Longevity and Health of U.S. Presidential Candidates for the 2020 Election:

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Longevity and Health of U.S. Presidential Candidates for the 2020 Election

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Abstract: The oldest person ever elected president of the U.S. could take office in 2021 – but questions about the health and longevity prospects of presidential candidates are now relevant given the advanced age of many of the candidates. In the absence of medical records, assessing health, longevity, and survival prospects for candidates requires the use of data from national vital statistics. Here we estimate the lifespan, healthspan, disabled lifespan, and four-year survival probabilities for U.S. citizens that match the attributes of all of the candidates and the sitting president for the next two election cycles. Results suggest that chronological age should not be a relevant factor in the forthcoming election.

One Sentence Summary: Chronological age should not be a relevant criterion used to judge presidential candidates.

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Table 1. Estimates of lifespan, healthy lifespan, disabled lifespan, and 4-year survival probabilities on inauguration day in 2021 and 2025 for the resident U.S. population that match the attributes of all of the candidates and the sitting president.

Candidate	Exact Current Age (in years)	Exact Age at Inauguration (in years)	LE Age at Inauguration (in years)	HL Age at Inauguration (in years)	DL Age at Inauguration (in years)	4-year Survival Probability (%)
First inauguration						
Mike Gravel	89.2	90.8	4.6	3.8	0.8	48.3
Bernie Sanders	77.9	79.4	8.7	8.4	0.3	76.8
Joe Biden	76.7	78.2	9.3	9.0	0.4	79.2
Bill Weld	74.0	75.5	10.9	10.4	0.4	83.6
Donald Trump	73.1	74.7	11.4	10.9	0.5	84.8
Elizabeth Warren	70.1	71.6	15.4	14.4	0.9	91.8
Jay Inslee	68.5	70.0	14.4	13.9	0.6	89.8
Joe Sestak	67.6	69.2	15.0	14.4	0.6	90.5
John Hickenlooper	67.5	69.0	15.1	14.5	0.6	90.6
Marianne Williamson	67.1	68.6	17.7	16.7	0.9	93.9
Tom Steyer	62.1	63.6	18.9	18.4	0.6	93.7
Amy Klobuchar	59.2	60.7	24.0	23.1	0.9	96.8
Bill de Blasio	58.2	59.7	21.8	21.3	0.5	95.0
John Delaney	56.3	57.8	23.3	22.8	0.5	95.7
Kamala Harris	54.9	56.5	27.6	26.7	0.9	97.6
Michael Bennet	54.7	56.2	24.6	24.1	0.5	96.2
Steve Bullock	53.3	54.8	25.7	25.2	0.5	96.6
Kirsten Gillibrand	52.6	54.2	29.6	28.7	0.9	98.0
Cory Booker	50.3	51.8	28.2	27.7	0.5	97.3
Beto O'Rourke	46.8	48.4	31.1	30.6	0.5	98.0
Tim Ryan	46.0	47.6	31.8	31.3	0.5	98.2
Wayne Messam	45.1	46.7	32.6	32.1	0.5	98.3
Julián Castro	44.9	46.4	32.9	32.3	0.5	98.4
Andrew Yang	44.5	46.1	33.2	32.6	0.5	98.4
Seth Moulton	40.8	42.3	36.5	36.0	0.5	98.8
Tulsi Gabbard	38.3	39.8	38.8	38.3	0.5	99.0
Pete Buttigieg	37.5	39.0	39.5	39.0	0.5	99.0

Second inauguration

Name	LE	HL	DL	4-year survival	
Mike Gravel	94.8	3.4	2.6	0.8	33.7
Bernie Sanders	83.4	6.6	6.5	0.1	66.6
Joe Biden	82.2	7.2	7.0	0.2	70.0
Bill Weld	79.5	8.6	8.3	0.3	76.6
Elizabeth Warren	75.6	12.5	11.6	0.9	88.0
Jay Inslee	74.0	11.8	11.3	0.5	85.6
Joe Sestak	73.2	12.3	11.8	0.5	86.7
John Hickenlooper	73.0	12.4	11.9	0.5	86.8
Marianne Williamson	72.6	14.7	13.7	0.9	91.1
Tom Steyer	67.6	16.1	15.5	0.6	91.6
Amy Klobuchar	64.7	20.7	19.8	0.9	95.7
Bill de Blasio	63.8	18.8	18.3	0.6	93.7
John Delaney	61.8	20.3	19.7	0.5	94.4
Kamala Harris	60.5	24.2	23.3	0.9	96.9
Michael Bennet	60.2	21.5	21.0	0.5	94.9
Steve Bullock	58.8	22.5	22.0	0.5	95.3
Kirsten Gillibrand	58.2	26.2	25.3	0.9	97.3
Cory Booker	55.8	24.9	24.4	0.5	96.3
Beto O'Rourke	52.4	27.7	27.2	0.5	97.2
Tim Ryan	51.6	28.4	27.9	0.5	97.4
Wayne Messam	50.7	29.1	28.6	0.5	97.6
Julián Castro	50.4	29.4	28.9	0.5	97.6
Andrew Yang	50.1	29.6	29.2	0.5	97.7
Seth Moulton	46.3	33.0	32.4	0.5	98.4
Tulsi Gabbard	43.8	35.2	34.6	0.6	98.7
Pete Buttigieg	43.0	35.9	35.3	0.5	98.7

LE = life expectancy or lifespan
HL = healthy lifespan or healthspan
DL = disabled lifespan
4-year survival probability is the statistical probability that an individual with these attributes will be alive exactly 4 years after inauguration day in 2021 or 2025. 100 minus this percentage is the probability of death in that 4-year time window.

Note: the sum of HL and DL may not add up to LE due to rounding. Current age estimated as of 7/15/2019.

To be eligible to become president of the United States one must be a natural born U.S. citizen; a resident for at least fourteen years; and be at least 35 years of age. There is no legally determined disqualifying upper age limit to be president. In the forthcoming election an unprecedented event will occur. Seven[a] of the 27 candidates would be aged 70 and older on inauguration day in January 2021; one would be over age 90. Three candidates would be required for the first time in American history to survive to over age 80 to complete their first term in office; and one would need to survive past age 94.

Legitimate concerns exist regarding the health and longevity of presidential candidates, regardless of age. Dr. David Scheiner – President Obama's personal physician – recently suggested that voters should not accept a candidate's declaration of health at face value, and that we're asking for trouble if the voting public does not have more information on the health and longevity prospects of presidential candidates *(1)*. For example, a candidate of any age that is harboring a lethal condition that is likely to lead to death while in office, or a cognitive impairment that could influence an ability to discharge the powers and duties of the office, could influence an election. Dr. Scheiner's admonition all but suggests that presidential candidates, and perhaps even sitting presidents, should make their medical records available for public scrutiny. Doing so, however, would violate current Health Insurance Portability and Accountability Act (HIPAA) privacy rules involving personal health information *(2)*.

In this paper, science-based estimates of the health and longevity of the U.S. resident population with attributes that match all of the presidential candidates are provided, and then the broader question as to whether the current age of candidates should be a relevant factor for voters in presidential elections is addressed.

Data and Methods

Established tools of population science are used to estimate for all 27 candidates, including the sitting president (hereinafter referred to as a candidate), their projected lifespan, healthy lifespan (healthspan), disabled lifespan, and the statistical probability of surviving to the end of a first and second term if re-elected, conditional on having survived to the end of the first term.

The usual approach to estimating longevity and health would be to ask each candidate to fill in a questionnaire as if they were applying for life insurance; some would be asked to provide a sample of blood and urine and undergo a thorough medical exam. The typical questions asked would include date of birth, gender, smoking status, height and weight to calculate body mass index, level of completed education, physical activity, self-reported health, family history of longevity, a list of prescription medications, and questions about any diseases their doctor told them they have, among others. Insurance companies use answers to these questions and information from body fluids to place people into general risk pools with higher or lower premiums attached to them. For example, smokers and people with a high BMI tend to pay more for life insurance while nonsmokers who are physically active tend to pay less. This decision is based on the widely documented observation that the latter live longer and healthier than the former.

While it is preferred that the candidates undergo this more thorough approach to assessing health and longevity, it is acknowledged that this is not realistically possible in this case. Instead, the assessment of lifespan and healthspan for each candidate begins with their current date of birth and base complete period life tables by gender and single year of age up to age 100 *(3)*. These life tables are published annually by the U.S. Social Security Administration

based on national vital statistics reported by the Centers for Disease Control and the Census Bureau. They illustrate the average expected remaining years of life for a person of a given age and gender for everyone in the country during a calendar year, assuming death rates at all ages observed in that year, remain stable in the future.[b] Tables just like this are used by insurance companies, physicians, actuaries, population scientists, and financial planners, to generate estimates of how long someone of a given age and gender might expect to live – recognizing the limitations associated with averaging.

In fact, it must be acknowledged that it is not possible for anyone to forecast in advance exactly how long someone will live, so the use of life tables from the U.S. to generate estimates of duration of life of individuals looks like an example of an 'ecological fallacy'. This fallacy or error occurs when inferences are inappropriately made about individuals based on inferences about a group to which those individuals belong. Predicting duration of life for an individual using only generic life tables, without prior knowledge of mortality risk and without taking into account the personal attributes of the individual, is in fact an ecological fallacy.

The ecological fallacy is not applicable in this case because it has already been established in advance that presidents – and by extension presidential candidates – are almost always highly educated; with high incomes; they have access to the best health care in the country; they are already self-selected for greater longevity because of the age requirement to be eligible for the office; and they have already been documented to be long lived *(4)*. That is, they tend to belong to the healthiest and the longest-lived subgroup of the U.S. population, so using an average lifespan estimate from population data as a frame of reference ensures that length and quality of life are conservatively underestimated. While it would be possible to infer answers to health questions for each candidate based on information gleaned from publicly available sources

(such as education, marital status, etc.), this was not done here because period life tables for the entire U.S. population are in fact the best option because they're based on reliable demographic and biological data on age and sex, and they're more conservative because they reflect a population average. **Estimates of health and survival using more precise personalized data for each candidate would most likely reinforce and enhance the conclusions reached here.**

When the projected longevity and health of individual presidential candidates are presented by name, the proper interpretation is that reference is being made to all men and women in the U.S. of the exact same age as those candidates; although it is expected that the actual longevity and health of the candidates will be higher than average because this has already been shown to be the case for presidents.

The mortality and survival data we used are drawn from a 2016 base complete Social Security Administration (SSA) life table for U.S. residents. Lifespan is interpolated to exact ages, conditional on survival to inauguration day in 2021 and 2025. Survival to the end of the first and second term are calculated by fitting a third-degree monotone cubic spline using Hyman filtering *(5)* to the single-year l(x) column of the life table. Healthy lifespan (HL) is calculated using the Sullivan method *(6)* applied to National Health Interview Survey data from 2017 based on the white college educated population. Needing help with at least one Activity of Daily Living (ADL), such as bathing and dressing, defined disability. Healthy lifespan corresponds to lifespan without disability and disabled lifespan is total lifespan minus healthy lifespan.

Results

Current Age. The average current age of all 27 candidates is 58.4 years. The youngest candidate is Mayor Pete Buttigieg at age 37 while the oldest candidate is Senator Mike Gravel at age 89. The oldest seven candidates that would be aged 70+ on inauguration day in 2021 have a

current average age of 75.6 years. Donald Trump is the oldest American president ever elected (at age 70), but six of the current candidates would beat this record if elected in 2021, and of course, President Trump would break his own record if re-elected. The previous record holder was Ronald Reagan who was elected to his second term at age 69. Surviving to the end of a first term (a second term for President Trump) would require making it to an average age of 81.2 for the oldest 7 candidates.

The average age of the 26 remaining candidates on inauguration day in 2024 (e.g., during a second term) would be 63.4 years; 9 of the candidates would be over age 70 on inauguration day; 3 would be over age 80; and one candidate would be over age 90. Surviving to the end of a second term would require making it to an average age of 82.7 for these same 9 candidates, with a maximum age of 98.8 for Senator Gravel.

Projected Lifespan. On inauguration day in 2021, the average projected remaining lifespan of the candidates would be 23.1 years. The average projected remaining lifespan for the 7 oldest candidates (aged 70+ on inauguration day) would be 10.7 years; the 7 youngest have a projected lifespan of 35.0 years; and the highest lifespan estimate is 39.5 years. On inauguration day in 2024 (e.g., during a second term) the average projected remaining lifespan for all candidates would be 20.5 years; the projected lifespan of the 9 candidates that would be aged 70+ on that day would be 9.9 years. The only candidate that approaches a lifespan estimate that is close to the length of the four-year term of office is Senator Gravel, who would have an estimated lifespan of 4.6 years entering his first term, and 3.4 years conditional on having survived to the end of a first term and being re-elected to a second term.

Projected Healthy and Disabled Lifespan (DL). On inauguration day in 2021, the average projected Healthy Lifespan (HL, e.g., lifespan without disability) for all of the candidates is 22.5

years. In most cases, the estimate of HL is between 0.5 and 1.0 years less than the total lifespan estimate for all of the candidates. This observation implies that most of the remaining survival time for all of the candidates (97.6%) is likely to be without disability, although it should be noted that the proportion of remaining lifetime expected to be disabled rises with chronological age. For example, Mayor Buttigieg has a DL estimate of 0.47 years – which means 98.8% of his remaining life is expected to be without disability. By contrast, Senator Gravel has a higher HL than Mayor Buttigieg because of selective survival to an older age, but the proportion of his remaining life expected to have some level of disability is 17.7 %, with 83.3% of his remaining life expected to be without disability. In 2025, the projected HL will have declined by just under four years and the DL is expected to decline slightly because of selective survival. Take note that for Senator Gravel, projections suggest that of his remaining 3.4-year projected lifespan on inauguration day in 2025, about 24% of his remaining lifetime on that date is expected to be with some level of disability.

Projected Survival Probabilities (first and second term). The average projected probability of surviving to the end of a first term conditional on having survived to inauguration day in 2021 is 92.0%. The highest 4-year survival probability is for Mayor Buttigieg at 99.0% while the lowest is for Senator Gravel at 48.3%. Of the 7 candidates that would be aged 70+ on inauguration day in 2021, the collective probability they will survive to the end of the term is 79.2%. The average projected probability of surviving to the end of a second term that begins in 2025 is 89.4%, with a range of 98.8% for Mayor Buttigieg to 33.7% for Senator Gravel. Keep in mind that if you examine survival probabilities for 8 of the 9 oldest candidates that would be aged 70+ during their second term (excluding the extreme case of Senator Gravel), the average 4-year survival probability would be 81.4%.

Determining the probability that death would occur in office is estimated by taking 100 minus the survival probability. For Mayor Buttigieg, there is less than a 1% chance he would die during his first year in office and a 1.3% chance he would die during his second term in office. For Senator Gravel, there is a 51.7% chance he'll die during his first term and, should he be re-elected and survive to inauguration day in 2025, there is a 66.3% chance he'll die during his second term. Every other candidate falls between these two extremes.

Discussion

Estimates of lifespan and healthspan and how they change with age may seem cold and calculated, because they are. The rising risk of death with age is so well established in the scientific, medical, and public health sciences that it is equivalent to a biological law that applies to not just people, but most living things *(7)*. The methods of evaluation used here are not only how science and insurance companies assess risk, this is how physicians and other healthcare professionals know what health advice to give their patients. The reason we're told not to smoke, and to eat less and exercise more is because those who do so have been documented to live longer and healthier than those that don't. Nevertheless, the estimates provided here (favorable or unfavorable) should not be interpreted as destiny for any of the candidates. Longer and healthier lives are often a matter of choice because of the decisions we make on a daily basis on how we choose to live life.

On the other hand, there are also random and sometimes not so random elements to life (e.g., accidents, homicide, suicide, infectious diseases, genetics, and circumstances of the timing and location of your birth, among others), that often play a critical role in shortening lives unpredictably *(8)*. Both of these elements operate simultaneously on populations to generate the great variation in longevity and health that is commonly observed in people living across the globe.

The methods used to estimate the lifespan and healthspan of the presidential candidates were intentionally conservative. This occurred first out of necessity because on a practical level, candidates could not be asked the kinds of questions that would reveal the unique survival and health prospects they each possess, but also because it is important to reveal large disparities in health and longevity that exist among population subgroups. The most privileged can often live a decade or more longer than the least privileged, which implies that some Americans today are living in an environment that is roughly equivalent to conditions that existed in the early 20th century *(9)*. So, it should be acknowledged that presidential candidates all fall within income and education brackets that are directly associated with better health and longevity outcomes relative to the population average.

The main questions addressed here are: 1) what is the estimated health and longevity of all of the presidential candidates, and 2) are any of the current candidates too old to be considered for the office? Alternatively, should chronological age be relevant when deciding on a presidential candidate? Four related health and survival metrics were used to gauge the current and future status of each presidential candidate. Here are the conclusions based on the scientific evidence.

- If projected lifespan on day of inauguration is used to determine the relevance of age, and if disqualification is defined, for example, as an estimated lifespan that is shorter than the term in office, then all of the candidates currently running for president meet this criteria of acceptability for the 2021 election. All of the candidates, with the exception of Senator Gravel, also meet this requirement for a second term beginning in 2025. However, even if the projected lifespan is shorter than the term in office, as long as the individual is cognitively intact prior to election, it is questionable whether this criterion alone should be disqualifying. The voting

public might feel otherwise, but at least now estimates of survival are available to make a decision.

- If projected 4-year survival probabilities through a first term in office is used to determine the relevance of age, and if, for example, disqualification is defined as less than a 50% chance of surviving the term of office, then the forecasts provided here suggest that all but one candidate has a greater than 76% chance of surviving through the first term. Most of the candidates have over a 90% chance of surviving four years after inauguration. Senator Gravel is the only exception -- he has a 48.4% chance of surviving through his first term. Keep in mind that this estimate is based on population averages -- and it is already known that presidential candidates are likely to live longer than average. As such, these conservative estimates suggest that all of the presidential candidates meet this criterion of acceptability for the 2021 election. The same conclusion would be made for a second term, again with the exception of Senator Gravel -- who would have a one-in-three chance of surviving through a second term. The question for voters then is, if such a survival threshold should be set, what might be an acceptable or disqualifying probability for surviving a 4-year term if the 50% threshold discussed here is not appropriate?

- If projected healthspan and disabled lifespan are used to determine the relevance of age, and if, for example, disqualification is defined as greater than a 50% chance of experiencing some form of disability while in office, then the forecasts provided here suggest that all of the candidates meet this criteria for eligibility for the 2021 election. This is no guarantee of course as aging often has unpredictable effects on mind and body, but for now; empirically derived forecasts bode well for everyone. The one candidate in question is Senator Gravel. Due to his advanced age he has a high probability of experiencing some aging related frailty and disability in his first

four years, and an even higher chance during a second term in office. However, a higher probability of a negative health event occurring is not a guarantee it will occur.

There is a robust population subgroup in the U.S. known as super-agers that are able to retain their mental capacity well past age 80 *(10)*. Without further testing, it is not possible to gauge whether any candidate falls into this unique category of exceptionally healthy octogenarians and nonagenarians that could be perfectly suited to the presidency. If the 50% threshold is acceptable as a disqualification criterion, then there is no empirically derived evidence that disability of any kind is an immediate issue for any of the candidates currently running for president in the next election. Once again, the question for voters is whether it is appropriate to use this 50% threshold for experiencing disability as a disqualifying metric, or whether some other percentage is appropriate, or whether there is no appropriate threshold?

Conclusion

Dr. David Scheiner stated that it is not acceptable to take the word of candidates or sitting presidents that they are healthy, and therefore candidates should make their medical records public so voters can make decisions based on a full disclosure of any medical conditions. At one level this makes sense because harboring a lethal condition that could lead to death while in office, might influence how people vote -- or at the least, lead voters to pay more attention to the choice for vice president. Yet, if a candidate is healthy today, it is unclear whether future health status should ever be a criterion used to judge a presidential candidate. The voting public and legal scholars need to weigh in on whether or not medical records should be required to be disclosed by candidates or a sitting president.

With regard to the relevance of age in deciding whom to vote for, estimates of healthspan realistically suggest that some of the presidential candidates are at a higher risk of experiencing

some level of frailty and disability during a first or second term in office *because* they are older. Health and longevity challenges are closer for candidates now in their 70s relative to those younger because age is an established risk factor for fatal and disabling conditions; but despite this, many survive to their 80s and 90s with their mental and physical capacities largely intact *(11)*. Without an ability to know in advance who among the candidates might fall into this category, chronological age itself should not be used as a sole disqualifier to run for or become president.

If the lower limit of age 35 was chosen by America's founding fathers because they envisioned the presidency requiring the experience, maturity, and wisdom that comes with age; or that time allows the voting public to make judgments based on a candidate's established track record; then one could make the case that the most qualified among the available candidates are older. Given the favorable health and longevity trajectories of almost all of the presidential candidates relative to the average member of the same age and gender group in the U.S., and the apparent current good health of all of the candidates, there is reason to question whether age should be used at all in making judgments about prospective presidential candidates.

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[a] Because Jay Inslee's birthday is March 1, he's included in this age window because he'll be age 70 just six weeks after inauguration in 2021.

[b] The assumption of unchanging death rates in period life tables might ordinarily pose a problem in generating estimates of longevity and survival, but in this case it is not an issue because death rates are unlikely to change enough in either direction over the short time frame for these forecasts to influence the results presented here.

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