Projected lifespan and healthspan of Joe Biden and Donald Trump before the 2020 election

Authors

S. Jay Olshansky, PhD, corresponding author, Professor of Public Health, University of Illinois at Chicago, Chicago, Illinois, sjayo@uic.edu

Hiram Beltrán-Sánchez, PhD, UCLA

Yang Claire Yang, PhD, University of North Carolina at Chapel Hill

Yi Li, PhD, University of Macao

Nir Barzilai, MD, Ingeborg and Ira Leon Rennert Chair in Aging Research, and Director, Institute for Aging Research, Albert Einstein College of Medicine

Paola Rode, MD, Former Medical Director of Hematology Oncology, Lahey North Medical Center; and Former Assistant Clinical Professor of Medicine, Tufts School of Medicine

Bradley Willcox, MD, Professor and Director of Research, Department of Geriatric Medicine, John A. Burns School of Medicine University of Hawaii

Projected lifespan and healthspan of Joe Biden and Donald Trump before the 2020 election

by S. Jay Olshansky, PhD; Hiram Beltrán-Sánchez, PhD; Yang Claire Yang, PhD; Yi Li, PhD; Nir Barzilai, MD; Paola Rode, MD; and Bradley Willcox, MD

To be eligible to become president of the United States one must be a natural born U.S. citizen; a resident for at least 14 years; and 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—the person elected president will be the oldest elected president in American history.

The health and longevity of presidential candidates and sitting presidents is important regardless of age. Questions have been raised as to whether voters should accept a presidential candidate's declaration of health at face value.[1] A candidate of any age that is harboring a lethal known condition that is likely to lead to death while in office, or a high risk for cognitive impairment that could influence the ability to discharge the powers and duties of the office, could influence an election outcome. This concern

leads to the question whether presidential candidates and sitting presidents should be required (or encouraged) to make their detailed medical records available for public scrutiny. Such a prerequisite, if required today, would violate current Health Insurance Portability and Accountability Act (HIPAA) privacy rules involving personal health information.[2]

In this analysis, empirically based estimates of the lifespan and healthspan of Joe Biden and Donald Trump are provided based on personal medical history data from publicly available records. Contained in these records are attributes of both candidates that reflect acquired and inherited risk factors for disease and survival that are more detailed and personalized relative to generic assessments previously published for both candidates,[3] and which can be used to estimate survival and health with validated methods of analysis from epidemiology

Projected lifespan and healthspan of Joe Biden and Donald Trump before the 2020 election

and the demographic/actuarial sciences. These records have also been reviewed independently by three physicians with expertise in aging for the purpose of assessing the prospective survival and health status of both candidates for the next four years, independent of the assessments of lifespan and healthspan using risk assessment methods from the demographic/actuarial sciences.

Data[a]

Joe Biden

Baseline biological, demographic, behavioral risk factor, and family history of longevity is contained in a publicly available medical record published on December 15, 2019, by Biden's personal physician (see Appendix A; summarized in Table 1). It is assumed that there has been no change in Biden's health status since this medical record summary was published; the data made available are accurate; and the survival estimate is based on the candidate's age as of last birthday. A full medical history summary—including past and current medical conditions and current prescription and non-prescription medications—along with biomarkers drawn from blood and urine, are contained in this source. These data also serve as the source of information used by the physicians to evaluate the survival and health status of Biden independent of baseline demographic data. Provided below is a summary of Biden's reported disease history and current medications.

Disease history

Past: Cerebral aneurysm in 1988, repaired surgically; second aneurysm discovered at that time and also treated; hospital course complicated by postoperative hospitalization for a deep vein thrombosis (DVT), with subsequent pulmonary embolism, treated with an inferior vena caval filter and short-term oral anticoagulant; anticoagu-

lant stopped when clots resolved and were attributed to immobilization from intracranial hemorrhage, subsequent testing revealed no innate hypercoagulability disorder; 2014 CT angiogram showed no recurrence of disease. He has also been surgically treated for benign prostatic hypertrophy (BPH); gallbladder was removed in 2003. He has also had mild diverticulosis; non-cancerous tubular adenoma in 2008. These are benign aging-related conditions.
Current: Atrial fibrillation (AF): asymptomatic cardiac arrythmia with normal ventricular response, no medication required for rate or rhythm control, on chronic anticoagulation for AF stroke risk; history of hyperlipidemia; gastroesophageal reflux; seasonal allergies.
Medications: Eliquis; Crestor; Nexium; Dymista and Allergan

Donald Trump

The medical records for Trump are publicly available and provided by his personal physician following his 2018 and 2019 annual physical exams (summarized in Table 1). Additionally, baseline biological, demographic, behavioral risk factor, and family history of longevity data are publicly available for Trump because the personal and family history of sitting presidents is heavily scrutinized by the media. Other relevant health statistics have been revealed during press conferences following annual health exams.[4,5] It is assumed that there has been no change in Trump's health status since his vital statistics contained in the medical record were last made public; the data made available are accurate; and the survival estimate is based on the candidate's age as of last birthday. Provided below is a summary of Trump's reported disease history and current medications.

Disease history

Past: Hypercholesterolemia, rosacea, appendectomy at age 11

Current: Unavailable
Medications: Rosuvastatin (Crestor), Acetylsalicylic Acid (Aspirin), Finasteride (Propecia), Ivermectin Cream (Soolantra), Multivitamin (Centrum Silver)

See Table 1 for demographic and medical history summaries[6,7,8,9] of the two candidates.

Methods[b]

The methodology used to estimate lifespan is based on the use of acquired and inherited attributes of each candidate that are documented in the scientific literature to influence lifespan and survival in a U.S. population.[10] These covariates or risk factors include well established biological, social and behavioral determinants of health and longevity such as blood biomarkers, physical activity, income, education, marital status, smoking status, obesity, etc., that have mortality risk ratios estimated from U.S. population based samples.[11] A personalized summary risk ratio based on all of the observed attributes of each candidate (see Table 1) was created and applied to a base complete U.S. period life table drawn from national vital statistics for the resident male population of the U.S. (e.g., Human Mortality Database; resident population observed in 2017)[12] matching Trump or Biden's age at last birthday. The result is a personalized complete life table for each candidate that yields expected remaining years of life and annual survival probabilities to all subsequent ages based on the unique combination of health risk factors documented to exist for each candidate and their established influence on survival.[13,14]

Healthy life expectancy (referred to here as 'healthspan') is calculated using the Sullivan method[15] as applied to National Health Interview Survey data from 2017, and based on the white college-educated

---

Footnote

[a] Data and results are presented for the candidates in alphabetical order. It is assumed here that the medical records provided by the personal physicians of both candidates are complete and accurate as reported; we acknowledge the possibility that information could be missing and/or unreported.

Executive summary

- Donald Trump and Joe Biden come from family histories of exceptional longevity (e.g., familial longevity). As such, there is suggestive evidence that both candidates are likely to be "super agers"—a subgroup of people that maintain their mental and physical functioning into late life and tend to live longer than the average person their age.

- Both candidates have a higher than average probability of surviving the next four years relative to other men their age (95.2% for Biden—average is 82.2%; 90.3% for Trump—average is 86.2%). The main force influencing these favorable survival estimates is familial longevity. Socioeconomic factors contributing to this conclusion are that both have access to excellent health care, high income, they are highly educated, and both are married.

- Both candidates are expected to have higher than average healthspans relative to other men their age in the US (about 10 years more than average).

- Biden is expected to outlive Trump, even though he is three years older. The reasons are that Biden has an exceptional health profile for a man his age (e.g., ideal Body Mass Index [BMI], physically active, few prescription medications, no identifiable lethal conditions, excellent cholesterol profile, low inflammation). He also has a family history of longevity. Trump also shares most of this profile, except his obesity and sedentary lifestyle work against his familial longevity history and his otherwise healthy biological profile. Trump's risk factors are significant but modifiable—it is unknown whether he has adhered to lifestyle recommendations from his physicians. However, this is not a longevity competition—both have a high prob-

ability of surviving a full term in office after the election.

- Trump does face an elevated familial risk of late onset Alzheimer's disease (AD) as this was a major contributor to his father's death (died of pneumonia, a common immediate cause of death in AD patients); and he also faces an elevated risk of heart disease due to verified risk factors publicly revealed by his personal physician.

- There is no evidence available in the public record to indicate that either candidate is facing a major cognitive functioning challenge—either now or during the next four years. Trump does face an elevated risk of Alzheimer's disease due to a family history of the disease on his father's side. It may be tempting to conclude that evidence of cognitive decline does not exist because extensive diagnostic assessments of cognitive functioning have not been completed, and if done, something significant might be revealed. Presidential candidates are evaluated by their personal physicians in much the same way the rest of the population is assessed. Diagnostic tests of cognitive function are not done unless the physician suspects the presence of a problem or if requested, and even then, a dementia screening test like the one completed by Trump (Montreal Cognitive Assessment Test–MoCA) is done first. There is no single diagnostic test that can determine if someone has Alzheimer's disease. The decision not to order an extended battery of medical, neuropsychological and other diagnostic tests during the candidates' most recent physicals is evidence for an absence of issues involving cognitive functioning for both Biden and Trump. It is unclear what would occur if a candidate or sitting president refused to undergo a screening or diagnostic test—if recommended by their physician.

- This review of inherited and acquired risk factors combined with an assessment of available medical records for both

candidates is not a guarantee of an anticipated survival or health outcome. Risk factors for health, longevity and cognitive functioning are subject to modification in either direction by both candidates; random elements to aging make it difficult to generate forecasts with precision; and both candidates are subject to health risks due to Covid-19.* Nevertheless, the familial, and personal health and medical history information publicly available from both candidates tend to favor the projected outcomes discussed here.

- *Based on a personalized assessment that includes an evaluation of inherited and acquired risk factors for health and longevity from a demographic and actuarial perspective; and from independent reviews of publicly available medical record data on both candidates by three independent physicians with expertise in aging; **it is our conclusion that chronological age is not a relevant factor for either candidate running for president of the United States**. Both candidates face a lower than average risk of experiencing significant health or cognitive functioning challenges during the next four years.*

* Donald Trump has tested positive for Covid-19 as this article is in production. This diagnosis raises his immediate and long-term risk of death by an undetermined amount. If Trump is a super ager, it's possible that the same factors that lead to decelerated aging, also offer added protection from the harmful effects of Covid-19 on his immune system. Initial evidence from centenarians infected with Covid-19 suggest that super agers weather this challenge quite effectively.

Projected lifespan and healthspan of Joe Biden and Donald Trump before the 2020 election

population. Needing help with at least one activity of daily living (ADL), such as bathing and dressing, defined disability. Healthspan corresponds to remaining lifespan without disability. The metric of healthspan is a byproduct of decades of research by scientists across the globe with the goal of devising a summary measure of population health that combines mortality risk with non-fatal health conditions. Healthspan was first measured in the late 1970s by Sullivan, and it is now a standard reporting metric by the Global Burden of Disease project, the World Health Organization, and in thousands of research articles since first developed.[16] Healthspan is a standardized reliable health metric that is reported annually for most countries.[17]

Results

Lifespan (independent of medical history)

- Biden life expectancy estimate using a combined risk factor approach = 96.8 years (average is 87.4 years)
- Biden probability of surviving a four-year term as president = 95.2% (average is 82.2%)
- Biden probability of surviving to age 85 years = 66% (average is 61.2%)

- Trump life expectancy estimate using a combined risk factor approach = 88.6 years (average is 86.2 years)
- Trump probability of surviving a second four-year term as president = 90.3% (average is 86.2%)
- Trump probability of surviving to age 85 years = 60% (average is 55.0%)

Healthspan

In an earlier assessment of healthspan for Biden and Trump,[3] it was estimated that men in the U.S. that are Biden's age have, on average, about 9 years of healthy life remaining while men in the U.S. that are Trump's age have an average of 10.9 years of healthy life remaining. Those assessments were based on expectations for a white college-educated subgroup of men, so they are consistent with what is expected for both candidates—which is an estimated healthspan that is higher than average. Since there is no reason to believe that either candidate has lost any of their activities of daily living (ADLs) or instrumental activities of daily living (IADLs), there is no basis for adjusting these healthspan estimates. However, given the more favorable overall health profile of Biden relative to Trump, even in spite of being three years older, it is safe to assume that the projected healthspans of the two candidates are roughly equal at approximately 10 years. Both candidates are projected to have a healthspan that extends beyond the end of the next presidential term.

Physician reviews (summary)

Dr. Nir Barzilai

Considering that over 90% of people over 65 in the U.S. have more than two morbidities (obesity considered one), the available medical records reveal an excellent overall health status of Joe Biden—placing him in the top 10% of his birth cohort for older adults. His most challenging condition is his atrial fibrillation that seems stable and asymptomatic with treatment to prevent thrombosis. There is nothing in his medical record to suggest that he is at a higher than normal risk for cardiovascular diseases, cancer, type 2 diabetes mellitus, cognitive decline or death during a first term in office. The aneurysms he experienced in 1990 are no longer a significant health risk for him given his healthy survival during the past 30 years. He's on a limited number of prescription medications—implying a better-than-average set of health risks. The best piece of evidence in the medical record suggesting that Biden could be long-lived is the exceptional longevity of his parents; both of whom reached advanced ages for their birth cohort—with his father surviving into his 80's and mother into her 90s. Having long-lived parents has independent effects on the longevity of offspring, even independent of risk factors and physical dysfunction.[18,19,20,21] For example, Alzheimer's disease and type 2 diabetes mellitus can be significantly delayed for people with long-lived parents. Overall, based on Biden's behavioral and medical risk profiles and his family history of exceptional longevity, there is a high probability Biden will survive with his physical and mental health intact through a first term in office.

Based on the available data, Trump has two major documented health issues, obesity and a level of physical activity defined as sedentary. There is suggestive evidence that his dietary and sleep habits are unfavorable, but in the absence of definitive evidence for both of these covariates, it is assumed here that these are non-issues. Aside from obesity and a lack of physical activity, the rest of the data available on Trump reveals excellent overall health prospects for a 74-year-old male in the U.S. relative to other men his age. Trump's high LDL levels suggest a risk for cardiovascular disease, especially because these high levels are observed while

Footnote

[b] It must be acknowledged that it is not possible for anyone to forecast in advance exactly how long someone will live. Using population-based data to estimate 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 the duration of life for an individual using generic data, 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 our analysis is based on the personal biological and psychosocial attributes of each candidate—available in the public record; consistent with our findings is that it has already been established in advance that American 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, in fact, have already been documented to be long-lived.

Table 1. Demographic and medical history summaries of Joe Biden and Donald Trump

	Joe Biden[6]	Donald Trump[7]
Date of birth	11/20/1942	6/14/1946
Gender	Male	Male
Education	16+ years	16+ years
Marital status	Married	Married
Height/Weight/Body Mass Index (BMI) [Underweight if BMI < 20; normal if BMI >= 20 and < 25; overweight if BMI >=25 < 30; obese if BMI ≥ 30]	5'11.65" / 178 / 24.38	6'3" / 244 / 30.1 [2020][8]
Blood pressure (mm Hg)	128/84 (normal)	118/80[9] (normal)
Smoking status	Nonsmoker	Nonsmoker
Physical activity	Moderate/vigorous	Sedentary
Alcohol consumption	None	None
Family history of longevity	Mother: 92 (complications from broken hip); Father: 86 (complications during heart surgery)	Mother: 88 (unknown); Father: 93 (pneumonia and AD)
Total cholesterol (mg/dL)	126	223
Triglycerides (mg/dL)	106	129
HDL (mg/dL) (risk if < 35; protective if ≥ 60)	36	67
LDL (mg/dL) (normal < 100 unless CHD present, then < 70); high risk if ≥ 130 plus one risk factor)	69	143
Cholesterol to HDL ratio (optimal < 4)	3.5	3.3
Complete blood count		
WBC (K/UL)		5.5
HGB (g/dL)		16.1
HCT (percent)		48.7
PLT (K/UL)		241
Cardiac C-reactive protein (optimal if < 1; recommended < 3; normal < 10)	0.29	0.7
Fasting blood glucose (normal if < 100; mg/dL)	81	89
BUN (mg/dL)		19.0
CREAT (mg/dL)		0.98
ALT (U/L)		27
AST (U/L)		19
Hemoglobin A1C (percent; normal is less than 5.7%)	5.1	5.0
Vitamin D (ng/ml)		20.0
PSA (ng/ml)		0.12
TSH (uIU/ml)		1.76
Urinalysis		
Appearance	–	Clear
Protein	Negative	Negative
Ketones	Negative	Negative
Glucose	Negative	Negative
Blood	Negative	Negative

Table 1. Demographic and medical history summaries of Joe Biden and Donald Trump

Projected lifespan and healthspan of Joe Biden and Donald Trump before the 2020 election

on cholesterol-reducing medication. Trump's level of obesity places him at risk for type 2 diabetes mellitus. He has no known risks for cancer, cognitive decline or death during the next term. The best piece of evidence suggesting that Trump could be long-lived is the familial exceptional longevity of his parents; both of whom reached advanced ages—with his father surviving into his 90s and mother into her late 80s. When familial longevity is considered together with his behavioral risk profile, it is my conclusion that there is a high probability Trump would survive with his physical and mental health intact through a second term in office.

Dr. Paola Rode

Recognizing that there are constraints on publicly available medical records, available data suggest that both candidates have a high likelihood of surviving the next four years. Biden may have a slight longevity advantage over Trump due to his lifestyle choices such as exercise and diet regimen as well as a Body Mass Index (BMI) within the normal range. Both candidates take less than the national average prescription medications for men their age in the U.S. A National Center for Health Statistics investigation reported that approximately a third of persons over age 60 were on ≥ 5 prescription medications in 2007–2008 (see detailed review below) As higher prescription medication use can be associated with worse health status than those on less medication, the fact that they are both taking fewer medications than average makes them less vulnerable. Both candidates have access to excellent health care and are known to have a higher income which correlates with an increased life expectancy. This speaks to the fact that despite the age difference, both candidates are expected to survive a four-year term with their mental and physical capacities intact.

Dr. Bradley Willcox

Joe Biden is in excellent overall health for a 77-year-old American male. His primary medical impairment is non-valvular atrial fibrillation (AF). This is a common age-as-sociated arrhythmia and does not appear to be due to underlying coronary artery disease. He has never had any cardiovascular disease (CVD) complications attributable to AF, does not require rate or rhythm control, and it is considered fairly benign. Case in point, he engages in vigorous physical activity that might overly stress a typical AF patient, without incident, and has done so most of his life. He has no clear evidence for CAD; he has a distant history of cerebral aneurysms, which were successfully treated after discovery and are no longer a risk; he has no other major age-related diseases, and all physiological systems appear to be functioning well. Biden's laboratory blood work is exceptional, particularly his metabolic/lipid profile (excellent cholesterol, fasting blood sugar, hemoglobin A1C). His C-reactive protein (CRP) is very low, suggesting very low systemic inflammation, which is a major driver of the aging process known as "inflammaging".[22] His medications are low-risk and minimal. His father and mother far outlived their birth cohort, living into their 80s and 90s, respectively. In addition to his family history of longevity, Biden has a healthy BMI, and practices excellent health habits, particularly eating a healthy diet and vigorous exercise. This includes aerobic activity and strength training, which are very important for healthy aging. Biden's overall health profile suggests that he has a very high probability of surviving through his first term in office with his physical and cognitive function intact.

Donald Trump's overall health profile suggests that he has been quite healthy over the years, but he now is aging at an accelerated pace. He has clear evidence (on several Cardiac CT scans) for subclinical CAD, the leading cause of mortality in the U.S., that has been worsening over the past decade. His otherwise lack of major disease and disability thus far may be largely genetic since his parents lived into their octogenarian and nonagenarian years, although his father had Alzheimer's disease for approximately six years before his death. However, family history is not destiny (two of his brothers have died younger than ex-pected) and Trump's poor lifestyle (unhealthy diet, lack of physical activity) may be catching up with him. This is evident from a worrisome increase in his coronary artery calcium (CAC) score over the past decade (2009–18), which has progressed from a low CAC score to a moderately high-risk score (approximately 7-fold increased risk for a major cardiovascular event [MI or sudden death] versus a score of zero[23]). On the positive side, other than obesity, he has a very good metabolic profile, he appears to be on few prescription medications for a man his age (less than a half-dozen low risk medications), appears to receive excellent medical care, practices some preventive health behaviors (e.g. takes a multivitamin, screening tests and immunizations appear up to date) and is married. In sum, based on these data, and assuming there is no further comorbidity in the limited medical records, he will likely live longer than a typical 74-year-old male.

Overall, the medical records and/or publicly available information suggest that Biden maintains an edge over Trump in terms of his chances of surviving, and surviving healthfully, over the next four years—in spite of the fact that Biden is three years older than Trump. However, both Biden and Trump are expected to survive the next presidential term with their mental and physical functioning intact.

Discussion

Both candidates are projected to live longer than the average man their age in the U.S. Lifespan forecasts suggest that Biden is likely to live longer than Trump, but both candidates are expected to survive past the four years following inauguration in 2021. The probability that Biden and Trump will reach age 85 is 66% and 60%, respectively. Biden is expected to live longer than Trump because Biden exhibits an ideal health risk profile while the president has significant but modifiable risk factors for mortality. Both candidates are likely to be in possession of familial attributes associated with exceptional longevity.

The medical reviews presented here suggest that there is no evidence for cognitive decline in either candidate. It may be tempting to conclude that such evidence does not exist because an extensive battery of diagnostic assessments of cognitive functioning has not been ordered by their personal physicians, and if done, something significant might be revealed. It is important to keep in mind that at present, presidential candidates are evaluated by their physicians in much the same way the rest of the population is assessed. Cognitive functioning tests are not done unless the physician suspects the presence of a problem or if requested by the patient, and even then, a screening test of cognitive function is done first, as was done with Trump (with the MoCA), followed by a battery of diagnostic assessment tools if the screen shows a worrisome score. Since the personal physicians of each candidate did not see the need for a detailed cognitive assessment, this represents suggestive evidence that such issues are not present. Whether candidates for the office or sitting presidents should be required or encouraged to voluntarily submit themselves to be evaluated for comprehensive cognitive functioning assessments is a subject for public debate.

Regardless of who is projected to live the longest, both candidates show signs that they would have no difficulty with their physical or mental functioning during the next four years. A review of the available personal medical history of Biden by three independent physicians yielded a consensus that his cerebral aneurysms and DVT/PE over 32 years ago are no longer relevant to his current or projected health and longevity, and that he is currently in exceptional health with no known significant inherited or acquired risk factors.

A comparable review of the medical information on Trump yielded a consensus that he too is in possession of a familial propensity for exceptional longevity, but this optimistic outlook based on family history alone is mitigated by the president's main acquired risk factors—obesity, a poor diet, a lack of physical activity, and evidence of subclinical cardiovascular disease from his cardiac CT tests—and the fact that both of his brothers died at significantly younger ages than what would have been projected for them. Most of the president's risk factors are modifiable—we cannot ascertain definitively whether he is following the health advice of his physicians who are encouraging him to eat more healthfully and be more physically active.[24]

Keep in mind that similar projections for exceptional longevity would have also been made for Trump's two brothers, and neither survived even close to the observed longevity of their father. This implies that while family history of longevity is important in estimating duration of life of offspring, even those in possession of a favorable genetic predisposition for longevity can override that advantage by acquiring unfavorable behavioral risk factors. Finally, the president does have a family history of Alzheimer's disease on his father's side, which places him at a several-fold higher risk of cognitive challenges in the coming years.[25]

The analysis presented here is no guarantee that long life or good health will ensue for either candidate as aging is unpredictable, and it is possible to enhance or diminish a genetic predisposition for exceptional longevity. However, there is evidence to suggest that presidents, and by extension presidential candidates, possess potential biological and socioeconomic advantages, including resilient phenotypes, high education, high income, and access to the best health care in the world, that favor longer and healthier lives.[12] There is no reason to believe either of these candidates will be any different with regard to the exceptional lifespan and healthspan experienced by many previous U.S. presidents.[26]

Finally, it is worth noting that both candidates could be potential members of an extremely unusual subgroup of the population known as "super-agers"—this is a robust population subgroup known to retain their physical and mental capacity well past age 80.[27] Without further testing and actually surviving to age 80+ years, it is not possible to determine definitively whether either candidate will fall into this unique category of exceptionally healthy men, but suggestive evidence and reviews by physicians suggest they both are likely to do so.

Conclusion

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 both candidates qualify as ideally suited for the presidency because of their chronological age. The empirical evidence presented here, when combined with assessments of medical information publicly available on both candidates, suggests that both Biden and Trump are likely to survive the next presidential term with their mental and physical attributes intact, and therefore, their chronological ages are not relevant factors in the forthcoming presidential election.

References

1. https://www.washingtonexaminer.com/policy/healthcare/2020-candidates-are-too-old-warns-obamas-former-doctor-were-asking-for-trouble

2. https://www.hhs.gov/hipaa/for-individuals/medical-records/index.html

3. Olshansky, S. J., Beltrán-Sánchez, H., Carnes, B. A., Yang, C., Li, Y., Willcox, B. (2020). Longevity and health of U.S. presidential candidates for the 2020 election. *Public Policy & Aging Report, 30*(2), 67–72. https://doi.org/10.1093/ppar/praa007

4. https://abcnews.go.com/Politics/white-house-releases-results-trumps-annual-physical-president/story?id=71049289

5. https://www.theguardian.com/us-news/2018/jan/17/donald-trump-medical-exam-full-transcript

6. See Appendix A.

7. Most of the data on Trump's medical statistics are from this source provided by his personal physician: https://www.politico.com/story/2018/01/16/donald-trump-physical-results-2018-343092

8. https://www.foxbusiness.com/healthcare/trumps-health-records-hydroxychloroquine-impact-on-his-health

9. https://abcnews.go.com/Politics/trumps-physical-results-show-gained-weight-good-health/story?id=61064837

10. Yang, Y., & Kozloski, M. (2012). Change in sex gaps and cause-specific mortality over the life span in the United States. *Annals of Epidemiology, 22*(2), 94–103.

11. Rizzuto, D., & Fratiglioni, L. (2014). Lifestyle factors related to mortality and survival: A mini-review. *Gerontology, 60,* 327–335. https://doi.org/10.1159/000356771

12. https://www.mortality.org/

13. Lloyd-Jones, D. M., Wilson, P. W., Larson, M. G., et al. (2004). Framingham risk score and prediction of lifetime risk for coronary heart disease. *American Journal of Cardiology, 94*(1), 20–24.

14. Karlamangla, A. S., Singer, B. H., McEwen, B. S., et al. (2002). Allostatic load as a predictor of functional decline. MacArthur studies of successful aging. *Journal of Clinical Epidemiology, 55,* 7, 696–710.

15. Sullivan, D. F. (1971). A single index of mortality and morbidity. *HSMHA Health Reports, 86*(4), 347–354. Rockville, MD: Health Services and Mental Health Administration.

16. Robine, J. M., & Ritchie, K. (1991). Healthy life expectancy: evaluation of global indicator of change in population health. *BMJ, 302*(6774), 457–460. https://doi.org/10.1136/bmj.302.6774.457

17. Kyu, H. H., Abate, D., Abate, K. H., et al. (2018). Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet, 392*(10159), 1859–1922. https://doi.org/10.1016/s0140-6736(18)32335-3

18. Gubbi, S., Schwartz, E., Crandall, J., et al. (2017). Effect of exceptional parental longevity and lifestyle factors on prevalence of cardiovascular disease in offspring. *American Journal of Cardiology, 120*(12), 2170–2175. https://doi.org/10.1016/j.amjcard.2017.08.040. Epub 2017 Sep 18. PMID: 29050682

19. Ayers, E., Barzilai, N., Crandall, J. P., et al. (2014). Association of exceptional parental longevity and physical function in aging. *Age* (Dordrecht, Netherlands), *36*(4), 9677. https://doi.org/10.1007/s11357-014-9677-5. Epub 2014 Jul 5. PMID: 24997018 Free PMC article.

20. Lipton, R. B., Hirsch, J., Katz, M. J., ... Barzilai, N., & Derby, C. A. (2010). Exceptional parental longevity associated with lower risk of Alzheimer's disease and memory decline. *Journal of the American Geriatrics Society, 58*(6), 1043–1049. https://doi.org/10.1111/j.1532-5415. 2010.02868.x. Epub 2010 May 7. PMID: 20487085

21. Florez, H., Ma, Y., Crandall, J. P., et al; Diabetes Prevention Program Research Group. (2011). Parental longevity and diabetes risk in the Diabetes Prevention Program. *Journals of Gerontology, Series A: Biological Sciences and Medical Sciences, 66*(11), 1211–1217. https://doi.org/10.1093/gerona/glr114. Epub 2011 Aug 17. PMID: 21852284

22. Franceschi, C., Garagnani, P., Parini, P., et al. (2018). Inflammaging: a new immune–metabolic viewpoint for age-related diseases *Nature Reviews Endocrinology, 14,* 576–590.

23. Weintraub, W. S., & Diamond, G. A. (2008). Predicting cardiovascular events with coronary calcium scoring. *New England Journal of Medicine, 358*(13), 1394–1396. https://doi.org/10.1056/nejme0800676.

24. https://www.usatoday.com/story/news/politics/2020/02/26/ronny-jackson-efforts-improve-trump-diet/4878600002/

25. Mayeux, R., Sano, M., Chen, J., et al. (1991). Risk of dementia in first-degree relatives of patients with Alzheimer's disease and related disorders. *Archives of Neurology, 48*(3), 269–273. https://doi.org/10.1001/archneur.1991.00530150037014

26. Olshansky, S. J. (2011). Aging of US presidents. *JAMA, 306*(21), 2328–2329. https://doi.org/10.1001/jama.2011.1786

27. Rogalski, E. J., Gefen, T., Shi, J., & Samimi, M. (2013). Youthful memory capacity in old brains: anatomic and genetic Clues from the Northwestern SuperAging Project. *Journal of Cognitive Neuroscience, 25*(1), 29–36. https://doi.org/10.1162/jocn_a_00300

28. Liptak, K. (2020, June 3). White House releases results of Trump's annual physical. https://www.cnn.com/2020/06/03/politics/donald-trump-annual-physical/index.html

29. Rumberger, J. A., Brundage, B. H., Rader, D. J, & Kondos, G. (1999). Electron beam computed tomographic coronary calcium scanning: a review and guidelines for use in asymptomatic persons [published correction appears in *Mayo Clinic Proceedings, 74*(5), 538, 1999]. *Mayo Clinic Proceedings, 74*(3), 243–252.

30. Lautenschlager, N. T., Cupples, L. A., Rao, V. S., et al. (1996). Risk of dementia among relatives of Alzheimer's disease patients in the MIRAGE study. What is in store for the oldest old? *Neurology, 46*(3), 641–650. https://doi.org/10.1212/WNL.46.3.641

31. Breitner, J. C., Silverman, J. M., Mohs, R. C., & Davis, K. L. (1988). Familial aggregation in Alzheimer's disease: comparison of risk among relatives of early-and late-onset cases, and among male and female relatives in successive generations. *Neurology, 38*(2), 207–212. https://doi.org/10.1212/wnl.38.2.207

32. World Health Organization. Health topics: obesity. Geneva, Switzerland: World Health Organization; 2011. Available at: http://www.who.int/topics/obesity/en/

33. Centers for Disease Control and Prevention. Overweight and obesity. Atlanta, GA: Centers for Disease Control and Prevention; 2011. Available at: http://www.cdc.gov/obesity

34. Gu, Q., Dillon, C. F., & Burt, V. L. (2010). Prescription Drug Use Continues to Increase: U.S. Prescription Drug Data for 2007–2008. Hyattsville, MD: National Center for Health Statistics.

35. Charlesworth, C. J., Smit, E., & Lee, D. S. (2015). Polypharmacy among adults aged 65 years and older in the United States: 1988–2010. *Journals of Gerontology, Series A: Biological Sciences and Medical Sciences, 70*(8), 989–995. https://doi.org/10.1093/gerona/glv013

36. Chetty, R., Stepner, M., Abraham, S., et al. (2016). The association between income and life expectancy in the United States, 2001–2014 [published correction appears in *JAMA, 317*(1), 90, 2017]. *JAMA, 315*(16), 1750–1766. https://doi.org/10.1001/jama.2016.4226

37. Benjamin, E. J., Wolf, P. A., D'Agostino, R. B., et al. (1998). Impact of atrial fibrillation on the risk of death: The Framingham Heart Study. *Circulation, 98,* 946–952. https://doi.org/10.1161/01.CIR.98.10.946

38. Li, X-Y., Zhang, M., Xu, W., et al. (2019). Midlife modifiable risk factors for dementia: a systematic review and meta-analysis of 34 prospective cohort studies. *Current Alzheimer Research, 16*(14), 1254–1268(15). https://doi.org/10.2174/1567205017666200103111253

39. McClelland, R. B., Nasir, K., Budoff, M., et al. (2009). Arterial age as a function of coronary artery calcium (from the Multi-Ethnic Study of Atherosclerosis [MESA]). *American Journal of Cardiology, 103*(1), 59–63. https://doi.org/10.1016/j.amjcard.2008.08.031

40. Smith, G. I., Mittendorfer, B., & Klein, S. (2019). Metabolically healthy obesity: facts and fantasies. *Journal of Clinical Investigation, 129*(10), 3978–3989. https://doi.org/10.1172/jci129186

41. Letter to Rear Admiral Jackson, January 11, 2018. http://cdn.cnn.com/cnn/2018/images/01/12/letter.to.radm.jackson.january.11.2018.pdf

42. Alzheimer's Association. (2018). 2018 Alzheimer's disease facts and figures. *Alzheimer's & Dementia, 14*(3), 367–429. https://doi.org/10.1016/j.jalz.2018.02.001

Appendix A[c]

DEPARTMENT OF MEDICINE
at The GW Medical Faculty Associates

Kevin C. O'Connor, D.O., FAAFP
Associate Professor of Medicine
Director, Executive Medicine, The GW Medical Faculty Associates
Medical Director, International & Diplomatic Affairs, GW Hospital
Senior Medical Advisor, Health Sciences Programs, GW School of Medicine & Health Sciences

15 December 2019

As requested by the patient, the following is a summary of the medical and surgical history of Vice President Joseph R. Biden. I have been his primary care physician since being assigned as Physician to the Vice President in 2009, while I was serving in the Army at the White House, and subsequently in my current capacity as Director of Executive Medicine at The GW Medical Faculty Associates.

Current Health:

Vice President Biden is an active 77-year-old white male who is currently being treated for the following:

1. Non-Valvular Atrial Fibrillation (A-fib)
   - When we met in 2009, this patient had a history of paroxysmal (episodic) a-fib. This was first discovered during a routine pre-operative EKG, as an incidental finding, when he had his gallbladder removed in 2003. I would now describe his rhythm as persistent (more constant) a-fib, with a normal ventricular response. He remains completely asymptomatic.
   - This patient has never required any medication or electrical treatments to address either his rate or his rhythm. Recent echocardiogram confirms that he has normal ventricular contractility, with no signs of heart failure. He takes apixaban (Eliquis) for standard anticoagulation.

2. Hyperlipidemia
   - This patient carried the diagnosis of hyperlipidemia when I first assumed his care. His lipid levels remain low on his current regimen of rosuvastatin (Crestor).
   - Recent labs are cited below, to include normal cardiac C-Reactive Protein and homocysteine levels.

3. Gastroesophageal Reflux
   - Vice President Biden experiences occasional symptoms of gastroesophageal reflux, primarily having to clear his throat more often. This may also contribute to occasional cough and sinus congestion. He has received endoscopy to rule out any more significant disease. He uses over-the-counter esomeprazole (Nexium) for this.

4. Seasonal Allergies
   - This patient has dealt with seasonal allergies and sinus congestion for most of his life.
   - His sinus symptoms have improved after several sinus and nasal passage surgeries, but he still uses fluticasone/azelastine (Dymista) and over-the-counter fexofenadine (Allegra) for these symptoms.

[c] Source: https://go.joebiden.com/page/-/CiU2iAa4Ig_%20j5EQzueoad.pdf

In summary, this patient's current medical considerations are detailed as above. They include a-fib with normal ventricular response, hyperlipidemia, mild gastroesophageal reflux and seasonal allergies. For these, he takes three common prescription medications and two common over-the-counter medications

He has no known medication allergies.

He does not use any tobacco products, does not drink alcohol at all, and he works out at least five days per week.

Medical and Surgical History:

Pertinent negatives of this patient's history include the following:

He has no history of diabetes, thyroid disease, hypertension, tobacco use, angina, myocardial infarction, Chronic Obstructive Pulmonary Disease (COPD), ulcer disease, inflammatory bowel disease, any neurologic disorder, or cancer of any kind other than localized, non-melanoma skin cancers.

Pertinent positives of this patient's history include the following:

The most note-worthy health incident that Vice President Biden has experienced was his intracranial hemorrhage from a cerebral aneurysm in 1988. His aneurysm was repaired surgically. During this workup, his team discovered a second aneurysm, which had not bled. This was also treated. He has never had any recurrences of any aneurysms. A 2014 CT angiogram showed no recurrence of disease.

His 1988 post-operative hospitalization was complicated by deep vein thrombosis and a pulmonary embolism. As a safety precaution against further lung embolism, an inferior vena caval filter was placed, as was typical practice at the time. He was treated with an oral anti-coagulant for several months. An extensive workup was completed, and no underlying clotting disorder was identified. The clots were attributed to his immobilization from the intracranial hemorrhage and surgeries. Anticoagulation was stopped.

As is often seen in patients who have significant allergies, this patient experienced exercise-induced asthma as a teenager and young adult. This has resulted in no sequalae, other than perhaps experiencing bronchospasm with the occasional upper respiratory infections that all of us experience. He has no lung disease at all now. Chest x-ray this year was normal.

This patient has been treated for Benign Prostatic Hyperplasia (BPH). This was initially treated with medication and was then definitively treated with surgery. He has never had prostate cancer.

This patient's gallbladder was removed in 2003. Additionally, he has received multiple physical therapy treatments and surgeries, for various sports medicine and orthopedic injuries. Obstructive Sleep Apnea (OSA) has been considered, but his symptoms have improved significantly after his sinus and nasal passage surgeries.

During routine screening colonoscopy, he was found to have mild diverticulosis. Similarly, he was found to have a single, non-cancerous tubular adenoma in 2008. Subsequent colonoscopies have demonstrated no recurrence. He has never had colon cancer.

Vice President Biden did spend a good deal of time in the sun in his youth. He has had several localized, non-melanoma skin cancers removed with Mohs surgery. These lesions were completely excised, with clear margins. He continues to receive close dermatologic surveillance.

Physical Exam:

Height: 5 feet, 11.65 inches, Weight: 178 lbs, Body Mass Index (BMI): 24.38
Blood Pressure: 128/84, Pulse: 72, Respiratory Rate: 14, Temperature: 98.6 F

Physical exam is unchanged from baseline. Head, ears, eyes, nose and throat are normal. He has no enlarged lymph nodes or goiter. Lungs are clear. Heart demonstrates a regular pulse rate and characteristically "irregularly irregular" rhythm. I heard no murmurs, gallops or rubs. Abdomen is soft, non-distended. Liver and spleen are normal size. Patient has no hernias. Extremities have a full range of motion. Strength and reflexes are all normal and symmetrical. Cranial nerves and vestibular function are normal. Patient does have several areas of lentigo and actinic changes.

Labs:

Comprehensive metabolic panel (CMP) was normal, to include electrolytes, creatinine, blood urea nitrogen, protein, estimated glomerular filtration rate and liver enzymes. Fasting blood glucose: 81 mg/dL, Hemoglobin A1C: 5.1%, Thyroid Panel was normal. Urinalysis was normal, no glucose, protein or blood. Complete blood count (CBC) normal. B12 and folate normal. Vitamin D normal.

Lipid Panel: Total Cholesterol 126/mg.dL, Triglycerides 106 mg/dL, High Density Lipoprotein (HDL) 36 mg/dL, Low Density Lipoprotein (LDL) 69 mg/dL, Very Low Density Lipoprotein (VLDL) 21 mgm/dL. Cardiac C-Reactive Protein: 0.29 mg/L, Homocysteine: 12.1 umol/L

EKG: Atrial fibrillation with normal ventricular response, no acute ST or T wave changes.

Chest X-ray: Normal

Summary

Vice President Biden is a healthy, vigorous, 77-year-old male, who is fit to successfully execute the duties of the Presidency, to include those as Chief Executive, Head of State and Commander in Chief.

Respectfully submitted,

Kevin C. O'Connor, D.O., FAAFP
Associate Professor of Medicine
Director, Executive Medicine
The GW Medical Faculty Associates

Appendix B. Medical reviews

Medical review by Dr. Nir Barzilai, MD, Ingeborg and Ira Leon Rennert Chair in Aging Research, and Director, Institute for Aging Research
https://www.einstein.yu.edu/faculty/484/nir-barzilai/

Joe Biden
Survival
The biodemographic analysis of Biden's personal attributes independent of his medical records suggest that he has a high chance of surviving through his first four-year term—his survival prospects are better than anticipated for most men his age in the U.S. The additional information contained in the medical records suggest that his survival prospects could be 10% higher than the elevated survival prospects already present based on his personal attributes. Biden currently has no significant physical or cognitive impairments that would be commonly observed in a man his age; his level of physical activity is exceptional; his BMI places him in the lowest mortality risk group; the medications he is now taking are treating minor health conditions, and he's tolerating his prescription medications without incident. I would place Biden in the top 10% in terms of prospective survival for his birth cohort.

Health
Biden's current health status based on the somewhat limited information indicates that he is likely to be in the top 10–20% for a man his age. Most men age 77 in the U.S. are taking an average of 5 prescription medications and exhibit 2–3 primary impairments—at least one of which will be life limiting. Biden currently exhibits no life-limiting impairments. Normal BMI and low levels of cholesterol, homocysteine, CRP and HbA1c crosses off lots of risks for age-related diseases. His major abnormal condition is atrial fibrillation and his worst test result is his low HDL choles-

terol, but with low LDL cholesterol and no diabetes, this does not represent a significant health risk for him. His medications are only for disease prevention or allergies. His past experience with an intracranial hemorrhage, which was repaired surgically in 1988, showed no signs of returning based on a CT angiogram in 2014; and given that he's now 32 years post repair, this issue is no longer a significant health concern. From a physical perspective, Biden is in my opinion likely in the top 5% of the population of men his age in terms of health status.

Cognitive functioning
There are no independently verified medical records available that measured and documented the cognitive functioning of Biden. However, his appearance on the campaign trail during the past year suggests that he is currently operating at an exceptionally high level. He is likely to pass the common screening tests for dementia like the mini-mental status exam (MMSE) and MoCA with a perfect score, but these tests would not be predictive because they're only screening tools used to determine whether a full diagnostic assessment is required. His stuttering and speech reaction time is typical at his age and are not indicative of cognitive decline. The Framingham Heart Study estimates that in the general population, the risk for Alzheimer's disease is around 10% at age 82 (Biden's age at the end of his first term).[25] Since Biden (and Trump) do not have dementia currently the risk is significantly lower.

Summary
Considering that over 90% of people over 65 in the U.S. have more than 2 morbidities (obesity considered one), the data here reveals excellent overall health status of Biden relative to other 77-year-old men in the U.S. Biden's most abnormal condition is his atrial fibrillation that seems stable and asymptomatic with treatment to prevent thrombosis. There is nothing in his medical record to suggest that he is at a higher than normal risk for cardiovascular diseases, cancer, type 2 diabetes mellitus, cognitive de-

cline or death during his first term in office. The aneurysms experienced by Biden in 1990 are no longer a significant health risk for him given his healthy survival during the past 30 years; he's on a limited number of prescription medications—implying a better-than-average set of health risks. For me the best prediction of Biden's survival prospects is familial exceptional longevity (father surviving to his 80s and mother surviving into her 90s). This information, when combined with his behavioral risk profile, suggests that there is a high probability he will survive with his physical and mental health intact through a first term in office.

Donald Trump
Survival
The biodemographic analysis of Trump's personal attributes independent of his medical records suggest that he has a higher than average chance of surviving through a second four-year term. The additional information contained in the medical records do not yield enough information to adjust that favorable survival probability in either direction. On the positive side, Trump comes from a family history of exceptional longevity—and this will no doubt influence his survival prospects in the next four years—but he also exhibits several behavior risk factors that are documented to shorten longevity; including obesity, a sedentary lifestyle, and dietary habits associated with a high intake of fat, sugar, and carbohydrates. There is also suggestive evidence that his sleeping pattern is not ideal.

Health
Trump's current health status based on limited information, suggests that he is likely to be in the top 10–20% in projected health for a man his age. Most men age 74 in the U.S. are taking an average of 4–5 prescription medications and exhibit 2–3 primary impairments—at least one of which will be life limiting. Trump currently exhibits no life limiting impairments although he is obese. This means he is at risk for severe illness if he were to contract

Covid-19, and he is at risk for Type 2 diabetes mellitus. His worst test result is his high LDL cholesterol in spite of being on lipid lowering drugs.

Cognitive functioning

There are no independently verified medical records available that have extensive, documented cognitive tests for Trump. However, his appearance on the campaign trail during the past year suggests that he is currently operating at an exceptionally high level. While a man Trump's age does face a 7% risk of cognitive impairment during the next four years, his family history includes a father that lived into his 90s with at least 6 years of a period during which Alzheimer's disease was documented—this elevates Trump's risk of dementia.

Summary

Donald Trump appears to have only one major comorbidity (obesity) and the rest of the data here reveals excellent overall health status for a 74-year-old male in the U.S. His high LDL levels suggest a risk for cardiovascular diseases, but it should not be this high unless he's not taking his statins. With obesity he is at risk for type 2 diabetes mellitus, but his HbA1c is in the normal range. He has no known risks for cancer, cognitive decline or death during the next term. For me the best prediction for longevity is familial exceptional longevity and both parents for their cohort reached very advanced age. When combined with his behavioral risk profile, the available evidence suggests there is a high probability he will survive with his physical and mental health intact through a second term in office.

Comparison

In viewing their medical information, Biden and Trump are very close with regard to their anticipated healthspan and lifespan. This is mainly because the risks of obesity and high LDL cholesterol in Trump are somewhat equal to the risks associated with chronic atrial fibrillation and low levels of HDL cholesterol in Biden. More than anything I would like to know their

exercise regimes; do they walk at least 10,000 steps a day or even have the results of a physiological provocation (exercise test). While stress is also a risk for mortality, here I assume that they are at similar risks. Screening cognitive tests are of limited value, all readers of this article will score top scores in a screening test. Finally, studying centenarians, I believe that the best prediction for exceptional longevity is having parents with exceptional longevity. Again, these candidates are tied. In fact, they both had parents that lived past the age of 90 while their spouses lived to high 80s. It is unusual considering their parents belonged to a cohort born ~100 years ago when life expectancy was much lower. This underlines for me the main conclusion to keep in mind that biological aging and not chronological age is what counts and that these candidates can have extended lifespans beyond their next terms.

Biden maintains a slight edge over Trump in terms of his chances of surviving, and surviving healthy, during the next four years—in spite of the fact that Biden is three years older than Trump.

Medical review by Dr. Paola Rode, MD, Former Medical Director of Hematology Oncology, Lahey North Medical Center; and Former Assistant Clinical Professor of Medicine, Tufts School of Medicine

https://www.lapetussolutions.com/portfolio/paola-rode-m-d/

Joe Biden

Health

Biden is in excellent health for a man his age in the United States. His BMI is 24.38 and he is a non-smoker and non-drinker. His blood pressure remains well controlled and he is a moderate/vigorous exerciser—working out at least 5 days a week. His lipids are well controlled on a current regimen

of rosuvastatin and there is no evidence that he has cardiac disease. Apart from paroxysmal atrial fibrillation, which is rate controlled and asymptomatic, recent echocardiogram showed no evidence of cardiac impairment or insufficiency. He is on apixaban for stroke prevention. For mild gastroesophageal reflux, he is controlled on over the counter (OTC) esomeprazole (Nexium). An upper endoscopy did not show anything of concern. Additionally, he takes medication for seasonal allergies with fluticasone/azelastine (dymista) and fexofenadine (Allegra) OTC. In the past, he had sinus and nasal passage surgeries. Significantly, he had an intracranial hemorrhage from a cerebral aneurysm in 1988. This was repaired surgically, and screening revealed a second aneurysm that was repaired and never bled. Post-operatively, he had a provoked deep vein thrombosis and pulmonary embolus. This was treated with placement of an inferior vena cava filter (as was the practice at that time) and he received oral anticoagulation for many months. Work-up revealed no acquired or congenital hypercoagulable (clotting) syndrome. It is now over 30 years and there have been no recurrent events. In 2014, a CT angiogram of the brain showed no evidence of recurrent disease. He has had no recurrent clots. He had an enlarged prostate (benign prostatic hyperplasia) initially treated medically followed by definitive surgery. There is no history of prostate cancer. Cholecystectomy (gallbladder removal) was performed in 2003. Colonoscopy in 2008 was significant for mild diverticulosis and a non-cancerous tubular adenoma was removed. As he is active, he has had multiple orthopedic injuries treated with either surgery or physical therapy. There is no history of diabetes mellitus or any end organ damage (see Appendix A).

Cognitive functioning

Biden's family history is significant for longevity with his mother living until age 92 and his father to age 86, with no documentation of any cognitive impairment. Such families with members who retain their mental or physical capability into the 70s

Appendix B. Medical reviews *Continued*

or 80s as opposed to their decades-younger counterparts, are referred to as "super agers". Super agers are people who have less evidence of brain atrophy, have thicker parts of the brain related to memory, and lower prevalence of the pathological changes associated with Alzheimer's disease. A study by scientists at the Northwestern University Feinberg School of Medicine suggests that having resilient memory performance during aging could be inherited, and that a particular gene might be associated with the designation of super ager.[27] Biden is a life-long stutterer and he admits that when fatigued, he can struggle with speech fluency. A stutter can be a lifelong articulation disorder that says nothing about cognitive functioning. No cognitive study is available to date.

Summary

Biden is in excellent health for a 77-year-old male. His medical record does not reveal any life-limiting health impairments that would place him at an elevated risk of either death or cognitive decline while in office. He is physically very active and takes only three prescription medications which is less than the average for a man his age. As noted above, he is likely to come from a family of super agers, which is associated with an inherited ability to function at a high capacity at an older age. Biden's vital statistics suggest that he has a very high probability of surviving through his first term in office.

Donald Trump

Health

Trump is 6'3" with a weight of 244 pounds, and a BMI of 30.1. This was recorded at Walter Reed Medical Center on November 16, 2019. He is known to have a sedentary lifestyle and takes rosuvastatin to lower cholesterol as well as a baby aspirin daily and a multivitamin. In 2018, rosuvastatin was increased from 10 mg a day to 40 mg a day (maximum dose). His current BMI is in the obese range and despite encouragement to alter lifestyle with diet and an exercise regimen, sources reported in early 2019 said that he made some minor changes to

his diet but he did not adhere to a consistent exercise regimen.[28] His blood pressure is controlled at 121/79. At the time of his visit, he was taking hydroxychloroquine. This was done with consultation with his care team members and close monitoring of the EKG for changes (in the QT interval). He was not noted to have suffered any ill effects from the drug. Cholesterol was found to be either 167 or 170 depending on the source, and his LDL was less than 100.

The fact that Trump is now obese with a BMI of 30.1 elevates his risk for heart disease, diabetes, stroke and some forms of cancer. His resting heart rate is good. Laboratory evaluations from 2018 show a normal glucose level, no evidence for diabetes, and normal liver, kidney and thyroid function. His PSA is normal and there is no evidence apart for any significant dermatologic disease. He does have rosacea and uses ivermectin cream as needed. Finasteride is used to prevent male hair pattern baldness. A screening low dose CT scan of the chest in 2018 was normal, without pulmonary pathology. An echocardiogram of the heart showed normal systolic function, exercise stress echocardiogram demonstrated above average exercise capacity based on age and sex. No ischemia was noted. A coronary calcium scan was performed, and his level was 133 (a level greater than 100 signifies that plaque is present). This is in comparison to a 2009 coronary calcium score of 34 and a 2013 score of 98. Based on large, observational studies of asymptomatic patients, calcium scores of 101–400 put a patient in the moderately high-risk category for cardiovascular events.[29] According to his cardiologist, when the test was performed in 2018, he was 71 years of age; and 46% of males had a better score than him. Colonoscopy in 2013 was apparently without abnormal findings.

Cognitive functioning

The Montreal Cognitive Assessment (MoCA) was performed and his score was normal at 30/30. This is a test to screen for mild cognitive impairment. It is not used to diagnose dementia.

Trump's family history is significant for both parents living into their late 80s and 90s. There is no family history of premature cardiac or neoplastic disease. Of note, his father had Alzheimer's disease (AD) for 6 years before his death and developed it at 87 years of age, which is late-onset AD. The likelihood of inheriting late-onset AD from a parent is much lower than the risk of inheriting the early-onset form from a parent with an autosomal dominant gene mutation.[30] Still, there is about a five-fold greater risk of developing AD by age 87 for a person of age 65 with a first degree relative who has the late-onset form of this disease.[31]

Summary

In summary, Trump is 74 years of age with a sedentary lifestyle and a BMI which qualifies him as obese. Overweight and obesity are defined by the World Health Organization as abnormal or excessive fat that accumulate and present a risk to health. A person with a BMI of 30 or more is considered obese.[32,33] Coronary calcium scans have been performed intermittently since 2009 and the latest result of 133 places him at moderate risk of cardiovascular events, such as heart attack or other heart disease. There is longevity in his family with both parents living into their late 80s and 90s. Despite his father having late onset AD, there is to date no evidence of cognitive impairment based on the MoCA—the only cognitive screening test known to have been performed on Trump. Nevertheless, his risk is elevated 5-fold in developing AD by age 87. It is known that one of his brothers died at age 43 secondary to alcoholism and a second brother died recently at age 71 of an unknown cause. While exceptional longevity is in his family, it is important to note that having two brothers die well before expected based on familial longevity, demonstrates the importance of lifestyle and its impact on health which can supersede the genetic advantage of exceptional longevity. Based on his vital statistics, Trump has a high likelihood of surviving a second term in office.

Comparison

In summary, within the constraints of available medical or publicly available records, both candidates have a high likelihood of surviving the next four years. Based on the limited information available, Biden may have a slight advantage over Trump due to his lifestyle choices such as exercise and diet regimen as well as a BMI within the normal range. Both candidates take less than the national average prescription medications. A National Center for Health Statistics investigation reported that approximately a third of persons over age 60 were on ≥ 5 prescription medications in 2007–2008.[34] As higher prescription medication use can be associated with worse health status than those on less medications, the fact that they are on less medications makes them less vulnerable.[35] Both candidates have access to excellent health care and are known to have a higher income which correlates with an increased life expectancy.[36] This speaks to the fact that despite the age difference, both would be expected to survive a four-year term.

Medical Review by Dr. Bradley Willcox, MD, Professor and Director of Research, Department of Geriatric Medicine, John A. Burns School of Medicine, University of Hawaii
https://www.orcls.org

Joe Biden
Health
Joe Biden is a 77-year-old married never smoker and non-drinker who is in excellent health. His primary medical impairment is non-valvular atrial fibrillation (AF), an irregular heart rhythm. This is a common age-associated arrhythmia and does not appear to be due to underlying coronary artery disease. AF typically raises the risk of death for men of all ages by 50–90 percent.[37] However, given that Biden has never required medication for his heart rate or

rhythm, has an otherwise normal heart function on echocardiogram and EKG, and has taken standard anticoagulation (to mitigate stroke risk) without complications for close to two decades, his risk appears to be mild compared to the average case. This is not expected to influence his projected health in a meaningful way.

Biden currently has no other significant physical or cognitive impairments that would otherwise be commonly observed in a man his age; his physiological assessment and blood work reflect healthy major organ systems; his BMI places him in the lowest mortality risk group; his level of physical activity is exceptional—encompassing both strength training and aerobic/cardiovascular activity, which is very important for healthy aging. He takes only a few prescription medications (including a statin for his cholesterol, an anticoagulant for his AF, and a proton pump inhibitor for reflux esophagitis). Otherwise, he takes common over the counter medications for minor issues such as seasonal allergies. His medical history includes cerebral aneurysm repair (complicated by postoperative deep vein thrombosis and pulmonary embolism), sinus/nasal passage surgery, cholecystectomy, sports-related orthopedic procedures, prostate surgery (for benign prostatic hyperplasia), possible sleep apnea, among other more minor issues. These have all been medically and/or surgically treated and/or cured, per imaging and other studies. He has excellent social support, medical care, health behaviors (including up-to-date cancer screening and immunizations) and, importantly, a family history of significant longevity. This suggests that he could be a "super-ager"—someone who is physiologically younger than his chronological age.[27]

Cognitive functioning
There are no formal cognitive tests for Biden in the available medical records. However, his mother lived until age 92 and his father to age 86, apparently with no documented cognitive impairment. Much of this may be due to genetic cognitive resilience, but Biden's very healthy lifestyle

and lack of vascular disease are also likely to prolong the duration of his high cognitive functionality. Modifiable risk factors for dementia include diet, physical activity, cardiovascular factors (e.g. hypertension, lipid profile, smoking), inflammation, among other factors.[38] None of these factors appear to present a risk to Biden. In fact, they are working in his favor. His excellent lipid/metabolic profile and low level of inflammation, evident in his blood-work, are evidence that he has ongoing key protective factors. While Biden is a life-long stutterer and he sometimes struggles with speech fluency, this has no relation to cognitive function.

Summary
Joe Biden is in excellent overall health for a 77-year-old American male. His primary medical impairment is non-valvular atrial fibrillation. This is a common age-associated arrhythmia and does not appear to be due to underlying coronary artery disease. He has never had any known complications, does not require rate or rhythm control, and it is considered fairly benign. Case in point, he engages in vigorous physical activity that might overly stress a typical AF patient, without incident, and has done so most of his life. He has no other major age-related diseases, all physiological systems appear to be functioning well, his laboratory blood work is exceptional, particularly his metabolic/lipid profile (excellent cholesterol, fasting blood sugar, hemoglobin A1C). His C-reactive protein (CRP) is very low, suggesting very low systemic inflammation (a major driver of the aging process known as "inflammaging"). He eats a healthy diet and is very physically active. His medications are minimal and low-risk. His father and mother far outlived their birth cohort, living into their 80s and 90s, respectively. Biden's overall health profile suggests that he has a very high probability of surviving through his first term in office with his physical and cognitive functioning intact.

Appendix B. Medical reviews *Continued*

Donald Trump

Survival

Donald Trump's medical records suggest that he has an excellent chance of surviving through a second four-year term. On the positive side, Trump comes from a family history of exceptional longevity—and this will no doubt influence his survival prospects over the next four years—but he also exhibits several comorbidities and behavioral risk factors that are documented to shorten life expectancy; including obesity, a sedentary lifestyle, and dietary habits associated with a high intake of unhealthy fat, sugar, and other high glycemic load carbohydrates.

Health

Trump's primary medical impairment is subclinical coronary artery disease (CAD), as evidenced by a cardiac CT scan in 2018 that revealed a coronary artery calcium (CAC) score of 133. This score is consistent with a moderate level of calcified plaque deposition in his coronary arteries. Findings revealed that a CAC score between 101 and 300 carries a moderate to high relative risk of 7.08 (3.05–16.47) p <0.001 compared to a score of zero—for a major cardiovascular event (e.g., heart attack, sudden death) over the next 10 years.[23] Of concern, Trump's CAC score has increased dramatically from 2009 when it was 34, to 98 in 2013, and most recently his CAC score in 2018 was 133. While this scan was performed at close to 72 years of age, and placed him at the 44th percentile for a 72-year old Caucasian male, and his score is better than average, it is far from ideal. His "arterial age", which is estimated from a validated algorithm for estimating risk for CVD "Hard end points (MI or sudden death), is estimated at 75 years (95% CI: 73–77 years. This suggests mildly accelerated arterial aging relative to a man his chronological age and places him at moderate risk of CVD death over the next 10 years (1% per year).[39] This algorithm is based on coronary calcium score, chronological age, sex, ethnicity, total cholesterol, HDL cholesterol, smoking status, systolic blood pressure (assumes the absence of both clinical CVD and treated diabetes), and is a better predictor of a major cardiac event than the Framingham risk score. His 2018 CAC score[39] is almost certainly higher now. Recently Trump was placed on a maximal statin dose in an attempt to mitigate this trend. The CAC score is an independent predictor of the risk of major cardiovascular events, with demonstrated superiority over the Framingham risk score, CRP level, and carotid intima-media thickness, among 700 other cardiovascular risk factors.[23]

In sum, Trump's major CVD risk factors are his age, history of high LDL cholesterol levels, his obesity, his poor diet and sedentary lifestyle. This is balanced by good family history, avoidance of smoking, high levels of HDL cholesterol, an excellent blood pressure (despite no antihypertensive medications), good fasting blood sugar (89–99; normal < 100k); healthy glycosylated hemoglobin (5.0%; normal < 5.7%), and very low CRP level (0.7; optimal < 1).

Trump's obesity is of particular concern (increased risk for CAD, stroke, cancer, etc.). While he appears metabolically healthy, the burden of cardiovascular disease and all-cause mortality in the metabolically healthy obese (MHO) population where Trump resides, is not benign. It falls between optimal risk (non-obese, metabolically healthy), and highest risk (obese, metabolically unhealthy).[40] Trump's other comorbidities are non-life limiting and typical of a male septuagenarian.

There are no detailed physiological data revealed from assessments of cardiovascular, pulmonary, hepatic, musculoskeletal, or other major organ system function. However, his exercise stress testing was apparently considered by his physician as "above average", echocardiograms and electrocardiograms have been considered "normal" again, with few details available to assess underlying risk. Per a CT scan, his lung architecture appears intact and there are no obvious, clinically significant anomalies. Some additional health clues can be ascertained from his blood work. For example, his eGFR is normal (indicating stable renal function), and his liver enzymes are normal. His cholesterol ratio is good with a very healthy Total: HDL (good) cholesterol ratio and a high HDL (longevity marker), somewhat mitigated by a high LDL (bad) cholesterol level, currently being treated with a full-dose statin. Thus, the biomarkers available to assess health and function are consistent with a reasonably healthy septuagenarian whose estimated lifespan is likely to be greater than average for a male his age, predicated partly on his ability to mitigate further build-up of cholesterol plaque in his coronary arteries.

Cognitive functioning

Trump has a family history of Alzheimer's dementia on his father's side (onset approximately age 87 years). Although this is considered common and late onset (over 40% of 85-year-olds have dementia), this still increases Trump's risk for dementia versus the average male. There have been concerns about his cognitive function in the media and among many health professionals, such that 71 health professionals jointly wrote a letter to his personal physician urging detailed cognitive testing.[41] This resulted in the only known cognitive screen for dementia that Trump has undergone—the Montreal Cognitive Assessment (MoCA) test. This is a screening test; there is not a single diagnostic test for dementia, as it's a clinical diagnosis based on a battery of tests, including blood tests to rule out other causes of cognitive impairment.

Apparently, Trump scored 30/30—a common score on the MoCA. A score of 26/30 or higher is considered normal but does not completely rule out dementia. A formal diagnosis of dementia and its clinical subtype (e.g. Alzheimer's dementia, vascular dementia, or another subtype) requires a battery of cognitive and neuropsychological tests. The percentage of people with Alzheimer's dementia (the most common cause of dementia in the U.S.) increases with age: 3 percent of people age 65–74, 17 percent of people age 75–84, and 32

percent of people age 85 years and older have Alzheimer's dementia.[42] Trump would be 78 years old at the end of a second term, and with his family history, he would exceed the dementia risk of the average person that age.

Summary

Trump's overall health profile suggests that he has been quite healthy over the years but now has subclinical coronary artery disease (CAD), with a moderate level of coronary plaque. His lack of major disease and disability thus far may be largely genetic since his parents lived into their octogenarian and nonagenarian years (mother died at 88 and father at 93 years of age, albeit with Alzheimer's disease for 6 years before his death). However, family history is not destiny (two of his brothers have died young) and his poor lifestyle (unhealthy diet, lack of physical activity) may be catching up with him. This is evident from a worrisome increase in his coronary artery calcium (CAC) score over the past 9+ years (2009–18), which has progressed from a low CAC score to a moderately high-risk score (increased risk for a major cardiovascular event including sudden death). On the positive side, other than obesity, he has a very good metabolic profile with healthy blood pressure, high HDL (good) cholesterol, good hemoglobin A1C level (healthy blood sugar level), and a low C-reactive protein (CRP) level. CRP is a marker of inflammation, and a low score suggests that a major driver of the aging process known as "inflammaging" is optimal (<1), as opposed to most people his age. He is also on few prescription medications for a man his age (less than a half-dozen low risk medications), appears to receive excellent medical care, practices some preventive health behaviors (e.g. takes a multivitamin, screening tests and immunizations appear up to date) and is married. In sum, based on these data, and assuming there is no further comorbidity in the medical records, he will likely live longer than a typical 74-year-old male and live through a second term in office with his physical and cognitive functioning intact.

Comparison

Overall, the limited amount of information contained in the medical records and/or publicly available information suggest that Biden maintains a slight edge over Trump in terms of his chances of surviving, and surviving healthfully, during the next four years—in spite of the fact that Biden is three years older than Trump. The most definitive clinical evidence for CAD, the leading killer of American men, in either candidate, is Trump's coronary calcium score on cardiac CT of 133 (in 2018), which by itself places Trump at a moderate risk for a major CVD event (including sudden death) over the next 10 years. The biological age of his coronary arteries is also a few years (approximately three years) older than his chronological age.[39] There is no such evidence for CVD in the Biden medical record. Biden has had cerebral aneurysms, but he received surgical treatment decades ago, and this is no longer considered a risk. He also has persistent atrial fibrillation (AF) but his rate and rhythm have never required treatment and he is on an anticoagulant medication that reduces his risk of stroke (from AF) to near normal.

While both candidates have a family history of longevity, excellent lipid, metabolic and inflammatory profiles, Biden has a much healthier BMI, and practices better health habits, particularly a healthier diet and vigorous exercise. This includes aerobic activity and strength training, which are very important for healthy aging. Genes, while important, are not inert and their expression can be modified for better or for worse, by health behaviors. While not all is known about Trump family health habits, a case in point is that two of the three Trump brothers have died young, leaving only one remaining brother, who other than abstaining from alcohol and tobacco, appears to practice few preventive lifestyle behaviors.

INTERNATIONAL
COUNCIL ON
ACTIVE AGING

ICAA

603-1112 West Pender Street
Vancouver, BC, V6E 2S1
Toll-free: 866-335-9777 Tel: 604-734-4466
www.icaa.cc