HHS Public Access

Author manuscript

J Am Board Fam Med. Author manuscript; available in PMC 2019 July 01.

Published in final edited form as:

J Am Board Fam Med. 2018 ; 31(4): 503–513. doi:10.3122/jabfm.2018.04.180008.

Multi-morbidity Trends in United States adults, 1988–2014

Dana E. King, MD, MS, **Jun Xiang, MS, MA**, and **Courtney S. Pilkerton, MD, PhD**

Department of Family Medicine, West Virginia University, Morgantown West Virginia 26505

Introduction

The simultaneous presence of multiple conditions in one patient (multi-morbidity) is a key challenge facing primary care. Multi-morbidity adds to the complexity of care and threatens the quality, coordination, continuity and safety of care in the United States (U.S.) health care system and elsewhere. Despite the seriousness and far reaching impacts of this phenomenon, characterization of this population, recent studies have focused on older populations, include a limited number of chronic conditions, and often do not include obesity as a chronic condition.[1–8] The burden on patients with multi-morbidity is considerable and is associated with increased mortality.[9–12] Nunes and colleagues recent meta-analysis of 5806 multimorbidity studies and mortality (26 studies were included) demonstrated a hazard ratio of 1.73 (95%CI: 1.41; 2.13) and 2.72 (95%CI: 1.81; 4.08) for people with 2 or more and 3 or more morbidities, respectively.[10]

In addition, heterogeneity in the included conditions of the studies has been high, and obesity was not always included in the list of co-morbidities potentially under-estimating the prevalence of multi-morbidity. [12–13] Including obesity in multi-morbidity estimates is also crucial due to the well-studied link between obesity and a variety of complications, including diabetes, heart disease, cancer, and many others.[14–19] Kivimaki and colleagues have documented considerably increased cardiovascular events in obese vs. non-obese cohorts in a pooled analysis of 16 cohort studies.[20]

The purpose of this study was to determine the current prevalence of multi-morbidity using eleven common conditions including obesity and to examine trends in prevalence during the last 25 years. A secondary objective was to examine age, gender, race and socioeconomic factors associated with multi-morbidity prevalence.

Corresponding author: Dana E. King MD MS, kingdana@wvumedicine.org, Department of Family Medicine, West Virginia University, Morgantown West Virginia 26505, Phone: 304-285-7089/Fax: 304-285-7373.

Drs. King, Pilkerton and Jun Xiang do not have any potential, perceived, or real conflicts of interest.

Methods

Study population

The National Health and Nutrition Examination Survey (NHANES) are serial cross-sectional, stratified multistage probability surveys designed to assess the health and nutrition status among U.S. civilian, noninstitutionalized population. The surveys are conducted by the National Center for Health Statistics (NCHS) and the data are collected on participants' demographic characteristics, nutrition, health, and diet through interviews in participants' homes and medical examinations conducted in a mobile examination center. All participants completed written informed consents and protocols for conducting the NHANES study were approved by the Center for Disease Control and Prevention Institutional Review Board. Details on survey design and response rates can be found on the NHANES website.[21]

The present study combined NHANES III, which was conducted between 1988 and 1994[22], and the continuous NHANES from 1999 to 2014 with data released in 2-year cycles.[22]

Study participants

Participants aged 20 years or older, with nonzero weights (not nonrespondents) were included in the study sample. Of the 57303 participants included in the study sample, there were 16573 from NHANES III, and 40,730 from NHANES 1999–2014.

Multi-morbidity

Multi-morbidity, defined as the presence of two or more chronic conditions in a person, was the primary outcome of the study. Eleven chronic conditions were selected based on their clinical relevance and the availability of the NHANES data; cardiovascular disease (CVD), chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), asthma, arthritis, cancer, stroke, hypertension, hyperlipidemia, diabetes, and obesity.

NHANES collects self-reports of diagnosis by a doctor for health conditions by asking a participant "have you ever been told by a doctor that you have that condition?" Participants were classified as having asthma, arthritis, stroke, and cancer, if participant gave a positive answer to the question regarding these conditions. Participants were classified as having CVD if they answered yes to having at least one of the following heart conditions: congestive heart failure, coronary heart disease, or heart attack. While all three heart conditions were asked about in NHANES 1999–2014, participants in NHANES III were only asked about two of these conditions, congestive heart failure and heart attack. Participants were classified as having COPD if they answered yes to having emphysema or chronic bronchitis.

Participants were classified as having hypertension, hyperlipidemia, or diabetes if gave a positive answer to the self-reported question or had an individual medical measurement equal or greater than the recommended threshold. For example, a participant would be identified as having diabetes if he/she answered "yes" to the question regarding diabetes or had a measured hemoglobin A1c ≥6.5%. Hemoglobin A1c cutoff was determined using the

consistent standard set by the American Diabetes Association summarized in their clinical guidelines.[23]

Blood pressure cutoffs for hypertension were greater than 140 mmHg for systolic blood pressure or 90 mmHg for diastolic blood pressure.[24] Cholesterol cutoff for determining hyperlipidemia was greater than 200 mg/dL of total cholesterol based on the Adult Panel III guidelines.[25]

Participants were classified as obese if they had a Body Mass Index (BMI) ≥ 30 kg/m^2.

There was no self-report of diagnosis question for CKD in NHANES. To identify participants with CKD, we estimated level of kidney function from estimated glomerular filtration rate (eGFR) which was calculated from re-calibrated serum creatinine[26] using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) creatinine equation.[27] Specifically, eGFR = 141 × min(Scr/k, 1)^a × max(Scr/k, 1)$^{-1.209}$ × 0.993^{Age} × 1.018 [if female] × 1.159 [if black]; Scr = serum creatinine (mg/dL); k=0.7 and a=−0.329 if female; k=0.9 and a=−0.411 if male. As lower values of eGFR correspond with diminished kidney function, participants with a value of eGFR<60 mL/min/1.73m^2 were identified as having CKD.

Multi-morbidity was categorized as ≥2 morbidities, ≥3 morbidities, and ≥4 morbidities.

Covariates

Other demographic characteristics extracted for this study included age, gender, race, and socioeconomic status (education level, health insurance status, and ratio of family income to poverty). Age was divided into three groups: 20–44 years, 45–64 years, and 65 years or older. Race was combined into four groups of non-Hispanic White, non-Hispanic Black, Hispanic, and other race. Participants' education level was grouped into two categories of "<High school" and "≥High school". Ratio of family income to poverty was recoded as "Above poverty" for greater or equal to 1.0 and "Under poverty" for less than 1.0. Participants' health insurance status was defined as "Yes" for having health insurance and "No" for not having health insurance.

Statistical Analysis

All data analyses were performed with SAS package version 9.3 (SAS institute Inc., Cary, NC). To account for the complex survey design (including oversampling), survey nonresponse, and post-stratification, we incorporated appropriate sampling weights and SAS survey analysis procedures following NHANES analytic and reporting guidelines.[28]Two year weights for NHANES 1999–2014 and 6-year weights for NHANES III were used for prevalence estimate of individual cohort. For trend analysis, we utilized the combined 6-year weights (NHANES III) and 16 year weight for NHANES 1999–2014. Missing data were assumed to be missing at random. To account for the confounding effect of age, age standardized prevalence levels of multi-morbidity (≥2 morbidities, ≥3 morbidities, and ≥4 morbidities) were estimated and compared using F tests for overall samples and subsamples stratified by NHANES cycles, race, gender, education level, health insurance status, and poverty level. US 2010 Census population of adults aged 20 years or older was used for the

calculation of the age group weights (20–44 years, weight 0.5114; 45–64 years, weight 0.3114; and 65 years or older, weight, 0.1772).[29] Logistic regression was performed to assess linear trends in levels of multi-morbidity across NHANES cycles overall and by demographic and socioeconomic status. P-values for trend analysis were calculated by regressing the levels of multi-morbidity on the median year of the survey cycle. Statistical significance was determined if a 2 sided p-value < 0.05.

Results

Prevalence of multi-morbidity by demographic characteristics in NHANES 2013–2014 is presented in Table 1. Among the total sample of 5541 participants in the 2013–2014 cycle, 59.6% [95% CI, 58.1%−61.1%] had ≥2 morbidities, 38.5% (95% CI, 36.3%−40.6%) had ≥3 morbidities, and 22.7% [95% CI, 21.1%−24.3%] had ≥4 morbidities. [Insert Table 1]

Compared to aged 45–64 years and 20–44 years groups, the weighted prevalence of ≥2 morbidities was higher in those aged 65 years or older (91.8% vs.70.6 vs. 37.5%, p<.0001). A similar significant difference between age groups was also found in the prevalence of individuals with ≥3 morbidities (76.5% vs.47.7 vs.15.3%, p<.0001) and ≥4 morbidities (55.6% vs. 26.4% vs. 6.0%, p<.0001).

There was higher age-standardized prevalence at all levels of multi-morbidity in female participants than in male participants (58.4% vs. 55.9%, p=.01 for ≥2 morbidities, 38.4% vs. 33.8%, p=.0002 for ≥3 morbidities, and 23.6% vs. 18.4%, p<.0001 for ≥4 morbidities).

Across all three levels of multi-morbidity, the age-standardized prevalence was consistently higher in non-Hispanic White and non-Hispanic Black participants than Hispanic participants or participants of other race. The age-standardized prevalence of all levels of multi-morbidity was similar among different education groups. Participants with health insurance had higher prevalence of ≥2 and ≥3 multi-morbidities than their counterparts without health insurance. There was a lower prevalence of ≥4 multi-morbidities in participants “above poverty” compared to those in “under poverty” group.

Tables 2, 3, and 4 summarize the trends in multi-morbidity prevalence between 1988 and 2014. The weighted overall prevalence of ≥2 multi-morbidities, ≥3 multi-morbidities, and ≥4 multi-morbidities significantly increased from 45.7%, 24.6%, and 12.0% in 1988–1994 to 59.6%, 38.5%, and 22.7% in 2013–2014 (p<.0001 for trend for all three levels) (as summarized in Figure 1). Significant increases in multi-morbidity prevalence over the study period were seen in all levels of multi-morbidity and for all age, gender, race health insurance status, poverty level, and education level groups except other race. Although not significant, there was a decreasing trend in multimorbidity prevalence for other race. [Insert Tables 2–4]

Figure 2 illustrates the prevalence of each individual morbidity condition in the cohorts included in the study. Obesity experienced the largest increased trend of any condition across the study timeframe (p<.0001).

Discussion

The current findings document the high and growing prevalence of multi-morbidity in adults in the U.S. Overall, we observed over half of all adults (59.6%) age 20 and older have 2 or more multi-morbidities, a proportion that has steadily increased from 45.7% in the 1988–94 survey period. The prevalence was highest in people aged 65 years or older (91.8%) and consistently higher in females than males.

These trend results are consistent with recent data from the CDC showing a high prevalence of comorbidity in people with chronic conditions. For example, data from the National Health Interview Survey showed that 49% of people with heart disease also had doctor-diagnosed arthritis.[30] Recent CDC data also showed that 25% of adults had at least 2 chronic conditions (out of ten possible conditions).[31] Dugolf and colleagues documented prevalence among Medicare beneficiaries and concluded that more than two-thirds of older adults have at least 2 chronic conditions.[32]

The current study results show higher prevalence than seen in other similar studies likely secondary to our selection of chronic conditions, notably including obesity. Obesity is associated with a large number of pathologic processes and risks, including metabolic syndrome, vascular disease, cancer, oxidative stress, inflammation, as well as many others. Due to the considerable morbidity of obesity and its impact on a variety of health systems, we felt it was important to include as a chronic condition rather than a control factor in the multi-morbidity calculations for the current study.[15–19]

Similar to the current study's observation of increasing multi-morbidity, this trend has been seen in other cohorts and other countries. Oostrum and colleagues examined multimorbidity trends from 2001–2011 and saw increases in multimorbidity, but published much lower rates of multimorbidity (14.3% to 17.5%, $p<0.01$), despite including 28 conditions seen in general practice.[33] Their list included heart, lung, mood disorders, as well as many others. A study in Canada by Pefoyo and colleagues, reported a multimorbidity rate that was increasing (24.3%), but was still much lower than in the current study.[34]

In U.S studies on a state level, similar patterns to the current study have been documented. Rocca and colleagues have studied a Minnesota cohort and reported similar trends for age and sex as in the current study.[35]

Their overall rate of multimorbidity using 20 conditions was 77.3% for age 65 years and older, compared to our finding of 91.8% in participants over 65, but their study did not include obesity as one of the conditions.

The increase in multi-morbidity over time suggests a worsening of the disease burden facing individuals of all demographic characteristics. Over 91% of people over 65 are dealing with at least two serious chronic conditions or risk factors, and many are facing four or more. Prince and colleagues have recently reviewed the chronic disease burden among older people and concluded that it is a global problem and epidemic.[36] Further, care of older adults with cardiovascular conditions is significantly complicated by the concurrent comorbidity burden that so frequently accompanies them.[37]

Possible explanations for the increasing prevalence of multi-morbidity have been documented in the literature on numerous occasions, including unhealthy diet patterns, infrequent regular physical activity, smoking, and socioeconomic factors.[38–44] Other possible explanations are the prevalence of health disparities and the ease and regularity of access to primary care which would lead to increased diagnosis.[45–46] The current study observed that much of the increasing trend in multi-morbidity was likely due to the significant increase in obesity.

The association between trends and morbidities in people with insurance is complex, and has been the subject of numerous studies, including 24 recent cross-sectional studies.[47]

Extensive further study will be needed to determine the roots of multimorbidity differences in populations and the impact on outcomes and disability.[48]

The association seen in the current study between having insurance and more co-morbidities may be a consequence of several possible factors, including that insured people have easier health care access and may more frequently be told a diagnosis. Under-diagnosis of poorer individuals and uninsured populations also may be contributing. The local physical/geographic environment, insurance co-pays, regional variation, and many other factors may be contributing to this insurance socioeconomic equation, and needs further research.

This study has several limitations including possible misclassification, consistency of data reported over cohort years, and cross-sectional data collection. Misclassification is a concern due to the reliance on self-report for determination of several of the chronic conditions. Participants were considered to have the specific chronic condition by either a doctor-diagnosed history or by reaching the threshold for certain conditions, even if not formally diagnosed, such as blood pressure >140/90, or cholesterol >200. However, classification standards were consistently applied across the NHANES cohorts in the current study.

In addition, the comorbidities included in this study were limited because all selected conditions had to be included in each year cohort of the general NHANES questionnaire. For example, depression, anxiety, opioid addiction, and other mental health conditions known to be associated with morbidity have not been included consistently for all adult age groups in the NHANES cohorts over the period of this study, thus making it likely that we have underestimated multi-morbidity. Specifically, opioid overuse or abuse data was not routinely collected even though it is recognized as a significant problem and growing contributor to premature mortality.[49]

Another limitation is that this study population consists of a series of cross-sectional studies, thus the study is examining different people at each interval and does not represent the course of chronic disease in any individual.

In conclusion, multi-morbidity for the eleven selected conditions is highly prevalent and has increased over the last 25 years. Obesity is a significant contributor to the trend. Public health leaders and policy makers should be attentive to these trends when designing policies and interventions to improve the public's health. Further research is needed to determine which interventions would be most helpful in addressing people with multi-morbidity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Sources of Support: “Research reported in this publication was supported by the National Institute of General Medical Sciences of the National Institutes of Health under Award Number 2U54GM104942–02. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.”

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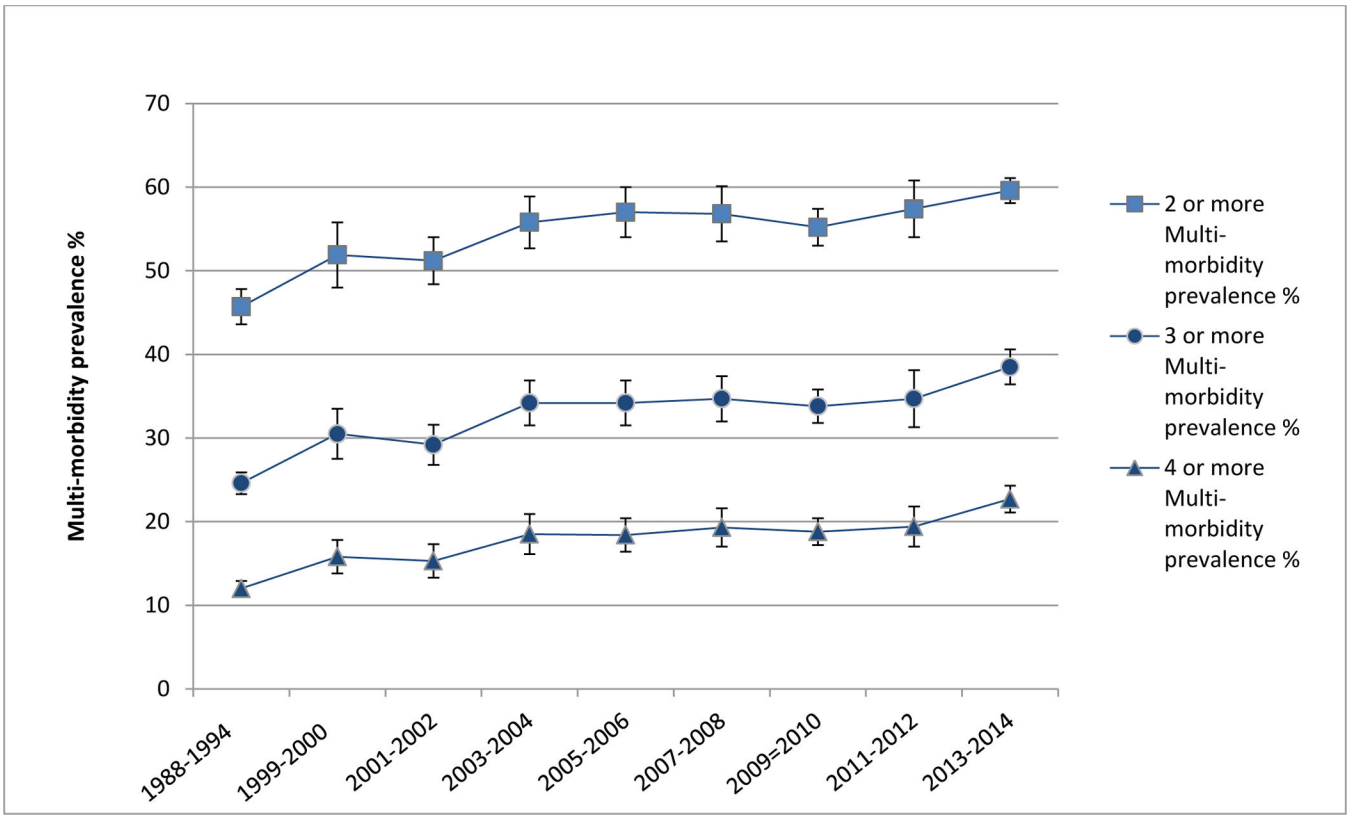

Figure 1.

Age-standarized trends in multi-morbidity prevalence for participants 20 years or older from NHANES 1988–2014 by number of comorbities.

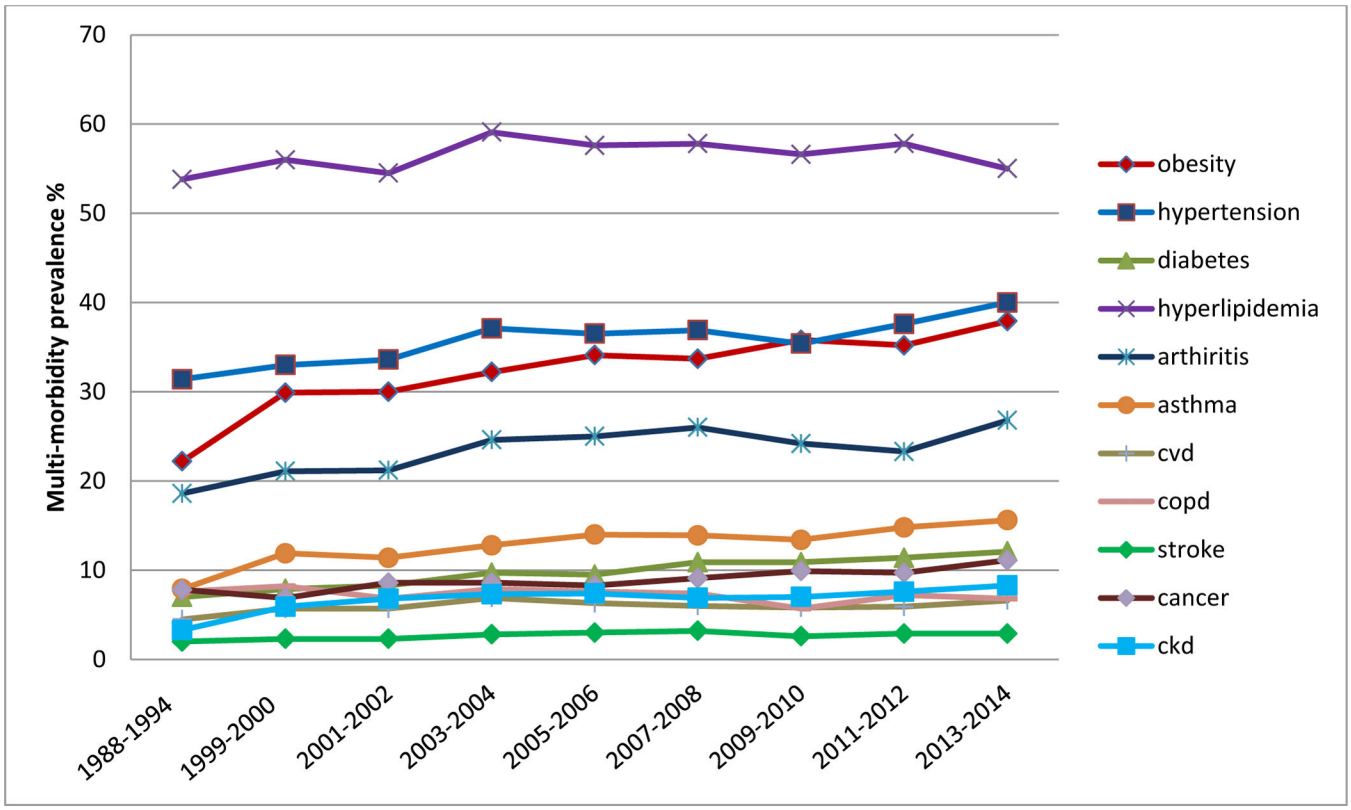

Figure 2.

Age-standardized prevalence of various chronic conditions in participants 20 years or older from NHANES 1988–2014.

Table 1.

Age standardized prevalence of multi-morbidity in participants 20 years or older stratified by age, sex, race, poverty, education, and insurance status for NHANES 2013–2014.

	Total No. of subjects (N)*	2 or more multi-morbidities			3 or more multi-morbidities			4 or more multi-morbidities		
		N*	Prevalence, % (95% CI) ±	P‡	N*	Prevalence, % (95% CI) ±	P‡	N*	Prevalence, % (95% CI) ±	P-value‡
Overall prevalence	5541	3342	59.6 (58.1–61.1)		2202	38.5 (36.3–40.6)		1321	22.7 (21.1–24.3)	
Age group, y										
20–44	2367	868	37.5 (35.4–39.5)	<.0001	364	15.3 (13.4–17.2)	<.0001	140	6.0 (4.7–7.2)	<.0001
45–64	1909	1333	70.6 (67.5–73.6)		902	47.7 (44.9–50.9)		512	26.4 (23.8–29.0)	
65+	1265	1153	91.8 (88.6–95.1)		936	76.5 (72.2–80.8)		669	55.6 (52.4–58.8)	
Sex										
Male	2669	1551	55.9 (54.6–57.2)	.01	964	33.8 (31.6–36.1)	.0002	538	18.4 (16.9–19.8)	<.0001
Female	2872	1803	58.4 (56.7–60.2)		1238	38.4 (36.3–40.5)		783	23.6 (21.7–25.6)	
Race										
Hispanic	1234	712	54.9 (52.8–57.1)	<.0001	409	30.1 (28.1–32.1)	<.0001	220	15.5 (14.2–16.9)	<.0001
White	2377	1570	59.2 (57.5–60.9)		1119	37.9 (35.9–39.9)		702	22.1 (20.9–23.3)	
Black	1135	734	60.1 (56.7–63.4)		495	39.3 (36.4–42.3)		310	23.9 (21.4–26.4)	
Others	795	338	45.0 (42.0–48.0)		179	27.8 (24.5–31.2)		89	15.8 (12.0–19.5)	
Ratio of family income to poverty										
Above Poverty (≥1.0)	3967	2426	57.5 (56.1–58.9)	.36	1600	36.2 (34.6–37.7)	.18	953	20.7 (19.4–22.0)	.02
Under Poverty (<1.0)	1149	672	58.0 (54.5–61.6)		455	39.1 (35.5–42.6)		280	25.1 (22.3–27.9)	
Health insurance										
Yes	4363	2834	58.7 (57.1–60.4)	.01	1935	37.3 (35.5–39.2)	.04	1201	21.7 (20.5–22.9)	.22
No	1172	516	51.3 (47.7–54.9		264	29.1 (23.4–34.8)		118	17.1 (12.2–22.1)	
Education										
≥ High school	4344	2584	57.4 (56.1–58.8)	.89	1677	36.2 (34.5–38.0)	.93	985	20.8 (19.4–22.1)	.20
< High school	1192	766	57.1 (53.1–61.0)		522	36.3 (31.9–40.7)		333	22.8 (19.3–26.2)	

Note: Numbers of subjects in each category may be different due to the missing values in some variables

*Un-weighted total number of subjects with multi-morbidity.

±The overall and age group prevalence were weighted. The sex, race, poverty ratio, health insurance, and education group prevalence were age standardized.

‡P-value from *F* test.

Chronic conditions included in determining multi-morbidity: cardiovascular disease (CVD), chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), asthma, arthritis, cancer, stroke, hypertension, hyperlipidemia, diabetes, and obesity.

J Am Board Fam Med. Author manuscript; available in PMC 2019 July 01.

Table 2.

Age-standardized prevalence of 2 or more multi-morbidities for participants aged 20 years or older stratified by age, sex, race, poverty, education, and insurance status for NHANES 1988–2014.

	1988–1994 (n=16573)	1999–2000 (n=4222)	2001–2002 (n=4792)	2003–2004 (n=4742)	2005–2006 (n=4481)	2007–2008 (n=5660)	2009–2010 (n=6011)	2011–2012 (n=5281)	2013–2014 (n=5541)	P for trend‡
No. with 2 or more multi-morbidities*	8535	2528	2735	2900	2664	3519	3618	3135	3354	
Overall prevalence (%)≠	45.7 (43.5–47.8)	51.9 (48.0–55.8)	51.2 (48.3–54.0)	55.8 (52.7–58.9	57.0 (54.0–60.0)	56.8 (53.5–60.1)	55.2 (52.9–57.4)	57.4 (54.0–60.8)	59.6 (58.1–61.1)	<.0001
Age group, y										
20–44	26.6 (24.2–28.9)	30.9 (26.9–34.9)	31.9 (29.3–34.6)	34.5 (31.5–37.5)	35.4 (30.9–39.9)	35.1 (31.3–39.0)	32.4 (30.2–34.6)	34.9 (31.4–38.4)	37.5 (35.4–39.5)	<.0001
45–64	63.1 (61.0–65.3)	68.0 (61.5–74.5)	63.6 (59.4–67.7)	70.1 (66.2–73.9)	69.0 (66.3–71.7)	68.8 (65.2–72.3)	67.3 (64.4–70.2)	69.2 (66.5–72.0)	70.6 (67.5–73.6)	<.0001
65+	83.5 (81.5–85.6)	91.7 (89.8–93.6)	88.9 (86.6–91.1)	90.6 (88.6–92.6)	91.5 (89.2–93.8)	90.5 (88.4–92.5)	90.8 (89.3–92.4)	89.8 (87.5–92.0)	91.8 (88.6–95.1)	<.0001
Sex										
Male	45.6 (43.6–47.5)	51.3 (46.0–56.8)	51.3 (48.6–54.0)	54.6 (51.4–57.9)	54.8 (51.8–57.8)	54.4 (51.2–57.5)	54.8 (52.7–56.9)	54.5 (52.0–57.0)	56.1 (54.8–57.3)	<.0001
Female	50.2 (48.5–51.9)	54.9 (51.2–58.5)	52.3 (49.8–54.7)	56.2 (53.4–59.0)	56.7 (53.7–59.6)	56.4 (53.1–59.7)	52.4 (50.7–54.1)	56.1 (53.4–58.7	58.7 (56.9–60.5)	<.0001
Race										
Hispanic	46.9 (45.2–48.7)	49.6 (45.3–53.9)	48.0 (43.6–52.3)	50.5 (46.3–54.6)	49.8 (46.5–53.1)	51.5 (48.5–54.4)	51.1 (47.5–54.7)	56.2 (52.4–60.0)	54.9 (52.8–57.1)	<.0001
White	44.0 (38.7–49.4)	53.5 (49.0–57.9)	52.2 (49.6–54.7)	56.6 (53.9–59.3)	56.5 (53.4–59.6)	56.3 (51.8–60.8)	53.9 (51.9–55.9)	55.1 (51.7–58.5)	59.2 (57.5–60.9)	<.0001
Black	47.9 (45.9–49.9)	57.5 (55.4–59.5)	56.0 (54.2–57.9)	58.8 (56.5–61.1)	58.9 (55.5–62.3)	58.6 (55.5–61.7)	61.5 (58.7–64.5)	61.6 (59.0–64.2)	60.1 (56.7–63.4)	<.0001
Others	52.9 (51.3–54.5)	52.7 (37.7–67.7)	47.9 (40.7–55.0)	45.3 (34.5–56.1)	53.5 (44.8–62.3)	49.8 (40.3–59.2)	42.6 (37.6–47.6)	45.0 (41.2–48.9)	45.0 (42.0–48.0)	.11
Ratio of family income to poverty										
Above Poverty (≥1.0)	47.4 (45.7–49.2)	52.7 (48.9–56.5)	51.4 (49.0–53.9)	55.3 (52.5–58.0)	55.6 (52.5–58.7)	55.3 (52.8–57.9)	53.4 (51.9–55.0)	54.8 (52.5–57.2)	57.5 (56.1–58.9)	<.0001
Under Poverty (<1.0)	53.1 (50.5–55.8)	58.9 (52.4–65.4)	54.0 (48.7–59.3)	58.4 (52.9–64.0)	57.1 (52.2–61.9)	59.1 (53.4–64.8)	58.4 (55.2–61.7)	57.0 (53.0–61.0)	58.0 (54.5–61.6)	.001
Health insurance										
Yes	48.1 (46.3–50.0)	54.2 (49.7–58.7)	52.9 (51.1–54.7)	57.0 (54.2–59.8)	57.5 (54.4–60.6)	56.6 (53.2–60.0)	54.6 (52.9–56.2)	55.5 (53.2–57.9)	58.7 (57.1–60.4)	<.0001
No	43.1 (38.3–47.8)	47.9 (40.7–55.1)	46.4 (38.5–54.3)	46.7 (40.0–53.3)	48.9 (44.9–53.0)	50.5 (46.4–54.7)	48.8 (44.1–53.4)	53.9 (50.0–57.7)	51.3 (47.7–54.9	<.0001
Education										
≥ High school	46.4 (44.7–48.2)	52.9 (48.6–57.2)	51.4 (49.3–53.6)	54.9 (52.4–57.4)	55.8 (52.8–58.9)	54.8 (51.8–57.9)	53.2 (51.7–54.7)	54.4 (52.0–56.7)	57.4 (56.1–58.8)	<.0001
< High school	52.5 (50.0–55.0)	54.4 (49.9–58.9)	53.8 (49.8–57.9)	58.2 (53.4–63.1)	56.1 (53.0–59.3)	57.6 (52.7–62.5)	55.5 (51.4–59.5)	60.3 (56.1–64.4)	57.1 (53.1–61.0)	.05

*Unweighted total number of subjects with 2 or more multi-morbidities

≠Weighted overall prevalence of 2 or more multi-morbidities

‡p-value from logistic regression analysis.

Chronic conditions included in determining multi-morbidity: cardiovascular disease (CVD), chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), asthma, arthritis, cancer, stroke, hypertension, hyperlipidemia, diabetes, and obesity.

Table 3.

Weighted prevalence of 3 or more multi-morbidities for participants aged 20 years or older for NHANES 1988–2014.

NHANES	1988–1994 (n=16573)	1999–2000 (n=4222)	2001–2002 (n=4792)	2003–2004 (n=4742)	2005–2006 (n=4481)	2007–2008 (n=5660)	2009–2010 (n=6011)	2011–2012 (n=5281	2013–2014 (n=5541)	P for trend[≠]
No. with 3 or more comorbidities [*]	4975	1591	1678	1893	1705	2349	2366	1996	2202	
Overall prevalence (%)[±]	24.6 (23.2–25.9)	30.5 (27.5–33.5)	29.2 (26.8–31.6)	34.2 (31.5–36.9)	34.2 (31.5–36.9)	34.7 (32.1–37.4)	33.8 (31.9–35.8)	34.7 (31.3–38.1)	38.5 (36.3–40.6)	<.0001

[*] Unweighted total number of subjects with 3 or more multi-morbidities

[±] Weighted overall prevalence of 3 or more multi-morbidities

[≠] p-value from logistic regression analysis.

Chronic conditions included in determining multi-morbidity: cardiovascular disease (CVD), chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), asthma, arthritis, cancer, stroke, hypertension, hyperlipidemia, diabetes, and obesity.

Table 4.

Weighted prevalence of 4 or more multi-morbidities for participants aged 20 years or older for NHANES 1988–2014.

NHANES	1988–1994 (n=16573)	1999–2000 (n=4222)	2001–2002 (n=4792)	2003–2004 (n=4742)	2005–2006 (n=4481)	2007–2008 (n=5660)	2009–2010 (n=6011)	2011–2012 (n=5281)	2013–2014 (n=5541)	P for trend[≠]	
No. with 4 or more comorbidities[*]	2521	875	924	1092	964	1413	1398	1152	1321		
Overall prevalence[≠]	12.0 (11.1–12.9)	15.8 (13.7–17.8)	15.3 (13.2–17.3)	18.5 (16.2–20.9)	18.4 (16.4–20.4)	19.3 (17.0–21.6)	18.8 (17.2–20.4)	19.4 (17.0–21.8)	22.7 (21.1–24.3)	<.0001	

[*] Un-weighted total number of subjects with 4 or more multi-morbidities

[≠] Weighted overall prevalence of 4 or more multi-morbidities

[≠] p-value from logistic regression analysis.

Chronic conditions included in determining multi-morbidity: cardiovascular disease (CVD), chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), asthma, arthritis, cancer, stroke, hypertension, hyperlipidemia, diabetes, and obesity.