Relation of Lifestyle Factors and Life's Simple 7 Score to Temporal Reduction in Troponin Levels Measured by a High-Sensitivity Assay (From The Atherosclerosis Risk in Communities Study)

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Abstract

The impact of lifestyle-related factors on temporal decreases in high-sensitivity cardiac troponin T (hs-cTnT), possibly reflecting reversal of subclinical myocardial damage, has not been evaluated in a community-based setting. We measured hs-cTnT twice, 6 years apart, in 9,256 participants from the Atherosclerosis Risk in Communities (ARIC) Study who were free of baseline cardiovascular disease. We used Poisson and multinomial regression to evaluate the associations of cigarette smoking, alcohol consumption, body mass index (BMI), healthy diet score, physical activity, and Life's Simple 7 (LS7) score (a composite measure of lifestyle-related health factors) with 6-year decreases in hs-cTnT. Of the 3,017 persons with detectable baseline hs-cTnT (≥5ng/L), 2,418 (80%) remained detectable while 599 (20%) had undetectable levels (<5ng/L) at the 6-year follow-up visit. Persons with a BMI <30 kg/m^2, adherence to AHA physical activity guidelines and average or optimal LS7 score were more likely to improve from a detectable to undetectable hs-cTnT level during follow-up. There was a robust association between optimal LS7 Score and temporal hs-cTnT reduction (RR 1.64, 95% CI: 1.11, 2.42, for baseline ≥5ng/L and follow-up <5ng/L). A greater duration of exposure to average or optimal LS7 score was also

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associated with increased likelihood of temporal hs-cTnT reduction (p-trend<0.001). In conclusion, we found that lifestyle factors and the LS7 score were associated with reversal of subclinical myocardial damage. In conclusion, our results support the growing evidence that hs-cTnT levels change in response to lifestyle modifications and hs-cTnT may serve as a useful dynamic surrogate for monitoring cardiovascular risk.

Keywords

hs-cTnT; troponin; Life's Simple 7; lifestyle factors

Cardiac troponin is a standard biomarker used to diagnose myocardial infarction in with the setting of chest pain. New highly sensitive assays for cardiac troponin can detect concentrations 10-times lower than earlier assays, extending its potential utility to monitoring cardiovascular risk in asymptomatic populations (1). Previous studies have demonstrated that a significant proportion of healthy middle-aged adults have detectable cardiac troponin T using a highly sensitive assay (2). The presence of detectable high-sensitivity cardiac troponin T (hs-cTnT) is thought to reflect subclinical myocardial damage and has been shown to strongly predict cardiovascular morbidity and mortality (3,4). Moreover, temporal decreases in hs-cTnT demonstrate lower risk of cardiovascular events, relative to individuals with no significant change (4,5). Evidence suggests hypertension, obesity, and diabetes are important risk factors for temporal changes in hs-cTnT (6,7). Because these clinical risk factors are influenced by lifestyle, the impact of health behaviors on temporal decreases in hs-cTnT is of substantial clinical interest. Identifying modifiable lifestyle factors associated with temporal reductions in hs-cTnT has potential utility for monitoring the beneficial impacts of health behaviors on cardiovascular risk during the subclinical period. The primary objective of our study was to investigate the associations between lifestyle-related health behaviors and 6-year decreases in hs-cTnT.

Methods

The Atherosclerosis Risk in Communities (ARIC) Study is a community-based prospective cohort of 15,792 participants sampled from four U.S. Communities: Washington County, Maryland; Forsyth County, North Carolina; Jackson, Mississippi; and suburban Minneapolis, Minnesota. The study began in 1987 and recruited participants aged 45–64 years. Follow-up visits were conducted every three years until 1998; a fifth visit was recently completed between 2011 and 2013. The ARIC Study was approved by the local institutional review boards and written informed consent was obtained from all participants. Hs-cTnT was measured at both visits 2 (1990–1992) and 4 (1996–1998). Of the 14,348 individuals who attended visit 2 (baseline for the present study), we excluded individuals with prevalent coronary heart disease, stroke, or heart failure, missing baseline or follow-up hs-cTnT measurement, missing baseline exposure information, and those who are neither black nor white, leaving 9,256 participants in the final study population (see Supplemental Figure 1 for additional detail).

Smoking, alcohol consumption, diet, and physical activity were assessed via self-report. Current alcohol consumption at visit 2 was categorized into moderate (1–7 drinks per week

for women; 1–14 drinks per week for men) and excessive (>7 drinks per week for women; >14 drinks per week for men). Dietary intake was assessed at visit 1 using a 66-item food-frequency questionnaire administered by trained interviewers (8). Diet was evaluated by meeting Life's Simple 7 nutritional guidelines in the following 5 component areas: fruits and vegetables, fish, fiber-rich whole grains, sodium and sugar-sweetened beverages. Leisure-time physical activity was assessed using the Baecke index at visit 1 (9) and categorized according to AHA Physical Activity Guidelines: ideal (meeting guidelines of 75 minutes/week of vigorous physical activity or 150 minutes/week of moderate physical activity), intermediate (1–74 minutes/week of vigorous physical activity or 1–149 minutes/week of moderate physical activity) or poor (no physical activity) (10). Body mass index (kg/m^2) was calculated from measured height and weight at visit 2 and categorized as normal weight (BMI 20–24.9), overweight (BMI 25–29.9), or obese (BMI 30).

Resting seated blood pressure was measured 3 times, and the mean of the second and third measurements were used in this analysis. Hypertension was defined as systolic blood pressure 140 mmHg, diastolic blood pressure 90 mmHg, or self-reported use of antihypertensive medication. Glucose was measured by the hexokinase method and total cholesterol levels by standard enzymatic procedures, from blood samples drawn at visit 2. Diabetes was defined as self-reported physician diagnosis or current use of glucose-lowering medication. Glomerular filtration rate (GFR) was estimated using the 2009 CKD-EPI, which was calculated based on serum creatinine measured at visit 2 (11). Left ventricular hypertrophy was measured using 12-lead electrocardiography and defined by Cornell criteria (12). All clinical variables were measured or reported at visit 2.

Life's Simple 7 (LS7) is a composition of 7 key health factors, identified by the American Heart Association in 2011 as part of a campaign for CVD prevention (13). We calculated the AHA Life's Simple 7 Score for each participant using: diet, BMI, physical activity, smoking status, blood pressure, glucose control, cholesterol levels. Because we had dietary and physical activity data only from visit 1, we carried forward these values for each participant at visit 2. Each component was scored as ideal (2 points), intermediate (1 point) or poor (0 points), and total LS7 score was categorized as optimal (10–14), average (5–9) or inadequate (0–4) (see Supplemental Table 1 for further detail).

Cardiac troponin T was measured at visits 2 and 4 using the same highly sensitive assay, Elecsys Troponin T (Roche Diagnostics, Indianapolis, Indiana). Hs-cTnT was measured in serum specimens from visit 2, collected in 1990–1992 and stored at −70°C until the time of assay measurement in 2012–2013 at the University of Minnesota, using a Roche Elecys 2010 Analyzer. Hs-cTnT was measured in plasma samples from visit 4 (collected 1996–1998) using a Cobas e411 Analyzer at Baylor College of Medicine in 2011. Both visit 2 and visit 4 measurements had low coefficients of variation, showing high level of precision (7). A formal calibration study demonstrated high correlation and no significant differences in the hs-cTnT measurements between the laboratories (14). For categorical analyses, we used a conventional threshold of 5 ng/L as the lower limit of detection, which is the lower limit of detection with reliability by the assay manufacturer (15).

The primary outcome of the study was 6-year reduction in hs-cTnT, represented by a transition from a detectable level (5 ng/L) at visit 2 (1990–1992) to an undetectable level (<5ng/L) at visit 4 (1996–1998) ("incident undetectable hs-cTnT"), compared to sustained detectable hs-cTnT at both visits 2 and 4. We compared characteristics of the study population according to 6-year categories of change in hs-cTnT and examined associations of baseline lifestyle- and health-related behaviors. We used Poisson regression to compare risk of incident undetectable hs-cTnT according to lifestyle factors. Model 1 included age (years), race-field center (black participants from Mississippi, black participants from North Carolina, white participants from North Carolina, white participants from Minnesota, white participants from Maryland), sex (male/female), education level (number of years completed), systolic blood pressure (mmHg), diastolic blood pressure (mmHg), antihypertensive medication use (yes/no), total cholesterol (mg/dL), diabetes (yes/no), estimated glomerular filtration rate (mL/min/1.73 m^3) and left ventricular hypertrophy (yes/ no). Because Life's Simple 7 Score included measures of blood pressure, cholesterol and hyperglycemia in the definition, model 2 was adjusted only for: age, race-field center, sex, education level, estimated glomerular filtration rate (eGFR), and left ventricular hypertrophy.

We performed additional analyses to examine the associations of temporal changes in lifestyle factors (occurring after the baseline visit) with incident undetectable hs-cTnT at visit 4. These secondary analyses were limited to those exposure variables that had additional follow-up data available at visits 3 (1993–1995) and 4 (1996–1998): smoking, alcohol consumption and BMI. For the Life's Simple 7 score, 2 of the components, diet and physical activity, were not available at both later visits and thus baseline values were carried forward.

We conducted sensitivity analyses examining incident undetectable hs-cTnT among those who remained free of CVD between visits 2 and 4, as well as analyses modeling percent change in hs-cTnT from baseline as the outcome of interest (4,6,16). For the percent change analyses, to account for differences in baseline level, we additionally adjusted for visit 2 troponin. We also performed analyses using 3 ng/L, the limit for detection for this assay, as the categorical endpoint (i.e. baseline 3 ng/L and follow-up <3 ng/L) (15). Lastly, we utilized multinomial regression to simultaneously model both incident undetectable hs-cTnT and risk of death between visit 2 and visit 4 as outcomes.

Results

At baseline, 33% of the eligible study population had detectable (5ng/L) levels of hs-cTnT (3,017/9,256). Of the 3,017 individuals with detectable hs-cTnT values at visit 2, 20% had incident undetectable levels at visit 4, 80% had sustained detectable levels, and 540 persons had an intervening death before visit 4. Individuals with hs-cTnT levels that fell into the undetectable range at follow-up were more likely to be female, normotensive, or nondiabetic, compared to individuals with sustained detectable hs-cTnT levels. Notably, persons with incident undetectable troponin had a higher average Life's Simple 7 Score and were more likely to have optimal levels of all LS7 components, except for diet, physical

activity and cholesterol. Generally, those with stable or increasing hs-cTnT over time had worse health behaviors than those with reversal of subclinical myocardial damage (Table 1).

Persons who were normal weight were significantly more likely to have temporal reductions in troponin over time compared to obese individuals (Table 2). Current smoking appeared to be weakly associated with temporal reductions in troponin, but this result was not statistically significant. There was no association between healthy diet score or alcohol consumption and incident undetectable hs-cTnT. Those who met ideal AHA recommendations for physical activity were 25% more likely to have incident undetectable troponin at follow-up.

As a summary metric of healthy behavior, higher Life's Simple 7 scores were also associated with temporal reductions in troponin. Those with average and optimal Life's Simple 7 scores were more likely to have incident undetectable troponin than those with inadequate scores. Results for lifestyle factors and change in troponin T were generally slightly stronger in the multinomial analyses where we modeled death as an additional outcome relative to the main analysis (Supplemental Table 2). Our results were attenuated after excluding those who developed clinical CVD (MI, stroke or CHF) between visits 2 and 4 (Supplemental Table 3), but were more robust when using 3 ng/L as the lower limit of detection (Supplemental Table 4). Analyses performed using >25% and >50% decrease in hs-cTnT from baseline had similar trends, although few of the associations were statistically significant (Supplemental Table 5).

We performed secondary analyses to test the association between consistently healthy lifestyle factors (using follow-up information at subsequent visits) and temporal reductions in troponin. In these analyses, we defined the reference group as those with the healthy lifestyle factor at 0 of the 3 visits (making the reference group the least consistently healthy behavior). Having a BMI <30 kg/m^2 at a greater number of visits was associated with increased likelihood of incident undetectable troponin. For example, those who remained consistently non-obese were significantly more likely to have incident undetectable troponin than those who were obese at all three visits. There was no association of troponin change with duration of moderate drinking. Finally, having a Life's Simple 7 Score that was consistently average or optimal over time was also associated with increased probability of incident undetectable troponin (p<0.001). For example, those with a Life's Simple 7 score of 5 or greater at all 3 visits were more likely to have incident undetectable troponin than those with below average scores at all visits (Table 3).

Discussion

In this large community-based cohort of middle-aged adults free of CVD at baseline, we found that 20% of study participants transitioned from detectable to undetectable hs-cTnT over a six-year period, possibly reflecting an improvement in subclinical myocardial damage. These individuals were more likely to be normal weight, meet the AHA physical activity guidelines, and have an average or optimal Life's Simple 7 Score. The maintenance of healthy lifestyle factors over time was also important; for example, we found that those who remained consistently non-obese from baseline through follow-up were more likely to

have incident undetectable hs-cTnT than those who were non-obese for just one or two visits. We also observed strong associations between consistently favorable Life's Simple 7 scores and incident undetectable hs-cTnT.

By studying lifestyle and other factors associated with temporal decreases in hs-cTnT, our analysis complements a previous ARIC study (6) that evaluated the association between traditional cardiovascular risk factors- including some unhealthy lifestyle and behavioral exposures- and temporal increases in hs-cTnT. Identifying favorable lifestyle and other variables associated with temporal reductions in hs-troponin is increasingly relevant, as this assay tracks well with clinical risk (4,5). Several studies have now shown that temporal reductions in hs-troponin are associated with relative reductions in clinical events (4,5,16). This suggests the potential of hs-troponin to serve as a dynamic and individualized marker of CVD risk that may respond to preventive interventions (17). Changes in high-sensitivity troponin over time may be used in clinical practice as a marker of the impact of lifestyle modifications on cardiovascular health to counsel individuals during the subclinical period. Moreover, subclinical markers may serve as tools to increase medication compliance and motivate patients' behavior change (18).

Our results are consistent with previous findings that have demonstrated associations between BMI (19), physical activity (20,21) and lifestyle factors more generally (22) with cardiovascular events, but extend this to subclinical cardiac damage. We complement these findings by showing they are reflected in changes in hs-cTnT, which might be used as a marker of altered risk behavior in the clinical setting, prior to the development of clinical CVD. To date, there have been few prior studies that have evaluated whether changes in healthy lifestyle factors might be associated with temporal reductions in hs-cTnT. Prior research has demonstrated that physical activity is associated with temporal reductions in hs-cTnT (23). Additionally, sedentary behavior was associated with progression of subclinical myocardial damage while moderate physical activity appeared to have a protective effect in older adults. Our study extends these findings to a middle-aged population and demonstrates the benefit of other health behaviors, such as maintaining both a normal weight and favorable Life's Simple 7 score.

In the current study, we did not find an association between healthy diet score and reversal of subclinical myocardial damage. One possible explanation is that the cardioprotective effects of a healthy diet are not realized in the short, 6-year follow-up of our study. Moreover, we carried forward the visit 1 dietary information, which may not best reflect diet at visit 2. The five components of the healthy diet score of the AHA Life's Simple 7 and the thresholds used to dichotomize the population as meeting criteria may not fully represent diet quality that are relevant for cardiovascular health. Additionally, the food frequency questionnaire, which was administered in the ARIC study, is not the ideal dietary assessment instrument for quantifying absolute intake of sodium (24). We also did not find an association between moderate alcohol consumption and incident undetectable hs-cTnT.

Our finding that current smoking may have a "protective", although non-significant, effect on subclinical myocardial damage in our main analysis, we observed a strong association between current smoking and risk of all-cause mortality during our study follow-up

(Supplemental Table 2), suggesting that the observed inverse association of current smoking on hs-cTnT may be influenced by survival bias or reverse causality. This inverse association is consistent with several prior studies (6,25). It has been postulated that smoking may reduce cardiac myocyte turnover and immune mediated myocardial remodeling, reflected in lower levels of circulating troponins (26). Additionally, given that smoking is associated with lower BMI (27), our counter-intuitive results may be in part mediated by the impact of smoking on reduced BMI, which is associated with decreased likelihood of incident myocardial damage.

We observed that the Life's Simple 7 lifestyle score was robustly associated with incident undetectable hs-cTnT, supporting the larger literature on the effectiveness of multifactorial risk factor interventions to reduce cardiovascular risk (28,29). This also suggests that Life's Simple 7 score may be a convenient way to more holistically capture lifestyle impacts on cardiovascular risk. Multifaceted lifestyle interventions that target several different health factors may have a greater impact on progression of subclinical cardiac disease than any single lifestyle factor alone (29). As such, our results suggest that hs-cTnT may be a useful clinical tool for monitoring the effects of lifestyle interventions on cardiac health in the primary care setting (5). Other cardiac biomarkers have shown prognostic value in assessing future cardiovascular risk during the subclinical period as well (30), but further research is necessary to determine their association with changes in lifestyle factors.

There are a few limitations to our study. First, hs-cTnT was measured at only two time points; thus, we were unable to evaluate more granular trends in subclinical myocardial damage with various lifestyle factors. Second, we did not have updated values for diet and physical activity at all time points and were required to carry forward visit 1 values for both the main and secondary analyses, which may underestimate the strength of association. These variables were also self-reported and may be under- or over-estimated, but we do not expect this to differ between the two groups. Lastly, as with any observational study, there remains the possibility of residual confounding.

In conclusion, we found that being non-obese, having ideal activity levels, and a favorable Life's Simple 7 score were all associated with temporal reductions in high-sensitivity troponin levels, compared to those individuals who had unfavorable levels of these factors. The associations with healthy lifestyle factors and improving troponin levels were most pronounced when the healthy behavior was sustained over a greater duration of follow-up, emphasizing the importance of sustained compliance with healthy lifestyle. These data add to growing evidence that hs-cTnT may be a useful cardiovascular surrogate that is altered in response to lifestyle and behavioral risk factors.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Table 1

Baseline Characteristics According to 6-Year Category of Change in hs-cTnT Among Persons With Detectable Baseline Troponin (hs-cTnT 5ng/L) and Without Cardiovascular Disease at ARIC Visit 2 (1990–1992)

Covariates	hs-cTnT (ng/L) <5 (n=599)	hs-cTnT (ng/L) 5 (n=2,418)	p-value
Age (years)	56.5 (5.6)	58.9 (5.6)	<0.001
Male	226 (38%)	1,635 (68%)	<0.001
Black	142 (24%)	609 (25%)	0.45
Education (high school graduate)	486 (81%)	1,884 (78%)	0.07
Total Cholesterol(mg/dL)	213.1 (40.6)	207.7 (39.5)	0.32
Systolic BP (mmHg)	119.5 (17.4)	125.2 (19.0)	0.02
Diastolic BP (mmHg)	71.7 (10.3)	73.5 (10.5)	0.09
Antihypertensive Use	165 (28%)	861 (36%)	<0.001
Diabetes Mellitus	58 (10%)	456 (19%)	<0.001
eGFR (<60 mL/min/1.73m^3)	7 (1.2%)	61 (2.5%)	0.05
Left ventricular hypertrophy	11 (1.8%)	81 (3.4%)	0.05
Alcohol consumption [*]			0.36
Current Excessive	30 (5%)	169 (7%)	
Current Moderate	308 (51%)	1,203 (50%)	
Former	124 (21%)	508 (21%)	
Never	137 (23%)	538 (22%)	
Average Life's Simple 7 Score	7.9 (2.1)	7.3 (2.2)	<0.001
Healthy Diet Score			0.34
Score 4-5	39 (6.5%)	152 (6.3%)	
Score 2-3	426 (71%)	1,655 (68%)	
Score 0-1	134 (22%)	611 (25%)	
Body Mass Index (kg/m^2)			<0.001
BMI 18-24.9	199 (33%)	594 (25%)	
BMI 25-29.9	250 (42%)	1,009 (42%)	
BMI 30	150 (25%)	815 (34%)	
Physical Activity [†]			0.40
Ideal	133 (22%)	477 (20%)	
Intermediate	148 (25%)	625 (26%)	
Poor	318 (53%)	1,316 (54%)	
Smoker [‡]			0.001
Ideal	290 (48%)	1,000 (41%)	
Intermediate	213 (36%)	1,064 (44%)	
Poor	96 (16%)	354 (15%)	
Blood Pressure (mmHg)			<0.001

Covariates	hs-cTnT (ng/L) <5 (n=599)	hs-cTnT (ng/L) ≥5 (n=2,418)	p-value
SBP<120 and DBP<80	319 (53%)	1,006 (42%)	
SBP 120-139 or DBP 80-89	197 (33%)	888 (37%)	
SBP ≥140 or DBP ≥90	83 (14%)	524 (22%)	
Fasting Glucose (mg/dL)			<0.001
<100	263 (44%)	849 (36%)	
100-125	282 (47%)	1,166 (48%)	
≥126	54 (9%)	403 (17%)	
Total Cholesterol (mg/dL)			0.008
<200	233 (39%)	1,105 (46%)	
200-239	237 (40%)	877 (36%)	
≥240	129 (22%)	436 (18%)	

[*] Excessive Alcohol Consumption: >14 drinks/week in men, >7 drinks/week in women; Moderate Alcohol Consumption: 1–14 drinks/week in men, 1–7 drinks/week in women

[†] Ideal Physical Activity: ≥75 mins/week or Moderate Activity ≥150 mins/week; Intermediate Physical Activity: Vigorous Activity 1-74 mins/week or Moderate Activity 1-149 mins/week; Poor Physical Activity: 0 mins/week any activity

[‡] Ideal Smoking Category: Never smoker or quit >12 months ago; Intermediate Smoking Category: Former smoker, quit ≤12 months ago; Poor Smoking Category: Current Smoker

Table 2

Adjusted Risk Ratios (95% CIs) for 6-Year Decrease[*] in hs-cTnT According to Lifestyle-Related Factors at Baseline

Visit 2 Exposure Variables	Adjusted Risk Ratio[†] (n=3017, N=599)
Smoker	
Never	REF[1]
Former	0.98 (0.81, 1.18)
Current	1.13 (0.89, 1.44)
Alcohol Drinker	
Never	REF[1]
Former	1.22 (0.95, 1.57)
Moderate Consumption	1.13 (0.90, 1.41)
Excessive Consumption	1.09 (0.73, 1.64)
Body Mass Index (kg/m^2)	
Obese (BMI 30 kg/m^2)	REF[1]
Overweight (BMI 25-29.9 kg/m^2)	1.40 (1.13, 1.73)
Normal Weight (BMI 18-24.9 kg/m^2)	1.45 (1.15, 1.82)
Diet[‡]	
Diet Score (0-1)	REF[1]
Diet Score (2-3)	1.04 (0.85, 1.27)
Diet Score (4-5)	1.06 (0.74, 1.52)
Physical Activity[‡]	
Poor	REF[1]
Intermediate	1.00 (0.82, 1.23)
Ideal	1.25 (1.01, 1.54)
Life's Simple 7 Score[§]	
Score 0-4	REF[1]
Score 5-9	1.66 (1.17, 2.36)
Score 10-14	1.64 (1.11, 2.42)

[*] Risk Ratio of Incident Undetectable Troponin (visit 4 hs-cTnT< 5ng/L) among those with detectable troponin (hs-cTnT 5ng/L) at visit 2, compared to Sustained Detectable Troponin

[†] Adjusted for Model 1: age, race-center, sex, education level, systolic blood pressure, diastolic blood pressure, antihypertensive medication use, total cholesterol, diabetes, eGFR, left ventricular hypertrophy

[‡] Assessed at visit 1

[§] Adjusted for Model 2: age, race-center, sex, education level, eGFR, left ventricular hypertrophy

Table 3

Adjusted Risk Ratios for 6-Year Decrease[*] in hs-cTnT by Duration of Exposure to Lifestyle-Related Factors at Baseline and Follow-up Visits

Exposure variables at visits 2, 3, and 4	Adjusted Risk Ratio[†] n=3017, N=599)
Smoker[§]	
Non-current smoker at 0/3 visits	REF[1]
Non-current smoker at 1/3 visits	0.66 (0.39, 1.12)
Non-current smoker at 2/3 visits	0.82 (0.52, 1.31)
Non-current smoker at 3/3 visits	0.73 (0.56, 0.96)
p-trend	0.06
Alcohol Drinker	
Moderate drinker at 0/3 visits	REF[1]
Moderate drinker at 1/3 visits	1.05 (0.81, 1.36)
Moderate drinker at 2/3 visits	1.20 (0.93, 1.55)
Moderate drinker at 3/3 visits	1.01 (0.81, 1.27)
p-trend	0.73
Body Mass Index[‖]	
Non-obese at 0/3 visits	REF[1]
Non-obese at 1/3 visits	1.35 (0.97, 1.88)
Non-obese at 2/3 visits	1.19 (0.80, 1.76)
Non-obese at 3/3 visits	1.45 (1.17, 1.80)
p-trend	0.001
Life's Simple 7 Score[‡]	
Average or Optimal LS7 at 0/3 visits	REF[1]
Average or Optimal LS7 at 1/3 visits	1.96 (0.82, 4.66)
Average or Optimal LS7 at 2/3 visits	1.63 (0.72, 3.68)
Average or Optimal LS7 at 3/3 visits	2.64 (1.25, 5.58)
p-trend	<0.001

[*] Risk Ratio of Incident Undetectable Troponin (visit 4 hs-cTnT< 5ng/L) among those with detectable troponin (hs-cTnT 5ng/L) at visit 2, compared to Sustained Detectable Troponin

[†] Adjusted for Model 1: age, race-center, sex, education level, systolic blood pressure, diastolic blood pressure, antihypertensive medication use, total cholesterol, diabetes, eGFR, left ventricular hypertrophy

[‡] Adjusted for Model 2: age, race-center, sex, education level, eGFR, left ventricular hypertrophy

[§] The reference category is current smoking at all 3 visits

[‖] The reference category is obese at all 3 visits