loading=0.56) and low television watching (loading=0.52). Two behaviors loaded on the second factor, “Abstinence”: never smoked (loading=0.57) and low alcohol consumption (loading=0.70). Two behaviors loaded on the third factor, “Weight control”: healthy BMI (loading=−0.53) and high fruit and vegetable consumption (loading=0.55). Finally, two behaviors loaded on the fourth factor, “Other”: adequate sleep (loading=0.57) and received all recent cancer screenings (loading=0.60) (for all factor loadings, see Supplementary Table S1).

Overall, 19% of the sample scored the maximum (2) on Movement; 35% of the sample scored the maximum on Abstinence; 16% on Weight control; and 44% on Other (Table 2). The mean scores were 0.83 for Movement, 1.25 for Abstinence, 0.79 for Weight control, and 1.31 for Other. Health behavior scores differed across all sociodemographic variables and covariates (all $p<.001$). For example, 21% of participants living in the least deprived neighborhoods, as measured by poverty quintile, scored the maximum on Movement (mean score=0.89, 95% confidence interval [CI]=0.88–0.89) compared to 16% of participants in the most deprived neighborhoods (mean score=0.77, 95% CI=0.76–0.77). Individuals with higher educational attainment and in excellent or very good health had higher scores than their counterparts on all four factors. Males and individuals who were married/living as married had higher scores than their counterparts on the Movement and Other factors but lower scores on the Abstinence and Weight Control factors.

Associations between neighborhood poverty and health behavior scores

Greater neighborhood poverty was associated with lower scores on all health behavior factors (Table 3). For example, compared to the first poverty quintile (least deprived), participants in the fifth quintile (most deprived) had a relative risk (RR) for scores on Movement of 0.95 (95% CI=0.94–0.96), on Abstinence of 0.98 (95% CI=0.97–0.99), on Weight control of 0.94 (95% CI=0.92–0.95), and on Other of 0.94 (95% CI=0.93–0.95). These associations adjusted for the covariates, all of which were also significantly associated with health behavior factors (except for age group and Abstinence).

Several cross-level interactions between neighborhood poverty and covariates were observed. For example, the negative association between poverty quintile and Abstinence was limited to the males (Figure 1A; interaction $p<.001$), but the negative association with Weight control was stronger for females than males (Figure 1B; interaction $p<.001$). In addition, the negative association between poverty quintile and Movement was limited to participants with more than a high school degree (Figure 2A; interaction $p<.001$).

Associations between neighborhood education and health behavior scores

Greater concentrations of residents with low education in a neighborhood were associated with lower scores on Movement, Weight control, and Other health behavior factors (Table 4). Compared to the first education quintile, participants in the fifth quintile had an RR for scores on Movement of 0.88 (95% CI=0.87–0.89), on Weight control of 0.89 (95% CI=0.88–0.90), and on Other of 0.90 (95% CI=0.89–0.91). Notably, no association was observed between neighborhood education and Abstinence. These associations adjusted for the covariates, most of which were also associated with health behavior factors.

Again, several cross-level interactions between neighborhood education and covariates were observed. For example, the association between education quintile and Abstinence was negative for males but positive for females (Figure 1C; interaction $p<.001$). The negative association between education quintile and Weight control was stronger for females than males (Figure 1D; interaction $p<.001$). In addition, the negative association between education quintile and Movement was stronger for participants with more than a high school degree compared to those with a high school degree or less (Figure 2B; interaction $p<.001$).

Supplementary analyses

The results of the revised Poisson regressions demonstrated findings consistent with the main analysis: increasing quintiles of neighborhood deprivation were associated with lower scores on the ACS behavior factor and the eight-point index (Supplementary Table S2). For example, compared to the first poverty quintile, participants in the fifth quintile had an RR of 0.98 (95% CI=0.97–0.98) for the ACS behavior factor and of 0.95 (95% CI=0.95–0.96) for the eight-point index. Compared to the first education quintile, participants in the fifth quintile had an RR of 0.95 (95% CI=0.94–0.96) for the ACS behavior factor and of 0.92 (95% CI=0.92–0.93) for the eight-point index.

When modelling the association between each health behavior score and neighborhood poverty and education quintiles simultaneously (Supplementary Table S3), the negative associations with education for Movement, Weight control, and Other were maintained after controlling for poverty (which, generally, was no longer associated with these scores). For Abstinence, the negative association with poverty maintained statistical significance, but education was not generally associated with Abstinence (in the main analysis or in this model).

Discussion

In an analysis of more than 300,000 middle-aged and older U.S. adults, eight cancer prevention behaviors clustered into four factors: adequate physical activity and low TV

watching (Movement); never having smoked and low alcohol consumption (Abstinence); healthy BMI and high fruit and vegetable consumption (Weight control); and adequate sleep and receiving selected cancer screenings (Other). We found less engagement in these behavioral clusters for those living in more deprived neighborhoods compared to their counterparts in less deprived neighborhoods.

The behaviors examined in this study are associated with cancer risk (Kushi et al., 2012; Song and Giovannucci, 2016). Some of the four behavioral clusters have been examined in other studies. For example, the overlap of smoking and alcohol use (Abstinence) has been demonstrated previously (Berrigan et al., 2003; Patterson et al., 1994). These two behaviors are independently associated with about 27% (Peto et al., 1994) and 4% (Boffetta et al., 2006) of cancer deaths, respectively. Based on their overlap, interventions to simultaneously discourage smoking and to moderate alcohol use may be more efficient than programs targeting just one behavior (Prochaska et al., 2008). Given the clustering of high physical activity and low television viewing (Movement), interventions to replace television viewing with physical activity may be especially effective at improving health (although much of this work has focused on children (Jenvey, 2007)).

Engagement in the clusters of cancer prevention behaviors varied by neighborhood poverty. Scores for all four factors were lower in the more deprived census block groups (i.e., with higher levels of poverty) compared to less deprived areas, even after controlling for individual-level covariates. Previous studies have demonstrated negative associations between neighborhood poverty and health behaviors (Datta et al., 2006; Kershaw et al., 2013). The associations in the present study were relatively small (RR=0.94–0.98 across factors); however, at the population level, these associations could translate into substantial public health impact (Rose, 2001), especially given the compounding risk of engaging in multiple risk behaviors (Warren Andersen et al., 2016). Some of the associations between neighborhood poverty and health behavior scores were moderated by individual-level characteristics. For instance, the negative association between neighborhood poverty and Movement was only statistically significant among participants with higher educational achievement. The observed interaction could indicate that the association for individual-level education was more important than the association for neighborhood-level SES with healthy BMI and fruit and vegetable consumption.

In addition, health behavior scores varied by neighborhood education level, consistent with previous studies (Finch et al., 2010; Ross, 2000). Scores for three factors were lower in more deprived census block groups compared to less areas. These associations were larger than those observed for neighborhood poverty (RR=0.88–0.90 versus RR=0.94–0.98, respectively) and were maintained even after controlling for neighborhood poverty in supplementary analysis. Notably, Abstinence scores did not vary by neighborhood education level. Previous studies have demonstrated higher rates of smoking in more deprived neighborhoods (Cubbin et al., 2001; Ross, 2000), but the associations for drinking are mixed (Fone et al., 2013; Stimpson et al., 2007); it could be that the combination of these two behaviors (with potentially opposing associations with deprivation) into one factor resulted in a net null finding. In interaction analyses, the association between neighborhood education and Abstinence was positive for females but negative for males.

A potential confound for this relationship is relation: Individuals with higher levels of religiosity are more likely to live in deprived neighborhoods (Hoverd et al., 2013) and more likely to abstain from substance use (Chitwood et al., 2008; Strawbridge et al., 2001). Further, this association between religiosity and abstinence tends to be stronger for women than for men (Parenteau, 2017; Strawbridge et al., 2001). Additional multilevel studies are needed to explicate the relationships among neighborhood-level SES and individual-level sex, religiosity, and substance use. However, the main effects and interactions for Abstinence with neighborhood education were slightly different from those demonstrated for neighborhood poverty (Tables 3 and 4; Figure 1A and 1C), which speaks to issues around indicators of area-level SES and what they capture (Krieger et al., 2002). That is, while there is overlap, neighborhoods classified as deprived in terms of poverty may not be the same neighborhoods that are classified as deprived in terms of education, and resources supporting Abstinence (e.g., cessation tools, lower density of tobacco and alcohol outlets) may vary across these areas (Cantrell et al., 2015; Diez Roux and Mair, 2010).

These findings may have implications for public health interventions aiming to reduce cancer risk, particularly among older adults. Increasingly, research suggests that intervening on multiple behaviors simultaneously can be more effective and efficient (Prochaska et al., 2008; Warren Andersen et al., 2016). In the present study, we observed consistently lower engagement in multiple health behaviors in more deprived neighborhoods compared to less deprived neighborhoods. Although more research is needed, it is possible that programs to improve neighborhood-level poverty and education levels (Berkman et al., 2014), or to ameliorate the deleterious effects of concentrated disadvantage on health (Finch et al., 2010; Massey, 1996), could be useful for increasing multiple cancer prevention behaviors concurrently.

In terms of study limitations, the NIH-AARP data used in the present analysis were observational and cross-sectional, limiting our ability to draw causal inferences. In addition, engagement in health behaviors was self-reported, which may be subject to social desirability bias (Johnson et al., 2005). The data were collected in the mid-1990s among primarily non-Hispanic white middle-aged and older adults, which limits the generalizability of the results to other periods or groups. The response rate could have introduced bias if people who engaged in fewer preventive behaviors were less likely to respond. Alternative methods of classifying health behaviors and creating clusters could result in different relationships with neighborhood SES; to begin to address this concern, we ran the two supplementary analyses using alternative methods, but found overall similar results to the main analysis. As with all studies, not all relevant variables were included; important variables, such as participants' household income, were not collected (Schatzkin et al., 2001) and thus excluded from the analysis.

In terms of study strengths, we used data from a large, geographically-diverse cohort. We evaluated engagement with health behaviors documented to influence cancer (Song and Giovannucci, 2016). This research represents a synthetic analysis of multiple health behaviors, advancing the work of numerous previous studies examining one or two health behaviors in isolation. Our results were consistent across neighborhood sociodemographic

variables (poverty and education) and across supplementary analyses, increasing our confidence in the validity of the observed associations.

Conclusions

Among middle-aged and older U.S. adults, we found that eight cancer prevention behaviors clustered into four behavioral factors. Scores on these factors demonstrated consistent negative associations with neighborhood deprivation measured by poverty and education. Theoretical and intervention work on multiple behavior change suggests that intervening on more than one health behavior can be efficient at improving public health (Prochaska et al., 2008; Warren Andersen et al., 2016). Future studies should seek to establish causal associations between neighborhood deprivation and health behavior clusters to support the development of multiple health behavior change interventions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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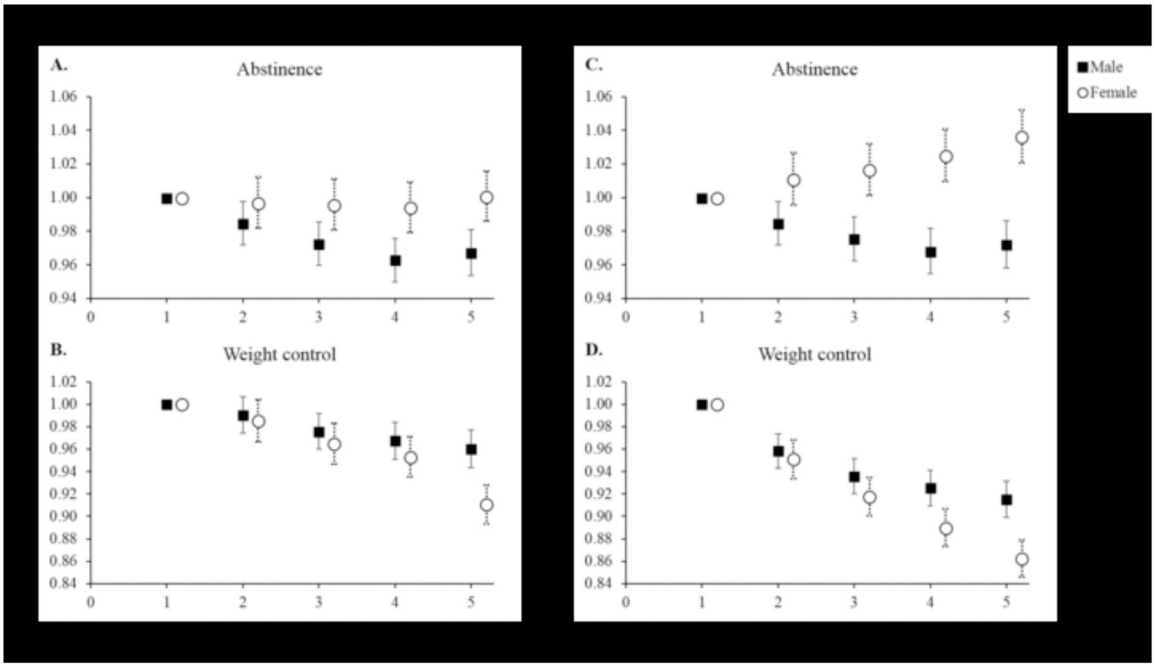

Fig. 1.

Cross-level interactions between neighborhood poverty quintiles (panels A–B) and education quintiles (C–D) with participant sex in their association with selected health behavior factors among NIH-AARP participants. Error bars are 95% confidence intervals. RR=relative risk

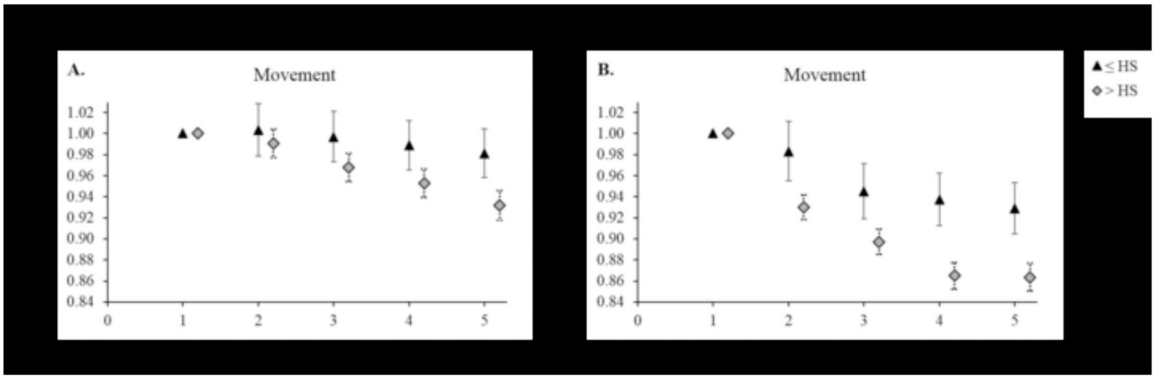

Figure 2.

Cross-level interactions between neighborhood poverty quintiles (panel A) and education quintiles (B) with participant educational attainment in their association with selected health behavior factors among NIH-AARP participants. Error bars are 95% confidence intervals. RR=relative risk; HS=high school degree

Table 1.

Prevalence of and phi correlations among health behaviors of NIH-AARP participants.

		(1)		(2)		(3)		(4)		(5)		(6)		(7)	
	%	*φ*	*p*	*φ*	*p*	*φ*	*p*	*φ*	*p*	*φ*	*p*	*φ*	*p*	*φ*	*p*
(1) Never smoked	36.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--
(2) Healthy BMI	37.0	0.047	***	--	--	--	--	--	--	--	--	--	--	--	--
(3) High F&V consumption	42.3	0.056	***	0.006	**	--	--	--	--	--	--	--	--	--	--
(4) High physical activity	47.4	0.017	***	**0.103**	***	**0.135**	***	--	--	--	--	--	--	--	--
(5) Low alcohol consumption	88.6	**0.136**	***	0.006	***	0.027	***	−0.011	***	--	--	--	--	--	--
(6) 7+ hours sleep/night	65.3	0.004	*	0.048	***	0.000		0.033	***	−0.048	***	--	--	--	--
(7) Low TV watching	35.1	0.083	***	**0.107**	***	0.048	***	0.073	***	0.010	***	0.035	***	--	--
(8) All recent screenings	65.8	−0.002		−0.011	***	0.044	***	0.066	***	−0.005	**	0.033	***	0.032	***

Note. Boldface indicates correlation magnitude greater than 0.10. BMI=body mass index; F&V=fruit and vegetable; TV=television.

* $p<.05$;

** $p<.01$;

*** $p<.001$.

Table 2.

Prevalence of achieving each score, and mean score, on four health behavior factors, overall and by sociodemographic variables, among NIH-AARP participants.

	Factor 1: Movement					Factor 2: Abstinence					Factor 3: Weight control					Factor 4: Other				
	%			M	95% CI	%			M	95% CI	%			M	95% CI	%			M	95% CI
	0	1	2			0	1	2			0	1	2			0	1	2		
Overall	35	46	19	0.83	(0.83–0.83)	9	56	35	1.25	(1.25–1.26)	36	48	16	0.79	(0.79–0.80)	13	44	44	1.31	(1.31–1.31)
Poverty quintiles																				
1 (least deprived)	32	46	21	0.89	(0.88–0.89)	10	55	36	1.26	(1.26–1.27)	35	48	17	0.82	(0.82–0.83)	10	42	47	1.37	(1.36–1.38)
2	33	46	20	0.87	(0.86–0.87)	10	56	35	1.25	(1.25–1.26)	35	48	17	0.81	(0.81–0.82)	11	43	46	1.35	(1.34–1.35)
3	35	46	18	0.83	(0.83–0.84)	9	56	34	1.25	(1.24–1.25)	36	48	16	0.80	(0.79–0.80)	12	43	44	1.32	(1.32–1.33)
4	37	46	17	0.80	(0.80–0.81)	9	57	34	1.24	(1.24–1.25)	37	48	15	0.78	(0.78–0.79)	13	44	42	1.29	(1.28–1.29)
5 (most deprived)	39	45	16	0.77	(0.76–0.77)	9	57	34	1.26	(1.25–1.26)	39	47	14	0.75	(0.75–0.76)	16	46	38	1.22	(1.22–1.23)
Education quintiles																				
1 (least deprived)	28	47	25	0.97	(0.97–0.98)	10	53	36	1.26	(1.25–1.26)	32	48	20	0.87	(0.87–0.88)	9	40	51	1.43	(1.42–1.43)
2	33	47	20	0.87	(0.87–0.88)	10	56	35	1.25	(1.25–1.26)	35	48	17	0.82	(0.81–0.82)	11	43	46	1.36	(1.35–1.36)
3	36	46	17	0.81	(0.80–0.82)	9	57	34	1.25	(1.24–1.25)	37	48	15	0.78	(0.78–0.79)	13	44	44	1.31	(1.30–1.31)
4	39	45	15	0.76	(0.76–0.77)	9	57	34	1.25	(1.24–1.25)	38	47	14	0.76	(0.75–0.76)	14	45	40	1.26	(1.25–1.26)
5 (most deprived)	41	44	15	0.73	(0.73–0.74)	8	58	34	1.26	(1.26–1.27)	40	47	13	0.73	(0.73–0.74)	17	47	37	1.20	(1.19–1.20)
Sex																				
Male	33	47	20	0.87	(0.87–0.88)	13	59	28	1.15	(1.14–1.15)	39	47	14	0.74	(0.74–0.75)	10	42	48	1.38	(1.37–1.38)
Female	39	44	17	0.77	(0.77–0.78)	4	52	44	1.40	(1.40–1.40)	32	49	19	0.87	(0.86–0.87)	16	46	38	1.22	(1.21–1.22)
Age group																				
<65 years	35	45	20	0.85	(0.84–0.85)	9	55	35	1.26	(1.26–1.26)	37	48	15	0.77	(0.77–0.78)	14	45	41	1.27	(1.27–1.27)
65+ years	36	47	17	0.81	(0.81–0.81)	9	57	34	1.24	(1.24–1.24)	35	48	17	0.82	(0.82–0.82)	11	42	48	1.37	(1.36–1.37)
Race/ethnicity																				
Non-Hispanic white	35	46	19	0.84	(0.83–0.84)	10	56	34	1.25	(1.24–1.25)	36	48	16	0.80	(0.79–0.80)	12	43	45	1.32	(1.32–1.33)
Other	39	46	15	0.76	(0.75–0.77)	6	54	40	1.34	(1.33–1.35)	38	48	14	0.77	(0.76–0.78)	19	50	31	1.12	(1.11–1.13)
Marital status																				
Married/living as married	33	47	20	0.86	(0.76–0.77)	10	56	34	1.23	(1.29–1.30)	37	48	15	0.79	(0.81–0.82)	11	42	47	1.37	(1.18–1.19)
Other	40	44	16	0.76	(0.86–0.87)	7	56	37	1.29	(1.23–1.24)	35	48	17	0.81	(0.78–0.79)	17	47	36	1.19	(1.36–1.37)

	Factor 1: Movement					Factor 2: Abstinence					Factor 3: Weight control					Factor 4: Other				
	%			M	95% CI	%			M	95% CI	%			M	95% CI	%			M	95% CI
	0	1	2			0	1	2			0	1	2			0	1	2		
Educational attainment																				
High school degree or less	44	44	12	0.67	(0.67–0.68)	8	59	33	1.25	(1.25–1.25)	40	47	13	0.73	(0.73–0.74)	16	47	37	1.20	(1.20–1.21)
More than high school	31	47	22	0.92	(0.91–0.92)	10	55	35	1.26	(1.25–1.26)	35	48	17	0.83	(0.82–0.83)	11	42	47	1.37	(1.37–1.37)
Self-reported health status																				
Less than very good	45	43	12	0.66	(0.66–0.67)	9	59	32	1.23	(1.22–1.23)	42	47	11	0.69	(0.69–0.70)	14	45	41	1.27	(1.26–1.27)
Excellent or very good	27	48	25	0.97	(0.97–0.98)	10	53	37	1.28	(1.27–1.28)	32	49	20	0.88	(0.88–0.88)	11	43	46	1.35	(1.34–1.35)

Note. Chi-square tests of differences in the distribution of scores for each factor across the respective characteristic were all $p<.001$. M=mean; CI=confidence interval.

Table 3.

Poisson regressions examining the association between neighborhood-level poverty quintile and scores on health behavior factors, controlling for individual-level demographic characteristics, among NIH-AARP participants.

	Movement		Abstinence		Weight control		Other	
	RR	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**
Neighborhood-level characteristic								
Poverty quintiles								
1 (least deprived)		(ref)		(ref)		(ref)		(ref)
2	0.99	(0.98–1.01)	0.99	(0.98–1.00)	0.99	(0.98–1.00)	0.99	(0.98–1.00)
3	0.97	(0.96–0.99)	0.98	(0.97–0.99)	0.97	(0.96–0.98)	0.98	(0.97–0.99)
4	0.96	(0.95–0.97)	0.98	(0.97–0.98)	0.96	(0.95–0.97)	0.97	(0.96–0.98)
5 (most deprived)	0.95	(0.94–0.96)	0.98	(0.97–0.99)	0.94	(0.92–0.95)	0.94	(0.93–0.95)
Individual-level characteristics								
Sex								
Male		(ref)		(ref)		(ref)		(ref)
Female	0.94	(0.94–0.95)	1.25	(1.25–1.26)	1.21	(1.20–1.22)	0.94	(0.94–0.95)
Age group								
<65 years		(ref)		(ref)		(ref)		(ref)
65+ years	0.99	(0.98–1.00)	1.00	(0.99–1.01)	1.09	(1.08–1.10)	1.08	(1.08–1.09)
Race/ethnicity								
Non-Hispanic white		(ref)		(ref)		(ref)		(ref)
Other	0.96	(0.94–0.97)	1.07	(1.05–1.08)	0.99	(0.97–1.01)	0.88	(0.87–0.89)
Marital status								
Married/living as married		(ref)		(ref)		(ref)		(ref)
Other	0.94	(0.93–0.95)	0.95	(0.94–0.95)	0.97	(0.96–0.97)	0.91	(0.90–0.91)
Educational attainment								
High school degree or less		(ref)		(ref)		(ref)		(ref)
More than high school	1.28	(1.26–1.29)	1.03	(1.02–1.03)	1.12	(1.11–1.13)	1.12	(1.11–1.12)
Self-reported health status								
Less than very good		(ref)		(ref)		(ref)		(ref)
Excellent or very good	1.41	(1.40–1.42)	1.04	(1.03–1.04)	1.25	(1.24–1.26)	1.04	(1.04–1.05)

Note. Each column represents one multivariable model. Shaded cells indicate statistically-significant interactions between the respective individual-level demographic characteristic and neighborhood-level poverty quintile in their association with the column health behavior factor. RR=relative risk; CI=confidence interval; ref=reference category.

Table 4.

Poisson regressions examining the association between neighborhood-level education quintile and scores on health behavior factors, controlling for individual-level demographic characteristics, among NIH-AARP participants.

	Movement		Abstinence		Weight control		Other	
	RR	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**
Neighborhood-level characteristic								
Education quintiles								
1 (least deprived)		(ref)		(ref)		(ref)		(ref)
2	0.94	(0.93–0.95)	0.99	(0.99–1.00)	0.96	(0.94–0.97)	0.97	(0.96–0.98)
3	0.90	(0.89–0.91)	0.99	(0.98–1.00)	0.93	(0.92–0.94)	0.95	(0.94–0.95)
4	0.88	(0.87–0.89)	0.99	(0.98–1.00)	0.91	(0.90–0.92)	0.92	(0.91–0.93)
5 (most deprived)	0.88	(0.87–0.89)	1.00	(0.99–1.01)	0.89	(0.88–0.90)	0.90	(0.89–0.91)
Individual-level characteristics								
Sex								
Male		(ref)		(ref)		(ref)		(ref)
Female	0.94	(0.94–0.95)	1.25	(1.24–1.26)	1.21	(1.20–1.22)	0.94	(0.94–0.95)
Age group								
<65 years		(ref)		(ref)		(ref)		(ref)
65+ years	0.99	(0.98–1.00)	1.00	(0.99–1.01)	1.09	(1.08–1.10)	1.08	(1.08–1.09)
Race/ethnicity								
Non-Hispanic white		(ref)		(ref)		(ref)		(ref)
Other	0.96	(0.95–0.98)	1.06	(1.05–1.08)	0.99	(0.98–1.01)	0.88	(0.87–0.89)
Marital status								
Married/living as married		(ref)		(ref)		(ref)		(ref)
Other	0.94	(0.93–0.95)	0.95	(0.94–0.95)	0.97	(0.96–0.97)	0.91	(0.90–0.91)
Educational attainment								
High school degree or less		(ref)		(ref)		(ref)		(ref)
More than high school	1.25	(1.24–1.26)	1.03	(1.02–1.03)	1.10	(1.09–1.11)	1.10	(1.09–1.11)
Self-reported health status								
Less than very good		(ref)		(ref)		(ref)		(ref)
Excellent or very good	1.40	(1.39–1.41)	1.04	(1.03–1.04)	1.24	(1.23–1.25)	1.04	(1.03–1.04)

Note. Each column represents one multivariable model. Shaded cells indicate statistically-significant interactions between the respective individual-level demographic characteristic and neighborhood-level education quintile in their association with the column health behavior factor. RR=relative risk; CI=confidence interval; ref=reference category.