



Published in final edited form as:

Am J Cardiol. 2018 July 15; 122(2): 347–352. doi:10.1016/j.amjcard.2018.04.002.

Prevalence of Ideal Cardiovascular Health Metrics in the Million Veteran Program

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Abstract

No data exist on the prevalence of ideal cardiovascular health metrics in a national sample of U.S. veterans. We assessed the prevalence of ideal Life's Simple Seven (LSS) metrics in a cross-sectional study of 554,855 U.S. veterans enrolled in the Million Veteran Program (MVP) from 2011 to 2017. We used the American Heart Association's established criteria to categorize each LSS metric as either poor, intermediate, or ideal for a veteran at time of MVP enrollment. Information on adiposity/body mass index, smoking status, diet, and physical activity was obtained from self-reported survey data, and clinical measurements for total cholesterol, blood pressure, and plasma glucose were obtained from electronic health records. Complete data on all LSS health factors were available for 201,745 veterans. The prevalence of having 0, 1, 2, 3, 4, 5, 6, and 7 ideal cardiovascular health metrics was 29.2%, 34.6%, 22.6%, 10.0%, 3.0%, 0.6%, <0.1%, and 0%, respectively. The frequency of ideal body mass index, physical activity, smoking status, total cholesterol, blood pressure, and plasma glucose was 19.4%, 3.8%, 27.0%, 21.8%, 17.8%, and 34.5%, respectively, in our study population. Among the 7 metrics, MVP participants were least likely to achieve ideal diet (0.4%), particularly the recommendation for fruit and vegetable (at least 4.5 cups/day) intake. Our data show an extremely low prevalence of ideal cardiovascular health factors among veterans in the MVP, especially for diet and physical activity. These findings

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Disclosures

This publication does not represent the views of the Department of Veterans Affairs or the United States Government. There are no conflicts of interests to disclose.

Supplementary Data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.amjcard.2018.04.002>.

underscore the need to improve adherence to modifiable lifestyle factors that could result in subsequent reduction in cardiovascular disease burden among veterans.

In 2010, the American Heart Association (AHA) introduced a metric, Life's Simple Seven (LSS), to classify 7 evidence-based, easily measured modifiable lifestyle and biological measures of cardiovascular health that are attainable and could improve patients' cardiovascular health.¹ Lifestyle measures linked to behaviors include nonsmoking, physical activity, healthy diet, and body mass index (BMI), whereas the biological factors are blood pressure, total cholesterol, and blood sugar level (fasting plasma glucose). Each measure is classified into 3 cardiovascular health categories: ideal, intermediate, and poor. Cardiovascular health has important implications on quality of life,²⁻¹² and greater attainment of ideal cardiovascular health during midlife and late life has been associated with lower cardiovascular disease prevalence and better cardiovascular function in the elderly.¹³ The overall aim of this research is to assess the prevalence of LSS ideal cardiovascular health factors among U.S. veterans.

Methods

The Million Veteran Program (MVP) is a longitudinal study designed to study genomic and nongenomic research questions among veterans¹⁴ Enrollees in the MVP consist of veterans who are active users of the Veterans Health Administration. Between January 2011 and March 2017, 554,855 participants have been enrolled. The current cross-sectional study utilizes data on MVP participants who have complete information on all 7 modifiable cardiovascular health behaviors and factors at time of MVP enrollment (Figure 1). Those missing information (n = 353,110) on any LSS factor were excluded from the main analysis.

Information on LSS cardiovascular health lifestyle behaviors for physical activity, dietary habits, BMI, and smoking status were obtained from self-reported MVP Baseline and Lifestyle Surveys. Questions about physical activity on the MVP Lifestyle Survey focused on the frequency (daily, several times/week, once/week, several times/month, once/month or less, or never) and levels of activity (vigorous, moderate, or light) at place of employment, at home, and during leisure/free time. Examples of vigorous activity include lifting heavy objects, long periods of rapid movement, intensive physical labor, digging in the garden, and competitive sports like running, swimming, or high-intensity aerobics. Examples of moderate activity include extended periods of walking, operating heavy power tools, mowing the lawn with a push mower, low impact aerobics, or golfing without a power cart. Light activity was characterized by activities such as office work, driving a small vehicle, sales, light housework like dusting or laundry, bowling, archery, easy walking, or golfing with a power cart, or fishing. Data for the 5 LSS cardiovascular health dietary components were taken from the MVP Lifestyle Survey. The MVP dietary questions focused on the average use in the previous year (never or less than once a month, 1 to 3 per month, once a week, 2 to 4/week, 5 to 6/week, once/day, 2 to 3/day, 4 to 5/day, or 6+/day) of fruits, vegetables, fish, dark bread, carbonated beverages with sugar, and noncarbonated fruit drinks. Dark bread was used as a proxy for whole grain consumption, and sugar-sweetened beverages were represented in our analyses by the combination of carbonated and

noncarbonated beverages. BMI was derived from self-reported height and weight from the MVP Baseline Survey. Smoking status was derived from the MVP Baseline and Lifestyle Surveys. Participants were asked if they had smoked at least 100 cigarettes in their life, at what age they started smoking, if they currently smoke cigarettes (if yes, how many cigarettes per day), and lifetime use of other tobacco products. Missing self-reported BMI and smoking data were supplemented with data from electronic health records when available.

Clinical components for LSS were obtained from electronic health data closest to enrollment date and could be obtained either before or after study enrollment. All 7 LSS health factor components were then categorized as either poor health = 0, intermediate health = 1, or ideal health = 2 according to established AHA LSS cardiovascular health factor criteria.¹

We made some adaptations to the AHA classifications because of data constraints in the MVP population (Supplementary Table S1). First, we did not have detailed smoking history to classify former smokers based on duration since quitting. According to LSS criteria, former smokers who quit more than 12 months ago are categorized as being ideal for the smoking metric, whereas former smokers who quit within the last 12 months or less are categorized as intermediate. In our study, smoking was categorized into never (ideal), former (intermediate), or current (poor) smokers, and self-reported smoking status was adjudicated with electronic health data.¹⁵ Second, in the absence of nutrients in the MVP database, we did not have information on sodium; hence, our definition of healthy diet in this study was based on the remaining 4 out of 5 dietary components: fruit and vegetable intake, fish consumption, whole grain consumption, and sugar-sweetened beverage consumption. Third, fasting plasma glucose was missing for more than half of the study population; therefore, we used nonfasting plasma glucose for subjects with missing fasting plasma glucose.

We selected baseline demographic data closest to the time of MVP enrollment. Age, gender, ethnicity, race, education, and income were self-reported from the MVP Baseline Survey, and if data were missing, information from electronic health records was used as a supplement when available.

Descriptive statistics (mean, SD, proportion) were used to describe baseline characteristics of our study cohort. We examined individual LSS cardiovascular health factor components among participants according to poor, intermediate, and ideal health. We also examined prevalence of ideal LSS metrics by gender as well as stratified analyses by race, ethnicity, mean age (<65 years old vs ≥65 years old), enrollment year, and geographic region. Enrollment years only included 2012 to 2016 to account for complete years in which enrollment occurred. The cardiovascular summary score, defined as the sum of all LSS modifiable cardiovascular behaviors and factors, was categorized into 3 groups where those with a summary score from 0 to 4 points were classified as having poor cardiovascular health, 5 to 9 as average cardiovascular health, and 10 to 14 points as achieving ideal cardiovascular health. All analyses were completed using SAS software version 9.4 (SAS Institute Inc., Cary, North Carolina).

Results

Of the 201,745 veterans with complete data on LSS cardiovascular health factors in the MVP, 91.9% were men and the mean age (SD) was 65.3 (11.7) years at baseline (Table 1). More than two-thirds of the study population had between 0 and 1 ideal metrics and less than 5% achieved ideal status for more than 4 metrics. The prevalence of having 0, 1, 2, 3, 4, 5, 6, and 7 ideal cardiovascular health metrics is presented in Figure 2. The median number of LSS ideal cardiovascular health factors was 1. When stratified by gender, the distribution of achieving ideal status for 1 to 7 LSS metrics did differ by gender. Among women, 44.1% had 0 or 1 ideal metrics and 10.3% achieved ideal status for more than 4 metrics. The median number of LSS ideal cardiovascular health factors among females was 2 (Supplementary Figure S1). When the MVP population was stratified by geographic region, enrollment year, race, or ethnicity, we did not observe any changes in the distribution of total ideal metrics. Dichotomizing the MVP population by mean age, we found that 6.2% of participants who were less than 65 years old had 4 or more ideal metrics and 54.2% had between 0 and 1 ideal metrics. The distribution of achieving ideal status for 1 to 7 LSS metrics did not differ from the distribution of ideal metrics for the overall MVP population for those who were 65 years and older (Supplementary Table S2).

LSS factors with the lowest prevalence in our MVP cohort were ideal physical activity (3.8%) and ideal healthy diet (0.4%), whereas ideal plasma glucose (34.5%) was the most prevalent (Figure 3). Among dietary factors, reported consumption of fruit and vegetables (at least 4.5cups/day) was the least likely to be achieved. The overall mean number of ideal metrics was 1.25 (SD 1.11) for the MVP.

When we examined the prevalence of ideal in each of the LSS metrics by gender, race, ethnicity, age, enrollment year, and geographic region, ideal physical activity and ideal healthy diet remained the least achieved (Supplementary Table S3). Compared with the overall MVP population, females (1.1%), blacks (2.4%), and persons <65 years of age (1.8%) had an even lower prevalence of ideal physical activity. Although the prevalence of ideal diet was higher among females (0.7%) and more than double among blacks (0.9%) compared with the overall MVP population, the majority of women and blacks still fell into the poor diet category. Relative to the overall MVP population, younger MVP participants (<65 years) had a higher prevalence of an ideal level of total blood glucose and of total cholesterol and of nonsmoking and nonuse of tobacco products. Although women were more likely to have higher prevalence of ideal status for each of the 7 metrics compared with the overall MVP population, their mean overall cardiovascular health score (6.4, SD 2.0) remained less than ideal. In general, the mean overall cardiovascular health score in the MVP was 5.8 (SD 1.9) on a scale of 0 (worst) to 14 (best), suggesting that most veterans do not achieve ideal cardiovascular health. Only 3.1% of veterans in the MVP achieved an overall cardiovascular health score that was 10 or greater (ideal).

Discussion

The concept of ideal cardiovascular health is a good measure of population health,¹⁶ and our study is the first to quantify cardiovascular health among a nationwide sample of veterans.

We observed that veterans participating in the MVP have an extremely low prevalence of achieving ideal status for LSS metrics. No veteran in our study was ideal for all 7 cardiovascular health metrics and less than 0.1% met 6 ideal metrics. Particular areas of concern were physical activity and healthy diet.

Previous assessments of LSS ideal cardiovascular health factors in other U.S.-based cohorts^{2,5,17-20} found that the prevalence of having 6 to 7 ideal LSS factors ranged from 0.5% to 12%, suggesting that achieving ideal status for cardiovascular health metrics in the MVP was lower compared with other U.S. studies. Findings from our analyses, however, were consistent with those from the Multiethnic Study of Atherosclerosis where approximately 0.1% of participants met the ideal criteria for all 7 components of LSS.¹¹ Females in the MVP had a higher mean number of ideal metrics compared with males, which was consistent with other studies.^{21,22} However, when we focused on gender-specific LSS classification, less than 1% of females in the MVP (0.04%) achieved 6 to 7 ideal metrics, with none having all 7 ideal and a mean of 1.8 (SD 1.3) ideal factors overall. These findings were not consistent with previous studies among female cohorts; findings from the National Health and Nutrition Examination Surveys (NHANES) indicated females 40 to 64 years old commonly exhibited 3 ideal cardiovascular health components and those older than 65 years achieved 2 to 3 ideal²²; the prevalence of females in the Atherosclerosis Risk in Communities (ARIC) study achieving ideal for 6 to 7 metrics was 3.3%.²³ When we compared the prevalence of achieving 0 to 1 ideal LSS metrics, only 18.1% of females in the ARIC study fell into this category versus 44.1% in the MVP female population. In our stratified analysis of LSS ideal cardiovascular health factors by race, we found that the prevalence of 6 to 7 LSS ideal cardiovascular health factors among blacks was substantially lower (<0.1% with none achieving 7 ideal metrics) compared with the results from the Mississippi Behavioral Risk Factor Surveillance System where 1.3% of blacks exhibited ideal levels of all 7 metrics,²¹ but supportive of the Jackson Heart Study (JHS) findings where no black men or women achieved ideal in 7 metrics.²⁰ We did not observe a difference in the distribution of total ideal metrics by race, which was observed in other studies.^{6,21,24} However, given that blacks were younger in our population, and a larger proportion of blacks were female compared with whites (13.1% vs 7.0%) in our study, future work examining LSS in the MVP will include multivariable models that adjust for gender and race.

A systematic review of the prevalence of ideal cardiovascular health found that ideal classification for diet was the least likely to be achieved among various U.S. cohorts and smoking was the most likely ideal classification among U.S. cohorts. The 0.4% prevalence of ideal diet in the MVP was consistent with findings from the systematic review where ideal diet was observed in 1% or less among populations² and supportive of findings in the NHANES 2003 to 2008 where ideal healthy diet score was least prevalent and ranged from 0.2% to 2.6% across different adult groups in the United States.²² In the JHS, prevalence of ideal diet among blacks was 0.9% which is consistent with results among blacks in MVP (1.0%).²⁰ Achieving a healthy plasma glucose level was the most prevalent ideal cardiovascular metric in MVP, which conflicts with most U.S. studies that found ideal smoking as the most likely ideal classification. Our prevalence of ideal status for cigarette smoking was 27% compared with 29% to 98% in other U.S. populations.² The lower

prevalence of ideal smoking in MVP might be due to an underestimation of ideal smoking status because we were unable to account for the length of time that had passed since a former smoker quit in our study. While we found that achieving ideal status for healthy plasma glucose level was the most prevalent in MVP, our findings should be interpreted with caution as fasting blood glucose was missing for more than half of the MVP study population and nonfasting plasma glucose levels, which may or may not assess postprandial blood sugar levels, were used as a substitute in our study.

Studies have suggested that the prevalence of 1 to 7 ideal LSS metrics is greater among those with higher levels of education and income status.^{21,24} In our MVP cohort, we found that participants with higher education beyond a high school diploma or equivalent and higher income (>50,000) had similar prevalence of 1 to 7 ideal LSS metrics (data not shown). However, these findings should be interpreted with caution as measurements of income and education were self-reported with no supplement from electronic health records and we may not have had enough data to look at differences in total ideal metrics across the education and income groups.

Our study has several limitations. First, study participants were recruited from active Veterans Health Administration users, and cross-sectional data do not represent changes in an individual veteran over time. Without repeated assessments, this study cannot examine the longitudinal changes in cardiovascular health metrics in the MVP. Future studies with repeated measures and more detailed cardiovascular health behaviors are in planning to understand if prevalence of ideal LSS metrics changes as the veteran population ages. Our study recruitment method may also be biased toward those who are sicker and in need of more frequent medical care. Second, only participants with complete data for all 7 components of LSS metrics were included in prevalence estimates for the number of ideal cardiovascular health factors. When we examined participants with incomplete LSS metrics, we found that this population had a very similar demographic profile for age and gender, but a different proportion of racial representation (Supplementary Table S4). This suggests that our study's results are not likely affected by sampling bias and that demographic factors do not bias the specific prevalence estimates of ideal cardiovascular health among veterans. Although some veterans chose not to return complete MVP surveys or returned partially completed surveys, this study relies on over 200,000 participants with complete data. A third consideration is the older age of our study population and high representation of Vietnam War era veterans. However, we do not expect the higher proportion of older Vietnam War era veterans to limit study generalizability. Fourth, height and weight (BMI), smoking status, and physical activity were self-reported, and misclassification could have biased our results. Efforts were made to clean and cross-validate self-reported data for BMI and smoking status with electronic health information. Last, because we did not have data on sodium intake and only basic information on whole grain consumption, our results for the healthy diet might be under- (or over-) estimating prevalence of healthy diet depending on prevalence of being ideal on sodium intake in the MVP. While there is also the possibility of misclassification of LSS metrics due to self-reported nutritional data, it is unlikely to affect the overall results of our study, given the large sample size and probability that veterans would be biased to report a more ideal dietary pattern than an unfavorable dietary behavior. However, given that ideal

diet is only 0.4% ideal, overreporting of ideal diet would not affect the study results substantially.

In conclusion, our results show that there is a low prevalence of LSS ideal cardiovascular health factors in the MVP population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgment:

We are grateful to the MVP participants and staff.

This research is based on data from the Million Veteran Program, Office of Research and Development, Veterans Health Administration, and was supported by award CSP# G002. This research was also supported by the VA Merit Award I01-CX001025.

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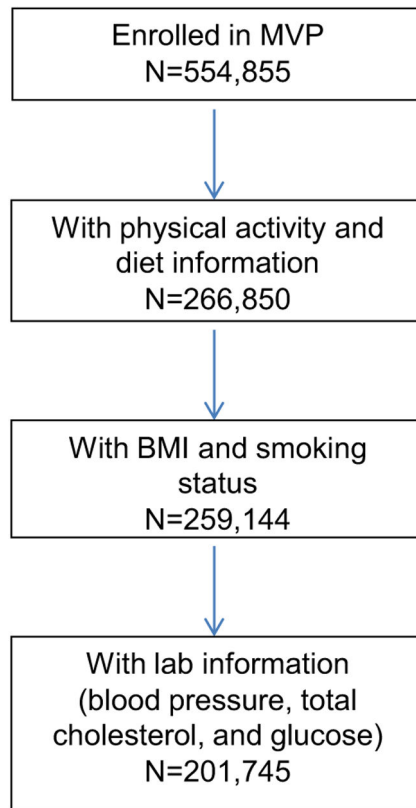


Figure 1. Selection of the Million Veteran Program’s Life’s Simple Seven cohort.

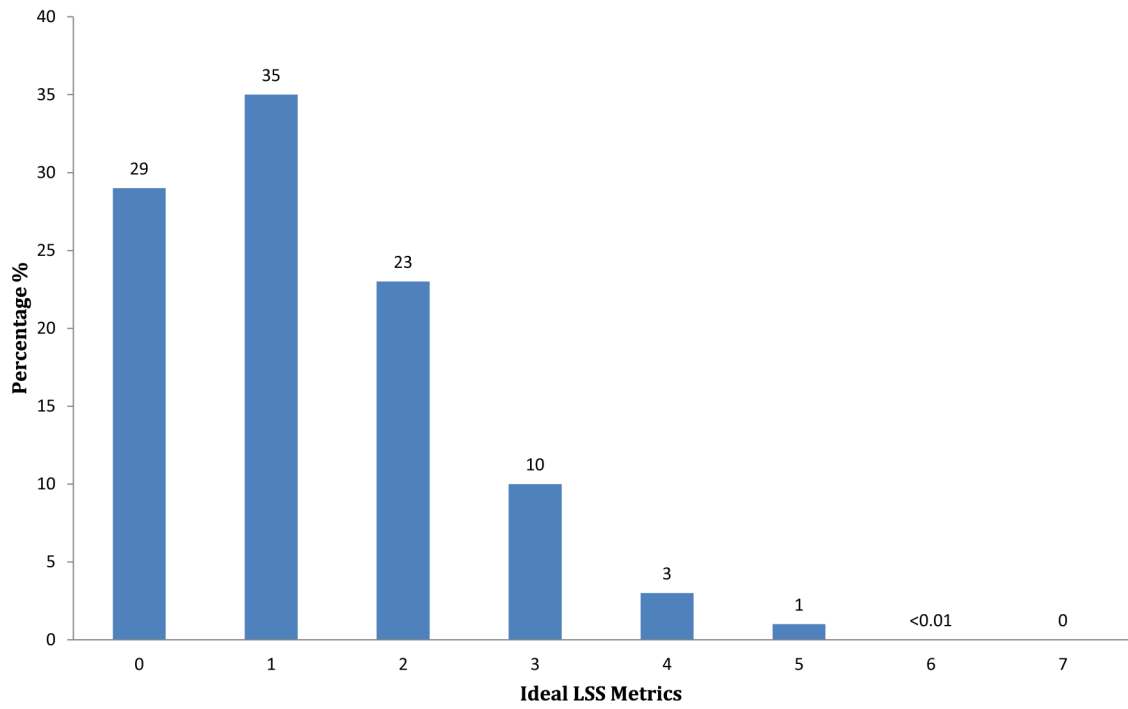


Figure 2. Prevalence of 1 to 7 ideal metrics among veterans in the study cohort (n = 201,745).

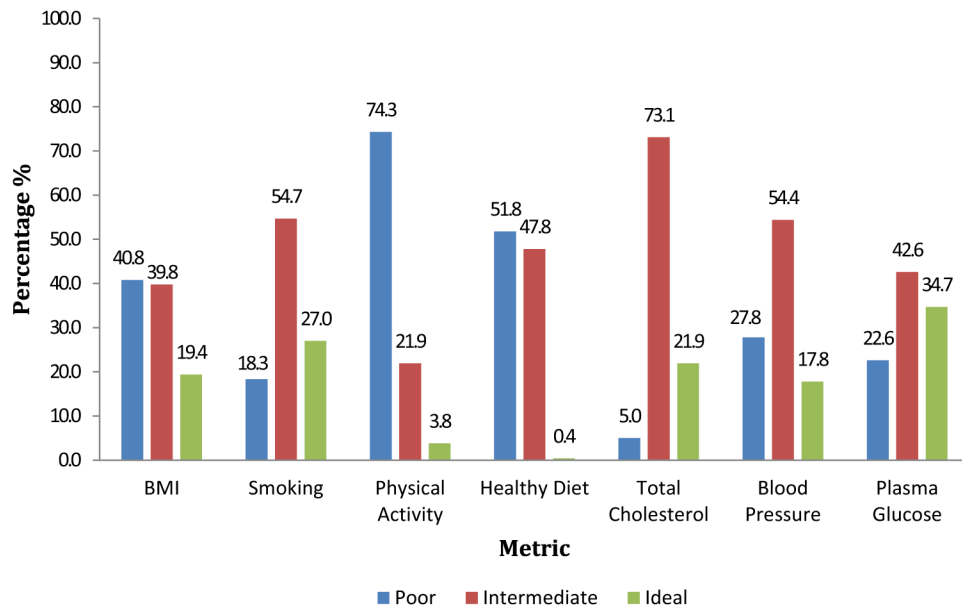


Figure 3. Prevalence of poor, intermediate, and ideal Life's Simple Seven Metrics in the study cohort (n = 201,745).

Table 1

Characteristics of 201,745 million veteran program participants

| | |
|-------------------------------|-------------|
| Age (mean years, SD) | 65.3 (11.7) |
| Male | 91.9% |
| Female | 8.1% |
| Missing | N = 5 |
| White | 80.7% |
| Black | 12.4% |
| Asian | 0.8% |
| Multiple | 3.6% |
| Other | 2.5% |
| Missing | N = 1732 |
| Non-Hispanic | 94.0% |
| Hispanic | 6.0% |
| Missing | N = 1631 |
| High school education or less | 25.0% |
| Some college | 43.7% |
| Graduated College | 18.4% |
| Post-college Degree | 12.9% |
| Missing | N = 23,114 |
| Income | |
| <\$20,000 | 22.0% |
| \$20,000-\$49,999 | 42.8% |
| \$50,000-\$74,999 | 19.0% |
| \$75,000-\$149,999 | 14.0% |
| \$150,000+ | 2.3% |
| Missing | N = 39,918 |
| Service Era | |
| Sept 2001 or later | 1.9% |
| Aug 1990 to Aug 2001 (GW) | 3.7% |
| May 1975 to July 1990 | 8.9% |
| Aug 1964 to April 1975 | 42.5% |
| Feb 1955 to July 1964 | 8.4% |
| July 1950 to January 1955 | 6.5% |
| Jan 1947 to June 1950 | 0.3% |
| Dec 1941 to Dec 1946 | 3.3% |
| Nov 1941 or earlier | 0.07% |
| Multiple | 24.6% |
| Missing | N = 83 |