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Association of Prevalent Stroke with Life's Simple Seven Score: Reasons for Geographic and Racial Differences

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William McClellan, MD, MPH
Committee Chair

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By

Zhi Cheng

Bachelor of Medicine
Capital Medical University
2010

Thesis Committee Chair: William McClellan, MD, MPH

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Epidemiology
2012

Abstract

Association of Prevalent Stroke with Life's Simple Seven Score: Reasons for Geographic and Racial Differences

By Zhi Cheng

Context: The American Heart Association's (AHA) Life's Simple 7 (LSS) metric includes biological (body mass index, blood pressure, cholesterol, and glucose) and behavioral (cigarette smoking, physical activity, diet, and body mass index) risk factors for cardiovascular disease.

Objective: Determine whether LSS scores differ among those with and without self-reported prevalent stroke among REGARDS participants and if the association between self-reported stroke and LSS score varies by race among REGARDS participants.

Design, Setting, and Participants: We included 24,795 participants without history of cardiovascular disease from the population-based REasons for Geographic and Racial Differences in Stroke (REGARDS) study (n=30,221). Data for LSS was collected by telephone, mail questionnaires and an in-home exam. Each of LSS components was assessed at baseline and categorized as being poor (0 point), intermediate (1 points) or ideal (2 points).An overall LSS score was categorized as optimum (10-14), average (5-9) and inadequate (0-4) cardiovascular health. Polytomous Logistic regression was to model LSS score categories with prevalence of stroke.

Results: There were 24,795 subjects with data on LSS and no past or prevalent history of CHD. In the baseline, there was 1278 self-reported stroke. Cardiovascular health categories were associated with prevalent stroke in a grade fashion. After controlling for age, race, sex, income, region, and education, people without stroke was 3 times more likely to have optimum Cardiovascular health (OR=3.21, 95%CI=2.46, 4.20) and 1.7 times likely to have average Cardiovascular health compared to individuals with stroke. (OR=1.65, 95%CI= (1.42, 1.91)) Race did not has effect modification on the association was found. (P-value=0.20)

Conclusions: In both blacks and white, prevalent stroke is related to poorer cardiovascular health based on LSS score and we need to improve it through a multiple intervention with health behaviors and risk factors.

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From the graduate student of the Rollins School of Public Health: Dr. Ambar Kulshreshtha

And most of all, thank you to my family and my friends who supported and encouraged me all the way.

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Introduction

Stroke is the fourth most common cause of death in United States, if considered separately from other cardiovascular diseases.[1] The overall prevalence of stroke is around 3.0%, the prevalence among blacks (4.0%) is higher than the prevalence among whites (2.4%). Around 795,000 people experience a new or recurrent stroke every year. [1] Stroke also results in substantial health care expenditures; the mean lifetime cost resulting from an ischemic stroke is estimated at $140,000per patient. In 2007, the estimated direct medical cost of stroke is $25.2 billion, which includes hospital outpatient or emergency room visits, prescribed medicines, and home health[2].

Although stroke has high prevalence, heavy burden of disability and economic cost, stroke is preventable with a multidisciplinary strategy that identifies and manages stroke risk factors, which include life style and health factors.[3] A previous cohort study showed that a low-risk lifestyle including moderate exercise (>=30min/d), not smoking, proper Body Mass Index (<25km/m^2) and modest alcohol consumption (5-30g/d for men, 5-15g/d for women) can reduce the risk of ischemic stroke by about 70% and 80% among men and women.[4] Collins et al demonstrated that statin therapy, which could reduce total cholesterol, rapidly reduces the incidence not only of coronary events but also of ischemic strokes, with no apparent effect on cerebral hemorrhage, even among individuals who do not have high cholesterol concentrations.[5] Another study found that even a small blood pressure reduction (5 to 6 mmHg systolic, 2 to 3 mmHg diastolic) would lead to 40% fewer strokes.[6] The treatment and lowering of blood pressure among hypertensive individuals was associated with a significant reduction in stroke risk,[7] and it is equally important in secondary prevention. [8] Other studies showed that even elder patients (more than 80 year-old) with isolated systolic hypertension benefit from antihypertensive therapy.[9-11]

The American Heart Association (AHA) in 2010 proposed Life's Simple Seven (LSS) score to monitor the prevalence of ideal cardiovascular health in the US population. [12]. The LSS score is based on three health factors (blood sugar, serum cholesterol, blood pressure) and four health behaviors (BMI, physical activity, diet and cigarette smoking), which play an critical role in prevention of both primary and secondary stroke events.[13]. Each component is categorized into ideal, intermediate, and poor levels as proposed by AHA. (Table 1) A previous study showed that the number of ideal cardiovascular health metrics is a strong predictor of mortality from all causes and disease of the circulatory system.[14]

However, the extent to which modification of self-reported risk behaviors and factors differs among stroke survivors from that of the general population is unclear. Recently, a prospective cohort study of Redfern et al showed that at 1 year after stroke, 36% of 169 stroke survivors who smoked before had given up completely and another 26% reported having reduced the amount smoked; 72% of 140 of those who drank heavily before their stroke, no longer drank more than the weekly limit. This suggests that stroke patients are likely to make lifestyle changes to reduce the risk of subsequent events.[15] In view of this it is reasonable to hypothesize that individuals who report having had a stroke would adopt a lifestyle aimed at reducing this risk.

Further, little is known about racial disparities in post-stroke risk factors and behaviors. The objectives of this study are to determine whether LSS scores differ among those with and without self-reported prevalent stroke among REGARDS participants. Further, we determine if the association between self-reported stroke and LSS score varies by race among REGARDS participants.

Methods

Participants

Participants were from REasons for Geographic and Racial Differences in Stroke (REGARDS) study is a national longitudinal cohort study to investigate stroke incidence of 30,221 African-American and European American individuals aged 45 years and older between January 2003 and October 2007.[16]

Race was defined by self-report and Hispanics and Latinos were excluded. Residents from the Southern US states, commonly referred to as the "stroke buckle" (coastal North Carolina, South Carolina, and Georgia) and "stroke belt" (remainder of North Carolina, South Carolina, and Georgia as well as Alabama, Mississippi, Tennessee, Arkansas and Louisiana) were over-sampled and represent 21% and 35% of the cohort with the remaining 44% of participants recruited from other 48 contiguous United States. Within each region, after stratification by race and gender, individuals were recruited from commercially available lists through an initial mailing followed by telephone contacts. The telephone response rate was 33% and the cooperation rate was 49%.[17] Demographic information and medical history were obtained by computer-assisted telephone interview.[18]

We included participants who have data on hypertension, cholesterol, diabetes, BMI, smoking, diet and physical activity (n=30,221). Participants who had a prevalent or past history of CHD (n=5,314) were excluded. Excluding 112 missing values, our final sample size was 24,795. The REGARDS study protocol was approved by the Institutional Review Boards governing research in human subjects at the participating centers and all participants provided informed consents.

Data

Demographic information and medical history were obtained by computer-assisted telephone interview, a self-administered questionnaire and an in-home examination. Information on participants' demographics, cigarette smoking, physical activity, assessment of socio-economic status (attained education and income) and were obtained by trained interviewers by telephone.

Physical measures were collected at in-home examinations, including height, weight, and waist circumference, blood pressure, and blood samples. At the end of the in-home examination, the Block 98 Food Frequency Questionnaire (FFQ) was provided to the participants for self-administration.[19,20] Each participant recorded food intake for one year prior to their in-home visit by FFQ. This form was mailed back to the REGARDS coordinating center for entry into a database by study personnel. Nutrient analysis was conducted by Nutrition Quest.

Study Exposure and Outcome

Self-reported stroke of physician diagnosis (prevalent stroke)

Self-reported stroke was derived from the CATI question "Were you ever told by a physician that you had a stroke".

Life's Simple 7

The LSS score was proposed by the American Heart/Stroke Association in 2010 and is based on three health factors (blood sugar, serum cholesterol, blood pressure) and four health behaviors (BMI, physical activity, diet and cigarette smoking).

These components are categorized as being poor, intermediate or ideal (Table1).Current and former smoking and time duration for smoking cessation for former smokers were investigated by questions followed: "Have you smoked at least 100 cigarettes in your lifetime?", "Do you smoke cigarettes now, even occasionally?" and "How old were you when you stopped smoking?" Physical activity was obtained through a single question "How many times per week do you engage in intense physical activity, enough to work up a sweat?"

Height and weight were assessed using calibrated equipment and body mass index was calculated. Systolic and diastolic blood pressure was measured two times following a standardized protocol using aneroid sphygmomanometers. The two BP measurements were averaged for the current analyses. The diet score for LSS was based on fish and fruit and vegetable consumption and sodium, sugar, and fiber/carbohydrate ratio intake. An ideal diet was defined by the following 5 factors: fish consumption ≥ 2 servings/week, fruit/vegetables ≥ 4.5 cups/day, sodium intake < 1500 mg/day, sugar < 450 kcal/week, and fiber/carbohydrate ratio >0.1. Total cholesterol was measured using an enzymatic reaction. Glucose was captured in serum using colorimetric reflectance spectrophotometry.

The LSS does not accumulate these seven components into an overall score, so we categorized each component equally into a sum score assigning 2, 1 or 0 points respectively to ideal, intermediate or poor status. (Table1) Those with the highest number of points are therefore in ideal health. An overall LSS score was categorized evenly as: Optimum (10-14), average (5-9) and inadequate (0-4) cardiovascular health.

Statistical Analysis

Descriptive analysis with means and proportions was used to access baseline characteristics and test differences by stroke status by t-test and chi-square test. The percentage of each level of each component of health metrics of LSS by stroke status in each component was tested by chi-square test.

For the analysis, stroke status and LSS was examined in several ways. First, we examined the distribution of LSS scores in those with and without a stroke history using both t-test and the Mann-Whitney U test. We then obtained crude odds ratios and 95%

confidence intervals for the association between stroke status and LSS with Inadequate (10-14) score group as reference group. (Table4)

Multivariate ordinal logistic regression with the proportional-odds model was used to determine the independent association between stroke status (dependent variable) and LSS score (independent variable), with Inadequate group as reference group and adjusting for age, race, sex, family history of CVD, socioeconomic status and region. The proportional odds assumption was tested and the score test for the proportional odds assumption was used.

In addition, the association between LSS and stroke status was described by general linear model (GLM) using LSS as dependent variable, measured the mean overall score by stroke status, adjusting for age, race, sex, family history, socioeconomic status and region. Next we repeated these analyses stratifying by race and determine whether race was an effect modifier, after controlling for other potential confounders, by adding an interaction between race and LSS scores.

SAS 9.3 will be used for all analysis.

Results

There were 24,795 subjects with data on LSS and no past or prevalent history of CHD. Mean age is 68 year old, 45% were men and 54% were black. Baseline socioeconomic and demographic factors for LSS categories by stroke status are presented in Table2 and Table3. In baseline, there was 1278 self-reported stroke. Participants with self-reported stroke had significant elder age, greater proportion of men and African American, self-reported Hypertension and Diabetic Mellitus, lower education and lower income. Only Geographic region were similar among the two groups. Mean [SD] for LSS score was 7.10 [2.17] for overall (Figure1); 6.30 [2.11] for stroke and 7.15 [2.16] for non-stroke participants (Figure 2). ($p<0.01$)

The distribution of LSS categories was significantly differed based on stroke status, only Body Mass Index is similar within two groups ($p=0.56$). Non-stroke participants had higher proportion of people in optimum category compared to those stroke participants. The LSS scores distributed varied widely by components. For example, for smoking around 84% participants are ideal (never smoked or quit >12 months) but almost none of them reached ideal level of diet, which is 4-5 components of the healthy diet component. Other proportion of ideal level was fasting glucose (63%), cholesterol (38%), physical activity (30%), BMI (25%) and blood pressure (19%) (Table3).

The proportional odds assumption was tested by score test, but the proportional odds assumption was not met. (P-value=0.04) Thus, Polytomous Logistic regression was to model LSS score categories with prevalence of stroke. Cardiovascular health categories were associated with prevalent stroke in a grade fashion. People without stroke was 4 times more likely to have optimum Cardiovascular health (OR=4.31, 95%CI=3.32, 5.59) and 1.8 times likely to have average Cardiovascular health compared to individuals with stroke (OR=1.83, 95%CI=1.59, 2.11) The association was slightly lower after controlling for age, race, sex, income, region, and education, which is 3.21[2.46, 4.20] and 1.65[1.42, 1.91], respectively. The association was found to be similar between races. (p=0.20)

Discussion

Stroke is a medical emergency and can cause permanent neurological damage, complications and death. To confront this this challenge, AHA developed LSS metric to monitor the prevalence of ideal cardiovascular health in the US population. In defining cardiovascular health, the 7 biological risk factors and health behaviors each met several criteria considered by the committee including being associated with a reduced risk for cardiovascular disease and being consistent with current clinical and public health guidelines. Considering the low rate of ideal cardiovascular health among US adults, the committee decided to focus on improvements in cardiovascular health generally. They recommended that improvement in the cardiovascular health of all Americans by 20% by 2020.

Several studies showed that improvements in a single health behavior or health factor in LSS could result in reduction of stroke and increase the number of ideal cardiovascular health factors can lower CVD and all-cause mortality. [14,21] In a recent cohort study of 19.5-year follow-up, BMI being a risk factor for stroke was identified. Compared with normal-weight men (BMI, 18.5-24.9), lean (BMI, < 18.5), overweight (BMI, 25.0-29.9), and obese (BMI, ≥30.0) men were 0.74, 1.23 and 1.59 times to experience stroke. Among women, the corresponding hazard ratios were 1.87, 1.08 and 1.30 for total stroke.[22] Nutrition, specifically the Mediterranean-style diet, which is high in beneficial oils, whole grains, fruits, and vegetables and low in cholesterol and animal fat, has the potential for decreasing the risk of having a stroke by more than half.[23] The Women's Health Study demonstrated a dose-response relationship between level of leisure-time walking time and pace and risk of stroke, with higher levels of activity associated with 20% to 40% reduction in risk.[24] In Northern Manhattan Study (NOMAS), a prospective cohort that included white, black and Hispanic who were followed for a median of 9 years, baseline physical activity was associated with an overall 35% reduction in risk of ischemic stroke.[25] Towfighi et al found that regular exercise (>12times/month) and abstinence from smoking were independently associated with lower all-cause mortality after stroke. Combinations of health lifestyle factors were associated with lower all-cause and cardiovascular mortality in a dose dependent fashion.[26] Using LSS score as integrate cardiovascular health metrics; our result was consistent with previous studies and added weight to those conclusions.

Our study has several notable strengths. The sample is a large national population-based sample of black and white adults. Over-sampling of blacks was helpful to examine racial differences. Data collection in REGARDS is done using standardized questionnaire administration, a validated dietary questionnaire, anthropometrics, blood pressure measurements, and laboratory data collection. In addition, our study also highlights the differences in LSS scores across racial groups though the result was negative.

However, our research does have some limitations. The findings from the present analyses should be interpreted within the context of known and potential limitations. This is a cross-sectional study and thus we cannot assess causation between LSS and stroke. Additionally, we failed to control potential confounders such as family history of Cardiovascular diseases, which is proved to be associated with substantially increased prevalence of may risk factors.[27] Some of the components in Life Simple 7 such as smoking and diet are themselves risk factors for other components like hypertension and diabetes, which would dilute the relationship in our study. Furthermore, data were not available on the LSS metrics for physical activity and diet score. As a result, modified definition of those health behaviors was used. Last but not the least, the cooperation rate during enrollment was 49%. Although, this cooperation rate is similar to other large national cohorts it may limit generalizability of the findings. Approximately one-third of REGARDS study participants did not return a FFQ and we used multiple imputations for these participants. However, the results were similar when these individuals were excluded in a sensitivity analysis.

In conclusion, in this large population-based sample of US adults, a healthier cardiovascular disease risk factor profile as defined and measured by the LSS metric was associated with a reduced prevalence for stroke. Our study also suggests no differences in LSS levels by race is vulnerable to having a poorer risk factor profile among people with better cardiovascular health. Our data also suggest that even modest differences in these health factors and behaviors may related to different status in stroke and would be critical to achieve AHA 2020 goals. Future studies are needed to determine the actual risk reduction benefit that can be achieved through a multiple intervention method to improve health behaviors and risk factors in a longitudinal study.

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Appendix

Table1: Definition and scoring of health factors and health behaviors in Life Simple Seven's (LSS)

Health Metric	Levels	Score *	Definition
Smoking	Ideal	2	Never or quit >12 months
	Intermediate	1	Former ≤12 months
	Poor	0	Current
Body mass index	Ideal	2	<25 kg/m^2
	Intermediate	1	25–29.99 kg/m^2
	Poor	0	≥30 kg/m^2
Physical activity*	Ideal	2	4 or more times per week of intense physical activity
	Intermediate	1	1-3 times per week of intense physical activity
	Poor	0	No physical activity
Healthy diet score†	Ideal	2	4–5 components
	Intermediate	1	2–3 components
	Poor	0	0–1 components
Total cholesterol	Ideal	2	<200 mg/dl, without medication
	Intermediate	1	200-239 mg/dl or treated to <200 mg/dl
	Poor	0	≥240 mg/dl
Blood pressure	Ideal	2	<120/<80 mm Hg, without medication
	Intermediate	1	SBP 120–139 or DBP 80–89 mm Hg or treated to <120/<80 mm Hg
	Poor	0	SBP ≥140 or DBP ≥90 mm Hg
Fasting serum glucose	Ideal	2	<100 mg/dl, without medication
	Intermediate	1	100–125 mg/dl or treated to <100 mg/dl
	Poor	0	≥126 mg/dl
Overall CVD Health Categories	Optimum	10-14	
	Average	5-9	
	Inadequate	0-4	

* Modified for REGARDS. Participants in REGARDS were asked, "How many times per week do you engage in intense physical activity, enough to work up a sweat?" We will define ideal physical activity as a frequency of 4 or more times per week, intermediate as 1-3 times per week, and poor as none.

† Modified for REGARDS. Responses to the Block FFQ will be used for the 'healthy diet score' that is based on how many components of the 5 diet goals are met. Responses to the Block FFQ will be used for the 'healthy diet score' that is based on how many components of the following 5 diet goals are met: Fruits and vegetables ≥ 4.5 cups/day; Fish 3.5 ounces ≥ 2 servings/week; Sodium <1500 mg/day; Sweets/sugar-sweetened beverages ≤ 450 kcal/week; Whole grains (1.1g of fiber in 10 gms of carbohydrates), 1-oz equivalent servings ≥ 3 services/day

Table2. Baseline Characteristics of Study Population

Table 2: Baseline characteristics of REGARDS study participants by stroke

	Stroke (n=1278)	Non-Stroke (n=23517)	P-value
Age (y) (mean[SD])	67.56(9.33)	63.89(9.29)	<.0001
Men (%)	44.91	41.40	.0131
African American (%)	54.46	42.05	<.0001
Education <12 years (%)	23.47	11.83	<.0001
Income <$20k (%)	30.28	16.52	<.0001
Geographic Region(Buckle)	19.22	20.98	.0661
Self-reported Diabetic Mellitus (%)	34.09	19.34	<.0001
Self-reported Hypertension (%)	78.59	53.92	<.0001

Table: 3 : Distribution of LSS components among REGARDS participants						
Health Metric		**Definition**	**Stroke** **No (%)**	**Yes(%)**	**Overall (%)**	**p-value**
Smoking	Ideal	Never or quit >12 months	84.10	78.56	83.74	<.0001
N=24,795	Intermediate	Former ≤12 months	1.86	2.58	1.96	
	Poor	Current	14.04	18.86	14.31	
Body mass index	Ideal	<25 kg/m^2	25.10	26.13	25.15	.5582
N=24,620	Intermediate	25–29.99 kg/m^2	36.68	37.05	36.69	
	Poor	≥30 kg/m^2	38.22	36.82	38.16	
Physical activity *	Ideal	4 or more times per week of intense physical activity	29.91	24.84	29.63	<.0001
N=24,428	Intermediate	1-3 times per week	37.30	28.75	36.84	
	Poor	No physical activity	32.78	46.41	33.53	
Healthy diet score †	Ideal	4–5 components	0.04	0	0.04	.0061
N=17,928	Intermediate	2–3 components	20.37	15.73	20.16	
	Poor	0–1 components	79.59	84.27	79.80	
Total cholesterol	Ideal	<200 mg/dl, without medication	37.96	34.00	37.75	.0021
N=23,857	Intermediate	200-239 mg/dl or treated to <200 mg/dl	49.81	55.03	50.11	
	Poor	≥240 mg/dl	12.24	10.97	12.14	
Blood pressure	Ideal	<120/<80 mm Hg, without medication	19.33	8.01	18.74	<.0001
N=24,727	Intermediate	SBP 120–139 or DBP 80–89 mm Hg or treated to <120/<80 mm Hg	58.99	62.32	59.13	
	Poor	SBP ≥140 or DBP ≥90 mm Hg	21.67	29.67	22.13	
Fasting Glucose	Ideal	<100 mg/dl, without medication	63.58	53.02	63.04	<.0001
N=20,694	Intermediate	100–125 mg/dl or treated to <100 mg/dl	26.60	30.42	26.82	
	Poor	≥126 mg/dl	9.82	16.56	10.13	
CVD Health	**Optimum**	**17-21**	14.20	5.95	13.73	<.0001
Categories	**Average**	**12-16**	74.35	73.40	74.26	
N=24,795	**Inadequate**	**<12**	11.44	20.66	12.00	

* modified for REGARDS. Participants in REGARDS were asked "How many times per week do you engage in intense physical activity, enough to work up a sweat?" We will define ideal

physical activity as a frequency of 4 or more times per week, intermediate as 1-3 times per week, and poor as none.

†modified for REGARDS. Responses to the Block FFQ will be used for the 'healthy diet score' that is based on how many components of the 5 diet goals are met. Responses to the Block FFQ will be used for the 'healthy diet score' that is based on how many components of the following 5 diet goals are met: Fruits and vegetables ≥ 4.5 cups/day; Fish 3.5 ounces ≥ 2 servings/week; Sodium <1500 mg/day; Sweets/sugar-sweetened beverages ≤ 450 kcal/week; Whole grains (1.1g of fiber in 10 gms of carbohydrates), 1-oz equivalent servings ≥ 3 services/day

Table4. Odds Ratio for stroke by levels of full LSS Score

Level	Crude OR	Adjusted OR
Optimum	4.31[3.32,5.59]	3.21[2.46, 4.20]
Average	1.83[1.59,2.11]	1.65[1.42,1.91]
Inadequate(Ref)	1.0	1.0

Figure 1: LSS score among REGARDS study participants

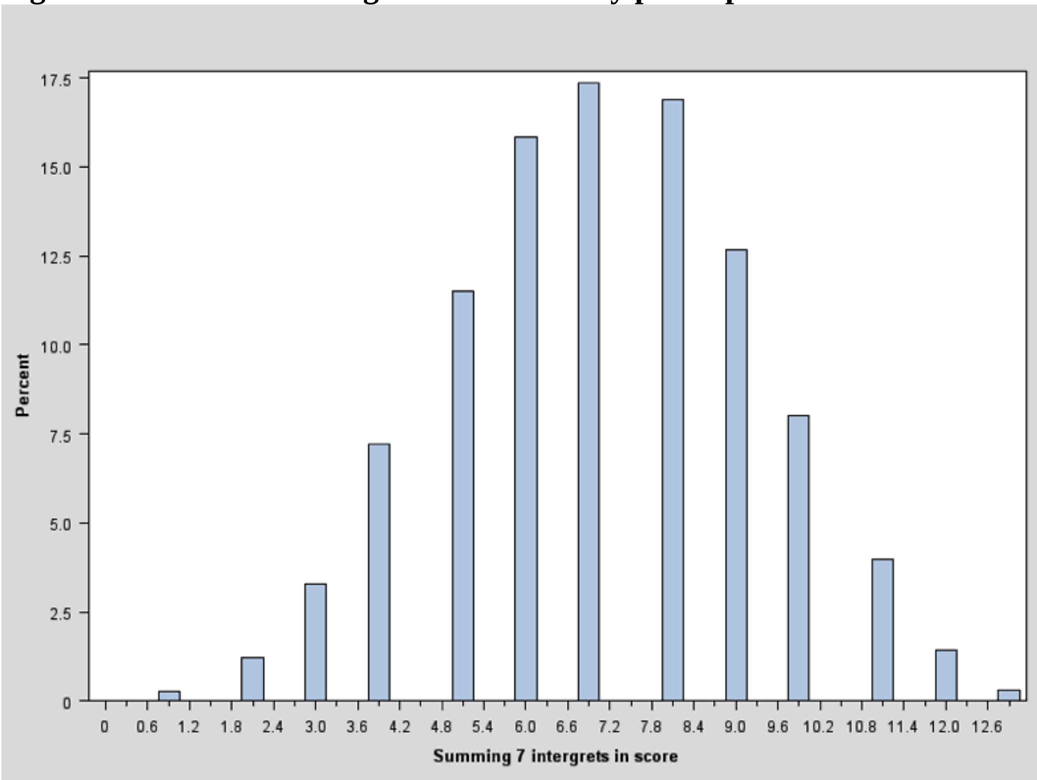

Figure 2: LSS score among REGARDS study participants