DISCUSSION PAPER SERIES

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ABSTRACT

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Low healthcare quality has been found to predict the development of several illnesses in older adults, while the evidence on dementia is still lacking. This study assesses whether and to what extent experiencing low healthcare quality can be associated with developing dementia in people 60-years-old and greater. Participants in the Health and Retirement Study (HRS), without dementia and 60-years-old and greater at baseline, were followed 2006 through 2019. Experiencing low healthcare quality was assessed at baseline through healthcare discrimination and dissatisfaction with healthcare services. The outcome, development of new cases of dementia, was determined through physician diagnosis or a cognition score compatible with dementia (assessed by the Telephone Interview for Cognitive Status). Cox regression is used to estimate the hazard ratio (HR) of dementia, adjusting for participants' demographic, health, and socioeconomic factors. Experiencing low healthcare quality is associated with increased dementia risk over 12 years (unadjusted HR: 1.68, 95%CI: 1.27 - 2.21, p-value< 0.001; fully adjusted HR: 1.50, 95%CI: 1.12 – 2.01, p-value: 0.006). Healthcare discrimination and dissatisfaction with the healthcare quality received are independently associated with increased dementia risk. To date, most measures to reduce dementia have focused on individual-level behaviors. Our findings suggest that implementing structural changes to improve healthcare quality delivery for older persons may reduce dementia prevalence.

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1. Introduction

Previous studies have identified potentially modifiable individual-level risk factors of dementia (e.g., physical inactivity and smoking).[1] However, promoting the management of these individual factors alone may be insufficient to deter dementia if structural risk factors are also contributing to dementia risk.[2] One such modifiable structural factor not yet investigated as a determinant of dementia risk is healthcare quality.

Older adults' experience with healthcare quality can include whether a healthcare system gives: patients preventive care advice and timely access to appropriate treatments; and healthcare providers training to avoid ageism (i.e., systematic stereotyping and discrimination against people simply because they are old)[3] in medical encounters.[4,5] as negative age beliefs have been found to predict dementia incidence. In addition, studies have found that in older adults, experiencing low healthcare quality predicts the development of and worse management of a number of dementia risk factors (e.g., hearing problems,[6] cardiovascular conditions,[7] depression[8]). Therefore, the goal of the current paper was to extend this healthcare quality literature to the risk of developing dementia. Based on this previous healthcare quality research, we predicted that experiencing low healthcare quality will increase the risk of dementia in older adults.

2. Methods

This was a longitudinal analysis using the Health and Retirement Study (HRS), a U.S. nationally representative cohort study.[9] Respondents were included in our study if: they were 60 years of age or older, did not have dementia at baseline, completed at least two consecutive waves of dementia assessment, and had information on all covariates (see Supplementary Figure S.1). To evaluate participants' experience with healthcare quality at baseline, we used two questions assessing the treatment they received: healthcare discrimination and healthcare satisfaction.[10] The healthcare discrimination question asked participants how frequently they received "poorer service or treatment than other people from doctors or hospitals." with four possible answers: 1) less than once a year, 2) a few times a year, 3) a few times a month, or 4) once a week or more.

The healthcare satisfaction question was: "Thinking about the quality, cost, and convenience of healthcare, how satisfied are you overall?," with three possible answers: 1) satisfied, 2) somewhat satisfied, or 3) dissatisfied.

To assess the participants' overall experience with healthcare quality, we summed the score in both variables. A higher overall score reflected a worse healthcare-quality experience. Participants were classified as experiencing adequate healthcare quality (overall score ≤ 25th percentile), intermediate healthcare quality (overall score between 25th and 75th percentile), or low healthcare quality (overall score > 75th percentile). This approach to create a single perceived-healthcare-quality indicator has been used in previous studies to improve indicator stability.[11,12]

Dementia was identified using a Telephone Interview for Cognitive Status (TICS)[13] score compatible with dementia (TICS score ≤ 6 pts.) or if participants reported a physician diagnosis of Alzheimer's Disease and Alzheimer's Disease Related Dementias (AD/ADRD). This method for assessing dementia in the HRS has been used previously.[14,15] Dementia was assessed biannually in the HRS from 2006 to 2019. Participants were censored if lost to follow-up, if they died without dementia before the end of the study, or if they completed the study without dementia.

Control variables that are related to the exposure and/ or the outcome,[1,16] were measured at baseline. These included demographic factors (age, sex, race or ethnicity, education, household income, census region, urban-rural location), the number of cardiovascular risk factors (diabetes, hypertension, and obesity), the number of unhealthy lifestyles (high-frequency drinking: drinking more than 5 days a week; physical inactivity: participating < 1 time per week in moderate or vigorous physical activity; and current smoking), having hearing problems, reporting depression (CES-D score > 2 points), being an *APOE*-e4 carrier, type of health insurance coverage, and the number of private health insurance plans (Supplementary Table S.1). All these control variables were included in the fully adjusted analyses.

Descriptive analyses were performed with Pearson's chi-squared test for categorical variables, and analysis of variance (ANOVA) for continuous variables. To examine whether experiencing low health quality was associated with risk of developing dementia, we used Cox regression modeling with two-tailed tests and 95% CI to estimate the hazard ratio (HR) of developing dementia. Unadjusted and fully adjusted model estimations by time-to-event (the month of the interview when dementia was identified in the HRS) and control variables were conducted. Analyses of both indicators of healthcare quality (healthcare discrimination and dissatisfaction with healthcare quality) were performed in the same way.

To evaluate the robustness of the findings, three sensitivity analyses were conducted. To assess whether results were influenced by selection bias, we performed a weighted analysis by the inverse probability of being selected in the study (IPSW).[17] To evaluate whether results were modified by assessment of the outcome, we conducted an analysis using dementia cases only defined by TICS score.[15] Finally, to assess whether the results were subject to reverse causality, we conducted an analysis with the subgroup of participants that had normal cognition (TICS score > 12 pts.), excluding participants with mild cognitive impairment and dementia at baseline (TICS score ≤ 11 pts.).[15] The analyses were performed using Python v.3.8.5 and R v.4.2.2. software. IRB approval was provided by Yale University.

3. Results

Among the 3,795 participants included in the cohort, 700 developed dementia during the 12 years of follow-up (mean person-time: 7.65, SD: 4.08 years, range: 0 – 12 years). Participants' characteristics are described in the Supplementary Table S.1. As predicted, those who experienced low healthcare quality were significantly more likely to develop dementia compared to those who experienced adequate healthcare quality (unadjusted HR: 1.68, 95%CI: 1.27 – 2.21, p-value< 0.001; fully adjusted HR: 1.50, 95%CI: 1.12 – 2.01, p-value: 0.006) (Figure 1).

In the analysis by healthcare-quality factors, participants who experienced healthcare discrimination once a week or more were significantly more likely to develop dementia compared to those who experienced healthcare discrimination less than once a year (fully adjusted HR: 2.37, 95%CI: 1.11 – 5.08, p-value: 0.026). Participants who experienced healthcare

quality dissatisfaction were more likely to develop dementia than those expressing satisfaction (fully adjusted HR: 1.45, 95%CI: 1.03 – 2.05, p-value: 0.034) (Table 1).

The three sensitivity analyses supported the robustness of our findings (Supplementary Table S.4). In the first sensitivity analysis , we found that the association between experiencing low healthcare quality and increased dementia risk was maintained after weighting by IPSW to account for potential selection bias (unadjusted HR: 1.58, 95%CI: 1.19 – 2.10, p: 0.001; fully adjusted HR: 1.43, 95%CI: 1.04 – 1.97, p: 0.027). In the second sensitivity analysis, we found that the association between experiencing low healthcare quality and increased dementia risk remained when dementia was defined by TICS score only (n: 3,606) (unadjusted HR: 1.96, 95%CI: 1.41 – 2.71, p< 0.001; fully adjusted HR: 1.50, 95%CI: 1.07 – 2.11, p: 0.020). In the third sensitivity analysis, suggesting that reverse causality was not explaining results, we found that the low healthcare quality-increased dementia risk association was maintained after excluding participants with mild cognitive impairment and dementia at baseline (n: 732) (unadjusted HR: 1.51, 95%CI: 1.01 – 2.24, p-value: 0.044; fully adjusted HR: 1.53, 95%CI: 1.01 – 2.33, p-value: 0.045).

Compared with those who experienced adequate healthcare quality, participants who experienced low healthcare quality were mostly Black, Latinx, were younger, had less than high-school education, belonged to the lowest household income group, presented more cardiovascular factors, engaged in more unhealthy behaviors, reported depression more often, were covered by Medicaid more frequently, and a greater proportion had no private healthcare insurance plans (Supplementary Table S.1).

4. Discussion

This study found that experiencing low healthcare quality was associated with an increased risk of developing dementia, even after adjusting for important control variables. To our knowledge, it is the first study to assess and report this association. Although, most previous research on determinants of dementia has focused on individual-level factors,[18] the results suggest that the structural-level factor of inadequate healthcare quality may also play an important role in dementia development.

The impact of healthcare-quality experiences on dementia risk may be due in part to giving inadequate training to healthcare professionals in providing personalized recommendation plans for addressing the health priorities of patients, including dementia prevention.[19] A quasi-experimental study found that when physicians gave a personalized recommendation plan for managing dementia risk factors, it lowered the risk of developing dementia, compared to usual care.[20] Only 5% of people 55 to 64-years-old in the U.S. report that a physician has discussed dementia prevention with them.[21] Among Canadian older women, the health priority most frequently reported was preventing memory loss (88%), however, only 11% perceived that healthcare providers addressed this priority.[22] When healthcare systems offer the chance to implement personalized care planning, it can improve treatment adherence and dementia-risk-factor management, with significant benefits for those at greater risk for dementia.[23,24] Another important source of poor healthcare quality experience that can contribute to increased dementia risk may be the lack of healthcare professionals' training to avoid ageism in medical encounters. Ageism is common among healthcare professionals and can lead to the denial of access to health services and treatments,[25] limiting the appropriate management of dementia-risk factors. It is estimated that almost 20% of older persons have experienced discrimination in healthcare encounters.[10] Further, a study found that 60% of healthcare professionals hold the negative and false age stereotype that dementia will inevitably develop among all older persons.[26]

Fortunately, healthcare quality can be improved for older persons in structural ways likely to reduce dementia risk, such as providing healthcare professionals with training on dementia-risk reduction and informing them about the harmful impact of negative aging stereotypes.[27] These measures are vital for promoting the prescription and adherence to pharmacological and non-pharmacological strategies for the management of dementia-risk factors, such as hypertension, obesity, smoking, alcohol consumption, and sedentarism in older adults. Moreover, changing other structural factors related to healthcare quality experience, such as increasing the diversity of healthcare providers, may improve the treatment and management of several dementia risk factors among populations at greater risk of developing dementia.[28]

It is concerning that in our study we found that those older persons who are Black, Latinx, and exposed to social determinants (e.g., low education, and low income) are the most likely to experience low healthcare quality. After initially experiencing mild cognitive impairment, Black persons and people who have not completed college tend to be excluded from memory-related care, while it is received by White people and participants with college degrees.[29] Future attempts to improve healthcare quality and reduce dementia risk need to be inclusive of communities of color and economically marginalized groups.

As healthcare quality is a multidimensional and complex construct,[30] future research should examine additional structural dimensions of healthcare quality, such as time to access healthcare, types of treatment prescribed, and the implementation of specific programs for the management of older persons' health.

Limitations of our study are the low number of participants from racially or ethnically minoritized groups, who are more likely to report experiencing low healthcare quality and are at greater risk of dementia.[31] Another limitation is that, as this is an observational study, a causal relationship cannot be determined. However, a sensitivity analysis suggested reverse causality does not explain the results as we found that the low healthcare quality-increased dementia risk association was maintained after excluding participants with mild cognitive impairment and dementia at baseline. Future research should examine if improving patients' experiences with healthcare is beneficial to the cognitive health of older adults.

In conclusion, these findings suggest that improving healthcare quality for older adults with evidence-based structural changes could be an important public health investment for reducing the risk of dementia.

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Impact statement

Experiencing low healthcare quality has been associated with a higher risk of several diseases. However, it has not been studied as a potential determinant of dementia risk. Thus, we examined if older persons (60-years-old and greater) who experience low healthcare quality are more likely to develop dementia. As predicted, participants who perceived worse healthcare quality were more likely to develop dementia in the next 12 years, even after adjusting for relevant control variables. These findings suggest that improving healthcare quality may reduce dementia risk.

Key points section

Key points

- Older persons who experienced low healthcare quality were more likely to develop dementia compared with those who experienced adequate healthcare quality.
- Reporting healthcare discrimination and healthcare quality dissatisfaction were independently associated with increased dementia risk.
- Black and Latinx participants were more prone to experience low healthcare quality.

Why does this paper matter?

Previous studies have identified individual-level factors associated with the risk of developing dementia. However, modifying individual-level factors alone may not be sufficient to achieve dementia risk reduction. We found that a modifiable structural level factor, experiencing worse healthcare quality, was related to an increased risk of dementia in the next 12 years. These findings suggest that improving healthcare quality delivery for older persons could reduce dementia prevalence.

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Figure 1. Association between Experiencing Low Healthcare Quality and Increased Risk of Developing Dementia.
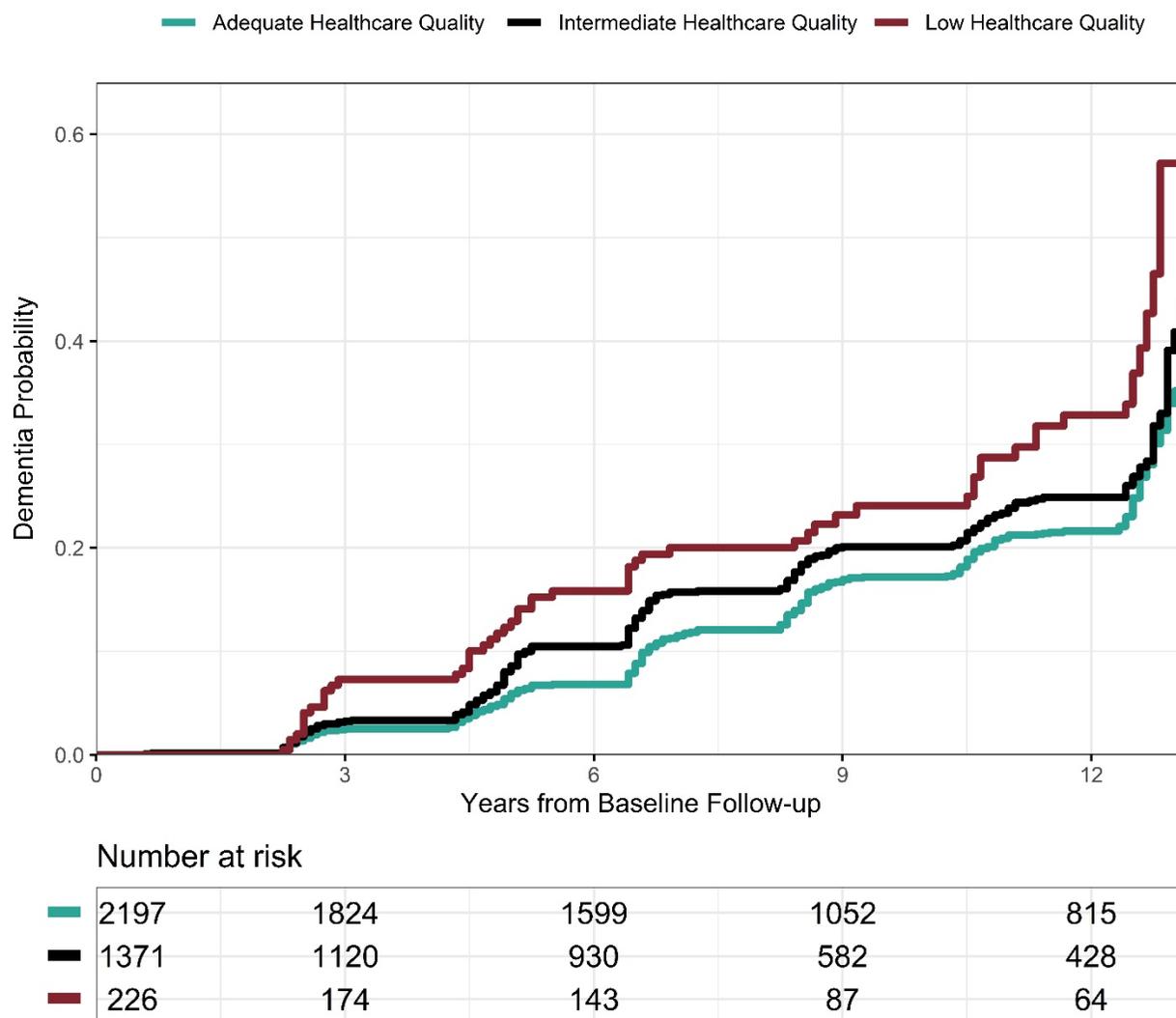
Model properties: model long-rank test p< 0.001. Unadjusted and fully adjusted model hazard proportionality assumption based on Schoenfeld residuals. The model meets the hazard proportionality assumption (test Chi-square: 36.693, df: 38, p-value: 0.530). All the variables meet the hazard proportionality assumption (p-value> 0.05).

Table 1. Associations between Experiencing Low Healthcare Quality and Dementia Risk by Overall Healthcare Quality Experience and Sub-Dimensions.

	N at risk / N dementia	Unadjusted HR (95%CI)	*P*-value	Fully adjusted HR[a] (95%CI)	*P*-value
Overall experience with healthcare quality[b]					
Adequate healthcare quality	2198/382	Reference		Reference	
Intermediate healthcare quality	1371/260	1.17 (1.00 – 1.37)	0.049	1.13 (0.96 – 1.33)	0.129
Low healthcare quality	226/58	1.68 (1.27 – 2.21)	< 0.001	1.50 (1.12 – 2.01)	0.006
Satisfaction with healthcare quality					
Satisfied	2288/403	Reference		Reference	
Somewhat satisfied	1375/258	1.14 (0.97 – 1.33)	0.113	1.09 (0.93 – 1.28)	0.287
Dissatisfied	132/39	1.77 (1.27 – 2.46)	< 0.001	1.46 (1.04 – 2.06)	0.031
Healthcare discrimination[c]					
Less than once in a year	3620/665	Reference		Reference	
A few times a year	125/24	1.18 (0.77 – 1.78)	0.422	1.28 (0.84 – 1.93)	0.253
few times per month	28/4	0.96 (0.36 – 2.56)	0.933	1.20 (0.44 – 3.25)	0.723
at least once a week or more	22/7	3.07 (1.46 – 6.48)	0.003	2.41 (1.13 – 5.17)	0.023

[a] Model fully adjusted by: age, gender, race or ethnicity, education, household income, Census region, urban/rural location, number of cardiovascular factors, number of unhealthy lifestyles, hearing loss, depression, APOE-e4 carriage, covered by Medicare, covered by Medicaid, and covered by private health insurance plans.
[b] Summed score between healthcare quality satisfaction and healthcare discrimination: adequate healthcare quality (overall score ≤ 25th percentile), intermediate healthcare quality (overall score between 25th and 75th percentile), or low healthcare quality (overall score > 75th percentile).
[c] Healthcare discrimination: they received poorer service or treatment than other people from doctors or hospitals.

Association between Experiencing Low Healthcare Quality and Developing Dementia

Supplementary Material.

Figure S.1. Flowchart of sample selection.

Table S.1. Descriptive characteristics of the sample at baseline.

Table S.2. Baseline characteristics of people with complete and incomplete information on healthcare quality variables.

Table S.3. Descriptive characteristics of the analyzed sample according to dementia ascertainment.

Table S.4. Sensitivity analyses for the associations between experiencing low healthcare quality and dementia risk.

Figure S.1. Flowchart of sample selection.
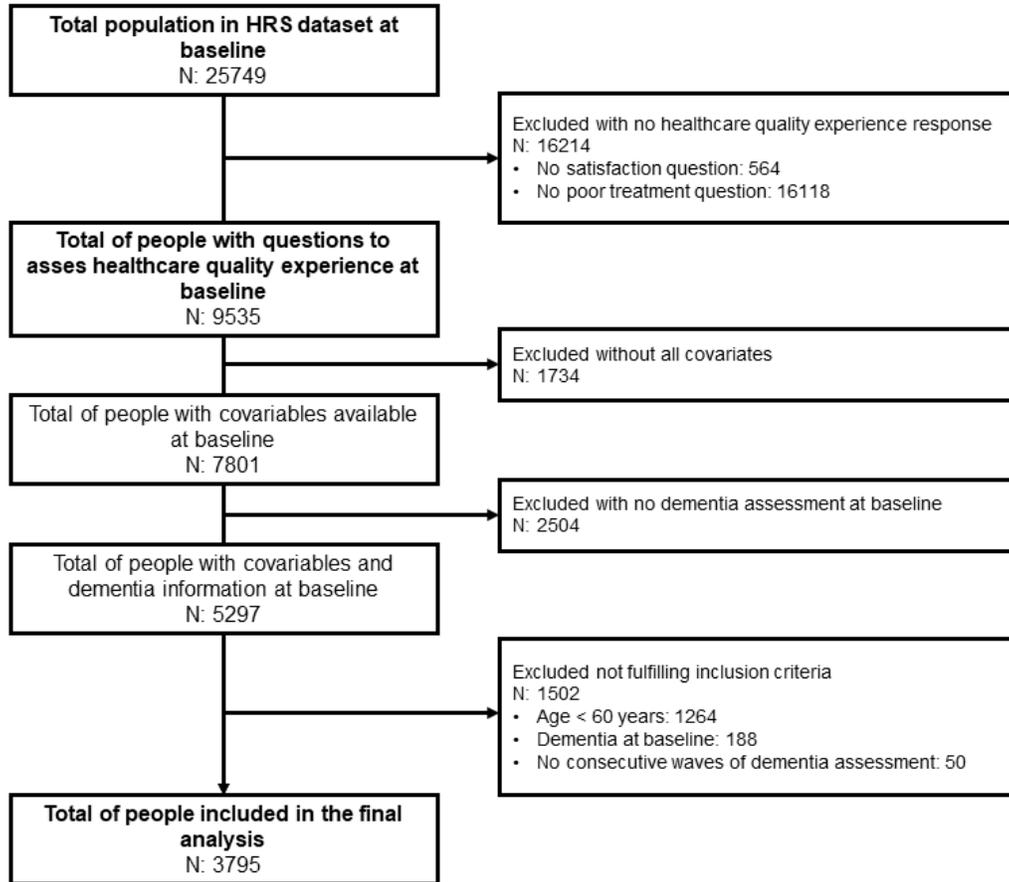
Table S.1. Descriptive characteristics of the sample at baseline.

Characteristics	Overall. Number (%)	Healthcare quality at baseline. Number (%)			*P*-value [a]
		Adequate healthcare quality	Intermediate healthcare quality	Low healthcare quality	
Number (% of the overall sample)	3,795	2,198 (57.9%)	1,371 (36.1%)	226 (6.0%)	
Age at baseline Mean (SD)	73.49 (7.125)	73.00 (7.004)	73.36 (7.204)	71.23 (7.406)	< 0.001
Gender					
Female	2132 (56.2%)	1238 (56.3%)	766 (55.9%)	128 (56.6%)	0.956
Male	1663 (43.8%)	960 (43.7%)	605 (44.1%)	98 (43.4%)	
Race or Ethnicity					
White	3225 (85.0%)	1941 (88.3%)	1130 (82.4%)	154 (68.1%)	<0.001
Black	457 (12.0%)	196 (8.9%)	198 (14.4%)	63 (27.9%)	
Other (American Indian, Alaskan Native, Asian, and Pacific Islander)	113 (3.0%)	61 (2.8%)	43 (3.1%)	9 (4.0%)	
Latinx	251 (6.6%)	125 (5.7%)	106 (7.7%)	20 (8.8%)	0.022
Education level					
Less than high-school	913 (24.1%)	467 (21.2%)	365 (26.6%)	81 (35.8%)	< 0.001
High-school graduate	1291 (34.0%)	741 (33.7%)	480 (35.0%)	70 (31.0%)	
Some college	828 (21.8%)	503 (22.9%)	281 (20.5%)	44 (19.5%)	
College and above	763 (20.1%)	487 (22.2%)	245 (17.9%)	31 (13.7%)	

Household income (US$ - quintile)					
$0.0 - $15,588.0	678 (17.9%)	350 (15.9%)	258 (18.8%)	70 (31.0%)	< 0.001
$15,588.0 - $28,715.7	872 (23.0%)	460 (20.9%)	347 (25.3%)	65 (28.8%)	
$28,715.7 - $47,158.0	920 (24.2%)	556 (25.3%)	323 (23.6%)	41 (18.1%)	
$47,158.0 - $83,006.2	739 (19.5%)	462 (21.0%)	251 (18.3%)	26 (11.5%)	
$83,006.2 or more	586 (15.4%)	370 (16.8%)	192 (14.0%)	24 (10.6%)	
Urban-rural location [b]					
Urban	1783 (47.0%)	1053 (47.9%)	620 (45.2%)	110 (48.7%)	0.649
Suburban	824 (21.7%)	474 (21.6%)	308 (22.5%)	42 (18.6%)	
Ex-urban	1183 (31.2%)	668 (30.4%)	441 (32.2%)	74 (32.7%)	
Not match rural-urban code	5 (0.1%)	3 (0.1%)	2 (0.1%)	NA	
Cardiovascular factors					
Diabetes	763 (20.1%)	423 (19.2%)	284 (20.7%)	56 (24.8%)	0.111
Hypertension	2294 (60.4%)	1304 (59.3%)	857 (62.5%)	133 (58.8%)	0.147
Obesity	1108 (29.2%)	605 (27.5%)	409 (29.8%)	94 (41.6%)	< 0.001
Number of cardiovascular factors Mean (SD)	1.10 (0.904)	1.06 (0.896)	1.13 (0.897)	1.25 (1.008)	0.002
Unhealthy lifestyles					
High frequency drinking	365 (9.6%)	242 (11.0%)	112 (8.2%)	11 (4.9%)	< 0.001
Physical inactivity	1052 (27.7%)	569 (25.9%)	394 (28.7%)	89 (39.4%)	< 0.001

Current smoker	363 (9.6%)	184 (8.4%)	136 (9.9%)	43 (19.0%)	< 0.001
Number of unhealthy lifestyles Mean (SD)	0.46 (0.611)	0.45 (0.605)	0.46 (0.601)	0.62 (0.703)	< 0.001
Hearing problems	212 (5.6%)	112 (5.1%)	86 (6.3%)	14 (6.2%)	0.303
Depression	719 (18.9%)	348 (15.8%)	280 (20.4%)	91 (40.3%)	< 0.001
APOE-e4 carrier	938 (24.7%)	554 (25.2%)	325 (23.7%)	59 (26.1%)	0.530
Healthcare access					
Covered by federal government health insurance program	3596 (94.8%)	2111 (96.0%)	1291 (94.0%)	194 (85.8%)	< 0.001
Covered by Medicare	3575 (94.2%)	2100 (95.5%)	1285 (93.7%)	190 (84.1%)	< 0.001
Covered by Medicaid	227 (6.0%)	120 (5.5%)	84 (6.1%)	23 (10.2%)	0.017
Covered by CHAMPUS / CHAMPVA	258 (6.8%)	191 (8.7%)	57 (4.2%)	10 (4.4%)	< 0.001
Number of private health insurance plans [c] Mean (SD)	0.62 (0.548)	0.64 (0.551)	0.62 (0.537)	0.47 (0.567)	< 0.001

Abbreviations: NA, not applicable; CHAMPUS, Civilian Health and Medical Program of the Uniformed Services; CHAMPVA, The Civilian Health and Medical Program of the Department of Veterans Affairs.

[a] : P values are from ANOVA test (for continuous variables); the rest of the P values are for Pearson's chi-squared test of association.

[b] : based on the 2003 Beale Rural-Urban Continuum Code. Ex-urban: farther out areas, beyond the suburbs (Fra Paleo, Urbano (2004). "Exurbia". In Caves, R. W. (ed.). Encyclopedia of the City. Routledge. p. 254.)

[c] : insurance through an employer or a business, coverage for retirees, or health insurances buy for patients.

Table S.2. Baseline characteristics of people with complete and incomplete information on healthcare quality variables.

Characteristics	Complete healthcare quality variables available	Incomplete healthcare quality variables available	*P*-value [a]
Number	9,535	16,214	
Age at baseline Mean (SD)	64.00 (11.217)	64.13 (12.040)	< 0.001
Gender			
Female	5,576 (55.8%)	9,319 (57.5%)	0.115
Male	3,959 (41.5%)	6,896 (42.5%)	
Race or Ethnicity			
White	7,443 (78.1%)	11,456 (70.9%)	< 0.001
Black	1,521 (16.0%)	3,278 (20.3%)	
Other (American Indian, Alaskan Native, Asian, and Pacific Islander)	565 (5.9%)	1426 (8.8%)	
Latinx	933 (9.8%)	2,354 (14.5%)	< 0.001
Education level			
Less than high-school	2,207 (23.1%)	4,644 (28.6%)	< 0.001
High-school graduate	2,892 (30.3%)	4,539 (28.0%)	
Some college	2,301 (24.1%)	3,778 (23.3%)	
College and above	2,135 (22.4%)	3,249 (20.0%)	
Household income (US$ - quintile)			
$0.0 - $15,588.0	1,706 (17.9%)	3,529 (21.8%)	< 0.001

$15,588.0 - $28,715.7	1,739 (18.2%)	3,092 (19.1%)	
$28,715.7 - $47,158.0	1,898 (19.9%)	3,071 (18.9%)	
$47,158.0 - $83,006.2	2,011 (21.1%)	3,180 (19.6%)	
$83,006.2 or more	2,181 (22.9%)	3,342 (20.6%)	
Urban-rural location [b]			
Urban	4,707 (49.4%)	8,501 (52.4%)	< 0.001
Suburban	1,961 (20.6%)	3,257 (20.1%)	
Ex-urban	2,852 (29.9%)	4,360 (26.9%)	
Not match rural-urban code	15 (0.2%)	94 (0.6%)	
Cardiovascular factors			
Diabetes	1,762 (18.5%)	3,102 (19.1%)	0.197
Hypertension	4,994 (52.4%)	8,469 (52.2%)	0.825
Obesity	3,175 (33.8%)	5,061 (32.0%)	0.004
Number of cardiovascular factors Mean (SD)	1.04 (0.931)	1.03 (0.917)	0.189
Unhealthy lifestyles			
High frequency drinking	776 (8.1%)	1,123 (6.9%)	< 0.001
Physical inactivity	2,540 (26.7%)	4,934 (30.5%)	< 0.001
Current smoker	1,448 (15.3%)	2,817 (17.5%)	< 0.001
Number of unhealthy lifestyles Mean (SD)	0.50 (0.629)	0.54 (0.637)	< 0.001
Hearing problems	437 (4.6%)	825 (0.5%)	0.067

Depression	2,040 (21.8%)	3,763 (25.4%)	< 0.001
APOE-e4 carrier	2,150 (26.8%)	2,998 (27.5%)	0.301
Healthcare access			
Covered by federal government health insurance program	5,453 (57.3%)	8,603 (54.1%)	< 0.001
Covered by Medicare	5,038 (52.9%)	7,770 (48.8%)	< 0.001
Covered by Medicaid	680 (7.2%)	1,618 (10.2%)	< 0.001
Covered by CHAMPUS / CHAMPVA	498 (5.2%)	757 (4.8%)	0.093
Number of private health insurance plans [c] Mean (SD)	0.68 (NA)	0.63 (NA)	< 0.001
Dementia outcome			
Overall dementia	264 (4.1%)	695 (6.4%)	< 0.001
Diagnosis of dementia or Alzheimer's disease	14 (0.7%)	82 (0.2%)	0.004
TICS score compatible with dementia [d]	250 (3.9%)	622 (5.8%)	< 0.001

Abbreviations: NA, not applicable; CHAMPUS, Civilian Health and Medical Program of the Uniformed Services; CHAMPVA, The Civilian Health and Medical Program of the Department of Veterans Affairs.

[a] : P values are from ANOVA test (for continuous variables); the rest of the P values are for Pearson's chi-squared test of association.

[b] : based on the 2003 Beale Rural-Urban Continuum Code. Ex-urban: farther out areas, beyond the suburbs (Fra Paleo, Urbano (2004). "Exurbia". In Caves, R. W. (ed.). Encyclopedia of the City. Routledge. p. 254.).

[c] : insurance through an employer or a business, coverage for retirees, or health insurances buy for patients.

[d] : score of 6 points or less on the Telephone Interview for Cognitive Status (TICS).

Table S.3. Descriptive characteristics of the analyzed sample according to dementia ascertainment.

Characteristics	Type of dementia ascertainment				*P*-value [a]
	No dementia	Dementia or Alzheimer's disease diagnosis only	TICS score compatible with dementia only [b]	Dementia diagnosis and TICS score compatible with dementia	
Number	3095	215	418	67	
Age at baseline Mean (SD)	73.04 (7.076)	75.32 (6.931)	75.12 (6.755)	78.0 (8.121)	< 0.001
Gender					
Female	1707 (55.2%)	124 (57.7%)	262 (62.7%)	39 (58.2%)	0.430
Male	1388 (44.8%)	91 (42.3%)	156 (37.3%)	28 (41.8%)	
Race or Ethnicity					
White	2692 (87.0%)	193 (89.8%)	291 (69.6%)	49 (73.1%)	< 0.001
Black	309 (10.0%)	18 (8.4%)	112 (26.8%)	18 (26.9%)	
Other (American Indian, Alaskan Native, Asian, and Pacific Islander)	94 (3.0%)	4 (1.9%)	15 (3.6%)	NA	
Latinx	194 (6.3%)	9 (4.2%)	44 (10.5%)	4 (6.0%)	0.017
Education level					
Less than high-school	663 (21.4%)	34 (15.8%)	181 (43.3%)	35 (52.2%)	< 0.001
High-school graduate	1068 (34.5%)	77 (35.8%)	128 (30.6%)	18 (26.9%)	

Some college	686 (22.2%)	61 (28.4%)	71 (17.0%)	10 (14.9%)	
College and above	678 (21.9%)	43 (20.0%)	38 (9.1%)	4 (6.0%)	
Household income (US$ - quintile)					
$0.0 - $15,588.0	498 (16.1%)	30 (14.0%)	131 (31.3%)	19 (28.4%)	< 0.001
$15,588.0 - $28,715.7	686 (22.2%)	48 (22.3%)	121 (28.9%)	17 (25.4%)	
$28,715.7 - $47,158.0	768 (24.8%)	56 (26.0%)	77 (18.4%)	19 (28.4%)	
$47,158.0 - $83,006.2	626 (20.2%)	46 (21.4%)	56 (13.4%)	11 (16.4%)	
$83,006.2 or more	517 (16.7%)	35 (16.3%)	33 (7.9%)	1 (1.5%)	
Urban-rural location [c]					
Urban	1460 (47.2%)	111 (51.6%)	180 (43.1%)	32 (47.8%)	0.135
Suburban	666 (21.5%)	44 (20.5%)	103 (24.6%)	11 (16.4%)	
Ex-urban	966 (31.2%)	60 (27.9%)	134 (32.1%)	23 (34.3%)	
Not match rural-urban code	3 (0.1%)	NA	1 (0.2%)	1 (1.5%)	
Cardiovascular factors					
Diabetes	620 (20.0%)	36 (16.7%)	88 (21.1%)	19 (28.4%)	0.106
Hypertension	1870 (60.4%)	123 (57.2%)	256 (61.2%)	45 (67.2%)	0.314
Obesity	930 (30.0%)	42 (19.5%)	119 (28.5%)	17 (17%)	0.050
Number of cardiovascular factors Mean (SD)	1.11 (0.906)	0.93 (0.846)	1.11 (0.895)	1.21 (1.023)	0.027
Unhealthy lifestyles					

High frequency drinking	308 (10.0%)	23 (10.7%)	29 (6.9%)	5 (7.5%)	0.256
Physical inactivity	839 (27.1%)	59 (27.4%)	121 (28.9%)	33 (49.3%)	0.002
Current smoker	301 (9.7%)	17 (7.9%)	40 (9.6%)	5 (7.5%)	0.717
Number of unhealthy lifestyles Mean (SD)	0.46 (0.615)	0.46 (0.601)	0.45 (0.574)	0.64 (0.644)	0.048
Hearing problems	167 (5.4%)	7 (3.3%)	33 (7.9%)	5 (7.5%)	0.074
Depression	546 (17.6%)	55 (25.6%)	99 (23.7%)	19 (28.4%)	0.669
APOE-e4 carrier	686 (22.2%)	83 (38.6%)	152 (36.4%)	17 (25.4%)	0.139
Healthcare access					
Covered by federal government health insurance program	2914 (94.2%)	211 (98.1%)	404 (96.7%)	67 (100%)	0.201
Covered by Medicare	2895 (93.5%)	210 (97.7%)	403 (96.4%)	67 (100%)	0.224
Covered by Medicaid	148 (4.8%)	9 (4.2%)	62 (14.8%)	8 (11.9%)	< 0.001
Covered by CHAMPUS / CHAMPVA	217 (7.0%)	17 (7.9%)	20 (4.8%)	4 (6.0%)	0.285
Number of private health insurance plans [d] Mean (SD)	0.638 (0.548)	0.64 (0.546)	0.53 (0.550)	0.51 (0.504)	0.043
Overall experience with healthcare quality [e]					
Adequate healthcare quality	1816 (58.7%)	122 (56.7%)	224 (53.6%)	36 (53.7%)	0.505
Intermediate healthcare quality	1111 (35.9%)	77 (35.8%)	161 (38.5%)	22 (32.8%)	

Low healthcare quality	168 (5.4%)	16 (7.4%)	33 (7.9%)	9 (13.4%)	
Satisfaction with healthcare quality					
Satisfied	1885 (60.9%)	131 (60.9%)	234 (56.0%)	38 (56.7%)	0.237
Somewhat satisfied	1117 (36.1%)	72 (33.5%)	164 (39.2%)	22 (32.8%)	
Dissatisfied	93 (3.0%)	12 (5.6%)	20 (4.8%)	7 (10.4%)	
Healthcare discrimination [f]					
Less than once in a year	2955 (95.5%)	203 (94.4%)	398 (95.2%)	64 (95.5%)	0.976
A few times a year	101 (3.3%)	8 (3.7%)	14 (3.3%)	2 (3.0%)	
few times per month	24 (0.8%)	2 (0.9%)	2 (0.5%)	0 (0.0%)	
at least once a week or more	15 (0.5%)	2 (0.9%)	4 (1.0%)	1 (1.5%)	

Abbreviations: NA, not applicable; CHAMPUS, Civilian Health and Medical Program of the Uniformed Services; CHAMPVA, The Civilian Health and Medical Program of the Department of Veterans Affairs.

[a]: P values are from ANOVA test (for continuous variables); the rest of the P values are for Pearson's chi-squared test of association.

[b]: score of 6 points or less on the Telephone Interview for Cognitive Status (TICS).

[c]: based on the 2003 Beale Rural-Urban Continuum Code. Ex-urban: farther out areas, beyond the suburbs (Fra Paleo, Urbano (2004). "Exurbia". In Caves, R. W. (ed.). Encyclopedia of the City. Routledge. p. 254.).

[d]: insurance through an employer or a business, coverage for retirees, or health insurances buy for patients.

[e]: Summed score between healthcare quality satisfaction and healthcare discrimination: 'Adequate healthcare quality' (overall score $\leq 25^{th}$ percentile), 'Intermediate healthcare quality' (overall score between 25th and 75th percentile), or 'Low healthcare quality' (overall score $> 75^{th}$ percentile).

[f]: if they received poorer service or treatment than other people from doctors or hospitals.

Table S.4. Sensitivity analyses for the associations between experiencing low healthcare quality and dementia risk.

	N at risk / N dementia	Unadjusted HR (95%CI)	*P*-value	Fully adjusted HR[a] (95%CI)	*P*-value
Sensitivity analysis 1: weighting by IPSW.[b]					
Adequate healthcare quality	2198/382	Reference		Reference	
Intermediate healthcare quality	1371/260	1.15 (0.98 – 1.34)	0.094	1.11 (0.94 – 1.31)	0.202
Low healthcare quality	226/58	1.58 (1.19 – 2.10)	0.001	1.43 (1.04 – 1.97)	0.027
Sensitivity analysis 2: using only TICS cases.[c]					
Adequate healthcare quality	2109/254	Reference		Reference	
Intermediate healthcare quality	1298/179	1.23 (1.02 – 1.49)	0.033	1.13 (0.93 – 1.37)	0.218
Low healthcare quality	199/42	1.96 (1.41 – 2.71)	< 0.001	1.50 (1.07 – 2.11)	0.020
Sensitivity analysis 3: excluding people with mild cognitive impairment at baseline.[d]					
Adequate healthcare quality	1890/246	Reference		Reference	
Intermediate healthcare quality	1083/140	1.09 (0.89 – 1.35)	0.404	1.11 (0.90 – 1.37)	0.341
Low healthcare quality	90/18	1.51 (1.01 – 2.24)	0.044	1.53 (1.01 – 2.33)	0.045

[a] Model fully adjusted by: age, gender, race or ethnicity, education, household income, CENSUS region, urban/rural location, number of cardiovascular factors, number of unhealthy lifestyles, hearing loss, depression, APOE-e4 carriage, covered by federal government health insurance program, covered by Medicare, covered by Medicaid, covered by CHAMPUS / CHAMPVA, and number of private health insurance plans.

[b] Sensitivity analysis 1: to assess if results were influenced by selection bias, we performed a weighted analysis by the inverse probability of being selected in the study (IPSW).

[c] Sensitivity analysis 2: to evaluate if results are modified by assessment of the outcome, we conducted an analysis using dementia cases only defined by a Telephone Interview for Cognitive Status (TICS) score (TICS ≤ 6 pts.) (n: 3,606).

[d] Sensitivity analysis 3: to assess if the results are subject to reverse causality, we excluded participants with mild cognitive impairment at baseline (n: 732) defined as presenting cognitive impairment not dementia (CIND) according to TICS score (TICS = 7-11 pts.).