Life's Simple 7 and Incidence of Diabetes Among American Indians: The Strong Heart Family Study

Amanda M. Fretts,[1,2]
Barbara V. Howard,[3,4]
Barbara McKnight,[2,5] Glen E. Duncan,[1]
Shirley A.A. Beresford,[1] Mihriye Mete,[3]
Ying Zhang,[6] and David S. Siscovick[1,2,7]

OBJECTIVE

The American Heart Association's recommendations for optimal health, summarized in Life's Simple 7, have been associated with reduced risk of cardiovascular disease (CVD)-related end points, but no studies have examined the association of these goals with incident type 2 diabetes, which is associated with high risk for CVD. The purpose of this analysis was to examine the associations of Life's Simple 7 goals with incident diabetes among American Indians, a population at high risk of cardiometabolic diseases.

RESEARCH DESIGN AND METHODS

Strong Heart Family Study participants without diabetes (*n* = 1,639) at baseline and who participated in a follow-up examination were included in the analysis. Risk scores ranging from 0 to 7 were created using physical activity, diet, BMI, smoking, blood pressure, fasting glucose, and cholesterol metrics in accordance with Life's Simple 7 goals. Diabetes was defined using 2003 American Diabetes Association criteria, including use of insulin or oral antidiabetes medication or a follow-up fasting plasma glucose level ≥126 mg/dL. Generalized estimating equations were used to examine the association of risk scores with incident diabetes.

RESULTS

During a mean 5-year follow-up (range 4–8 years), we identified 210 cases of incident type 2 diabetes. Compared with participants who achieved 0–1 goals, those who achieved 2–3 or 4+ goals had lower odds of diabetes, with odds ratios = 0.40 (95% CI 0.29–0.56) and 0.11 (95% CI 0.05–0.21), respectively.

CONCLUSIONS

The adoption of as few as two or three Life's Simple 7 goals is associated with a lower risk of diabetes.

[1]Department of Epidemiology, University of Washington, Seattle, WA
[2]Cardiovascular Health Research Unit, University of Washington, Seattle, WA
[3]MedStar Health Research Institute, Washington, DC
[4]Georgetown and Howard Universities Center for Clinical and Translational Research, Washington, DC
[5]Department of Biostatistics, University of Washington, Seattle, WA
[6]Center for American Indian Health Research, University of Oklahoma, Oklahoma City, OK
[7]Department of Medicine, University of Washington, Seattle, WA

Corresponding author: Amanda M. Fretts, amfretts@u.washington.edu.

The American Heart Association's (AHA's) Strategic Planning Task Force and Statistical Committee recently implemented 2020 Impact Goals for cardiovascular health promotion called Life's Simple 7 (1). These goals are based on the current understanding of modifiable risk factors for cardiovascular disease (CVD) and provide up-to-date goals for optimal cardiovascular health. The goals comprise four health behaviors and three health factors: a physically active lifestyle; healthy diet; healthy BMI; avoiding smoking; and lower blood pressure, fasting glucose, and total cholesterol (1). Current AHA guidelines recommend achieving the seven goals to

maintain optimal cardiovascular health. To date, several studies have examined the association of achievement of these goals with risk of CVD and other CVD-related end points, including kidney disease, depression, and mortality (2–5). However, no published studies have examined the association of the goals with incident diabetes, which is associated with high CVD risk (6).

The overarching goals of Life's Simple 7 are to improve the cardiovascular health profiles of all Americans and reduce deaths from CVD by 20% by 2020 (1). Moreover, the Life's Simple 7 strategic plan highlights racial disparities in cardiovascular health in the U.S. and emphasizes the importance of promoting Life's Simple 7 in minority populations. Although diabetes is a leading risk factor for CVD and mortality for all Americans, the burden of diabetes in American Indian (AI) communities is particularly troubling (7). AIs are 2.5 times more likely to have diabetes than non-Hispanic whites of similar age (8). In the Strong Heart Family Study (SHFS), the prevalence of diabetes among AIs (median age 37 years) was 31% in 2009. Additionally, as in other ethnic groups, obesity, physical inactivity, poor diet, and smoking are common in AI communities (9,10). Previous studies in primarily white populations have shown that a low-risk cardiometabolic health profile, including regular physical activity, a healthy diet, abstinence from smoking, moderate alcohol use, and a healthy BMI, is associated with a lower risk of diabetes (11–13). However, many of these behaviors are largely culturally determined (14,15), and the generalizability of the findings to other ethnic groups with high rates of obesity and diabetes remains unclear. Thus we examined the combined effect of a low-risk health profile on diabetes risk among AIs, a population with high rates of diabetes and CVD.

The purpose of this analysis was to examine the associations of low-risk health behaviors and factors, as defined using the Life's Simple 7 goals, with incident type 2 diabetes among AIs who participated in the SHFS. The SHFS offers a unique opportunity to assess the relationship of the Life's Simple 7 goals with incident diabetes because of its large size and availability of rigorously collected risk factors and outcome measures.

RESEARCH DESIGN AND METHODS

The SHFS is a population-based longitudinal study of the genetic, metabolic, and behavioral risk factors for CVD in 13 AI communities in Arizona, North Dakota, South Dakota, and Oklahoma. The SHFS included two examinations over an 8-year period (2001–2009). Both exams included a standardized personal interview, physical examination, medication review, laboratory testing, and a 1-week pedometer log for ascertaining physical activity levels. Details of the study design and measurements have been described previously (10,16–19). The institutional review boards from each Indian Health Service region and all 13 communities approved the study, and written informed consent was obtained from all participants at each exam.

There were 2,458 SHFS participants who did not have diabetes at the baseline examination in 2001–2003 and had a follow-up examination in 2007–2009. We excluded those with a history of myocardial infarction, stroke, or heart failure or who were currently pregnant (n = 115) at baseline, because these conditions may influence other health behaviors, such as diet or physical activity. Participants missing baseline glucose measures, family information, physical activity data, smoking information, or BMI measures or who were <18 or ≥75 years old were also excluded (n = 472). Finally, participants with missing or implausible dietary measures, as previously defined (10), were excluded (n = 232). In total, 1,639 persons comprised the study population. SHFS participants excluded from the analytic sample due to loss to follow-up or missing data were less likely to be female (54 vs. 63%) but otherwise similar to those included in the analytic sample.

Classification of Low Risk

A low-risk score was defined using established criteria for physical activity, diet, smoking, BMI, cholesterol, blood pressure, and fasting glucose. Specifically, we categorized participants based on 1) physical activity (ideal [accumulated 10,000+ steps/day], intermediate [accumulated 3,500–10,000 steps/day], poor [accumulated <3,500 steps/day]), 2) diet (ideal [achieved 4–5 dietary components], intermediate [achieved 2–3 dietary components], poor [achieved 0–1 dietary component]), 3) BMI (ideal [<25 kg/m^2], intermediate [25 to <30 kg/m^2], poor [30+ kg/m^2]), 4) smoking (ideal [never or quit >12 months], intermediate [former ≤12 months], poor [current]), 5) cholesterol (ideal [<200 mg/dL without medication], intermediate [200–239 mg/dL or treated to <200 mg/dL], poor [≥240 mg/dL]), 6) blood pressure (ideal [<120/<80 mmHg, without medication], intermediate [systolic blood pressure (SBP) 120–139 mmHg or diastolic blood pressure (DBP) 80–89 mmHg or treated to <120/<80 mmHg], poor [SBP ≥140 mmHg or DBP ≥90 mmHg]), and 7) fasting glucose (ideal [<100 mg/dL, without medication], intermediate [100–125 mg/dL or treated to <100 mg/dL], poor [not applicable by design since participants with diabetes at baseline were excluded from analyses]). Aside from the physical activity metric, the above classifications are taken directly from the Life's Simple 7 impact goals (1). The Life's Simple 7 goals classify physical activity levels based on total activity time (minutes per day), but in the SHFS, physical activity was assessed with pedometers (steps per day). As several studies suggest that individuals who accumulate at least 10,000 steps per day have a decreased risk of obesity and hypertension and better glucose tolerance and lipid profiles compared with individuals who accumulate fewer steps per day (20–24), accumulation of 10,000+ steps per day was considered an ideal level of activity.

We created a composite metric of low-risk cardiovascular health status based on achievement of "ideal" status for each of the individual health metrics. Although the Life's Simple 7 only consider individuals who achieve "ideal" status for all 7 health metrics as "low risk," we chose categorization of 0–1, 2–3, and 4+ for the composite to most closely represent the distribution of below average, average, and above average goal achievement in the SHFS population and to be consistent with the three-tiered classification scheme for the individual health metrics.

Diabetes

Incident diabetes was defined using 2003 American Diabetes Association criteria, including use of insulin or oral antidiabetes medication or with a fasting plasma glucose level ≥126 mg/dL at

the second exam. Because type 1 diabetes is rare in AI populations and all SHFS participants were at least 18 years of age at baseline, we assumed that all new occurrences of diabetes were type 2.

To account for potential correlation between members of the same family within the data, generalized estimating equations with an independence working correlation structure and sandwich SEs were used to examine whether achievement of 0–1, 2–3, or 4+ goals was associated with diabetes risk (25). Additionally, we examined whether achievement of the health behavior goals (0–1 vs. 2+), health factor goals (0–1 vs. 2+), or individual health behavior or health factor goals (poor vs. intermediate or ideal) influenced diabetes risk. Odds ratios (ORs; 95% CI) were calculated comparing participants who achieved 2–3 or 4+ goals (or 2+ goals for the health behaviors or health factors analyses), using those who achieved 0–1 goals as the referent group. For the analyses of the individual goals, ORs (95% CI) were calculated comparing participants who achieved "intermediate" or "ideal" status, using those with "poor" status as the referent group. All models were adjusted for a priori confounders, including age, sex, site, education, and family history of diabetes. Because the associations of goal achievement with diabetes risk may differ by sex or age, we examined the interaction of each goal (and the combined goals) with sex and age on risk of diabetes. Wald's tests were used to evaluate the statistical significance of the multiplicative interaction term in each model. As the association of the Life's Simple 7 goals and diabetes risk may differ among older versus younger individuals, we stratified the analyses at the median age in sensitivity analyses. All statistical analyses were conducted using STATA version 9.0 (Stata Corp., College Station, TX).

RESULTS

Of the 1,639 SHFS participants who comprised the analytic cohort, 63% were women, and the mean age at the baseline examination was 38 years. Table 1 describes the distribution of goal achievement for study participants. There were 71% of participants with cholesterol levels <200 mg/dL without

medication and 40% of participants with blood pressure less than <120/80 without medication at the baseline exam. Additionally, 57% of study participants were classified as never smokers or quit at least 12 months ago. There were 18% of participants with BMI <25 and 12% of study participants who accumulated 10,000+ steps per day. No study participants achieved 4+ dietary guidelines based on the Life's Simple 7 dietary criteria. In total, 25% of participants achieved 4+ of the 7 Life's Simple 7 goals and 16% of participants achieved only 0–1 goals. Achievement of each Life's Simple 7 goal was only modestly correlated with diabetes; the Spearman correlation coefficient for achievement of the fasting glucose goal and diabetes was −0.33, while the correlation coefficients of all other individual goals with diabetes were small (less than 0.15 in absolute values [data not shown]).

During a mean follow-up of 5 years (range 4–8 years), 210 participants developed diabetes. The ORs of diabetes according to the number of low-risk health metrics the participants achieved at baseline are shown in Table 2. Compared with participants who achieved 0–1 goals, participants who achieved 2–3 goals or 4+ goals had a lower risk of diabetes, with OR = 0.40 (95% CI 0.29–0.56) and OR = 0.11 (0.05–0.21), respectively. The lower risk of diabetes was attributable to both health behaviors

(OR comparing participants who achieved 2+ to 0–1 health behavior goals = 0.54 [95% CI 0.32–0.92]) and health factors (OR comparing participants who achieved 2+ to 0–1 health factor goals = 0.26 (95% CI 0.19–0.37]).

In general, participants were more likely to achieve the health factor goals than the health behavior goals. More than 70% of study participants achieved the fasting glucose and total cholesterol goals, while less than 20% achieved the BMI, physical activity, or dietary goals. The ORs of diabetes comparing levels of the individual health metrics are shown in Table 3. Lower BMI was associated with lower odds of developing diabetes. Comparing the ideal category (BMI <25 kg/m^2) to the poor category (BMI 30+ kg/m^2), the OR was 0.12 (95% CI 0.05–0.30). In addition, higher levels of physical activity and lower levels of blood pressure were associated with lower odds of diabetes. Contrasting the intermediate or ideal activity categories with the poor category for accumulated steps per day, the ORs for diabetes were 0.73 (95% CI 0.52–0.98) and 0.65 (95% CI 0.38–1.11), respectively. For blood pressure, compared with participants with poor blood pressure (SBP ≥140 mmHg or DBP ≥90 mmHg), participants with ideal blood pressure (<120/<80 mmHg without medication) had a lower odds of developing diabetes (OR = 0.42 [95% CI 0.26–0.69]). Because the outcome of interest for this analysis was

Table 1—Distribution of low-risk health metrics among 1,639 SHFS participants aged 18–74 years free of CVD and diabetes

	n (%)
Low-risk health behaviors	
Physical activity (accumulate at least 10,000+ steps/day)	203 (12.4)
Healthy diet (achieve at 4+ of the 5 AHA's Life's Simple 7 dietary goals)*	0*
Dietary goals	
4.5+ cups fruits and vegetables/day	62 (3.8)
2+ 3.5 oz. servings of fish/week	6 (<1)
3+ servings of whole grains/day†	15 (<1)
<1,500 mg sodium/day	226 (13.8)
<36 oz. (450 calories/week) of sugar-sweetened beverages/week	476 (29.0)
BMI (<25 kg/m^2)	287 (17.5)
Smoking (never or quit >12 months)	931 (56.7)
Low-risk health factors	
Total cholesterol (<200 mg/dL without medication)	1,158 (70.7)
Blood pressure (<120/<80 mmHg without medication)	649 (39.6)
Fasting glucose (<100 mg/dL without medication)	1,185 (72.2)

*92% of SHFS participants met 0–1 dietary goal, and 8% of participants met 2 dietary goals.
†Whole-grain intake was estimated from a food frequency questionnaire using the criterion that whole grains contain ≥1.1 g fiber per 10 g carbohydrate.

Table 2—ORs of diabetes according to number of low-risk health metrics achieved among 1,639 SHFS participants aged 18–74 years

	No. cases	No. at risk	Unadjusted OR (95% CI)	OR (95% CI)†
Number of total low-risk metrics achieved‡				
0–1	66	264	1.00	1.00
2–3	128	972	0.45 (0.33–0.63)	0.40 (0.29–0.56)
4+	16	403	0.12 (0.07–0.23)	0.11 (0.05–0.21)
Number of low-risk health behaviors achieved§				
0–1	193	1,401	1.00	1.00
2+	17	238	0.48 (0.29–0.80)	0.54 (0.32–0.92)
Number of low-risk health factors achieved‖				
0–1	129	591	1.00	1.00
2+	81	1,048	0.30 (0.22–0.40)	0.26 (0.19–0.37)

Total low-risk health metrics achieved, number of low-risk health metrics achieved, and number of low-risk health factors achieved represent independent regression models. †Model includes age, sex, site, education (years), and family history of diabetes. ‡Includes all Life's Simple 7 goals, including achievement of physical activity, diet, BMI, smoking, total cholesterol, fasting glucose, and blood pressure goals. §Includes only health behavior goals, including achievement of physical activity, diet, smoking, and BMI goals. ‖Includes only health factor goals, including achievement of total cholesterol, fasting glucose, and blood pressure goals.

incident diabetes, participants with poor levels of fasting glucose at baseline (≥126 mg/dL) were excluded by design. However, compared with participants with intermediate fasting glucose (100–125 mg/dL), participants with ideal fasting glucose (<100 mg/dL) had a lower odds of developing diabetes: OR = 0.14 (95% CI 0.10–0.20). We found no association of diet, smoking, or total cholesterol with diabetes risk (Table 3).

In secondary analyses, modeling the Life's Simple 7 risk score linearly (0–7 goals achieved) did not materially alter reported ORs (data not shown). There were also no statistically significant interactions of each health metric with sex

Table 3—ORs of diabetes according to Life's Simple 7 metrics among 1,639 SHFS participants aged 18–74 years

	No. cases	No. at risk	Unadjusted OR (95% CI)	Adjusted OR (95% CI)†
Physical activity				
Poor, <3,500 steps/day	73	430	1.00	1.00
Intermediate, 3,500–9,999 steps/day	117	1,006	0.64 (0.46–0.90)	0.73 (0.52–0.98)
Ideal, 10,000+ steps/day	20	203	0.53 (0.32–0.90)	0.65 (0.38–1.11)
Healthy diet score				
Poor, 0–1 component	192	1,506	1.00	1.00
Intermediate, 2–3 components	18	133	1.07 (0.62–1.86)	1.02 (0.59–1.79)
Ideal, 4–5 components	0	0	N/A	N/A
BMI				
Poor, 30+ kg/m^2	172	910	1.00	1.00
Intermediate, 25 to <30 kg/m^2	31	442	0.32 (0.21–0.51)	0.33 (0.21–0.52)
Ideal, <25 kg/m^2	7	287	0.11 (0.04–0.26)	0.12 (0.05–0.30)
Smoking				
Poor, current	69	644	1.00	1.00
Intermediate, former ≤12 months	5	65	0.69 (0.26–1.85)	0.74 (0.27–2.01)
Ideal, never or quit >12 months	136	930	1.43 (0.96–1.95)	1.25 (0.92–1.68)
Total cholesterol				
Poor, ≥240 mg/dL	15	103	1.00	1.00
Intermediate, 200–239 mg/dL or treated to <200 mg/dL	54	378	0.98 (0.55–1.73)	0.96 (0.53–1.73)
Ideal, <200 mg/dL without medication	141	1,158	0.81 (0.47–1.40)	0.79 (0.46–1.32)
Blood pressure				
Poor, SBP ≥140 mmHg or DBP ≥90 mmHg	51	273	1.00	1.00
Intermediate, SBP 120–139 mmHg or DBP 80–89 mmHg or treated to <120/<80 mmHg	103	717	0.73 (0.53–1.00)	0.75 (0.52–1.08)
Ideal, <120/<80 mmHg without medication	56	649	0.41 (0.28–0.61)	0.42 (0.26–0.69)
Fasting serum glucose				
Poor, ≥126 mg/dL	0	0	N/A by design	N/A by design
Intermediate, 100–125 mg/dL or treated to <100 mg/dL	138	454	1.00	1.00
Ideal, <100 mg/dL without medication	72	1,185	0.15 (0.11–0.20)	0.14 (0.10–0.20)

Each health behavior or factor represents an independent regression model. N/A, not applicable. †Each adjusted model includes age, sex, site, education (years), and family history of diabetes.

when assessing risk of diabetes (data not shown). In sensitivity analyses, omitting fasting glucose from the combined health metrics and the health factors analyses slightly attenuated reported ORs, while omitting BMI from the health behaviors analysis largely attenuated the observed association (data not shown). Associations of the Life's Simple 7 goals with diabetes incidence were similar in analyses stratified by median age (data not shown).

CONCLUSIONS

Participants who achieved at least two of the Life's Simple 7 goals had a lower risk of diabetes than participants who met one or none of these criteria. This effect was graded across the metrics where participants achieving 2–3 or 4+ goals had a 60% and 89% lower risk of diabetes when compared with participants who only achieved 0–1 goals. When the health behaviors and health factors were examined separately, both were associated with diabetes risk. However, the association of health factors with diabetes was largely explained by differences in baseline fasting glucose.

Although no participants achieved all seven goals, goal achievement was similar to that in other cohort studies and the National Health and Nutrition Examination Survey (2–5,26–29). The health factors goals were more likely to be achieved than the health behaviors goals, and the dietary goal was the least likely to be achieved. Developing strategies to encourage the American population to achieve optimal diet, physical activity, and BMI remains a major challenge in cardiometabolic disease prevention efforts (30). More research is needed to better understand if the current Life's Simple 7 health behavior thresholds represent realistic health targets for the American population at large or if promoting less aggressive (or incremental) changes in health behaviors better stimulates behavioral change (31).

To our knowledge, this is the first study that has examined the association of low-risk health behaviors and factors with incident diabetes using Life's Simple 7 goals. The results of these analyses are comparable with two published observational studies that have examined the association of lifestyle factors and incident diabetes in other populations using different criteria. In the Nurse's Health Study and the Cardiovascular Health Study, participants with a healthy lifestyle—including physically active nonsmokers with low/moderate alcohol use and diets high in fiber and the ratio of polyunsaturated to saturated fat, and low in trans fat and glycemic load—had a 89% lower risk of developing diabetes when compared with less healthy study participants (11,12). Our results complement these studies and suggest that a healthier lifestyle and low-risk health factors are associated with a lower risk of diabetes among AIs.

In the present analyses, dietary factors were not associated with diabetes risk. Because 92% of the cohort achieved ≤2 of the core dietary goals and only 210 participants developed diabetes during follow-up, we had limited ability to adequately assess this relationship. Because we had no participants who met the criteria for ideal diet, and diet quality is a major determinant of diabetes risk (32,33), our results are likely an underestimation of the association of achievement of the Life's Simple 7 criteria and incidence of diabetes. Surprisingly, we found no association of smoking status with diabetes risk. However, as smoking in this population often involves intermittent smoking and rarely exceeds 10 cigarettes per day, we had limited ability to evaluate this association.

Strengths of this study include detailed information on health behaviors and factors for all study participants and 4–8 years of follow-up. Additionally, this is the only large multitribal longitudinal study of chronic disease among AIs. Although AIs have a particularly high burden of obesity and diabetes, the risk factors for diabetes are similar across ethnic groups, and we expect these findings to be generalizable to other populations with similar risk profiles. This study also has limitations. Although physical activity was assessed using an objective measurement tool, SHFS participants may have altered physical activity patterns during the days that the pedometer was worn. Additionally, food frequency questionnaire data are prone to measurement error. Physical activity, diet, smoking, BMI, fasting glucose, total cholesterol, and blood pressure may also be associated with other unmeasured behaviors, such as access to medical care, compliance with medical advice, and other unmeasured elements of behavior that likely influence diabetes risk. The Life's Simple 7 criteria comprise a crude additive scoring method based on achievement of 0–7 of the health behavior and factor goals; however, the magnitude of the association of each individual health behavior or metabolic factor is not the same, and the Life's Simple 7 scoring may oversimplify the association of the goals with diabetes risk (27). Finally, the Life's Simple 7 criteria were designed as a broad public health metric to promote cardiovascular health and prevent deaths from CVD. Although there is overlap between risk factors for CVD and diabetes (e.g., physical inactivity, diet, BMI, smoking, and fasting glucose), dyslipidemia and hypertension are more closely related to CVD than diabetes.

The results of this study suggest that achievement of as few as two or three of the Life's Simple 7 goals is associated with a lower risk of diabetes in AIs, an underserved group with a high risk of cardiometabolic diseases. This study adds to the growing body of evidence demonstrating the health benefits of achieving healthy lifestyle goals as summarized in the AHA Life's Simple 7 and specifically suggests the potential impact of achievement of a modest number of these goals on metabolic health.

Author Contributions. A.M.F. was responsible for developing the research question of interest, performing the literature review and data analysis for the project, as well as writing the manuscript. B.V.H. and D.S.S. were the senior investigators on the project and supervised all activities and aided in all aspects of the project, including development of the research question and writing the manuscript. B.M. was the biostatistician on the project and supervised the statistical methods of the paper as well as reviewed all drafts of the manuscript. G.E.D., S.A.A.B., M.M., and Y.Z. participated in all analyses and writing the manuscript. A.M.F. is the guarantor of this work and, as such, had full

access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

References

1. Lloyd-Jones DM, Hong Y, Labarthe D, et al.; American Heart Association Strategic Planning Task Force and Statistics Committee. Defining and setting national goals for cardiovascular health promotion and disease reduction: the American Heart Association's strategic Impact Goal through 2020 and beyond. Circulation 2010;121:586–613

2. Folsom AR, Yatsuya H, Nettleton JA, Lutsey PL, Cushman M, Rosamond WD; ARIC Study Investigators. Community prevalence of ideal cardiovascular health, by the American Heart Association definition, and relationship with cardiovascular disease incidence. J Am Coll Cardiol 2011;57:1690–1696

3. Kronish IM, Carson AP, Davidson KW, Muntner P, Safford MM. Depressive symptoms and cardiovascular health by the American Heart Association's definition in the Reasons for Geographic and Racial Differences in Stroke (REGARDS) study. PLoS ONE 2012;7:e52771

4. Kulshreshtha A, Vaccarino V, Judd SE, et al. Life's Simple 7 and risk of incident stroke: the reasons for geographic and racial differences in stroke study. Stroke 2013;44:1909–1914

5. Muntner P, Judd SE, Gao L, et al. Cardiovascular risk factors in CKD associate with both ESRD and mortality. J Am Soc Nephrol 2013;24:1159–1165

6. Howard BV, Magee MF. Diabetes and cardiovascular disease. Curr Atheroscler Rep 2000;2:476–481

7. Acton K, Burrows N, Wang J, et al.; Centers for Disease Control and Prevention (CDC). Diagnosed diabetes among American Indians and Alaska Natives aged <35 years—United States, 1994-2004. MMWR Morb Mortal Wkly Rep 2006;55:1201–1203

8. Acton K, Burrows N, Geiss L, et al.; Centers for Disease Control and Prevention (CDC). Diabetes prevalence among American Indians and Alaska Natives and the overall population—United States, 1994-2002. MMWR Morb Mortal Wkly Rep 2003;52:702–704

9. Fretts AM, Howard BV, Kriska AM, et al. Physical activity and incident diabetes in American Indians: the Strong Heart Study. Am J Epidemiol 2009;170:632–639

10. Fretts AM, Howard BV, McKnight B, et al. Associations of processed meat and unprocessed red meat intake with incident diabetes: the Strong Heart Family Study. Am J Clin Nutr 2012;95:752–758

11. Hu FB, Manson JE, Stampfer MJ, et al. Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. N Engl J Med 2001;345:790–797

12. Mozaffarian D, Kamineni A, Carnethon M, Djoussé L, Mukamal KJ, Siscovick D. Lifestyle risk factors and new-onset diabetes mellitus in older adults: the cardiovascular health study. Arch Intern Med 2009;169:798–807

13. Wing RR, Hamman RF, Bray GA, et al.; Diabetes Prevention Program Research Group. Achieving weight and activity goals among diabetes prevention program lifestyle participants. Obes Res 2004;12:1426–1434

14. Duncan GE, Goldberg J, Buchwald D, Wen Y, Henderson JA. Epidemiology of physical activity in American Indians in the Education and Research Towards Health cohort. Am J Prev Med 2009;37:488–494

15. Wolever T, Hamad S, Gittelsohn J, et al. Nutrient intake and food use in an Ojibwa-Cree Community in Northern Ontario assessed by 24h dietary recall. Nutr Res 1997;17:603–618

16. Howard BV, Welty TK, Fabsitz RR, et al. Risk factors for coronary heart disease in diabetic and nondiabetic Native Americans. The Strong Heart Study. Diabetes 1992;41(Suppl. 2):4–11

17. Lee ET, Welty TK, Fabsitz R, et al. The Strong Heart Study. A study of cardiovascular disease in American Indians: design and methods. Am J Epidemiol 1990;132:1141–1155

18. North KE, Howard BV, Welty TK, et al. Genetic and environmental contributions to cardiovascular disease risk in American Indians: the strong heart family study. Am J Epidemiol 2003;157:303–314

19. Storti KL, Arena VC, Barmada MM, et al. Physical activity levels in American-Indian adults: the Strong Heart Family Study. Am J Prev Med 2009;37:481–487

20. Tudor-Locke C, Bassett DR Jr. How many steps/day are enough? Preliminary pedometer indices for public health. Sports Med 2004;34:1–8

21. Swartz AM, Strath SJ, Bassett DR, et al. Increasing daily walking improves glucose tolerance in overweight women. Prev Med 2003;37:356–362

22. Sugiura H, Sugiura H, Kajima K, Mirbod SM, Iwata H, Matsuoka T. Effects of long-term moderate exercise and increase in number of daily steps on serum lipids in women: randomised controlled trial [ISRCTN21921919]. BMC Womens Health 2002;2:3

23. Tudor-Locke C, Ainsworth BE, Whitt MC, Thompson RW, Addy CL, Jones DA. The relationship between pedometer-determined ambulatory activity and body composition variables. Int J Obes Relat Metab Disord 2001;25:1571–1578

24. Moreau KL, Degarmo R, Langley J, et al. Increasing daily walking lowers blood pressure in postmenopausal women. Med Sci Sports Exerc 2001;33:1825–1831

25. Diggle P, Heagerty P, Liang K-Y, et al. *Analysis of Longitudunal Data*. Oxford, Oxford University Press, 2013

26. Shay CM, Ning HY, Allen NB, et al. Status of cardiovascular health in US adults: prevalence estimates from the National Health and Nutrition Examination Surveys (NHANES) 2003-2008. Circulation 2012;125:45–56

27. Dong CH, Rundek T, Wright CB, Anwar Z, Elkind MS, Sacco RL. Ideal cardiovascular health predicts lower risks of myocardial infarction, stroke, and vascular death across whites, blacks, and Hispanics: the Northern Manhattan Study. Circulation 2012;125:2975–2984

28. Yang QH, Cogswell ME, Flanders WD, et al. Trends in cardiovascular health metrics and associations with all-cause and CVD mortality among US adults. JAMA 2012;307:1273–1283

29. Bambs C, Kip KE, Dinga A, Mulukutla SR, Aiyer AN, Reis SE. Low prevalence of "ideal cardiovascular health" in a community-based population: the heart strategies concentrating on risk evaluation (Heart SCORE) study. Circulation 2011;123:850–857

30. Marteau TM, Hollands GJ, Fletcher PC. Changing human behavior to prevent disease: the importance of targeting automatic processes. Science 2012;337:1492–1495

31. Golay A, Brock E, Gabriel R, et al. Taking small steps towards targets - perspectives for clinical practice in diabetes, cardiometabolic disorders and beyond. Int J Clin Pract 2013;67:322–332

32. van Dam RM, Rimm EB, Willett WC, Stampfer MJ, Hu FB. Dietary patterns and risk for type 2 diabetes mellitus in U.S. men. Ann Intern Med 2002;136:201–209

33. Fung TT, Schulze M, Manson JE, Willett WC, Hu FB. Dietary patterns, meat intake, and the risk of type 2 diabetes in women. Arch Intern Med 2004;164:2235–2240