No Healthcare Utilization and Death

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BACKGROUND: An inappropriately low frequency of healthcare utilization has been reported to be associated with poor control of chronic diseases, accelerating healthcare disparities. However, the evidence is limited regarding the association between no healthcare utilization and mortality.

OBJECTIVES: To examine whether individuals without healthcare utilization have the increased risks of mortality among the US general population.

DESIGN: Prospective cohort study

PARTICIPANTS: Adults aged ≥ 20 years (n = 39,067) in the National Health and Nutrition Examination Survey (NHANES)1999–2014 linked to national mortality data through December 2015.

MAIN MEASURES: The exposure was the number of visits to healthcare providers during the past year (healthcare utilization): none, 1–3 times (referent), 4–9 times, or ≥ 10 times. Cox hazard regression models were employed to estimate the adjusted hazard ratios (aHR) of all-cause, cardiovascular, and cancer mortality adjusting for socio-demographic characteristics and comorbidities.

KEY RESULTS: During a median follow-up of 7.4 years, participants without visit over the past year showed higher risks of all-cause mortality (aHR [95% CI] = 1.16 [1.04–1.30]) and cardiovascular mortality (aHR [95% CI] = 1.62 [1.28–2.05]) than those who visited the office 1–3 times. We found no evidence of the association between no visit and cancer mortality. The association between no providers' office visit and all-cause mortality was stronger among males (aHR [95% CI] = 1.22 [1.06–1.40]) than females (aHR [95% CI] = 0.97 [0.79–1.19]; p-for-interaction = 0.01) and among uninsured individuals (aHR [95% CI] = 1.22 [0.98–1.51]) than insured individuals (aHR [95% CI] = 1.09 [0.95–1.25]; p-for-interaction = 0.04).

CONCLUSION: No providers' office visit over a year was associated with increased risks of all-cause and cardiovascular mortality. Further investigations are warranted to identify the underlying reasons for the elevated mortality risks due to no healthcare utilization.

KEY WORDS: Healthcare utilization; Access to healthcare services; Healthcare access; Mortality; Cardiovascular mortality.

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Association of No Healthcare Utilization with Mortality Among Adults in the USA

INTRODUCTION

Limited healthcare utilization is considered as one of the key upstream determinants of health disparity—a major public health issue in the USA,[1–3] and is strongly related to social determinants of health (e.g., sex, race/ethnicity, socio-economic status, geography).[3–10] In general, individuals with severe medical conditions are likely to visit clinics or be admitted to hospitals frequently,[11,12] while relatively healthy individuals use healthcare services less frequently. In this context, the association between the number of healthcare utilization and adverse health outcomes is expected to be positive (or close to the null if all information on disease severity is controlled for). Meanwhile, it is also true that some people, even with health problems, do not have access to or cannot afford healthcare services due to limited financial support, literacy or awareness of diseases, and geographical reasons.[2,6,7,13,14] Previous cross-sectional studies have shown that an inappropriately low frequency of healthcare utilization was associated with poor control of chronic conditions including diabetes mellitus,[15] hypertension,[15–17] and dyslipidemia.[18] Possible mechanisms of this association may include the lack of optimal interaction between patients and healthcare providers or the lack of opportunities to take optimal management or medication among the individuals with the lower frequency of healthcare utilization.[15,18] However, it is still unclear whether individuals with few or no healthcare utilization are associated with long-term health outcomes such as mortality.

In addition, the possible impact of limited healthcare utilization on health outcomes may differ by individuals' socio-demographic characteristics. For example, individuals with insurance are more likely to utilize healthcare services and have better health outcomes than those without insurance.[19,20] A previous evidence showed that the improvement of insurance coverage, through Medicare expansion, has increased appropriate healthcare utilization and reduced overall mortality.[5] Furthermore, a previous study has shown that the relationship between socio-demographic characteristics and frequency of healthcare utilization differs between males and females.[21] In this context, it is imperative to identify the subpopulation which has a high mortality risk due to an inappropriately low frequency of healthcare utilization so that decision-makers could build an effective strategy targeting such population to improve their health and potentially achieve health equity.

In this study, we hypothesized that people with no healthcare utilization would have higher mortality risks than those with moderate (considered adequate) frequency of healthcare utilization, and the association would vary by their socio-demographic characteristics. To address this hypothesis, we examined the association of the frequency of providers' office visits (as a proxy of healthcare utilization), particularly no visit (vs. 1–3 times of visits), with all-cause mortality and cause-specific(cardiovascular and cancer, the leading causes of death in the USA[22]) mortality of the US general population. To identify the subpopulation at high risk of mortality related to no visit of healthcare providers, we also examined whether the association differs by individuals' socio-demographic characteristics.

METHODS

Data Source and Study Cohort

We used the National Health and Nutrition Examination Survey (NHANES)1999–2014 linked with national mortality data through December 2015. The NHANES had been conducted to assess the health and nutritional status of the non-institutionalized US civilian population using a stratified, multistage probability sampling design. This survey included structured interview data, physical examination data, and laboratory test data, which were released every 2 years.[23] The unweighted response rates for the household interview and physical examinations during 1999–2014 were 71–84% and 69–80%, respectively.[24] Among 43,793 adults aged ≥ 20 years enrolled in the NHANES 1999–2014, we excluded participants without the data of the number of visits to healthcare providers (n = 34), self-reported health condition (n = 30), smoking status (n = 56), marital status (n = 581), educational status (n = 102), income levels (n = 3,889), insurance status (n = 293), history of cardiovascular diseases (CVD) (n = 218), and history of cancer (n = 53). The final analytical sample included 39,067 participants (89%). The NHANES study protocols were approved by the National Center for Health Statistics Research Ethics Review Board, and the informed consent of all participants was obtained at enrollment.[25] This study was conducted following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.[26]

Exposure Ascertainment: the Frequency of Healthcare Utilization

This household interview collects information on the frequency of provider visits (healthcare utilization) during the past year of the NHANES interview. Participants are asked the following question: "During the past 12 months, how many times have you seen a doctor or other healthcare professional about your health at a doctor's office, a clinic, hospital emergency room, at home or some other place?" Based on the answer to this question ("none," "once," "twice or 3 times," "4 to 9 times," "10 to 12 times," or "13 times or more"), we divided the participants into four groups as follows: no visit (n = 6244), 1–3 times of visits (reference group; n = 17,168), 4–9 times of visits (n = 9751), and 10 or more times of visits (n = 5904). We set 1–3 times of visits instead of once as the reference group to ensure a sufficient statistical power in our main and subgroup analyses for death outcomes as a previous study did.[15]

Outcome Ascertainment: All-Cause and Cardiovascular Mortality

Our primary outcome was all-cause mortality, and secondary outcomes were cardiovascular and cancer mortality based on the National Death Index (NDI) ascertained from the NCHS using probabilistic matching based on social security number, name, date of birth, race/ethnicity, sex, state of birth, and state of residence.[27] Cardiovascular mortality was defined as death from heart diseases and stroke by using the International Classification of Diseases, 10th revision (ICD-10) including acute rheumatic fever and chronic rheumatic heart diseases (I00–I09), hypertensive heart disease (I11), hypertensive heart and renal disease (I13), ischemic heart diseases (I20–I25), other heart diseases (I26–I51), and cerebrovascular diseases (I60–I69). Cancer mortality was defined as malignant neoplasm (C00–C97) in the ICD-10. Time to events was defined as days between the interview date and the end of follow-up (i.e., December 2015) or the date of death.

Other Covariates

Socio-demographic characteristics including age (years), sex (male, female), race/ethnicity (white, black, Hispanic, others), self-reported health condition (excellent, very good, good, fair, poor), smoking status (ever, never), drinking status (never, former, current light/moderate [≤ 2 drinks per day for men or ≤ 1 drink per day for women], current heavy [> 2 drinks per day for men or > 1 drink per day for women]), marital status (married, unmarried), educational status (less than high school, high school, college, graduate), income levels (family poverty-income ratio), and insurance status (uninsured, private, public) were self-reported. Income levels were assessed

Table 1 Demographic Characteristics According to the Number of Visits to Healthcare Providers During the Past Year of the Study Enrollment, NHANES 1999–2015

	Overall(n = 39,067)	Number of visits to the healthcare provider during the past year			
		None(n = 6244)	1–3 times(n = 17,168)	4–9 times(n = 9751)	≥ 10 times(n = 5904)
Age (mean years ± SD)	49.4 ± 18.5	41.1 ± 14.9	47.6 ± 17.8	55.2 ± 18.6	54.1 ± 19.3
Male (%)	18,832 (48.2)	4204 (67.3)	8406 (49.0)	3961 (40.6)	2261 (38.3)
Race/ethnicity (%)					
White	18,732 (47.9)	2231 (35.7)	8058 (46.9)	5228 (53.6)	3215 (54.5)
Black	8021 (20.5)	1147 (18.4)	3667 (21.4)	2051 (21.0)	1156 (19.6)
Hispanic	9524 (24.4)	2328 (37.3)	4118 (24.0)	1902 (19.5)	1176 (19.9)
Others	2790 (7.1)	538 (8.6)	1325 (7.7)	570 (5.8)	357 (6.0)
Self-reported health condition (%)					
Excellent	6119 (15.7)	1293 (20.7)	3259 (19.0)	1060 (10.9)	507 (8.6)
Very good	10,286 (26.3)	1609 (25.8)	5261 (30.6)	2342 (24.0)	1074 (18.2)
Good	13,487 (34.5)	2270 (36.4)	5954 (34.7)	3488 (35.8)	1775 (30.1)
Fair	7279 (18.6)	990 (15.9)	2337 (13.6)	2281 (23.4)	1671 (28.3)
Poor	1896 (4.9)	82 (1.3)	357 (2.1)	580 (5.9)	877 (14.9)
Smoking status (%)					
Ever	18,205 (46.6)	2977 (47.7)	7574 (44.1)	4634 (47.5)	3020 (51.2)
Never	20,862 (53.4)	3267 (52.3)	9594 (55.9)	5117 (52.5)	2884 (48.8)
Marital status (%)					
Married	20,756 (53.1)	3037 (48.6)	9290 (54.1)	5310 (54.5)	3119 (52.8)
Unmarried	18,311 (46.9)	3207 (51.4)	7878 (45.9)	4441 (45.5)	2785 (47.2)
Educational status (%)					
Less than high school	10,891 (27.9)	2268 (36.3)	4210 (24.5)	2649 (27.2)	1764 (29.9)
High school	9065 (23.2)	1474 (23.6)	3950 (23.0)	2255 (23.1)	1386 (23.5)
College	10,853 (27.8)	1574 (25.2)	4983 (29.0)	2714 (27.8)	1582 (26.8)
Graduate	8258 (21.1)	928 (14.9)	4025 (23.4)	2133 (21.9)	1172 (19.9)
Family PIR (mean ± SD)	2.5 ± 1.6	2.1 ± 1.5	2.7 ± 1.6	2.6 ± 1.6	2.4 ± 1.6
Insurance status (%)					
Uninsured	8361 (21.4)	3213 (51.5)	3609 (21.0)	997 (10.2)	542 (9.2)
Private insurance	13,705 (35.1)	1470 (23.5)	6717 (39.1)	3661 (37.5)	1857 (31.5)
Public insurance	17,001 (43.5)	1561 (25.0)	6842 (39.9)	5093 (52.2)	3505 (59.4)
Survey cycle year (%)					
1999–2002	8530 (21.8)	1381 (22.1)	3721 (21.7)	2094 (21.5)	1334 (22.6)
2003–2006	9363 (24.0)	1437 (23.0)	3949 (23.0)	2358 (24.2)	1619 (27.4)
2007–2010	10,858 (27.8)	1759 (28.2)	4791 (27.9)	2751 (28.2)	1557 (26.4)
2011–2014	10,316 (26.4)	1667 (26.7)	4707 (27.4)	2548 (26.1)	1394 (23.6)
History of diabetes (%)	4642 (11.9)	126 (2.0)	1319 (7.7)	1862 (19.1)	1335 (22.6)
History of hypertension (%)	15,006 (38.4)	782 (12.5)	5566 (32.4)	5333 (54.7)	3325 (56.3)
History of dyslipidemia (%)	12,784 (32.7)	747 (12.0)	5123 (29.8)	4355 (44.7)	2559 (43.3)
History of CVD (%)	4455 (11.4)	160 (2.6)	1164 (6.8)	1716 (17.6)	1415 (24.0)
History of cancer (%)	3605 (9.2)	133 (2.1)	1106 (6.4)	1339 (13.7)	1027 (17.4)

Abbreviations: SD standard deviation, PIRpoverty-income ratio, CVD cardiovascular disease, NHANES National Health and Nutrition Examination Survey

using the family poverty-income ratio that was calculated from the ratio of the family income to the federal poverty level.[23,28] We defined the history of diabetes mellitus, hypertension, and dyslipidemia based on self-report of clinical diagnosis and medications. We also defined the history of CVD (heart attack, angina, heart failure, and stroke) and cancer based on self-report.

The physical examination data and biomarkers of metabolic disorders were measured according to the NHANES laboratory procedure guideline,[23] including body mass index (BMI), systolic blood pressure, diastolic blood pressure, estimated granular filtration rate (eGFR), glycated hemoglobin (HbA1c), total cholesterol (T-Chol), high-density lipoprotein cholesterol (HDL-Chol), and triglyceride. BMI was calculated as weight in kilograms divided by height in meters squared. eGFR was calculated using the Chronic Kidney Disease Epidemiology Collaboration equation (eGFR = $141 \times \min[\mathrm{Scr}/k, 1]^{a} \times \max[\mathrm{Scr}/k, 1]^{-1.209} \times 0.993^{\mathrm{age}} \times 1.018$[if female] $\times$ 1.159[if black]; $k = 0.9$ for male and 0.7 for female, $a = -0.411$ for male and -0.329 for female, and minimum indicates the minimum of Scr/k or 1 and max indicates the maximum of Scr/k or 1).[29] Low-density lipoprotein cholesterol (LDL-Chol) was calculated from measured values of T-Chol, triglyceride, and HDL-Chol using the Friedewald calculation ([LDL-Chol] = [T-Chol] − [HDL-Chol] − [triglyceride/5]).

Statistical Analysis

First, we described socio-demographic characteristics according to the frequency of visits to healthcare providers during the past year of the study enrollment. Next, we employed multivariable linear regression models to investigate the cross-sectional association between the frequency of visits to healthcare providers and metabolic markers including BMI, systolic blood pressure, diastolic blood pressure, eGFR, HA1c, T-Chol, HDL-Chol, LDL-Chol, and triglyceride. In these models, we adjusted for age and sex, and then race/ethnicity, self-reported health condition, smoking status, marital status, educational status, family poverty-income ratio, insurance status, and the NHANES survey cycles per 4 years (1999–2002, 2003–2006, 2007–2010, or 2011–2014) (model 1). Using the obtained parameters in the regression models, we

Table 2 Distribution of Measurements and Biomarkers of Metabolic Disorders According to the Number of Visits to Healthcare Providers During the Past Year of the Study Enrollment, NHANES 1999–2015

		Number of visits to the healthcare provider during the past year			
		None	1–3 times	4–9 times	≥ 10 times
BMI (kg/m^2)	Number of participants	5881	16,236	9139	5389
	Age- and sex-adjusted mean (95% CI)	28.1 (28.0 to 28.3)	28.4 (28.3 to 28.5)	29.5 (29.3 to 29.6)	29.6 (29.4 to 29.7)
	Model 1 adjusted mean (95% CI)*	28.1 (27.9 to 28.3)	28.2 (28.1 to 28.4)	28.9 (28.8 to 29.1)	28.8 (28.6 to 29.0)
Systolic BP (mmHg)	Number of participants	5374	14,774	8385	4919
	Age- and sex-adjusted mean (95% CI)	127.5 (127.0 to 128.0)	125.1 (124.8 to 125.4)	124.5 (124.2 to 124.9)	124.0 (123.5 to 124.5)
	Model 1 adjusted mean (95% CI)*	127.5 (127.0 to 128.1)	125.8 (125.5 to 126.2)	125.0 (124.6 to 125.4)	124.2 (123.7 to 124.7)
Diastolic BP (mmHg)	Number of participants	5374	14,774	8385	4919
	Age- and sex-adjusted mean (95% CI)	71.4 (71.1 to 71.8)	70.9 (70.7 to 71.1)	69.7 (69.4 to 70.0)	69.2 (68.8 to 69.6)
	Model 1 adjusted mean (95% CI)*	72.2 (71.8 to 72.7)	71.4 (71.1 to 71.7)	70.1 (69.7 to 70.4)	69.6 (69.2 to 70.0)
eGFR (mL/min/1.73 m^2)	Number of participants	5612	15,567	8823	5136
	Age- and sex-adjusted mean (95% CI)	96.2 (95.7 to 96.6))	94.9 (94.6 to 95.1)	94.3 (94.0 to 94.7)	92.4 (92.0 to 92.9)
	Model 1 adjusted mean (95% CI)*	95.6 (95.1 to 96.1)	95.6 (95.2 to 95.9)	95.5 (95.1 to 95.9)	93.9 (93.4 to 94.4)
HbA1c (%)	Number of participants	5670	15,763	8964	5233
	Age- and sex-adjusted mean (95% CI)	5.62 (5.60 to 5.65)	5.62 (5.61 to 5.64)	5.73 (5.71 to 5.75)	5.79 (5.76 to 5.82)
	Model 1 adjusted mean (95% CI)*	5.72 (5.69 to 5.74)	5.77 (5.75 to 5.79)	5.85 (5.82 to 5.87)	5.86 (5.83 to 5.89)
T-Chol (mg/dL)	Number of participants	5622	15,607	8846	5155
	Age- and sex-adjusted mean (95% CI)	203.5 (202.4 to 204.7)	197.5 (196.9 to 198.2)	194.1 (193.2 to 195.0)	195.6 (194.4 to 196.8)
	Model 1 adjusted mean (95% CI)*	203.0 (201.7 to 204.2)	197.5 (196.6 to 198.3)	194.4 (193.4 to 195.5)	196.1 (194.8 to 197.4)
HDL-Chol (mg/dL)	Number of participants	5622	15,605	8847	5155
	Age- and sex-adjusted mean (95% CI)	52.8 (52.4 to 53.2)	53.2 (53.0 to 53.5)	52.1 (51.8 to 52.4)	52.1 (51.7 to 52.5)
	Model 1 adjusted mean (95% CI)*	53.3 (52.9 to 53.8)	52.8 (52.5 to 53.1)	52.3 (51.9 to 52.7)	52.9 (52.5 to 53.4)
LDL-Chol (mg/dL)	Number of participants	2647	7348	4063	2377
	Age- and sex-adjusted mean (95% CI)	122.3 (120.9 to 123.7)	117.3 (116.5 to 118.1)	112.7 (111.6 to 113.8)	112.1 (110.7 to 113.6)
	Model 1 adjusted mean (95% CI)*	121.2 (119.7 to 122.8)	116.6 (115.5 to 117.6)	112.5 (111.2 to 113.8)	112.3 (110.7 to 113.9)
Triglyceride (mg/dL)	Number of participants	2761	7602	4236	2510
	Age- and sex-adjusted mean (95% CI)	136.9 (132.2 to 141.6)	134.7 (131.9 to 137.4)	142.3 (138.5 to 146.0)	152.2 (147.3 to 157.0)
	Model 1 adjusted mean (95% CI)*	136.7 (131.5 to 141.9)	139.4 (135.8 to 142.9)	143.8 (139.4 to 148.1)	148.1 (142.9 to 153.3)

Abbreviations: CI confidence interval, BP blood pressure, BMI body mass index, eGFR estimated glomerular filtration rate, HbA1c glycated hemoglobin, T-Chol total cholesterol, LDL-Chollow-density lipoprotein cholesterol, HDL-Cholhigh-density lipoprotein cholesterol, NHANES National Health and Nutrition Examination Survey

**Model 1 adjusted mean was calculated adjusting for age, sex, race/ethnicity, self-reported health condition, smoking status, marital status, educational status, family poverty-income ratio, insurance status, and survey cycle year*

calculated the adjusted mean value of the metabolic markers in each exposure category. Third, we employed the multivariable Cox proportional hazard models to estimate the adjusted hazard ratio (aHR) of all-cause and cardiovascular mortality according to the frequency of visits to healthcare providers. In model 2, we included the history of comorbidities (e.g., diabetes mellitus, hypertension, dyslipidemia, CVD, and cancer) in addition to covariates in model 1.

To evaluate the heterogeneity of aHR by individuals' socio-demographic characteristics, we conducted stratified analyses by age, sex, race/ethnicity, self-reported health condition, smoking status, marital status, education status, income levels, and insurance status. As sensitivity analyses, we re-analyzed the data (i) additionally adjusting for drinking status in our main models (n = 34,123), (ii) restricting participants to those without a history of severe medical conditions such as CVD and cancer (n = 31,925), and (iii) by redefining the groups and setting participants who visited the providers' office at once (n = 6891) during the past year instead of 1–3 times of visits as the reference group. We applied the NHANES sampling weights to account for the differential probability of selecting the participants and nonresponse of those eligible and approached. All statistical analyses were conducted using R software version 4.0.3.

RESULTS

Socio-demographic characteristics according to the frequency of healthcare utilization are shown in Table 1. The mean ± standard deviation of age was 49.4 ± 18.5 and females were 51.8%. Participants with lower numbers of healthcare utilization were more likely to be young, male, less educated, with low-income levels, and uninsured. They were also less likely to be White, married, and with chronic comorbidities compared with participants with higher numbers of healthcare utilization.

Table 3. Association of the number of visits to healthcare providers during the past year of the study enrollment with all-cause, cardiovascular, and cancer mortality, NHANES 1999–2015.

	Number of visits to the healthcare provider during the past year			
	None (*n* = 6244)	1–3 times (*n* = 17,168)	4–9 times (*n* = 9751)	≥ 10 times (*n* = 5904)
All-cause mortality				
Number of events	427	1654	1761	1429
Hazard ratio (95% CI)				
Age- and sex-adjusted	1.25 (1.12 to 1.39)	Reference	1.34 (1.26 to 1.44)	2.01 (1.87 to 2.16)
Model 1*	1.16 (1.04 to 1.29)	Reference	1.21 (1.13 to 1.30)	1.57 (1.46 to 1.70)
Model 2†	1.16 (1.04 to 1.30)	Reference	1.15 (1.07 to 1.23)	1.44 (1.33 to 1.55)
Cardiovascular mortality				
Number of events	101	330	409	312
Hazard ratio (95% CI)				
Age- and sex-adjusted	1.65 (1.32 to 2.07)	Reference	1.49 (1.29 to 1.73)	2.08 (1.78 to 2.43)
Model 1*	1.53 (1.21 to 1.93)	Reference	1.30 (1.12 to 1.51)	1.51 (1.29 to 1.78)
Model 2†	1.62 (1.28 to 2.05)	Reference	1.18 (1.01 to 1.37)	1.31 (1.11 to 1.55)
Cancer mortality				
Number of events	98	362	367	319
Hazard ratio (95% CI)				
Age- and sex-adjusted	1.14 (0.91 to 1.43)	Reference	1.34 (1.16 to 1.55)	2.13 (1.83 to 2.48)
Model 1*	1.11 (0.88 to 1.39)	Reference	1.25 (1.07 to 1.45)	1.81 (1.54 to 2.12)
Model 2†	1.08 (0.85 to 1.36)	Reference	1.21 (1.04 to 1.40)	1.69 (1.44 to 1.99)

Abbreviation: CI confidence interval, NHANES National Health and Nutrition Examination Survey

**Model 1 included age, sex, race/ethnicity, self-reported health condition, smoking status, marital status, educational status, family poverty-income ratio, insurance status, and survey cycle year*

†Model 2 included age, sex, race/ethnicity, self-reported health condition, smoking status, marital status, educational status, family poverty-income ratio, insurance status, survey cycle year, history of diabetes, history of hypertension, history of dyslipidemia, history of cardiovascular diseases, and history of cancer

Association Between the Frequency of Healthcare Utilization and Metabolic Markers

After adjusting for socio-demographic characteristics (model 1), we found that participants with no visit during the past year of the study enrollment had higher systolic and diastolic blood pressure, higher total cholesterol, higher HDL-cholesterol, and higher LDL-cholesterol compared with participants who visited the healthcare providers 1–3 times (p value < 0.05 for all outcomes) (Table 2). We also found that the group with higher frequency of healthcare utilization showed a relatively higher adjusted mean of BMI, HbA1c, and triglyceride, and lower adjusted mean of systolic and diastolic blood pressure, eGFR, T-Chol, HDL-Chol, and LDL-Chol.

Association of the Frequency of Healthcare Utilization and Mortality

During the median follow-up of 7.4 (interquartile range, 4.1 to 11.4) years, we observed 5271 (13.5%) all-cause mortality, 1152 (2.9%) cardiovascular mortality, and 1146 (2.9%) cancer mortality. After adjusting for socio-demographic characteristics (model 1), we found higher aHRs for all-cause and cardiovascular mortality among participants with no visit compared with those with 1–3 times of visits (aHR [95% CI] = 1.16 [1.04–1.29] for all-cause mortality and aHR [95% CI] = 1.53 [1.21–1.93] for cardiovascular mortality), but not for cancer mortality (aHR [95% CI] = 1.11 [0.88–1.39]) (Table 3). We also found the increased risk of mortality among participants with 4–9 times of visits (aHR [95% CI] = 1.21 [1.13–1.30] for all-cause mortality, aHR [95% CI] = 1.30 [1.12–1.51] for cardiovascular mortality, and aHR [95% CI] = 1.25 [1.07–1.45] for cancer mortality) and ≥ 10 times of visits (aHR [95% CI] = 1.57 [1.46–1.70] for all-cause mortality, aHR [95% CI] = 1.51 [1.29–1.78] for cardiovascular mortality, and aHR [95% CI] = 1.81 [1.54–2.12] for cancer mortality). The results did not change when additionally adjusting for history of comorbidities (model 2).

In the subgroup analysis of the association between no visit of healthcare providers (vs. 1–3 times of visits) and mortality (Fig. 1), we found the higher aHR of all-cause mortality among males than females (males, aHR [95% CI] = 1.22 [1.06–1.40]; females, aHR [95% CI] = 0.97 [0.79–1.19]; p-for-interaction = 0.01), and among the uninsured individuals than the insured individuals (uninsured, aHR [95% CI] = 1.22 [0.98–1.51]; insured, aHR [95% CI] = 1.09 [0.95–1.25]; p-for-interaction = 0.04). We found no evidence of heterogeneity of the association between no visits and cardiovascular or cancer mortality by any socio-demographic characteristics (Figs. 2 and 3).

In the sensitivity analyses, the results did not substantially change when additionally adjusting for drinking status (Supplemental Table 1), restricting participants to those without a history of CVD and cancer (Supplemental Table 2), or re-analyzing the data by setting participants who visited the office once during the past year as the reference group (Supplemental Table 3).

DISCUSSION

Using the nationally representative sample of US adults, we found that participants with no healthcare utilization during

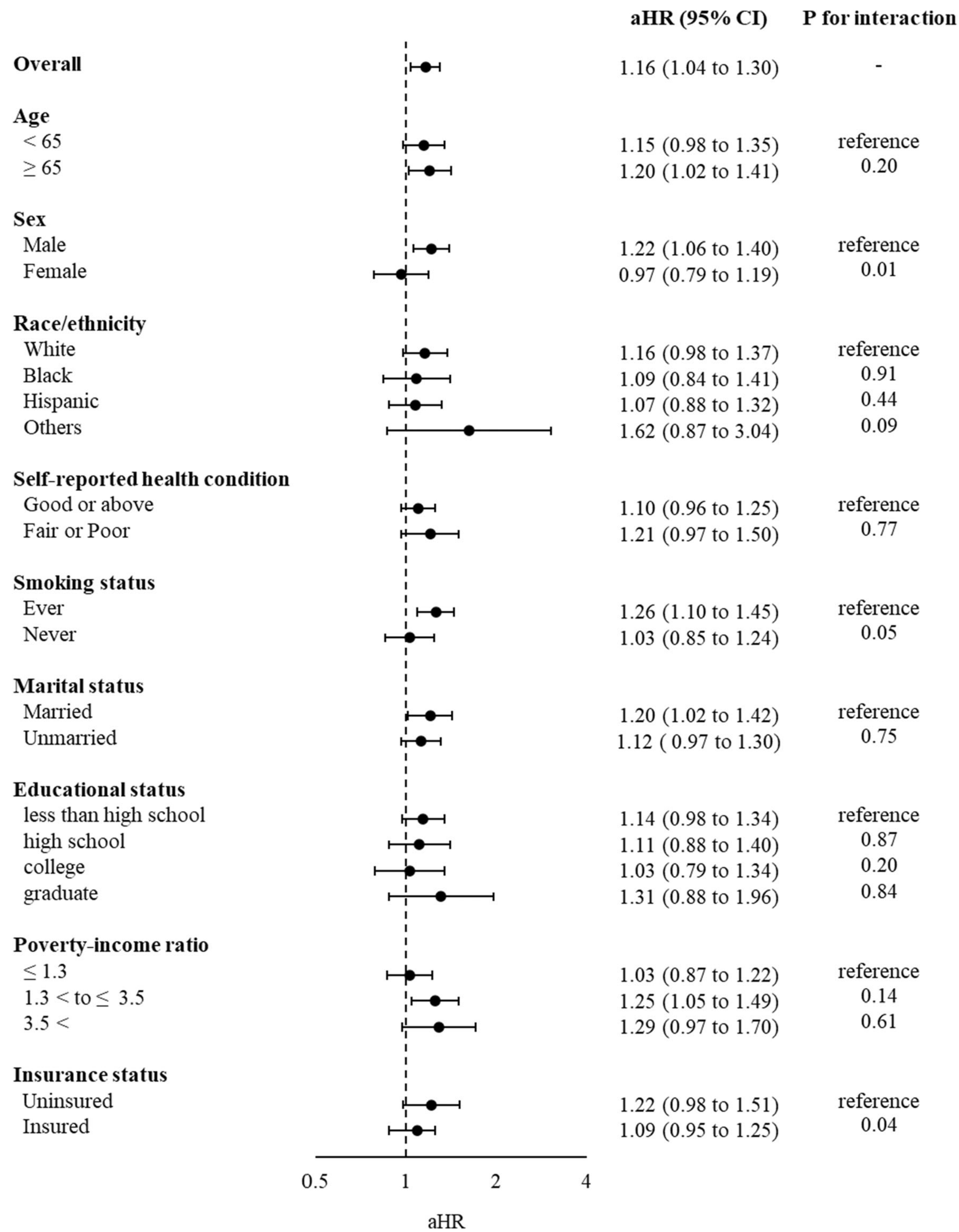

Figure 1 Association of no visit of healthcare provider (vs 1–3 times of visits) during the past year of the study enrollment with all-cause mortality according to participants' demographic characteristics, NHANES 1995–2015. Abbreviation: CI, confidence interval; aHR, adjusted hazard ratio.

the past year of the study enrollment were associated with higher risks of all-cause and cardiovascular mortality compared with those with 1–3 times of healthcare utilization. The association between no healthcare utilization and all-cause mortality was stronger among males than females and uninsured individuals than insured individuals.

Consistent with previous studies,[15–18,30,31] our study using the most updated NHANES cohort showed that some physical examination data and biomarkers (i.e., systolic and diastolic blood pressure, LDL-Chol) were less favorable among individuals without providers' office visit during the past year of the study enrollment than those with 1–3 times of visits, and extended these findings to all-cause and cardiovascular mortality. Although our findings do not necessarily indicate the causal relationship mainly due to the presence of unmeasured

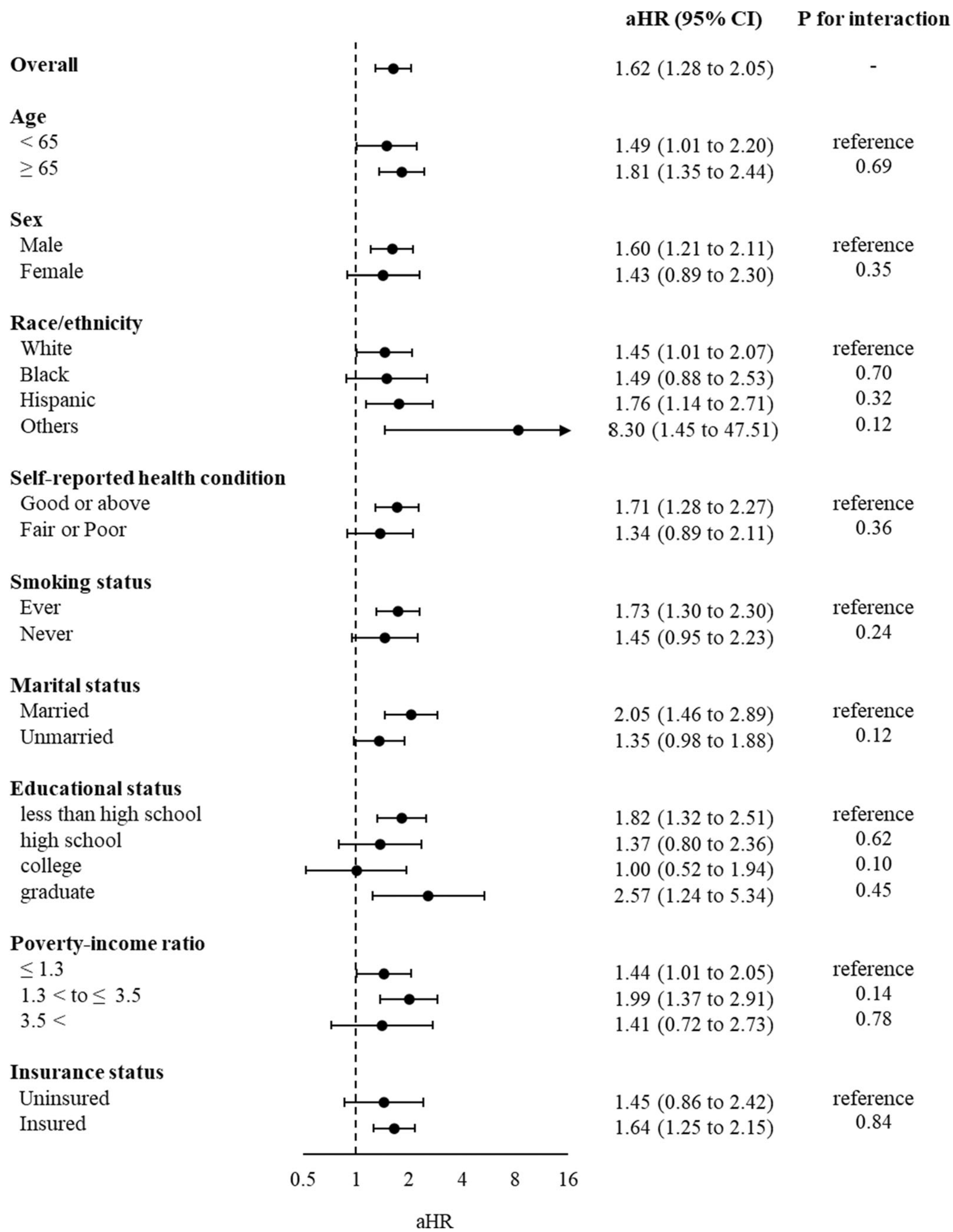

Figure 2 Association of no visit of healthcare provider (vs 1–3 times of visits) during the past year of the study enrollment with cardiovascular mortality according to participants' demographic characteristics, NHANES 1995–2015. Abbreviation: CI, confidence interval; aHR, adjusted hazard ratio.

common causes of healthcare utilization and mortality such as disease severity and healthcare literacy,[7,11–14] the present study identified the important fact that there is a certain number of individuals who had unfavorable medical conditions increasing mortality risks but have inadequate interaction with healthcare providers and thus fewer opportunities to receive treatment and care for their conditions.[15,18] The underlying reasons may include the lack of affordability and accessibility to healthcare services due to limited financial supports and geographical barriers,[2,7,14] low healthcare literacy,[13] and unawareness of diseases.[7,14,18] In addition, the annual checkup and screening program for some diseases (e.g., cancer, diabetes, hypertension, dyslipidemia, etc.) may contribute to better health outcomes among individuals with 1–3 visits than those with no healthcare utilization. Given many other factors that could prevent people from using healthcare services such as geographic area, language barrier, immigration status, and religion,[6,7,14] our findings suggest the need for further studies to identify the effective interventions to ensure the optimal healthcare utilization for people who need the care that would eventually reduce health disparities by social risks.[32]

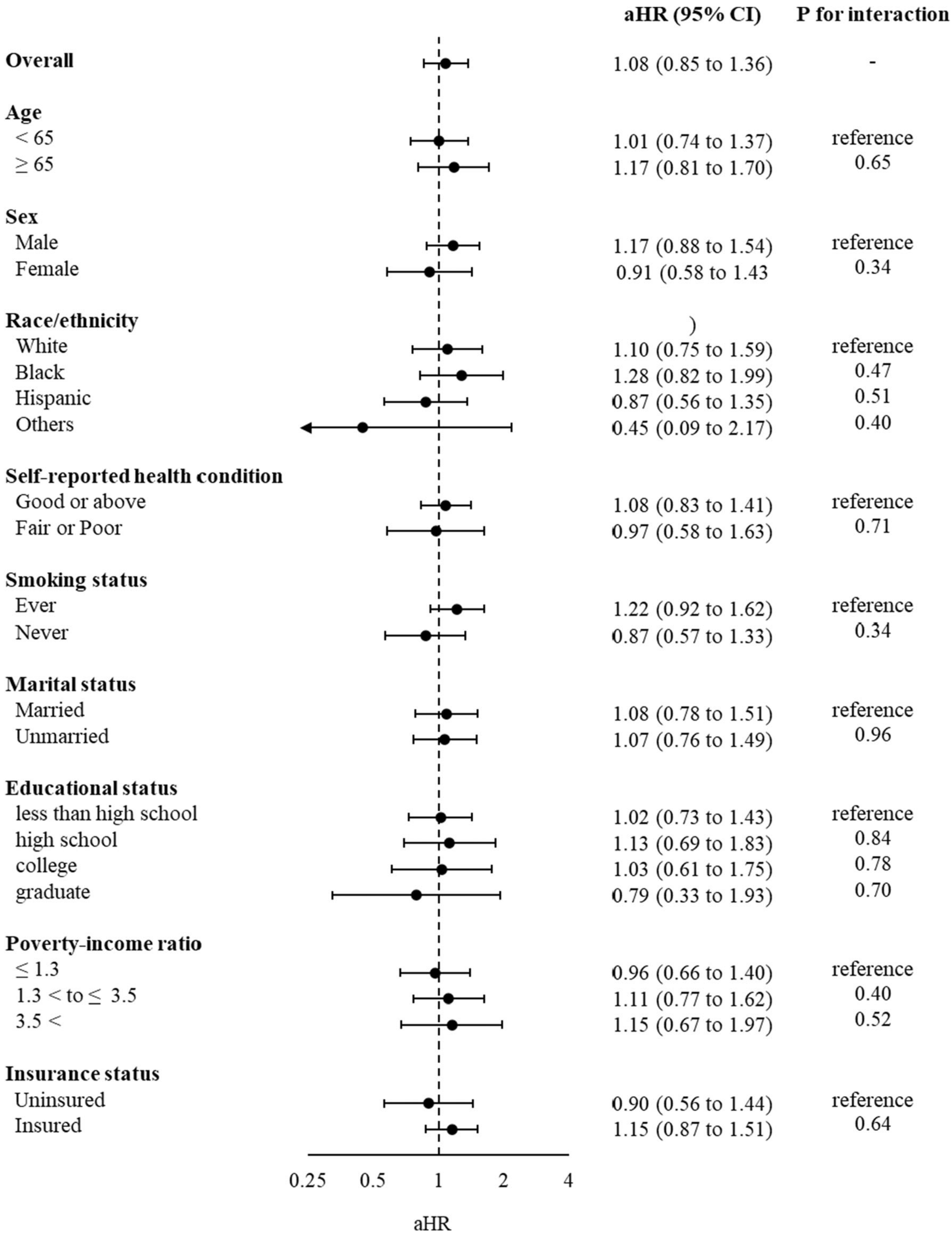

Figure 3 Association of no visit of healthcare provider (vs 1–3 times of visits) during the past year of the study enrollment with cancer mortality according to participants' demographic characteristics, NHANES 1995–2015. Abbreviation: CI, confidence interval; aHR, adjusted hazard ratio.

Our subgroup analyses showed that the association between no healthcare utilization (vs. 1–3 times) and all-cause mortality was stronger among males than females. Although the underlying reasons are unclear, the sex difference in preference of using healthcare services (i.e., females are more likely to visit the clinic than males) might have contributed to the heterogeneous association by sex.[10] Another possible reason may include the favorable role of sex steroid hormones, particularly estrogen, on cardiovascular systems. In general, cardiovascular mortality risk among males accelerates at a relatively young age while that among females tends to increase in postmenopausal years due to the lack of estrogen.[33,34] Because individuals with no healthcare utilization in our study were younger than other groups, our null findings for mortality among females might be partially explained by such protective effect of estrogen among younger individuals with no healthcare utilization.

We found a stronger association between no healthcare utilization (vs. 1–3 times) and all-cause mortality among uninsured individuals than insured individuals. Given the beneficial impact of insurance coverage on healthcare utilization,[5,19,20] most of the insured individuals without healthcare utilization in our study sample might have not needed to use healthcare services while a certain number of uninsured individuals without healthcare utilization might have needed but not been able to use them. Because our follow-up data was collected before the implementation of the Affordable Care Act (ACA)[35] and the longitudinal data on insurance status was not available, future studies will be called for to evaluate the association between no healthcare utilization and long-term adverse health outcomes among insured and uninsured individuals after the expansion of insurance coverage through ACA.

Our results suffer from confounding due to disease severity, as indicated by the observed increased mortality risks among participants with ≥ 4 times of healthcare utilization compared with those with 1–3 times of healthcare utilization. However, given the negative relationship between disease severity and no healthcare utilization (i.e., individuals at lower mortality risks are less likely to use healthcare services[11,12]), such confounding introduces bias toward the null for the association between no healthcare utilization (vs. 1–3 visits) and mortality risks.[36] Thus, our findings of the increased mortality risks among people with no healthcare utilization are considered to be robust even in the presence of confounding bias due to disease severity.

There are several other limitations of this study. First, we cannot rule out other potential uncontrolled confounders such as healthcare literacy, which would introduce bias away from the null (i.e., overestimation because people with low healthcare literacy are less likely to use healthcare services and more likely to have high mortality risks due to worse health behaviors or lower perceived health competence[7,13,14]). Second, as the information on healthcare utilization and participants' medical conditions were reported at the NHANES enrollment, the temporal ordering of these variables was not clear. Our consistent findings of model 1 (without adjusting for comorbidities) and model 2 (with adjusting for comorbidities) indicate that this limitation would not change our conclusion. Given that some participants without insurance before 2013 might have received insurance coverage after the Medicaid expansion,[35] future studies are needed to validate our findings after the implementation of the Affordable Care Act. Third, our study might have a risk of misclassification due to self-report of healthcare utilization and comorbidities. Lastly, although we included around 40,000 US adults, statistical power was not sufficient to assess the heterogeneity of cardiovascular mortality risks related to no healthcare utilization.

CONCLUSION

To the best of our knowledge, this is the first study to investigate the association between the frequency of healthcare utilization and mortality in the US general population. We found an increased risk of all-cause and cardiovascular mortality among individuals without healthcare utilization over the past year of the study enrollment, particularly among males and uninsured individuals. These results generate a hypothesis that a certain number of individuals without healthcare utilization might have needed to use healthcare services to improve their health. Further studies are needed to validate our hypothesis, clarify the underlying reasons for the elevated mortality risks due to inappropriately low healthcare utilization, and identify the high-risk subpopulations for future interventions to reduce health disparity.

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Declarations:

Conflict of Interest: *The authors declare that they do not have a conflict of interest.*

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