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Description of the process by which someone else could obtain the data and computing code required to replicate the results reported in your submission: A replication data set including the raw data and statistical code to reproduce the paper results is publicly available and posted on Dr. Harper's Open Science Page: https://osf.io/tqsvu/.

To the Editor:

In 2015, for the first time in nearly 25 years, life expectancy decreased in the United States.[1] The decrease was small–from 78.2 to 78.1 years–but is nevertheless a cause for concern given recent studies[2,3] showing adverse trends in mortality (although these studies were limited to whites). Understanding the components of changes in life expectancy, and how they differ across demographic groups, is an important first step toward identifying root causes and potential ameliorative interventions.

We abstracted data on deaths and population from the US National Vital Statistics System by age, cause of death, and race-ethnicity for 2014 and 2015.[4] We limited our analysis to non-Hispanic blacks and non-Hispanic whites because of longstanding concerns for black-white differences in life expectancy. We created abridged life tables and used Arriaga's method for decomposing changes in life expectancy by age and cause of death.[5] We selected *International Classification of Disease, 10th edition* codes (see Figure 1) to capture leading causes of death among gender and race groups. We used Stata software (version 14) to analyze the data and do not present measures of precision because the mortality data are available for the entire population.

Among non-Hispanic men, life expectancy at birth decreased from 76.6 to 76.5 years for whites and from 72.7 to 72.4 for blacks. For non-Hispanic women, life expectancy decreased from 81.3 to 81.1 years for whites and remained essentially constant (78.8 years) for blacks. The largest absolute increases in age-adjusted death rates between 2014 and 2015 were for Alzheimer's and cardiovascular disease among women, unintentional poisoning for men, and homicide for black men (eTable 1).

Among white women, increases in cardiovascular and Alzheimer's disease accounted for 71% of the decrease in life expectancy (Figure 1). Alzheimer's disease also made a notable (20%) contribution among white men, but the majority (50%) of the decline was due to unintentional poisoning, in addition to suicide (12%) and motor vehicle crashes (11%). For black men, however, increases in homicide accounted for nearly 60% of the life expectancy decrease, alongside contributions from unintentional poisoning (23%) and motor vehicle crashes (16%). Improvements in cancer survival kept life expectancy from decreasing further in all groups. Analysis by age group showed that the increase in mortality among the oldest group (85 and over) accounted for 49% of the decrease in life expectancy for white women, whereas mortality increases among those 15-44 accounted for 80% and 65% of the decrease for black and white men, respectively (eFigure 1, eTable2).

The decline in US life expectancy resulted from a heterogenous group of causes of death, and did not affect all demographic groups equally. Black men lost nearly twice as many years of life expectancy than did white men, and black women showed virtually no change in life expectancy.

The increase in cardiovascular disease is worrisome and consistent with other reports of stalling progress in mortality declines, but our estimates show that this primarily affected life expectancy among white women. Considerable attention has also focused on middle-aged whites that have experienced sustained increases in mortality, largely due to the rise in opioid overdose deaths.[2,3] However, the rise in homicide, which disproportionately affects young black men, has received little attention. Although the homicide rate has shown impressive declines since peaking in the 1970s, the 2015 increase requires additional investigation.[6] If this trend were sustained it could erode the substantial progress made in reducing the black-white life expectancy gap.[7] On a more positive note, improvements in cancer survival kept life expectancy from decreasing by more than it otherwise would have.

Our analysis used the underlying cause of death and may underestimate the contribution of factors involved in multiple causes. Our findings demonstrate that paths to decreased life expectancy differ substantially by gender and race.

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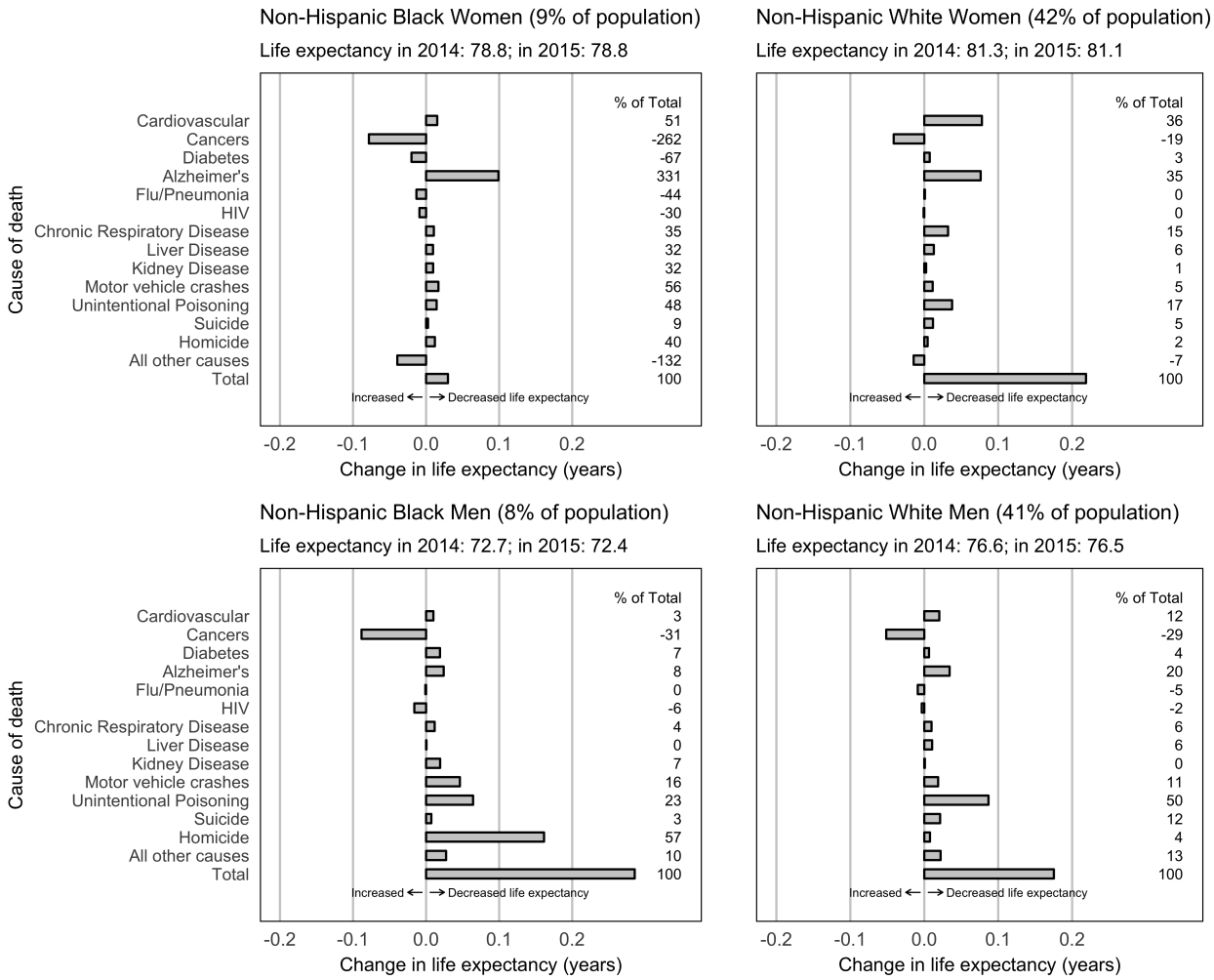
Fig. 1: Contribution of cause-of-death groups[a] to the change in life expectancy between 2014 and 2015, by gender and race-ethnicity[b].



[a] *International Classification of Diseases, Tenth Revision* (ICD-10) categories taken from National Center for Health Statistics list of 113 selected causes of death: Cardiovascular diseases (I00-I78); Cancers (C00-C97); Diabetes (E10-E14); Alzheimer's disease (G30); Influenza and pneumonia (J09-J18); Human immunodeficiency virus (B20-B24); Chronic lower respiratory disease (J40-J47); Liver disease (K70,K73-K74); Kidney disease (N00-N07,N17-N19,N25-N27); Motor vehicle crashes (V02-V04,V09.0,V09.2,V12-V14,V19.0-V19.2,V19.4-V19.6,V20-V79,V80.3-V80.5,V81.0-V81.1,V82.0-V82.1,V83-V86,V87.0-V87.8,V88.0-V88.8,V89.0,V89.2); Unintentional poisoning (X40-X49); Suicide (*U03,X60-X84,Y87.0); Homicide (*U01-*U02,X85-Y09,Y87.1); All other causes (all other codes). Available from: http://www.cdc.gov/nchs/data/dvs/Part9InstructionManual2011.pdf.

[b] Race and Hispanic origin were classified by the funeral director for death certificates and self-reported for population estimates, and were reported separately on the death certificate in accordance with standards set forth by the US Office of Management and Budget.

eAppendix

Life expectancies were estimated using standard methods for creating abridged life tables, with eleven age groups in ten-year increments after age 5 (0-1, 1-4, 5-14, 15-24,. . . , 85+). We calculated the contribution of each age group and cause-of-death to the difference in life expectancy between 2014 and 2015 within each race-ethnicity and gender group using the methods developed by Arriaga. Briefly, the contribution of a particular age group is both a direct function of the change in age-specific mortality rates at that age plus an additional contribution resulting from the fact that mortality changes at a given age will produce additional survivors at older ages, given by the formula below:

$$ {}_n\Delta_x = \left[\underbrace{l_x^{2015}/l_0^{2015}}_{\text{fraction of survivors}} \times \overbrace{\left(\frac{{}_nL_x^{2014}}{l_x^{2014}} - \frac{{}_nL_x^{2015}}{l_x^{2015}} \right)}^{\text{direct effect}} \right] + \overbrace{\left[\frac{T_{x+n}^{2014}}{l_{x+n}^{2014}} \times \frac{\frac{l_x^{2015} l_{x+n}^{2014}}{l_x^{2014}} - l_{x+n}^{2015}}{l_0^{2015}} \right]}^{\text{indirect effect + interaction}} $$

where ${}_n\Delta_x$ is the total contribution for a given age interval between x and $x+n$, l_x is number alive at age x, L_x is the person-years lived in interval, and T_x is the person-time lived beyond age x.

The contribution ${}_n\Delta_x^i$ of each cause of death i within a given age group is a function of the difference between the two time periods in the proportion of deaths due to a given cause:

$$ {}_n\Delta_x^i = {}_n\Delta_x \times \frac{\overbrace{\left({}_np_x^{i,2014} \times {}_nr_x^{2014} \right) - \left({}_np_x^{i,2015} \times {}_nr_x^{2015} \right)}^{\text{difference in share of deaths for cause } i}}{\underbrace{{}_nr_x^{2014} - {}_n\,r_x^{2015}}_{\text{overall mortality rate difference}}} $$

where ${}_n\Delta_x$ is the total contribution for an age group, ${}_np_x^i$ is the proportion of deaths within age group x due to cause i, and ${}_nr_x$ is the overall age-specific death rate. The total difference in life expectancy at birth is the net sum of the age-cause components:

$$ \sum_i {}_n\Delta_x^i = {}_n\Delta_x, \text{ and } e_0^{2014} - e_0^{2015} = \sum_x {}_n\Delta_x = \sum_x \sum_i {}_n\Delta_x^i $$

The total difference in life expectancy at birth between 2014 and 2015 is the sum of the age-cause specific components. The total contribution of a given age group to the change in life expectancy is

equal to the sum of its contributions across all causes of death. Likewise, the contribution of a particular cause of death is the sum of its contributions across age groups.

eTable 1: Age-adjusted mortality rates for selected causes of death, 2014 and 2015, by gender and race-ethnicity.

	Age-Adjusted Death Rate per 100,000 Population[b]					
	Non-Hispanic Black			Non-Hispanic White		
Cause of Death[a]	2014	2015	Change (%)[c]	2014	2015	Change (%)[c]
Women						
Cardiovascular diseases	239.2	239.9	0.7 (0.3)	181.0	185.1	4.1 (2.3)
Cancers	160.8	156.6	-4.2 (-2.6)	142.7	140.6	-2.1 (-1.5)
Diabetes	34.0	32.8	-1.2 (-3.5)	14.6	14.9	0.3 (2.1)
Alzheimer's disease	24.5	30.0	5.5 (22.4)	29.9	34.4	4.5 (15.1)
Influenza and pneumonia	13.9	13.7	-0.2 (-1.4)	13.4	13.8	0.4 (3)
Human Immunodeficiency Virus	5.6	5.3	-0.3 (-5.4)	0.3	0.3	0.0 (0.0)
Chronic lower respiratory disease	23.8	24.3	0.5 (2.1)	42.5	44.4	1.9 (4.5)
Liver disease	5.1	5.5	0.4 (7.8)	7.4	7.9	0.5 (6.8)
Kidney disease	22.5	22.9	0.4 (1.8)	10.0	10.1	0.1 (1.0)
Motor vehicle crashes	5.8	6.3	0.5 (8.6)	6.5	6.8	0.3 (4.6)
Unintentional poisoning	6.6	7.1	0.5 (7.6)	11.8	13.0	1.2 (10.2)
Suicide	2.1	2.1	0.0 (0.0)	7.5	7.8	0.3 (4.0)
Homicide	4.9	5.1	0.2 (4.1)	1.6	1.7	0.1 (6.2)
All other causes	182.5	179.4	-3.1 (-1.7)	165.5	164.2	-1.3 (-0.8)
Men						
Cardiovascular diseases	349.8	350.3	0.5 (0.1)	266.4	268.4	2.0 (0.8)
Cancers	237.5	231.0	-6.5 (-2.7)	197.7	194.3	-3.4 (-1.7)
Diabetes	43.9	45.1	1.2 (2.7)	23.4	23.8	0.4 (1.7)
Alzheimer's disease	18.9	21.3	2.4 (12.7)	21.5	24.9	3.4 (15.8)
Influenza and pneumonia	20.2	20.3	0.1 (0.5)	17.6	17.6	0.0 (0.0)
Human Immunodeficiency Virus	12.3	11.6	-0.7 (-5.7)	1.5	1.4	-0.1 (-6.7)
Chronic lower respiratory disease	37.6	38.5	0.9 (2.4)	49.7	50.5	0.8 (1.6)
Liver disease	10.1	10.2	0.1 (1.0)	14.1	14.6	0.5 (3.5)
Kidney disease	29.7	31.4	1.7 (5.7)	15.2	15.2	0.0 (0.0)
Motor vehicle crashes	18.2	19.9	1.7 (9.3)	16.2	17.0	0.8 (4.9)
Unintentional poisoning	13.7	16.7	3.0 (21.9)	21.5	24.7	3.2 (14.9)
Suicide	9.7	10.0	0.3 (3.1)	25.8	26.6	0.8 (3.1)
Homicide	32.3	37.6	5.3 (16.4)	3.3	3.6	0.3 (9.1)
All other causes	226.2	225.8	-0.4 (-0.2)	199.0	199.7	0.7 (0.4)

[a] *International Classification of Diseases, Tenth Revision* (ICD-10) categories taken from National Center for Health Statistics list of 113 selected causes of death: Cardiovascular diseases (I00-I78); Cancers (C00-C97); Diabetes (E10-E14); Alzheimer's disease (G30); Influenza and pneumonia (J09-J18); Human immunodeficiency virus (B20-B24); Chronic lower respiratory disease (J40-J47); Liver disease (K70,K73-K74); Kidney disease (N00-N07,N17-N19,N25-N27); Motor vehicle crashes (V02-V04,V09.0,V09.2,V12-V14,V19.0-V19.2,V19.4-V19.6,V20-V79,V80.3-V80.5,V81.0-V81.1,V82.0-V82.1,V83-V86,V87.0-V87.8,V88.0-V88.8,V89.0,V89.2); Unintentional poisoning (X40-X49); Suicide (*U03,X60-X84,Y87.0); Homicide (*U01-*U02,X85-Y09,Y87.1); All other causes (all other codes). Available from: http://www.cdc.gov/nchs/data/dvs/Part9InstructionManual2011.pdf.

[b] Age-adjusted to the year 2000 US standard million (authors' calculations). Race and Hispanic origin were classified by the funeral director for death certificates and self-reported for population estimates, and were reported separately on the death certificate in accordance with standards set forth by the US Office of Management and Budget.

[c] Calculated as [(2015 rate−2014 rate)/(2014 rate)]×100.

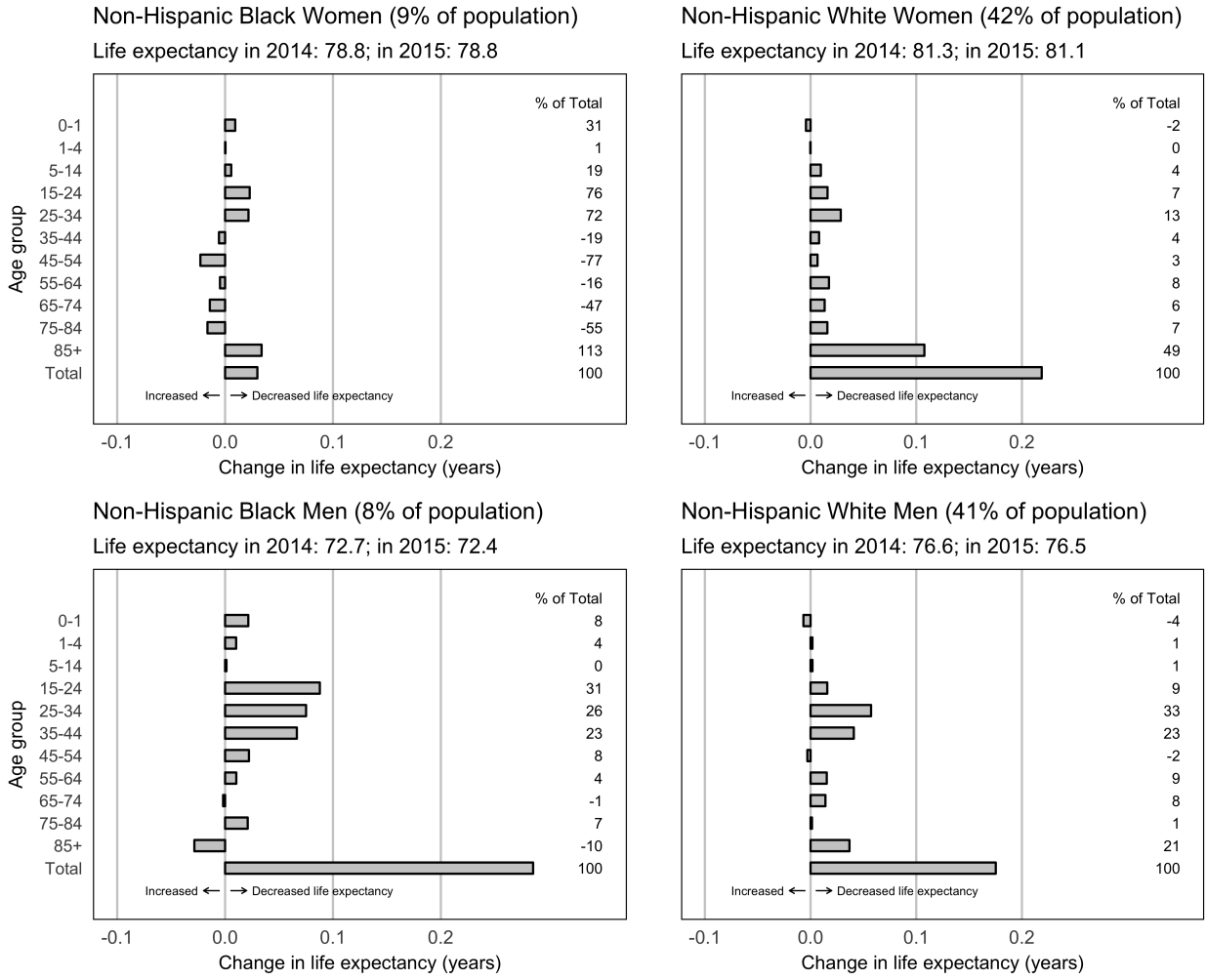
eTable 2: Age-specific mortality rates in 2014 and 2015, by gender and race-ethnicity.

	Death Rate per 100,000 Population[a]					
	Non-Hispanic Black			Non-Hispanic White		
Age Group	2014	2015	Change (%)[b]	2014	2015	Change (%)[b]
Women						
00-01 years	1013.7	1025.6	11.9 (1.2)	450.8	445.4	-5.4 (-1.2)
01-04 years	34	34.1	0.1 (0.3)	20.2	20.1	-0.1 (-0.5)
05-14 years	15.1	15.9	0.8 (5.3)	9.8	11.2	1.4 (14.3)
15-24 years	44.2	48.0	3.8 (8.6)	37.4	40.0	2.6 (7)
25-34 years	93.7	98.1	4.4 (4.7)	73	78.6	5.6 (7.7)
35-44 years	203.5	202.0	-1.5 (-0.7)	143.2	145.1	1.9 (1.3)
45-54 years	472.2	464.5	-7.7 (-1.6)	325.0	327.0	2 (0.6)
55-64 years	999.8	997.5	-2.3 (-0.2)	653.5	661.2	7.7 (1.2)
65-74 years	1924.1	1912.9	-11.2 (-0.6)	1465.6	1475.2	9.6 (0.7)
75-84 years	4447.4	4420.7	-26.7 (-0.6)	4091	4115.4	24.4 (0.6)
85+ years	11854.7	11965.4	110.7 (0.9)	13322.4	13717.6	395.2 (3.0)
Men						
00-01 years	1184.7	1214.7	30 (2.5)	549.6	540.8	-8.8 (-1.6)
01-04 years	45.3	48.9	3.6 (7.9)	24.9	25.5	0.6 (2.4)
05-14 years	22.2	22.4	0.2 (0.9)	14.2	14.5	0.3 (2.1)
15-24 years	142.3	158.9	16.6 (11.7)	90.6	93.4	2.8 (3.1)
25-34 years	224.6	242.1	17.5 (7.8)	155.5	167.7	12.2 (7.8)
35-44 years	323.4	343.2	19.8 (6.1)	226.5	237.5	11.0 (4.9)
45-54 years	691.9	700.9	9.0 (1.3)	510.2	509.1	-1.1 (-0.2)
55-64 years	1649.2	1655.7	6.5 (0.4)	1084.4	1092.6	8.2 (0.8)
65-74 years	3109.9	3107.9	-2.0 (-0.1)	2172.0	2185.0	13.0 (0.6)
75-84 years	6295.6	6351.2	55.6 (0.9)	5509.7	5512.6	2.9 (0.1)
85+ years	13548.1	13359.3	-188.8 (-1.4)	15322.5	15561.9	239.4 (1.6)

[a] Race and Hispanic origin were classified by the funeral director for death certificates and self-reported for population estimates, and were reported separately on the death certificate in accordance with standards set forth by the US Office of Management and Budget.

[b] Calculated as [(2015 rate−2014 rate)/(2014 rate)]×100.

eFigure 1: Contribution of age groups to the change in life expectancy between 2014 and 2015, by gender and race-ethnicity[a].



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