Background

Chronic diseases such as cancer and cardiovascular disease are leading causes of death in the United States.[1] A combination of lifestyle factors is associated with the risk of all-cause, cardiovascular, and cancer mortality (Loef, Walach, 2012). [2]Smoking, physical inactivity, failure to maintain a normal BMI (18.5-24.9), heavy alcohol consumption, and unhealthy diet are associated with an increased risk of cardiovascular disease, and mortality of all causes. [3]A healthy lifestyle is defined as not smoking (never a smoker or have quit smoking), moderate alcohol consumption, regular physical activity, healthy diet, and maintaining a normal BMI. National trends have shown a reduction in the prevalence of smoking, but an increased prevalence of physical inactivity, unhealthy diet and obesity among Americans. [4]While many previous studies have examined the associated between healthy lifestyle factors and mortality due to all-causes, and various types of cardiovascular disease, relatively few have examined cancer mortality alongside cardiovascular and all-cause mortality and separated participants into five age groups (20-39, 40-59, 60-79, over 80 years).

The objective of this study is to examine the impact of the number of healthy lifestyle behaviors (not smoking, moderate alcohol consumption, healthy diet, and maintaining a normal BMI) across five age groups (20-39, 40-59, 60-79, over 80 years) on mortality from all causes, cancer, and cardiovascular disease.

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[1] Troost Jonathan P, et al., Temporal and Regional Trends in the Prevalence of Healthy Lifestyle Characteristics: United States, 1994–2007 American Journal of Public Health l July 2012, Vol 102, No. 7

[2] Loef Martin, Walach Harald, The combined effects of healthy lifestyle behaviors on all cause mortality: A systematic review and meta-analysis, Elsevier Preventive Medicine 55 (2012) 163-170

[3] Ford Earl S., et al., Healthy lifestyle behaviors and all-cause mortality among adults in the United States, Elsevier, Preventive Medicine 55 (2012) 23-27

[4] ?

Methods

We used public data files for participants in the National Health and Nutrition Examination Survey (NHANES) between 2003 and 2016. We included participants ≥ 20 years in our analysis. Four behaviors of interest were included: smoking, alcohol consumption, physical activity, and diet. Moderate alcohol consumption was defined as 5-15g alcohol per day in some and 5-30g alcohol per day in men. Participants were considered to be adequately active if the participant engaged in 150 or more minutes of moderate or vigorous activity per week. We used the Healthy Eating Index score as our measure of dietary behavior. The Healthy Eating Index has 10 subcomponents each with a score ranging from 0 to 10; grains, fruits, vegetables, dairy, meats, fats, saturated fat, cholesterol, sodium, and variety. Participants in the upper quartile of the Healthy Eating Index were considered to show evidence of a healthy dietary pattern. Participants with a BMI between 18.5 and 24.9 were deemed to have a normal BMI. We included age, sex, race/ethnicity, educational status, poverty income ratio, self reported history of cardiovascular disease (myocardial infarction, stroke, or congestive heart failure). Participants were divided into four age groups: 20-39, 40-59, 60-79, ≥ 80 years). The study outcomes—all-cause, cardiovascular, and cancer mortality were recorded from the NHANES mortality follow-up data. Cause specific mortality was coded using the tenth revision of the International Classification of Diseases, Injuries and Causes of Death (ICD - 10). Cardiovascular mortality was coded under ICD-10 100-178, and cancer mortality was coded under ICD-10 C00-C97.

Results

Over the past 13 years, the percent of adults aged ≥ 20 years with a BMI ≥30 has increased from 68% to 73.1 percent (P<.05); the percent of those who were physically active increased from 34.4% to 36.3%; smoking rates decreased from 25.5% to 18.4% (P<.05); those with and HEI score ≥ 50 remained unchanged, remaining at 50.6% ; and moderate alcohol use

has increased from 21.0% to 23.5%. Adherence to 3 or more healthy lifestyle behaviors increased from 17.5% to 21%. The overall percent of adults aged ≥ 20 years with 0 healthy lifestyle behaviors amongst participants from 2003-2016 was 7.62 percent; the percent of those who adhered to 1 healthy lifestyle behavior was 41.19 percent; the percent of those who adhered to 2 healthy lifestyle behaviors was 34.49%; the percent of those who adhered to 3 healthy lifestyle behaviors was 13.72%; the percent of those who adhered to 4 healthy lifestyle behavior was 2.81%; and the percent of those who adhered to all 5 healthy lifestyle behaviors was 0.16%. The overall percent of those adhering to 3 or more healthy lifestyle behaviors was 16.69%.

There were disparities in adhering to healthy lifestyle habits by age, sex, ethnicity, and level of education. In general, those who were older, those classified as non-hispanic white, and those with at least a high school education were more likely to report adherence to at least 3 healthy lifestyle habits (Table 1a). Men, those classified as non-hispanic white, those with a PIR > 200, and with at least a high school education were more likely to adhere to a higher number of healthy lifestyle habits regardless of age group (Table 1b). For each individual healthy lifestyle behavior, those who were older were more likely to report healthy lifestyle habits than those who were younger, except for being physically active, and limiting alcohol intake (Table 2). The rate of adhering to healthy lifestyle habits was evaluated in those with cardiovascular disease and risk conditions. Those with self-reported cardiovascular disease, history of cancer, and diabetes, were less likely to report adherence to healthy lifestyle habits (P<.05). Not smoking in adults aged 20-39 has decreased by the greatest absolute percentage, from 67.8% to 79.0%, while those aged 40-59 have gone from 73.0% to 79.5%, those aged 60-79 have decreased from 86.8% to 85.7%, and those aged ≥ 80 years have increased from 96.4% to 97.1%.

Table 1a	# Healthy Lifestyle Behaviors—NHANES 2003-2016—General Population Aged ≥20 years										
Variable	0		1		2		3		4+		p-value
	Count	% (SE)	Count	% (SE)	Count	% (SE)	Count	% (SE)	Count	% (SE)	
Men	997	44.2	4892	42.6	5047	50.1	2270	55.9	458	48.6	< 0.001
Women	1193	55.7	6950	57.4	4869	49.9	1675	44.1	396	51.4	
Mexican American	321	7.7	2330	10.1	1544	7.9	441	5.4	52	2.8	< 0.001
Other Hispanic	163	4.4	1193	5.6	819	5.1	307	4.2	52	2.9	
Non-Hispanic White	1030	68.1	4886	66.1	4428	68.1	2081	76.2	592	86.6	
Non-Hispanic Black	541	13.7	2721	13.0	2046	10.8	607	7.0	77	3.5	
Other Race	135	5.8	712	5.1	1079	8.1	509	7.3	81	4.2	
PIR≤200%	1346	49.5	5539	35.6	3827	28.1	1151	20.2	206	17.3	< 0.001
PIR>200%	697	44.7	5368	58.2	5367	65.9	2552	75.2	606	78.3	
≤12th Grade Education	1439	59.8	6449	46.2	4222	34.9	1174	23.0	166	13.3	< 0.001
≥12th Grade Education	750	40.1	5385	53.8	5686	65.1	2768	77.0	688	86.7	
History of Cardiovascular Disease	240	9.4	1042	7.1	605	4.8	183	3.5	38	2.6	
History of Cancer	164	7.9	1109	10.0	867	9.3	342	8.9	112	11.9	
History of Diabetes	289	9.9	1842	12.4	937	7.4	210	3.6	15	1.1	

Table 1b	# Healthy Lifestyle Behaviors—NHANES 2003-2016—General Population Aged ≥20 years										
Variable	0		1		2		3		4+		p-value
	Count	% (SE)	Count	% (SE)	Count	% (SE)	Count	% (SE)	Count	% (SE)	
Age 20-39											
Men	346	43.6	1,571	45.9	1,998	51.5	1,034	59.0	220	55.0	< 0.001
Women	446	56.4	2,152	54.1	1,939	48.5	725	41.0	162	45.0	< 0.001
Mexican American	115	10.1	881	15.8	720	11.6	237	8.1	30	4.7	< 0.001
Other Hispanic	59	5.2	355	7.5	333	6.6	152	6.0	28	4.4	< 0.001
Non-Hispanic White	384	64.2	1,364	55.7	1,507	58.9	801	67.8	245	81.8	< 0.001
Non-Hispanic Black	168	13.3	848	14.9	856	12.8	316	9.4	41	4.8	< 0.001
Other Race	66	7.2	275	6.1	521	10.1	253	8.7	38	4.2	< 0.001
PIR≤200%	533	59.0	2,004	45.1	1,704	34.2	654	29.4	131	26.9	< 0.001
PIR>200%	212	36.3	1,475	49.7	1,969	60.1	1,006	65.9	230	68.0	< 0.001
≤12th Grade Education	508	60.9	1,915	46.0	1,536	33.2	490	22.7	81	16.2	< 0.001
≥12th Grade Education	284	39.1	1,808	54.0	2,399	66.8	1,268	77.3	301	83.8	< 0.001
History of Cardiovascular Disease	18	1.7	41	1.0	24	0.5	14	0.8	1	0.1	< 0.001
History of Cancer	26	2.8	82	2.5	59	1.8	21	1.6	11	3.0	
History of Diabetes	29	3.1	113	2.8	86	2.0	16	0.8	2	0.6	< 0.001
Age 40-59											
Men	404	43.2	1,669	44.6	1,606	51.4	606	52.7	99	39.8	< 0.001
Women	517	56.8	2,263	55.4	1,476	48.6	504	47.3	119	60.2	< 0.001
Mexican American	127	6.7	770	9.1	486	6.7	119	3.9	13	1.6	< 0.001
Other Hispanic	62	4.3	404	5.3	270	4.9	92	3.2	16	2.0	< 0.001
Non-Hispanic White	449	70.0	1,482	66.2	1,272	69.7	589	81.1	151	90.4	< 0.001
Non-Hispanic Black	232	14.2	1,007	13.8	700	11.2	158	5.7	15	2.2	< 0.001
Other Race	51	4.8	269	5.6	354	7.5	152	6.1	23	3.9	< 0.001
PIR≤200%	539	44.0	1,627	28.8	1,025	21.5	215	10.6	27	7.0	< 0.001
PIR>200%	320	50.4	2,015	66.0	1,842	72.9	830	85.6	182	90.3	< 0.001
≤12th Grade Education	606	58.9	2,007	43.1	1,218	32.5	306	21.9	31	8.5	< 0.001
≥12th Grade Education	314	41.1	1,922	56.9	1,864	67.5	804	78.1	187	91.5	< 0.001
History of Cardiovascular Disease	106	10.5	221	4.7	117	3.5	19	1.3	2	1.3	< 0.001
History of Cancer	63	8.6	235	7.8	180	7.5	68	8.1	18	10.3	
History of Diabetes	139	11.5	578	11.8	297	8.0	61	4.0	3	0.8	< 0.001

Table 1b (continued)	# Healthy Lifestyle Behaviors—NHANES 2003-2016—General Population Aged ≥20 years										
Variable	0		1		2		3		4+		p-value
	Count	% (SE)	Count	% (SE)	Count	% (SE)	Count	% (SE)	Count	% (SE)	
Age 60-79											
Men	243	50.0	1,376	37.1	1,178	48.0	500	56.3	110	48.4	< 0.001
Women	219	50.0	2,082	62.9	1,099	52.0	342	43.7	92	51.6	< 0.001
Mexican American	78	5.2	637	5.2	304	3.4	80	2.0	8	0.8	< 0.001
Other Hispanic	42	3.4	394	4.2	193	2.8	54	1.6	8	1.4	< 0.001
Non-Hispanic White	186	72.1	1,502	76.9	1,154	80.7	494	85.1	150	90.1	< 0.001
Non-Hispanic Black	139	13.8	784	10.2	442	7.2	120	4.3	16	2.1	< 0.001
Other Race	17	5.5	141	3.5	184	5.9	94	6.9	20	5.6	< 0.001
PIR≤200%	264	42.3	1,550	31.9	838	25.0	206	14.1	39	12.2	< 0.001
PIR>200%	162	49.2	1,577	59.6	1,258	68.1	587	81.6	153	82.3	< 0.001
≤12th Grade Education	314	59.5	2,077	49.2	1,106	38.3	285	24.0	41	13.6	< 0.001
≥12th Grade Education	148	40.5	1,379	50.8	1,169	61.7	556	76.0	161	86.4	< 0.001
History of Cardiovascular Disease	108	24.9	572	15.7	308	12.5	88	10.2	18	6.5	< 0.001
History of Cancer	72	18.3	592	20.2	426	24.1	180	24.6	57	28.6	
History of Diabetes	119	22.1	974	25.1	456	16.3	110	9.3	8	2.3	< 0.001
Age ≥80											
			0-1		2		3+				
			Count	% (SE)	Count	% (SE)	Count	% (SE)			
Men			280	30.3	265	34.3	159	46.5			< 0.001
Women			464	69.7	355	65.7	127	53.5			< 0.001
Mexican American			43	2.2	34	2.0	6	0.6			
Other Hispanic			40	2.3	23	2.1	9	1.6			
Non-Hispanic White			549	85.9	495	89.1	243	91.7			
Non-Hispanic Black			84	6.8	48	4.1	18	3.3			
Other Race			28	2.8	20	2.8	10	2.7			
PIR≤200%			368	45.1	260	38.1	85	25.9			< 0.001
PIR>200%			304	44.7	298	51.8	170	62.7			< 0.001
≤12th Grade Education			461	58.4	362	56.9	106	32.2			< 0.001
≥12th Grade Education			280	41.6	254	43.1	179	67.8			< 0.001
History of Cardiovascular Disease			216	29.1	156	25.8	79	27.8			
History of Cancer			203	30.5	202	34.3	99	38.2			
History of Diabetes			179	21.7	98	15.8	25	7.0			< 0.001

Discussion

The principal finding of this study is that the general adherence to healthy lifestyle behaviors has increased slightly during the last 13 years; adherence to 3 or more healthy lifestyle behaviors has gone from 17.5% to 21%. There exist many potential reasons for the increase in the prevalence of healthy lifestyle behaviors, including cultural attitudes toward these behaviors, a result inconsistent with other studies.[56] However, although those in older age categories generally reported higher percentages of adherence to healthy lifestyle behaviors than those in younger age categories, older adults reported higher incidences of all risk diseases. Adherence to healthy lifestyle behaviors had the least effect on cancer risk, compared to other risk diseases among the general population. Risk for certain types of cancer has been shown to resist certain lifestyle interventions.[78] Of equal or greater concern is the finding that women, those who are non-white, and those who are less educated were less likely to adhere to healthy lifestyle behaviors, and demonstrates that more investigation by the public health industry into the factors which lead to disparities in sex, education level, and race regarding adherence to healthy lifestyle behaviors is needed.

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[5] Fang, Jing et al., Reporting of adherence to healthy lifestyle behaviors among hypertensive adults in the 50 states and the District of Columbia, 2013
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This study has several limitations. As with other epidemiologic studies, misclassification due to lack of disease awareness is of concern.[9][10] Both NHANES, as well as the HEI rely on self-report, which is subject to bias and error.[11][12][13]

Another limitation is that socioeconomic status was not reported. It has been shown that socioeconomic status influences health outcomes, and is linked to race and education level.[14][15][16] What actions are needed in order to counteract the disparities in adherence to healthy lifestyle behaviors regarding race, sex, and education level? Promising methods which may increase adherence to various healthy lifestyle behaviors include the use of wearables, and

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[9] Fang, Jing et al., Reporting of adherence to healthy lifestyle behaviors among hypertensive adults in the 50 states and the District of Columbia, 2013
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[10] King, Dana E. et al.,Adherence to Healthy Lifestyle Habits in US Adults, 1988-2006
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fostering a community committed to healthy lifestyle behaviors, as well as a "healthy eating identity".[171819]

In conclusion, this study provides recent estimates of adherence to healthy lifestyle behaviors amongst those across the lifespan, ethnicity, education level, sex, and risk diseases, as well as at biannual intervals. Although the prevalence of adherence to healthy lifestyle behaviors increased slightly, several disparities were shown across groups. These findings provide information that health providers can use to inform strategies for promoting the adherence to healthy habits and addressing the disparities between demographic groups.

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Mya Greene