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RESEARCH ARTICLE

Financial Stress and Risk of Coronary Heart Disease in the Jackson Heart Study

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Introduction: Financial hardship is associated with coronary heart disease risk factors, and may disproportionately affect some African American groups. This study examines whether stress because of financial hardship is associated with incident coronary heart disease in African Americans.

Methods: The Jackson Heart Study is a longitudinal cohort study of cardiovascular disease risks in African Americans in the Jackson, Mississippi metropolitan statistical area. Participant enrollment began in 2000. Analyses were performed in 2017 and included adjudicated endpoints through December 2012. Financial stress was assessed from the Jackson Heart Study Weekly Stress Inventory and categorized into four levels: (1) did not experience financial stress, (2) no stress, (3) mild stress, and (4) moderate to high stress. Incident coronary heart disease was defined as the first event of definite or probable myocardial infarction, definite fatal myocardial infarction, definite fatal coronary heart disease, or cardiac procedure. There were 2,256 individuals in this analysis.

Results: Participants with moderate to high (versus no) financial stress were more likely to have incident coronary heart disease events after controlling for demographics, SES, access to care, and traditional clinical risk factors (hazard ratio=2.42, 95% CI=1.13, 5.17). The association between financial stress and coronary heart disease was no longer statistically significant in a model adjusting for three specific risk factors: depression, smoking status, and diabetes (hazard ratio=1.99, 95% CI=0.91, 4.39).

Conclusions: Financial stress may be an unrecognized risk factor for coronary heart disease for African Americans. Additional research should examine these associations in intervention studies that address perceived stress, in addition to other coronary heart disease risk factors, in patients experiencing financial stress.

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INTRODUCTION

African Americans experience a disproportionate burden of coronary heart disease (CHD), the leading cause of death in the U.S.[1] Traditional risk factors alone, including hypertension and diabetes, do not fully explain racial disparities in CHD risk for African Americans.[1] Instead, social determinants of health that lead to chronic stress exposures may increase the burden of CHD incidence in African Americans.[2–5]

Financial hardship is a common chronic stressor that varies by race and may relate to CHD risk. Pew Research Center data show the average white household has 1 month's income in savings, compared with 5 days for African Americans.[6] WHO conceptualizes social determinants of health, such as financial hardship, as having

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influences on biology, behavior, material conditions, or psychosocial perceptions and relationships.[7] Financial hardship may plausibly influence health through limited access to material resources, through perceptual and psychological responses—the "stress" experience—of that hardship, or through biological changes or coping behaviors associated with stress.[8–13] Though prior studies have investigated material aspects of financial stress, associations between the psychological stress experience of financial hardship and incident CHD in African Americans have not been fully examined.[12,14–17] A better understanding of how social determinants contribute to CHD risks may advance prevention efforts in clinical and public health settings.

The primary aim of this study is to examine the association between financial stress and incident CHD in a large sample of African Americans without CHD at baseline, with the hypothesis that perceiving a financial hardship as stressful is associated with CHD risk in excess of clinical and behavioral risk factors, such as hypertension, diabetes, or smoking.

METHODS

Study Population

The Jackson Heart Study (JHS) cohort was used to conduct this analysis. The JHS is a longitudinal observational cohort study of 5,306 African American men and women residing in the Jackson, Mississippi metropolitan statistical area. The study design has been described previously.[18] Participants, aged 33–84 years, were recruited from four sources: (1) a random sample from a commercially available list of residents, (2) volunteers recruited to be representative of the African American population in the Jackson metropolitan area, (3) participants from the Atherosclerosis Risk in Communities study, and (4) relatives of initial JHS participants.[18]

The IRBs of Jackson State University, Tougaloo College, and University of Mississippi Medical Center approved the JHS study protocol. The Partners HealthCare IRB approved the current-analyses.

JHS began in 2000 and this analysis included 12 years of follow-up through the year 2012. A total of 598 individuals with a history of CHD prior to study entry were excluded and the cohort was limited to 3,180 individuals who returned a weekly stress inventory (WSI) survey. After excluding individuals with missing covariates (n=924) the final analytic sample included 2,256 individuals. Sensitivity analyses were conducted to evaluate the potential impact of missing data, which are described below. Analyses were performed in 2017.

Measures

Financial stress was measured using the WSI, an 87-item survey of minor stressors distributed at the baseline visit.[19,20] Factor analysis was used to develop an index of financial stress from the WSI.[21] Factor analysis identified five items that were measures of financial hardship: (1) not enough money for basics, (2) ran out of pocket money, (3) had unexpected bills, (4) had problems paying bills, and (5) not enough money for fun. Thus, in this analysis, financial stress was operationalized as the self-reported stress associated with these five measures of financial hardship. For each of these five items, respondents had been instructed to decide whether that event happened to them during the past week. If the event did not occur, they indicated accordingly. If the event did occur, respondents were asked to rate the degree to which the event was stressful on a 7-point Likert scale. To create the financial stress measure, an unweighted average was calculated across each of the five stressors surveyed. Of the individuals who completed the WSI, 33 had missing data because of item nonresponse and were included in the analysis. A sensitivity analysis was conducted excluding these participants and the results were similar. The 5-item financial stress measure had high internal reliability (Cronbach's α=0.92). Financial stress was categorized into four response levels: (1) did not experience (if the respondent reported that they did not experience any of the five hardships), (2) no stress (if they experienced one or more financial hardship, but reported all experiences as not stressful), (3) mild stress (if the average response to the five questions was below the financial stress response of moderately stressful), and (4) moderate to high stress (if the average response to the five hardship questions was at or above the financial stress response of moderately stressful). Appendix Methods 1 (available online) provides the financial stress items and responses.

Incident CHD has been defined in this population previously.[22] In brief, incident CHD was classified as the first event of definite or probable myocardial infarction, definite fatal myocardial infarction, definite fatal CHD, or cardiac procedure, which included percutaneous transluminal coronary angioplasty, stent placement, coronary artery bypass grafting, or other coronary revascularization.[22] Person time (in years) at risk for a CHD event was calculated for participants from the date of first clinical exam to the date of incident CHD event, fatal non-CHD event, or the end of the follow-up period.

Clinical, lifestyle, demographic, and SES covariates were assessed during the baseline exam (2000–2004). Age and sex were assessed via survey. Education level was classified into categories: less than high school, high school graduate/GED, some college, or college graduate or higher. Annual family income was scaled for family size and classified into quartiles: $801–$13,832, $14,000–$27,118, $27,995–$42,500, and $44,290–$131,701.[23] Physical activity was measured via a validated active lifestyle scale and classified as no activity versus any activity.[24] Participants were classified as current/former smokers versus never smokers via self-reported survey.[24] Cholesterol levels were obtained by venipuncture.[25] Diabetes was defined as having an HbA1c ≥6.5%, a fasting plasma glucose ≥126 mg/dL, or taking diabetes medications. Hypertension was defined as systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg or taking hypertension medications. High waist circumference was defined as ≥102 cm for males and ≥88 cm for females. Insurance coverage was assessed via survey data indicating at least one health insurance product that covered most or all medical expenses. Ability to afford medications was classified via a questionnaire that queried barriers to taking medications (Appendix Methods 2, available online). Depression was measured at baseline using the Center for Epidemiologic Studies Depression scale.[26] The Center for Epidemiologic Studies Depression scale responses were categorized into

validated cutpoints: no depression (0–15), depressive symptoms (16–20), and depression (≥21).[26]

Statistical Analysis

Descriptive statistics are presented for all covariates by financial stress. Age- and sex-adjusted CHD incidence rates by financial stress index categories were calculated assuming a Poisson distribution with log link, and chi-square test for a linear trend in the relationship between CHD incidence and financial stress.

Cox proportional hazard models were used to calculate hazard ratios (HRs) for incident CHD by category of financial stress in five models: (1) adjusted for age and sex; (2) adjusted for Model 1, plus income and education; (3) adjusted for Model 2, plus insurance status and ability to pay for medications; (4) adjusted for Model 3, plus smoking status and physical activity; (5) adjusted for Model 4, plus waist circumference, diabetes, hypertension, and total cholesterol; and (6) adjusted for Model 5, plus depression. Finally, additional models were analyzed to determine whether a more parsimonious constellation of factors might predict incident CHD or account for the relation between financial stress and CHD.

Among those who answered the WSI, the largest source of missing data was income (14.5%), followed by total cholesterol (7.5%) and ability to afford medications (6.2%). Other covariates had between 0.03% and 3.9% missing values. To examine potential bias from list-wise deletion of missing covariates, a sensitivity analysis was conducted examining imputed missing data using a Markov chain Monte Carlo multiple imputation technique.[27] All participants without prior CHD events (n=4,708) and all independent covariates were included in the multiple variable imputation. Next, a second sensitivity analysis was conducted to evaluate potential survey nonresponse bias among patients who did not answer the WSI. After imputing missing data for financial stress and other missing covariates, the analysis was stratified to explore any different associations between financial stress and CHD among participants who returned the survey (n=3,180) compared with those who did not (n=1,528).

All analysis was conducted in SAS, version 9.4.

RESULTS

Overall, 98 of the 2,256 participants included in this sample had a CHD event (4.3%). Median time to CHD event was 4.7 years. Mean years of follow-up was 9.6 years (interquartile range, 9.0–10.8 years), representing 21,643 total person years contributing to the analysis.

Table 1 shows study participant characteristics by levels of financial stress. Participants with moderate to high financial stress were younger than those with no financial stress. Females were more likely to experience moderate to high financial stress than males. Individuals with moderate to high financial stress were more likely to be uninsured and have trouble paying for medications. Compared with participants with no financial stress, participants who had moderate to high financial stress were more likely to have depression or depressive symptoms, have diabetes, and to smoke currently or in the past.

Participants with moderate to high financial stress were more likely to have a CHD event than those with no financial stress. In age- and sex-adjusted analyses, compared with those with no financial stress (2.78 per 1,000 person years, 95% CI=1.48, 5.21 per 1,000 person years), individuals with mild financial stress had nearly two times the incidence of CHD (5.52 per 1,000 person years, 95% CI=3.90, 7.82 per 1,000 person years), and individuals with moderate to high financial stress had three times the incidence of CHD (10.07 per 1,000 person years, 95% CI=6.72, 15.08 per 1,000 person years; Figure 1).

Table 2 shows HRs of the associations between financial stress levels and incident CHD, adjusted for covariates. In the age- and sex-adjusted model, participants who reported moderate to high financial stress had a greater risk for CHD (HR=3.12, 95% CI=1.49, 6.53) compared with those who reported no stress. The association was observed after adjusting for SES (HR=2.96, 95% CI=1.40, 6.25), access to care (HR=2.88, 95% CI=1.36, 6.11), health behaviors (HR=2.68, 95% CI=1.26, 5.70), and clinical risk factors (HR=2.42, 95% CI=1.13, 5.17). The association became nonsignificant in the fully adjusted model with depression. A more parsimonious model showed the combination of depressive symptoms, smoking status, and diabetes together attenuated the association between incident CHD and financial stress. Age, sex, smoking status, diabetes, hypertension, and depression had statistically significant associations with CHD in the fully adjusted model. Changing the reference category from individuals who experienced financial stressors but described them as not stressful to those who did not experience any of the stressors did not change the reported results (Appendix Table 1, available online).

Among participants who answered the WSI, participants with complete income data had a slightly higher incidence of CHD (5.12 per 1,000 person years, 95% CI=4.41, 5.95 per 1,000 person years) compared with those with missing income data (3.61 per 1,000 person years, 95% CI=2.43, 5.36 per 1,000 person years), though this difference was not statistically significant.

Among participants who did not answer the WSI, there were 84 incident CHD events. Compared with participants who answered the WSI, those who did not were older (aged 58 vs 54 years), more likely to be male (38.4% vs 34.8%), have low income (26.9% vs 21.4%), and have less than high school education (25.3% vs 13.2%). They were more likely to have diabetes (22.3% vs 19.5%), to have hypertension (58.8% vs 52.2%), to smoke (16.5% vs 12.8%), and to be sedentary (53.9% vs

Table 1. Distribution of CHD Events and Risk Factors by Level of Financial Stress

CHD events and risk factors	Total (N=2,256)	Level of financial stress			
		Did not experience stressors (*n*=734)	Not stressful (*n*=357)	Mildly stressful (*n*=783)	Moderately to highly stressful (*n*=382)
CHD events, n	98	31	10	33	24
Age, years, median (IQR)	54 (44–63)	59 (49–66)	55 (44–64)	52 (43–61)	49 (42–60)
Sex					
Female	1,489 (66.0)	461 (62.8)	228 (63.9)	516 (65.9)	284 (74.4)
Male	767 (34.0)	273 (37.2)	129 (36.1)	267 (34.1)	98 (25.7)
SES					
Income					
$801–$13,832	447 (19.8)	85 (11.6)	52 (14.6)	166 (21.2)	144 (37.7)
$14,000–$27,118	547 (24.3)	160 (21.8)	94 (26.3)	193 (24.7)	100 (26.2)
$27,995–$42,500	621 (27.5)	184 (25.1)	104 (29.1)	246 (31.4)	87 (22.8)
$44,290–$131,701	641 (28.4)	305 (41.6)	107 (30.0)	178 (22.7)	51 (13.4)
Education					
Less than high school	259 (11.5)	82 (11.2)	34 (9.5)	89 (11.4)	54 (14.1)
High school graduate/GED	401 (17.8)	115 (15.7)	65 (18.2)	144 (18.4)	77 (20.2)
Some college	697 (30.9)	178 (24.3)	107 (30.0)	262 (33.5)	150 (39.3)
College graduate	899 (39.9)	359 (48.9)	151 (42.3)	288 (36.8)	101 (26.4)
Healthcare access					
Health insurance status					
Insured	1,975 (87.5)	684 (93.2)	312 (87.4)	676 (86.3)	303 (79.3)
Uninsured	281 (12.5)	50 (6.8)	45 (12.6)	107 (13.7)	79 (20.7)
Trouble paying for medications					
No	1,897 (84.1)	687 (93.6)	321 (89.9)	632 (80.7)	257 (67.3)
Yes	359 (15.9)	47 (6.4)	36 (10.1)	151 (19.3)	125 (32.7)
Depression					
No depressive symptoms	1,792 (79.4)	666 (90.7)	329 (92.2)	607 (77.5)	190 (49.7)
Depressive symptoms	233 (10.3)	50 (6.8)	16 (4.5)	105 (13.4)	62 (16.2)
Depression	231 (10.2)	18 (2.5)	12 (3.4)	71 (9.1)	130 (34.0)
Chronic conditions					
Abdominal obesity					
Low/normal	776 (34.4)	272 (37.1)	124 (34.7)	279 (35.6)	101 (26.4)
High	1,480 (65.6)	462 (62.9)	233 (65.3)	504 (64.4)	281 (73.6)
Diabetes					
No	1,846 (81.8)	608 (82.8)	296 (82.9)	655 (83.7)	287 (75.1)
Yes	410 (18.2)	126 (17.2)	61 (17.1)	128 (16.4)	95 (24.9)
Hypertension					
No	1,051 (46.6)	312 (42.5)	174 (48.7)	392 (50.1)	173 (45.3)
Yes	1,205 (53.4)	422 (57.5)	183 (51.3)	391 (49.9)	209 (54.7)
Total cholesterol					
Cholesterol, mg/dL, median (IQR)	196 (173–222)	198 (175–224)	191 (167–217)	199 (174–225)	193 (168–217)
Health behaviors					
Smoking					
Never smoker	1,985 (88.0)	671 (91.4)	327 (91.6)	682 (87.1)	305 (79.8)
Current or former smoker	271 (12.0)	63 (8.6)	30 (8.4)	101 (12.9)	77 (20.2)
Physical activity					
Any physical activity	1,293 (57.3)	428 (58.3)	208 (58.3)	456 (58.2)	201 (52.6)
No physical activity	963 (42.7)	306 (41.7)	149 (41.7)	327 (41.8)	181 (47.4)

Note: Data presented as n (%) unless otherwise indicated.
CHD, coronary heart disease; IQR, interquartile range.

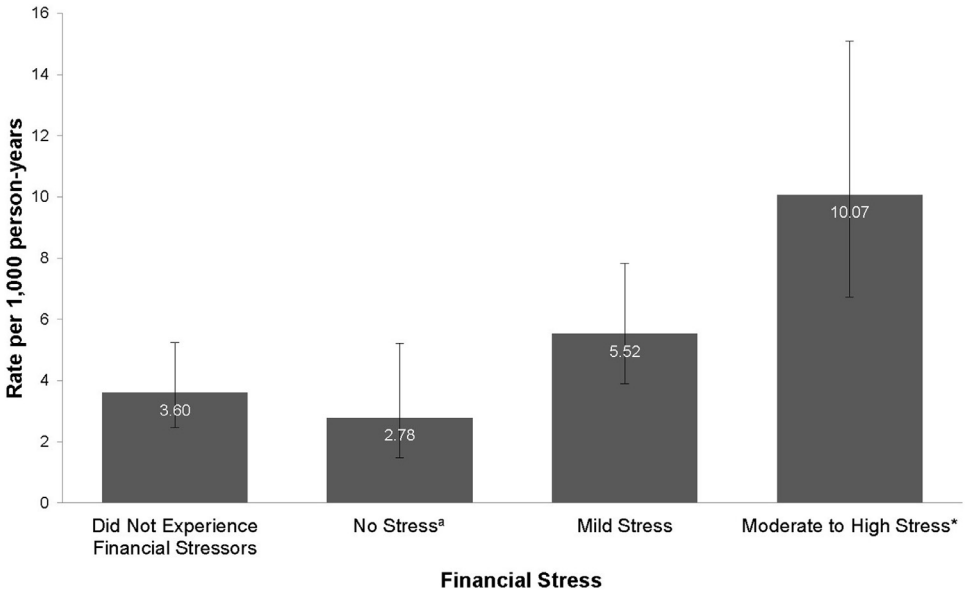

Figure 1. Age- and sex-adjusted CHD incidence rate per 1,000 person-years.
[a]Reference category.
*$p<0.05$.
CHD, coronary heart disease.

45.5%). They were equally likely to have access to health insurance (13.8% vs 13.4%; Appendix Table 2, available online). Those who did not answer the WSI had a higher incidence of CHD (5.6 per 1,000 person years, 95% CI=4.5, 6.9 per 1,000 person years) compared with those who answered the WSI (4.5 per 1,000 person years, 95% CI=3.8, 5.4 per 1,000 person years), though this difference was not statistically significant. After adjusting for all covariates, multiple imputation data demonstrated an association between high financial stress and incident CHD among those participants who answered the WSI, similar to results using list-wise deletion to manage missing data. Among participants who did not answer the WSI, there was not an association with high financial stress and incident CHD in the imputed data (Appendix Table 3, available online).

Table 2. CHD Association with Level of Financial Stress

Variable	Model 1: Age and sex	Model 2: Model 1 + SES[a]	Model 3: Model 2 + access to care[b]	Model 4: Model 3 + health behaviors[c]	Model 5: Model 4 + risk factors[d]	Model 6: Model 5 + depression status
Did not experience financial stressors	1.22 (0.60, 2.49)	1.26 (0.61, 2.57)	1.26 (0.62, 2.59)	1.28 (0.62, 2.62)	1.33 (0.65, 2.73)	1.32 (0.65, 2.71)
Not stressful (ref)	1.00	1.00	1.00	1.00	1.00	1.00
Mildly stressful	1.90 (0.94, 3.86)	1.88 (0.92, 3.83)	1.83 (0.89, 3.73)	1.82 (0.89, 3.72)	1.83 (0.89, 3.76)	1.74 (0.84, 3.58)
Moderately to highly stressful	**3.11 (1.49, 6.53)****	**2.96 (1.40, 6.25)****	**2.88 (1.36, 6.11)****	**2.68 (1.26, 5.70)***	**2.42 (1.13, 5.17)***	1.99 (0.91, 4.39)

Note: Values are hazard ratio (95% CI). n=2,256. Boldface indicates statistical significance (*$p<0.05$; **$p<0.01$).
[a]Income and education.
[b]Insurance status and ability to pay for medications.
[c]Smoking, physical activity.
[d]Waist circumference, diabetes, hypertension, cholesterol.
CHD, coronary heart disease.

DISCUSSION

The role of social factors as determinants of health is increasingly recognized.[28,29] In this analyses of African American adults, those who experienced moderate to high financial stress had an increased risk of incident CHD compared with those who did not experience financial stress. These results suggest moderate to high financial stress may be a risk factor for CHD for African Americans, in addition to traditional risk factors, such as hypertension and diabetes. These data also suggest financial stress may be correlated with a constellation of risk factors, namely smoking status, diabetes, and depressive symptoms.

Existing literature has not directly explored associations between the stress associated with financial hardship and incident CHD in African Americans, though these findings are consistent with prior studies that have found associations between measures of financial hardship and clinical risk factors for CHD.[14,15,30] In the Midlife in the United States study, difficulty paying for monthly bills has been associated with weight gain among a national representative sample of adults, and smoking among a subset of middle-aged blacks.[14,15] Difficulties paying for necessities like food or utilities are well-established social determinants of health, and associations with incident CHD may reflect material deprivation.[31] However, the results of this study suggest the relation between financial hardship and health may reflect a more complicated process than solely material deprivation. The results suggest financial stress may be also associated with CHD through psychological/emotion-based pathways. Additionally, social relationships have long been linked to health, including cardiovascular disease mortality.[2,32–35] It is plausible that avoiding social occasions due to a lack of money may lead to social isolation and loneliness, which are known predictors of adverse health outcomes.[36,37] Importantly, depression is recognized as a correlate of CHD risk.[38] The findings of these analyses suggest an association between CHD; financial stress; and other stress-associated behaviors and health conditions, namely smoking; diabetes; and depression, that should be explored further with causal data. For example, preventive care interventions to manage perceived stress, depression, diabetes, and smoking in a financially stressed population should be explored.

Limitations

This study has limitations that should be noted. First, this study is observational and does not draw causal interpretations from the associations observed; this limitation is mitigated by the prospective, longitudinal design that strengthens the interpretation of the direction of the association. Second, the response rate to the WSI was 68%. The length of the survey may have deterred some participants from completing it. Additionally, the WSI was distributed to participants at the end of their study visit with instructions to complete it at home and mail it to study staff or bring the completed form to their clinic exam, which may have reduced the completion rate. Nearly all of the participants who did not complete the WSI survey also did not complete the depression survey (98.7%). A sensitivity analysis was conducted to facilitate the interpretation of the findings in light of these missing data. The analysis that imputed missing covariates among those who did return the WSI shows a strong association between financial stress and incident CHD, suggesting minimal bias in the interpretation of these results because of item nonresponse. No association was found between financial stress and incident CHD in the simulated imputed data among those who did not return the survey. Those individuals who did not complete the survey had lower SES and more comorbidities than those who returned the survey. It is possible that the survey results do not fully reflect the experience of those with multiple medical and social factors who did not return the survey. Third, data analyzed in this cohort were completed in 2012; however, this time period was 3 years after the end the Great Recession, and thus provides an opportunity to examine risks associated with financial stress among African Americans surrounding this historic period. Though a single measurement of the WSI was taken at baseline, the longitudinal associations reported could suggest that the experience of financial stress is chronic or has a chronic impact.

There are also several strengths of the study. First, the JHS has a prospective study design, with a large sample of African Americans and validated methods of CHD event ascertainment. Second, this measure of financial stress has good reliability. Third, the sensitivity analyses show strong internal validity of the results for participants who did return the survey. Importantly, this analysis provides insight into the multiple complex pathways by which financial stress might plausibly affect incident CHD, which should be further explored in intervention studies. For example, interventions that connect patients to social services may be used to study potential health impacts of alleviating financial stress in diverse groups.[29]

CONCLUSIONS

These data provide a unique opportunity to examine the risk of incident CHD associated with financial stress among African Americans. The results suggest the

potential importance of identifying and addressing financial stress as a strategy for reducing differential risks for CHD.[29] Future research should determine whether interventions that directly influence financial stressors, or that influence the psychological, behavioral, and clinical correlates of financial stress, are effective in reducing the CHD burden that disproportionately affects some African Americans. Additional research should investigate these associations in more vulnerable African American groups who are not reached by traditional research survey techniques.

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SUPPLEMENTAL MATERIAL

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