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Correlates of Self-reported Resilience during the COVID-19 Pandemic: The C4R Study

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Abstract

Objectives: To examine correlates of self-reported resilience during the COVID-19 pandemic in multi-ethnic, US community-dwelling adults.

Methods: The Collaborative Cohort of Cohorts for COVID-19 Research (C4R) Study assessed the impact of the pandemic on participants from 14 established U.S. prospective cohort studies via questionnaires. Based on one item from the Brief Resilience Scale, "I tend to bounce back quickly after hard times," participants who responded with "agree" were defined as resilient and compared to those who responded "neutral" or "disagree" (not resilient). Logistic regression was used to test associations of self-reported resilience with age, sex, race and ethnicity, education, body mass index (BMI), smoking, hypertension, diabetes, COVID-19 vaccination status, COVID-19 infection history, insurance status, and household income.

Results: Of 31,007 participants (mean age 64.1±15.7 years; 60.2% female; 51.4% White, 21.7% Black, 20.3% Hispanic, 3.8% American Indian, 1.8% South Asian, 0.9% East Asian), 74.4% self-identified as resilient. Race and ethnicity were significantly associated with reports of resilience. Compared to White participants, Black participants had 25% higher odds of self-reported resilience (aOR:1.25; 95%CI:1.16-1.34), Hispanic participants had 42% higher odds (aOR 1.42;1.30-1.55), American Indian participants had 20% lower odds (aOR 0.80; 0.69-0.92), and East Asian participants had 52% lower odds (aOR 0.48; 0.38-0.62) in fully adjusted models.

Higher education (≥ college vs. <high school: aOR 1.41;1.28-1.55; some college vs. <high school: aOR 1.30; 1.17-1.43; high school vs. <high school: aOR 1.27; 1.16-1.40), being married/living as married (vs. single: aOR 1.11; 1.02-1.21), higher income (>$100,000 vs. <$50,000: aOR 1.22; 1.11-1.34), and being overweight (vs healthy BMI: OR 1.12, 1.04-1.20) were also associated with higher odds of resilience. Female sex (vs. male: aOR 0.84; 0.79-0.89), diabetes (vs. non-diabetes: aOR: 0.90; 0.85-0.96), obesity (vs healthy BMI: aOR 0.81; 0.74-0.88) and being unemployed (vs. employed: aOR 0.85; 0.80-0.90) were associated with lower odds of self-reported resilience.

Conclusions: During the COVID-19 pandemic, nearly three-quarters of this diverse sample of US adults reported being resilient. Significant variations in self-reported resilience were observed according to race and ethnicity, with the highest odds among Black and Hispanic participants and the lowest odds among East Asian participants compared to White participants. Sociodemographic factors such as higher education, being married, and higher income were also associated with higher self-reported resilience. These findings highlight the complex interplay of individual and social factors in shaping perceptions of resilience.

Abbreviations

ARIC	Atherosclerosis Risk in Communities
C4R	Collaborative Cohort of Cohorts for COVID-19 Research
CARDIA	Coronary Artery Risk Development in Young Adults
COPDGene	Genetic Epidemiology of COPD
COVID-19	Coronavirus Disease 2019
FHS	Framingham Heart Study
HCHS/SOL	Hispanic Community Health Study/Study of Latinos
JHS	Jackson Heart Study
MASALA	Mediators of Atherosclerosis in South Asians Living in America
MESA	Multi-Ethnic Study of Atherosclerosis
NOMAS	Northern Manhattan Study
PASC	Post-Acute Sequelae of SARS-CoV-2 Infection
PrePF	Prevent Pulmonary Fibrosis
REGARDS	REasons for Geographic and Racial Differences in Stroke
SARP	Severe Asthma Research Program
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
SPIROMICS	Subpopulations and Intermediate Outcome Measures in COPD Study
SHS	Strong Heart Study

Running Title: Correlates of Resilience

Introduction

Resilience, defined as overcoming adversity or bouncing back from hardship, is an important factor linked to health and wellbeing.[1–3] Acute and chronic stress can accelerate biological aging and chronic disease risk through inflammatory, metabolic, and behavioral pathways.[4,5] Resilience capabilities that mitigate distress severity, support stress recovery, and promote wellness behaviors may influence such downstream effects.[6–8] For example, higher resilience (defined as the capacity of responding positively to stressful events) was associated with reduced hypertension risk over 10 years in middle-aged adults.[9–11] Psychosocial resilience may be a promising target for improving stress-related mechanisms that impact health.[12]

The COVID-19 pandemic came with prolonged, widespread difficulty spanning health, economic, and social spheres.[13–15] However, quantitative indicators of coping capacity and resilience manifestations in the face of the pandemic remain underexplored. This impact may be especially pronounced among sociodemographic groups experiencing social marginalization, since these groups tend to bear disproportionate burdens of chronic diseases, including cardiovascular disease. Examining pandemic-related resilience factors across a broad spectrum of populations can inform whether strengthened psychosocial interventions may be needed within communities most impacted.

We aimed to assess correlates of self-reported resilience during the COVID-19 pandemic using data from the Collaborative Cohort of Cohorts for COVID-19 Research (C4R) Study, a national observational study of adults comprising 14 established US prospective cohort studies. In the context of major racial and ethnic disparities in COVID-19 outcomes, we furthermore tested for differences in self-reported resilience and its correlates in major US racial and ethnic groups.

Methods

Study sample

The current analysis leverages data from the C4R study, which includes 14 established US prospective cohort studies[16] initially designed to study cardiovascular, pulmonary, and neurological health: Atherosclerosis Risk in Communities (ARIC),[17,18] Coronary Artery Risk Development in Young Adults (CARDIA),[19] Genetic Epidemiology of COPD (COPDGene),[20] Framingham Heart Study (FHS),[21] Hispanic Community Health Study/Study of Latinos (HCHS/SOL),[22,23] Jackson Heart Study (JHS),[24,25] Mediators of Atherosclerosis in South Asians Living in America (MASALA),[26] Multi-Ethnic Study of Atherosclerosis (MESA),[27] Northern Manhattan Study (NOMAS),[28] Prevent Pulmonary Fibrosis (PrePF),[29] REeasons for Geographic and Racial Differences in Stroke (REGARDS),[30] Severe Asthma Research Program (SARP),[31] Subpopulations and Intermediate Outcome Measures in COPD Study (SPIROMICS),[32] and the Strong Heart Study (SHS).[33,34] Details on each of the component cohorts are provided in Supplementary Materials.

The study sample consisted of C4R survey participants who responded to the self-reported resilience measure on a C4R questionnaire completed between January 2021 and February 2023 (**Supplemental Figure 1**).

The study was approved by cohort-specific Institutional Review Boards (IRB) as well as the Columbia University IRB. Participants provided informed consent for COVID-19-related follow-up activities. Data access was governed by an Analysis Commons model to facilitate data sharing while maintaining confidentiality and aligning with cohort-specific data use agreements.[16]

Outcome

The primary outcome variable was self-reported resilience assessed during the COVID-19 pandemic via a single item from the Brief Resilience Scale (BRS)[35]. The BRS is a standardized 6-item questionnaire assessing the ability to bounce back from stress and adversity. For this study, only one item from the BRS was available from the C4R questionnaire: "I tend to bounce back quickly after hard times." Participants responded to this item using a 5-point scale with options of "strongly disagree," "disagree," "neutral," "agree," or "strongly agree." For analysis, responses were dichotomized into two categories: reported resilience and reported non-resilient. Participants who responded "agree" or "strongly agree" were classified as reporting resilience, defined as having the ability to quickly recover from difficult situations. Those who responded "neutral," "disagree," or "strongly disagree" were classified as reporting non-resilience.[36]

Correlates

Variables included as potential correlates were race and ethnicity, demographic variables, clinical and behavioral factors and social determinants of health. Self-reported race/ethnicity was categorized as White, Black, Hispanic, American Indian, East Asian, or South Asian. Self-reported race/ethnicity categorization in the cohorts followed the approach used in the U.S. 2000 census,[37] which did not separate race and ethnicity as distinct constructs. Categories included White, Black, Hispanic, American Indian or Alaska Native, Asian (further divided into East Asian and South Asian), and Native Hawaiian or Other Pacific Islander.[16] Demographic variables included age in years at the time of C4R survey completion and sex. Clinical and behavioral factors were assessed at the time of the most recent pre-pandemic exam and consisted of body mass index, smoking status (never smoker, former smoker, current smoker), hypertension (defined as self-report or systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥ 90 mmHg at the last cohort exam or being on antihypertensive therapy), diabetes (defined as self-reported diabetes or fasting blood sugar ≥126 mg/dl at the last cohort exam or being on oral hypoglycemic agents/insulin), COVID-19 vaccination status at C4R survey completion, and self-reported history of COVID-19 infection at C4R survey completion. Social determinants of health assessed prior to the pandemic included educational attainment (< high school, high school, some college, college graduate), marital status (single, married, widowed, divorced, other), occupational status at C4R survey completion (employed, not employed), health insurance status at C4R survey completion (private, public, both, none), and consumer price index adjusted (CPI) annual household income in US dollars at C4R survey completion (<$50,000, $50,000-100,000, >$100,000).

Statistical Analysis

The associations of self-reported resilience with the potential correlates were examined using multivariable logistic regression models. A minimally adjusted model included race/ethnicity, age, and sex. The fully adjusted model incorporated body mass index, smoking status, hypertension, diabetes, COVID-19 vaccination status at the time of questionnaire completion, COVID-19 infection status, and social determinants of health (educational attainment, marital status, occupation, health insurance status, and income). Effect modification by race/ethnicity was tested via multiplicative interaction terms and fully stratified models.

To account for missing covariate data (<5% except for marital status, household income, and insurance; **Table 1**), multiple imputation was implemented using the Multiple Imputation by Chained Equations (MICE) package in R to generate 5 imputed datasets. Complete case analyses were included as secondary analyses. Analyses were conducted independently in each imputed dataset, and results were pooled using the SAS PROC MIANALYZE procedure under Rubin's Rules.

All analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC). Statistical significance was defined as a two-tailed alpha level of 0.05.

Results

Participant characteristics are provided in **Table 2**. Of 31,007 participants in the imputed dataset, 74.4% (n=23,078) were classified as resilient. There were differences in the prevalence of self-reported resilience across racial and ethnic groups (p<0.0001), ranging from 76.2% for Black to 54.9% in East Asian participants (**Table 1**). There were differences in self-reported resilience across BMI categories, smoking status groups, and hypertension, diabetes, COVID-19 vaccination status, COVID-19 infection status, education level, marital status, employment status, insurance status, and income levels.

Correlates of self-reported resilience

Correlates of resilience are presented in **Table 3**. In the fully adjusted model, Black and Hispanic participants reported 25% (aOR 1.25, 95% CI 1.16-1.34) and 42% (aOR 1.42, 95% CI 1.30-1.55) higher odds of resilience compared to White participants, while East Asian and American Indian participants had 52% (OR 0.48, 95% CI 0.38-0.62) and 20% (OR 0.80, 95% CI 0.69-0.92) lower odds, respectively.

Participants with a high school degree, some college, or a college degree or higher reported 27% (aOR 1.27, 95% CI 1.16-1.40), 30% (aOR 1.30, 95% CI 1.17-1.43), and 41% (aOR 1.41, 95% CI 1.28-1.55) higher odds of resilience, respectively, compared to those with less than a high school education. Single participants reported 10% lower odds of resilience compared to married/living as married participants (OR 0.90, 95% CI 0.83-0.98). Unemployment was associated with 15% lower odds of resilience (OR 0.85, 95% CI 0.80-0.90).

Compared to those with public insurance only, participants with no insurance, private insurance only, or both private and public insurance reported 18% (aOR 1.18, 95% CI 1.01-1.37), 27% (aOR 1.27, 95% CI 1.12-1.45), and 20% (aOR 1.20, 95% CI 1.02-1.41) higher odds of resilience, respectively. Those earning $50,000-100,000 and over $100,000 annually reported 9% (aOR 1.09, 95% CI 1.01-1.18) and 22% (aOR 1.22, 95% CI 1.11-1.34) higher odds of resilience, respectively, compared to those earning less than $50,000.

Stratified Analysis by Race and Ethnicity

Results were similar in models stratified by race and ethnicity, although there was evidence to suggest effect modification for several correlates. Compared to males, females reported lower odds of resilience among White (aOR 0.85, 95% CI 0.79-0.92), Black (aOR 0.83, 95% CI 0.73-0.95), and Hispanic (aOR 0.76, 95% CI 0.67-0.87) participants, and higher odds of resilience among South Asian participants (aOR 1.92, 95% CI 1.20-3.08) (interaction p value <0.026; **Figure 1**). Hypertension was associated with resilience in Hispanic participants only (aOR 0.81, 95% CI 0.71-0.92; interaction p value <0.001), (**Figure 2**). Compared to married/living as married participants, those who were single reported lower odds of resilience among White participants (aOR 0.86, 95% CI 0.75-0.99) and Black participants (aOR 0.76, 95% CI 0.62-0.94), but not other racial and ethnic groups (interaction p value 0.004; **Figure 3**). Compared to those with public insurance only, Hispanic participants with no insurance reported higher odds of resilience (aOR 2.09, 95% CI 0.48-2.31) whereas lack of insurance was inversely associated with resilience in other groups (interaction p-value <.001; **Figure 4**). A significant interaction was observed between race/ethnicity and age in relation to resilience (p<0.001). Despite this interaction, the overall pattern of how age related to resilience was generally consistent across racial and ethnic groups, with only minor variations in the strength of the association (**Figure 5**).

Complete case analyses

Participant characteristics for complete cases were similar to the primary (imputed) analysis sample (**Supplemental Table 1).** Complete case analysis results were similar to the main results (**Supplemental Table 2**).

Discussion

In a nationwide meta-cohort of US adults, self-reported resilience differed by sociodemographic and clinical factors. Greater self-reported resilience was observed among Black and Hispanic participants, and those with higher education, married status, and higher income, while female sex and unemployment were associated with lower resilience. The findings of this study should be interpreted in the context of the COVID-19 pandemic, which created an unprecedented global crisis that exposed and exacerbated existing social, economic, and health disparities.[38] The strain on healthcare systems, widespread job losses, and disruptions to daily life likely had a profound impact on individuals' perception of their ability to cope with and bounce back from adversity.[14,39,40]

In this context, the observed differences in self-reported resilience across racial, ethnic, and sociodemographic groups may reflect the unequal distribution of resources, support, and opportunities that enable individuals to navigate the challenges of the pandemic.[41,42] For example, the lower odds of resilience among East Asian participants may be related to the increased discrimination and stigma faced by Asian Americans during the pandemic.[43] Similarly, the lower resilience among persons with lower education and income may reflect the disproportionate economic impact of the pandemic on these groups, as well as their limited access to healthcare and other essential resources.[44,45]

The higher odds of resilience among Black and Hispanic participants, despite the well-documented health and social inequities faced by these populations,[46] may seem counterintuitive.

However, this finding shows the importance of considering resilience as a dynamic process shaped by the interaction between individuals and their environment.[47,48] The resilience reported by these populations may reflect the collective strengths, resources, and coping strategies that have been developed in response to historical and ongoing adversity.[49,50] It is crucial to recognize and build upon these community-level assets while also addressing the structural inequities that create the need for resilience in the first place.

The associations between sociodemographic factors and resilience observed in this study align with previous research, emphasizing the importance of education, income, and social support in promoting resilience.[51] However, the persistence of racial and ethnic differences in resilience, even after accounting for these factors, show an additional need to identify and address the unique challenges and resources that shape resilience outcomes in various populations, potentially leading to more effective interventions and policies.

Resilience is a complex construct that has been defined and operationalized in various ways in the literature. It is often described as the ability to bounce back or recover from adversity, stress, or trauma.[1,47] However, there is ongoing debate about the precise definition and measurement of resilience. Some researchers conceptualize resilience as a trait or personal characteristic, while others view it as a dynamic process that can be developed and strengthened over time.[52–54] The findings of this study suggest that resilience is not solely an individual trait but rather a product of the complex interplay between individuals, their environment, and their current sociopolitical context, in this case, during the COVID-19 pandemic. Additionally, the single-item measure of resilience used in this study, from the Brief Resilience Scale (BRS),[35] while providing a snapshot of participants' perceived ability to bounce back from adversity, may not fully capture the multidimensional nature of resilience in the context of a global pandemic.

Although reports of resilience in this study may reflect individuals' ability to cope with and adapt to the specific stressors and adversities related to the pandemic, it is possible that resilience levels and associated factors could differ in other contexts or during non-crisis times. Hence, perhaps resilience could be conceptualized as “healthy” versus “unhealthy” resilience. "Healthy resilience" refers to the ability to adapt and cope with adversity in a manner that promotes overall well-being and growth. In contrast "unhealthy resilience" involves coping mechanisms that may provide short-term relief but ultimately have detrimental effects on mental and physical health.[55,56] The distinction between "healthy" and "unhealthy" resilience highlights the need for a nuanced understanding of resilience that considers not only the immediate ability to bounce back from adversity but also the long-term implications for individual and collective well-being.

The findings of this study have important implications for interventions and policies aimed at promoting resilience in the face of the COVID-19 pandemic and future crises. While most participants in our study reported being resilient during the pandemic, it is unclear whether this resilience was “healthy” or “unhealthy.” Distinguishing between these different types of resilience and their associated outcomes would be important; this could involve developing and validating measures that capture the multidimensional nature of resilience and longitudinal studies that track the effects of resilience over time. However, it is crucial to recognize that the development of resilience is not solely an individual responsibility but is also influenced by the broader social, economic, and political contexts. The observed disparities in resilience across racial, ethnic, and socioeconomic groups in our study show the impact of systemic inequities and underinvestment in communities on individuals' capacity to cope with adversity. Therefore, efforts to promote resilience must address the structural inequities and social determinants of health that create differential vulnerability to adversity.[57] This may involve policies that ensure equitable access to healthcare, education, and economic opportunities and interventions that build community-level resilience through social support, collective action, and advocacy.[58] While individual-level interventions, such as teaching coping skills and stress management techniques, can be beneficial, a comprehensive approach that recognizes the complex interplay between individual, community, and societal factors is necessary to foster resilience and promote health equity.[48,57,59]

Finally, the findings of this study underscore the importance of considering the social and structural factors that shape resilience. The observed disparities in resilience across racial and ethnic groups and sociodemographic factors suggest that resilience is not solely an individual trait but is also influenced by the broader social and economic context. Efforts to promote resilience should, therefore, address not only individual-level factors but also the social determinants of health that may constrain or enable resilience in different populations.[60]

Limitations

This study has several limitations that should be considered when interpreting the results. While the study included a large and diverse sample, it was not sampled to be directly representative of the U.S. general population. Also, there may be additional factors related to resilience that were not captured in this study, such as personality traits, coping strategies, and community-level factors. Considerations should be accorded to these and other potential sources of resilience to develop a more comprehensive understanding of this important construct. We also acknowledge the presence of wide confidence intervals for some estimates in the context of smaller sample sizes.

Conclusion

This study provides important insights into the factors associated with self-reported resilience during the COVID-19 pandemic in a large, diverse sample of U.S. adults. Our findings highlight significant racial and ethnic differences in self-reported resilience. At the same time, our results indicate the importance of considering the social and structural factors that contribute to resilience, including the critical role of the environmental context in shaping resilience outcomes. Higher levels of education, income, and social support were consistently associated with greater resilience across racial and ethnic groups, highlighting the need for policies and interventions that promote access to these resilience-enhancing resources. The finding that social determinants of health partially mediated the relationship between race/ethnicity and resilience further emphasizes the role of social and economic inequities in shaping disparities in resilience outcomes and highlights the need for a more comprehensive and equity-focused approach to promoting resilience in the face of adversity.

As the world continues to grapple with the impacts of the COVID-19 pandemic and other global challenges, understanding and promoting "healthy" resilience is important. This study provides important information on the complex interplay of individual, social, and structural factors that shape resilience. It shows the need for a multifaceted approach that goes beyond individual-level factors and addresses the broader social, economic, and political contexts that shape individuals' experiences of adversity and their capacity to cope and adapt. Recognizing and addressing the structural inequities that create differential vulnerability to crises, can lead to building a more resilient and just society for all.

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Tables

Table 1. Sociodemographic Characteristics of Participants with Missingness, Stratified by Race/Ethnicity

Sample Characteristics[a]	White n = 15933 (51.39%)	East Asian n = 293 (0.94%)	Black n = 6724 (21.69%)	Hispanic n = 6307 (20.34%)	AIAN n = 1185 (3.82%)	South Asian n = 565 (1.82%)	Total N = 31007	**p-value Chi-sq**
Resilience[b]								<.0001
Disagree	4110 (25.8)	132 (45.05)	1599 (23.78)	1556 (24.67)	394 (33.25)	138 (24.42)	7929 (25.57)	
Agree	11823 (74.2)	161 (54.95)	5125 (76.22)	4751 (75.33)	791 (66.75)	427 (75.58)	23078 (74.43)	
Sex								<.0001
Female	8915 (55.95)	155 (52.9)	4399 (65.42)	4060 (64.37)	804 (67.85)	322 (56.99)	18655 (60.16)	
Male	7016 (44.03)	138 (47.1)	2325 (34.59)	2247 (35.63)	381 (32.15)	243 (43.01)	12350 (39.83)	
Missing	2 (0.01)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (0.01)	
Age (years)								<.0001
Age <65	3909 (24.53)	15 (5.12)	2045 (30.41)	3805 (60.33	630 (53.16)	325 (57.52)	10729 (34.6)	
65-74	4189 (26.29)	133 (45.39)	2021 (30.06)	1552 (24.61)	177 (14.94)	170 (30.09)	8242 (26.58)	
75-84	5542 (34.78)	95 (32.42)	1958 (29.12)	796 (12.62)	226 (19.07)	70 (12.39)	8687 (28.02)	
≥85	2270 (14.25)	50 (17.06)	685 (10.19)	154 (2.44)	43 (3.63)	0 (0)	3202 (10.33)	
Missing	23 (0.14)	0 (0)	15 (0.22)	0 (0)	109 (9.2)	0 (0)	147 (0.47)	
Body Mass Index[c]								<.0001
Underweight	145 (0.91)	7 (2.39)	41 (0.61)	37 (0.59)	7 (0.59)	1 (0.18)	238 (0.77)	
Healthy	4412 (27.69)	177 (60.41)	981 (14.59)	1036 (16.43)	157 (13.25)	222 (39.29)	6985 (22.53)	
Overweight	5977 (37.51)	94 (32.08)	2133 (31.72)	2494 (39.54)	351 (29.62)	251 (44.42)	11300 (36.44)	
Obesity	4289 (26.92)	15 (5.12)	2821 (41.95)	2393 (37.94)	500 (42.19)	86 (15.22)	10104 (32.59)	
Severe Obesity	608 (3.82)	0 (0)	739 (10.99)	343 (5.44)	169 (14.26)	5 (0.88)	1864 (6.01)	
Missing	502 (3.15)	0 (0)	9 (0.13)	4 (0.06)	1 (0.08)	0 (0)	516 (1.66)	
Smoking Status								<.0001
Never	7094 (44.52)	215 (73.38)	3477 (51.71)	3830 (60.73)	459 (38.73)	459 (81.24)	15534 (50.1)	
Former	7368 (46.24)	72 (24.57)	2134 (31.74)	1578 (25.02)	296 (24.98)	93 (16.46)	11541 (37.22)	

Current	1428 (8.96)	6 (2.05)	1050 (15.62)	873 (13.84)	427 (36.03)	13 (2.3)	3797 (12.25)	
Missing	43 (0.27)	0 (0)	63 (0.94)	26 (0.41)	3 (0.25)	0 (0)	135 (0.44)	
Hypertension								<.0001
No	6409 (40.22)	122 (41.64)	1642 (24.42)	3044 (48.26)	474 (40.0)	306 (54.16)	11997 (38.69)	
Yes	9395 (58.97)	171 (58.36)	5081 (75.57)	3263 (51.74)	711 (60.0)	259 (45.84)	18880 (60.89)	
Missing	129 (0.81)	0 (0)	1 (0.01)	0 (0)	0 (0)	0 (0)	130 (0.42)	
Diabetes								<.0001
Missing	210 (1.32)	0 (0)	29 (0.43)	0 (0)	3 (0.25)	0 (0)	242 (0.78)	
No	13256 (83.2)	227 (77.5)	4763 (70.8)	4777 (75.7)	740 (62.5)	276 (48.9)	24039 (77.5)	
Yes	2467 (15.5)	66 (22.5)	1932 (28.7)	1530 (24.3)	442 (37.3)	289 (51.2)	6726 (21.7)	
Vaccine Status								<.0001
Missing	208 (1.3)	7 (2.4)	303 (4.5)	99 (1.6)	59 (5.0)	1 (0.2)	677 2.2)	
No	2486 (15.6)	22 (7.5)	637 (9.5)	1047 (16.6)	226 (19.1)	181 (32.0)	4599 (14.8)	
Yes	13239 (83.1)	264 (90.1)	5784 (86.0)	5161 (81.8)	900 (76.0)	383 (67.8)	25731 (83.0)	
Infection								<.0001
Missing	39 (0.2)	0 (0)	17 (0.3)	1 (0.02)	0 (0)	0 (0)	57 (0.18)	
No	14254 (89.46)	282 (96.26)	6025 (89.6)	4350 (68.97)	724 (61.1)	534 (94.51)	26169 (84.4)	
Yes	1640 (10.29)	11 (3.75)	682 (10.14)	1956 (31.01)	461 (38.9)	31 (5.49)	4781 (15.42)	
Education								<.0001
Missing	859 (5.39)	0 (0)	113 (1.68)	38 (0.6)	15 (1.27)	0 (0)	1025 (3.31)	
< High School	522 (3.28)	65 (22.18)	685 (10.19)	2275 (36.07)	157 (13.25)	6 (1.06)	3710 (11.97)	
High School	2919 (18.32)	42 (14.33)	1669 (24.82)	1533 (24.31)	514 (43.38)	16 (2.38)	6693 (21.59)	
Some College	3103 (19.48)	59 (20.14)	1467 (21.82)	958 (15.19)	291 (24.56)	27 (4.78)	5905 (19.04)	
College+	8530 (53.54)	127 (43.34)	2790 (41.49)	1503 (23.83)	208 (17.55)	516 (91.33)	13674 (44.1)	
Marital Status								<.0001
Missing	1615 (10.14)	0 (0)	2152 (32.0)	28 (0.44)	14 (1.18)	0 (0)	3809 (12.28)	
Single	1190 (7.46)	4 (1.37)	526 (7.82)	1374 (21.79)	264 (22.28)	8 (1.42)	3366 (10.86)	

Married/Living as Married	10172 (63.84)	241 (82.25)	2190 (32.57)	3427 (54.34)	601 (50.72)	525 (92.92)	17156 (55.33)	
Widowed	1264 (7.93)	32 (10.92)	721 (10.72)	85 (1.35)	74 (6.24)	20 (3.54)	2196 (7.08)	
Divorced/Separated	1652 (10.37)	16 (5.46)	1067 (15.87)	1393 (22.09)	232 (19.58)	12 (2.12)	4372 (14.1)	
Other	40 (0.25)	0 (0)	68 (1.01)	0 (0)	0 (0)	0 (0)	108 (0.35)	
Occupation								<.0001
Missing	591 (3.71)	0 (0)	134 (1.99)	34 (0.54)	829 (69.96)	565 (100)	2153 (6.94)	
Employed	8049 (50.52)	117 (39.93)	3984 (59.25)	3123 (49.52)	256 (21.6)	0 (0)	15529 (50.08)	
Other than Employed	7293 (45.77)	176 (60.07)	2606 (38.76)	3150 (49.94)	100 (8.44)	0 (0)	13325 (42.97)	
Household Income[d]								<.0001
Missing	2517 (15.8)	0 (0)	683 (10.16)	565 (8.96)	127 (10.72)	565 (100.0)	4457 (14.37)	
< $50,000	5044 (31.66)	188 (64.16)	3376 (50.21)	4750 (75.31)	761 (64.22)	0 (0)	14119 (45.53)	
$50,000-100,000	4074 (25.57)	58 (19.8)	1568 (23.32)	776 (12.3)	249 (21.01)	0 (0)	6725 (21.69)	
>$100,000	4298 (26.98)	47 (16.04)	1097 (16.31)	216 (3.42)	48 (4.05)	0 (0)	5706 (18.4)	
Insurance - Types								<.0001
Missing	1627 (10.21)	0 (0)	383 (5.7)	25 (0.4)	870 (73.42)	565 (100)	3470 (11.19)	
No insurance	277 (1.74)	7 (2.39)	427 (6.35)	1525 (24.18)	103 (8.69)	0 (0)	2339 (7.54)	
Private Insurance Only	4258 (26.72)	75 (25.6)	1965 (29.22)	291 (4.61)	134 (11.31)	0 (0)	6723 (21.68)	
Public Insurance Only	770 (4.83)	107 (36.52)	599 (8.91)	299 (4.74)	37 (3.12)	0 (0)	1812 (5.84)	
Private & Public Insurance	1016 (6.38)	98 (33.45)	351 (5.22)	186 (2.95)	18 (1.52)	0 (0)	1669 (5.38)	
Unknown Insurance[e]	7985 (50.12)	6 (2.05)	2999 (44.6)	3981 (63.12)	23 (1.94)	0 (0)	14994 (48.36)	

[a]This table indicates proportion of missing data for each variable
[b]W1Q measurement of resilience is favored when the participants have both W1Q and W2Q measures. We adopted the first record of resilience. Additionally, we combined the original "Strongly Disagree," "Disagree" and "Neutral" groups into the new "Disagree" group, the original "Strongly Agree" and "Agree" groups into the new "Agree" group.
[c] The BMI categories are underweight (<18.5,) healthy weight (18.5-24.9,) overweight (25.0-29.9,) obesity (30.0-39.9) and severe obesity (>40.0.)
[d]Income is standardized into 2020 dollars using customer price index (CPI, CPI_{2020} = 258.811.)
[e]Participants have insurance, but the exact insurance type is unknown

Table 2. Participant characteristics by self-reported resilience status using multiple imputed data

	Response to "I tend to bounce back quickly after hard times"		
Sample characteristics [a]	**Agree or strongly agree, "Resilient" (%)** [b]	**Neutral, disagree, or strongly disagree, "Not Resilient" (%)**	**Total**
Classified events, n	23078 (74.4)	7929 (25,6)	31007
Race and ethnicity [c]			
White	11823 (51.2)	4110 (51.8)	15933 (51.4)
American Indian	791 (3.4)	394 (5.0)	1185 (3.8)
Black	5125 (22.2)	1599 (20.2)	6724 (21.7)
East Asian	161 (0.7)	132 (1.7)	293 (0.9)
Hispanic	4751 (20.6)	1556 (19.6)	6307 (20.3)
South Asian	427 (1.9)	138 (1.7)	565 (1.8)
Age group			
<65 years	8065 (34.9)	2727 (34.4)	10792 (34.8)
65 − *<75 years*	6186 (26.8)	2084 (26.3)	8270 (26.7)
75 − *<85 years*	6518 (28.2)	2206 (27.8)	8724 (28.1)
≥85 years	2309 (10.0)	912 (11.5)	3221 (10.4)
Sex			
Female	13580 (58.8)	5076 (64.0)	18656 (60.2)
Male	9498 (41.2)	2853 (36.0)	12351 (39.8)
BMI			
Underweight (<18.5 kg/m^2)	172 (0.7)	70 (0.9)	242 (0.8)
Healthy (18.5- 24.9 kg/m^2)	5188 (22.5)	1928 (24.3)	7116 (22.9)
Overweight (25.0-29.9 kg/m^2)	8694 (37.7)	2783 (35.1)	11477 (37.0)
Obesity (30.0-39.9 kg/m^2)	7692 (33.3)	2593 (32.7)	10284 (33.2)
Severe obesity (>40.0 kg/m^2)	1333 (5.8)	555 (7.0)	1888 (6.1)
Smoking status			
Never	11578 (50.2)	4034 (50.9)	15612 (50.4)
Former	8754 (37.9)	2829 (35.7)	11583 (37.4)
Current	2746 (11.9)	1065 (13.4)	3812 (12.3)
Diabetes	4896 (21.2)	1861 (23.5)	6758 (21.8)
Hypertension	14018 (60.7)	4908 (61.9)	18926 (61.0)
Vaccinated at time of C4R survey	19594 (84.9)	6702 (84.5)	26296 (84.8)

COVID-19 infection at time of C4R survey	3583 (15.5)	1206 (15.2)	4789 (15.4)
Education			
< high school	2653 (11.5)	1164 (14.7)	3817 (12.3)
High school	5057 (21.9)	1847 (23.3)	6904 (22.3)
Some college	4461 (19.3)	1585 (20.0)	6046 (19.5)
College +	10907 (47.3)	3333 (42.0)	14240 (45.9)
Marital status			
Single	2877 (12.5)	1097 (13.8)	3973 (12.8)
Married/living as married	14629 (63.4)	4772 (60.2)	19401 (62.6)
Widowed	1816 (7.9)	653 (8.2)	2469 (8.0)
Divorced/Separated	3756 (16.3)	1407 (17.7)	5163 (16.7)
Employed	12854 (55.7)	4006 (50.5)	16859 (54.4)
Health insurance			
No insurance	2212 (9.6)	791 (10.0)	3004 (9.7)
Private insurance only	6111 (26.5)	1809 (22.8)	7920 (25.5)
Public insurance only	1439 (6.2)	648 (8.2)	2087 (6.7)
Private and public insurances	1326 (5.7)	470 (5.9)	1796 (5.8)
Unknown type of insurance[e]	11989 (52.0)	4211 (53.1)	16201 (52.2)
Household Income[f]			
< $50,000	11787 (51.1)	4521 (57.0)	16308 (52.6)
$50,000 – 100,000	5823 (25.2)	1856 (23.4)	7678 (24.8)
> $100,000	5469 (23.7)	1552 (19.6)	7021 (22.6)
Study			
ARIC	3260 (14.1)	849 (10.7)	4109 (13.3)
CARDIA	1353 (5.9)	445 (5.6)	1798 (5.8)
COPDGene	1896 (8.2)	472 (6.0)	2368 (7.6)
FHS	2190 (9.5)	899 (11.3)	3089 (10.0)
HCHS	4161 (18.0)	1205 (15.2)	5366 (17.3)
JHS	1250 (5.4)	330 (4.2)	1580 (5.1)
MASALA	427 (1.9)	138 (1.7)	565 (1.8)
MESA	1402 (6.1)	507 (6.4)	1909 (6.2)
NOMAS	313 (1.4)	293 (3.7)	606 (2.0)
PrePF	392 (1.7)	133 (1.7)	525 (1.7)
REGARDS	5076 (22.0)	2087 (26.3)	7163 (23.1)
SARP	167 (0.7)	84 (1.1)	251 (0.8)

SHS	760 (3.3)	379 (4.8)	1139 (3.7)
SPIROMICS	431 (1.9)	108 (1.4)	539 (1.7)

[a] All counts and column percentages are averaged values from 5 imputed datasets.
[b] W1Q measurement of resilience is favored when the participants have both W1Q and W2Q measures. We adopted the first record of resilience. Additionally, we combined the original "Strongly Disagree," "Disagree" and "Neutral" groups into the new "Disagree" group, the original "Strongly Agree" and "Agree" groups into the new "Agree" group.
[c] Asian participants in cohorts other than MASALA or MESA were dropped due to unclear race and ethnicity measurements and small sample sizes.
[d] The BMI categories are underweight (<18.5,) healthy weight (18.5-24.9,) overweight (25.0-29.9,) obesity (30.0-39.9) and severe obesity (>40.0.)
[e]Participants have insurance, but the exact insurance type is unknown
[f]Income is standardized into 2020 dollars using customer price index (CPI, CPI_{2020} = 258.811.)

Table 3. Multivariable-adjusted associations with self-reported resilience using multiple imputed data

Variable (reference)	**Model 1**		**Model 2**	
Race and ethnicity (White)	OR (95% CI)	p-value	OR (95% CI)	p-value
American Indian	**0.71 (0.62, 0.80)**	**<.0001**	**0.80 (0.69, 0.92)**	**0.003**
Black	**1.13 (1.06, 1.21)**	**0.0003**	**1.25 (1.16, 1.34)**	**<.0001**
East Asian	**0.42 (0.33, 0.53)**	**<.0001**	**0.48 (0.38, 0.62)**	**<.0001**
Hispanic	1.06 (0.99, 1.14)	0.10	**1.42 (1.30, 1.55)**	**<.0001**
South Asian	1.05 (0.87, 1.28)	0.60	0.91 (0.74, 1.12)	0.37
Age group (Age <65)				
≤ 65 *and <75*	1.00 (0.94, 1.07)	0.96	**1.08 (1.01, 1.17)**	**0.03**
≤ 75 *and <85*	1.00 (0.93, 1.07)	0.98	**1.09 (1.01, 1.19)**	**0.03**
Age>85	**0.86 (0.79, 0.95)**	**0.002**	0.96 (0.86, 1.07)	0.47
Sex (Male)				
Female	**0.80 (0.76, 0.84)**	**<.0001**	**0.84 (0.79, 0.89)**	**<.0001**
BMI (Healthy)				
Underweight			0.98 (0.74, 1.31)	0.90
Overweight			**1.12 (1.04, 1.20)**	**0.002**
Obesity			**1.08 (1.01, 1.17)**	**0.03**
Severe obesity			0.92 (0.82, 1.04)	0.19
Smoking status (Never)				
Former			**1.10 (1.03, 1.16)**	**0.002**
Current			0.97 (0.89, 1.06)	0.49
Diabetes status (No)				
Yes			**0.90 (0.85, 0.96)**	**0.003**
Hypertension status (No)				
Yes			0.96 (0.91, 1.02)	0.25
Vaccine status at completion of C4R survey (No)				
Yes			1.01 (0.94, 1.09)	0.84
COVID-19 infection at time of C4R survey (No)				
Yes			1.04 (0.96, 1.12)	0.34
Education (< high school)				
High school			**1.27 (1.16, 1.40)**	**<.0001**

Some college			**1.30 (1.17, 1.43)**	**<.0001**
College +			**1.41 (1.28, 1.55)**	**<.0001**
Marital status (Married/living as married)				
Single			**0.90 (0.83, 0.98)**	**0.02**
Widowed			1.12 (1.00, 1.26)	0.05
Divorced/Separated			0.92 (0.85, 1.00)	0.05
Occupation (Employed)				
Other than employed			**0.85 (0.80, 0.90)**	**<.0001**
Health insurance (Public insurance only)				
No insurance			**1.18 (1.01, 1.37)**	**0.04**
Private insurance only			**1.27 (1.12, 1.45)**	**0.0005**
Private and public insurances			**1.20 (1.02, 1.41)**	**0.03**
Unknown type of insurance			1.09 (0.97, 1.22)	0.16
Income (< $50,000)				
$50,000 – 100,000			**1.09 (1.01, 1.18)**	**0.02**
> $100,000			**1.22 (1.11, 1.34)**	**0.0001**

Bold: Statistically significant at p<0.05; Ref. Reference

Figure Legends

Figure 1. Forest plot of associations of each correlate with self-reported resilience by race and ethnicity

Figure 2. Forest plot of associations of sex with self-reported resilience by race and ethnicity

Figure 3. Forest plot of associations of hypertension with self-reported resilience by race and ethnicity

Figure 4. Forest plot of associations of marital status with self-reported resilience by race and ethnicity

Figure 5. Forest plot of associations of insurance with self-reported resilience by race and ethnicity

Figures

Figure 1. Forest plot of associations of age with self-reported resilience by race and ethnicity

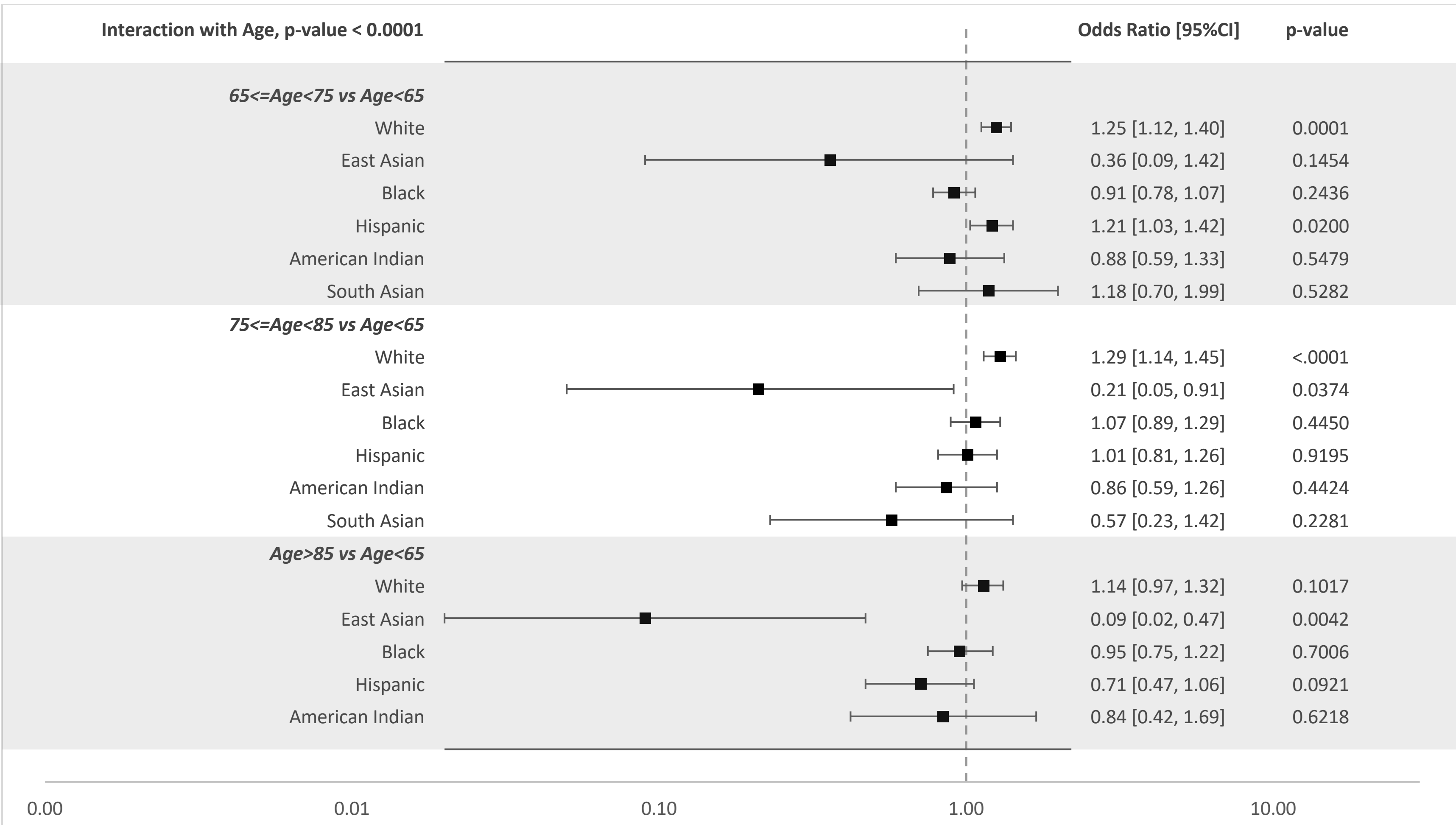


Figure 2. Forest plot of associations of sex with self-reported resilience by race and ethnicity

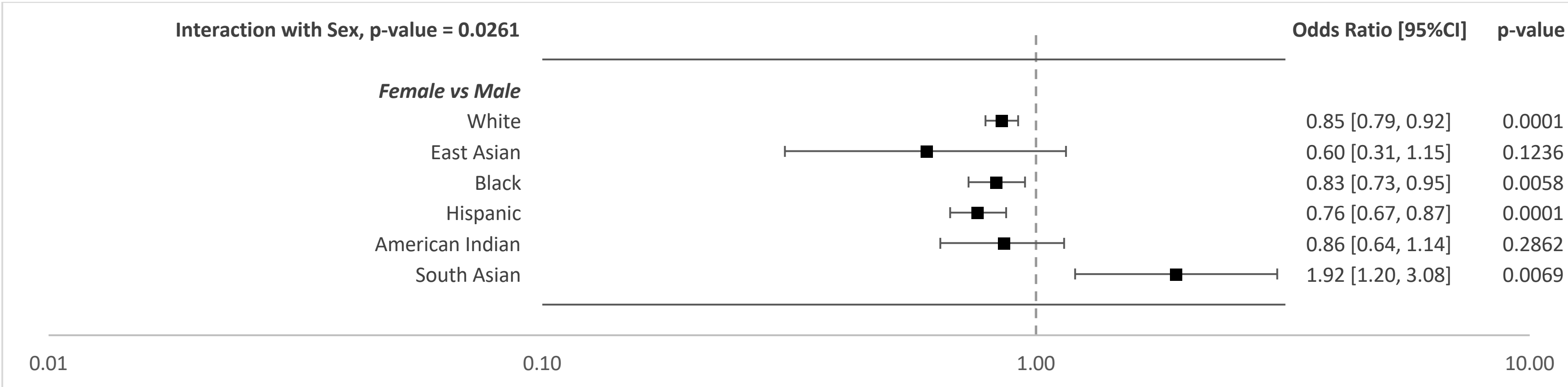


Figure 3. Forest plot of associations of hypertension with self-reported resilience by race and ethnicity

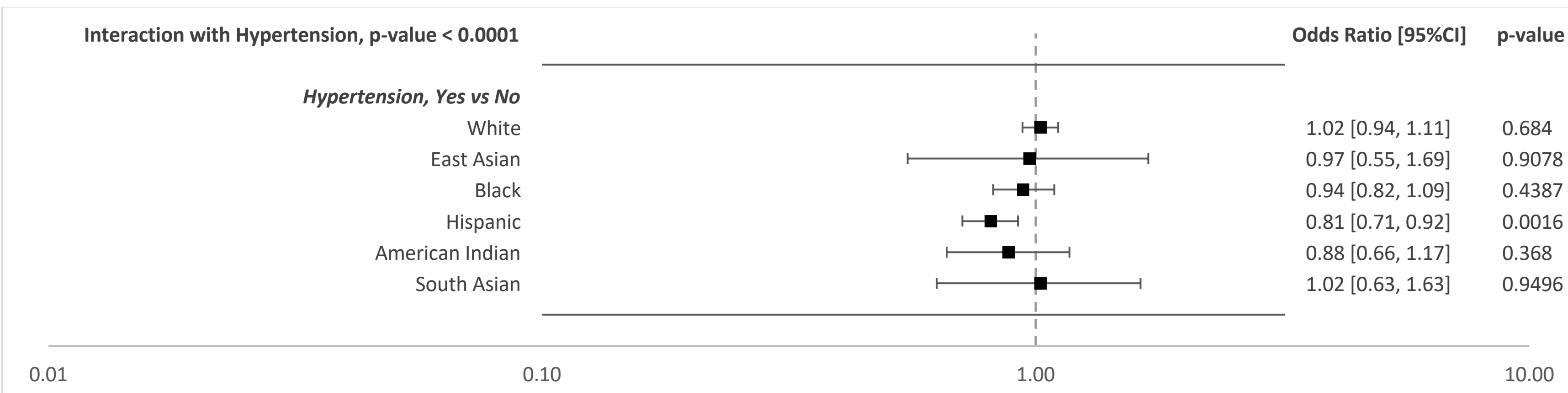


Figure 4. Forest plot of associations of marital status with self-reported resilience by race and ethnicity

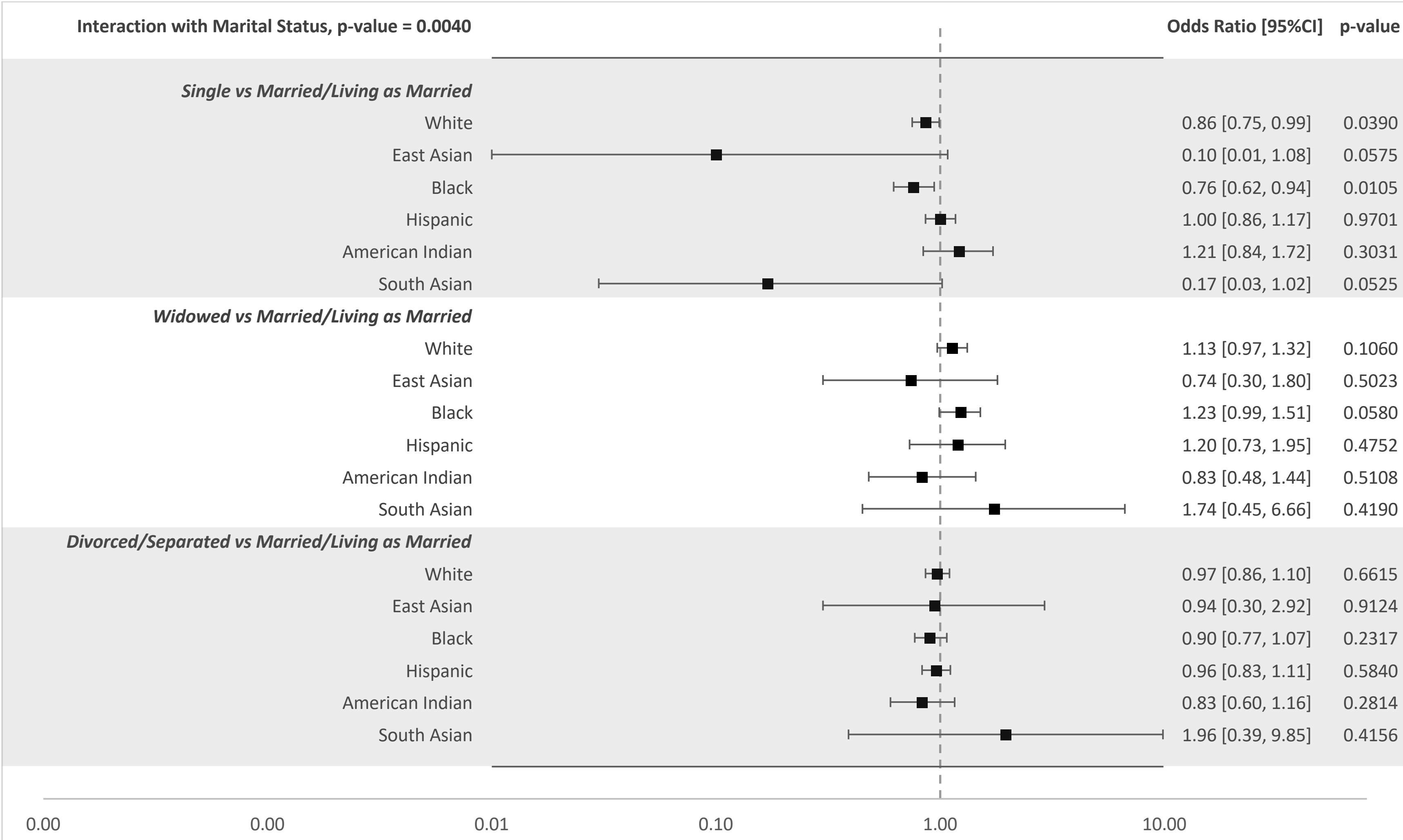
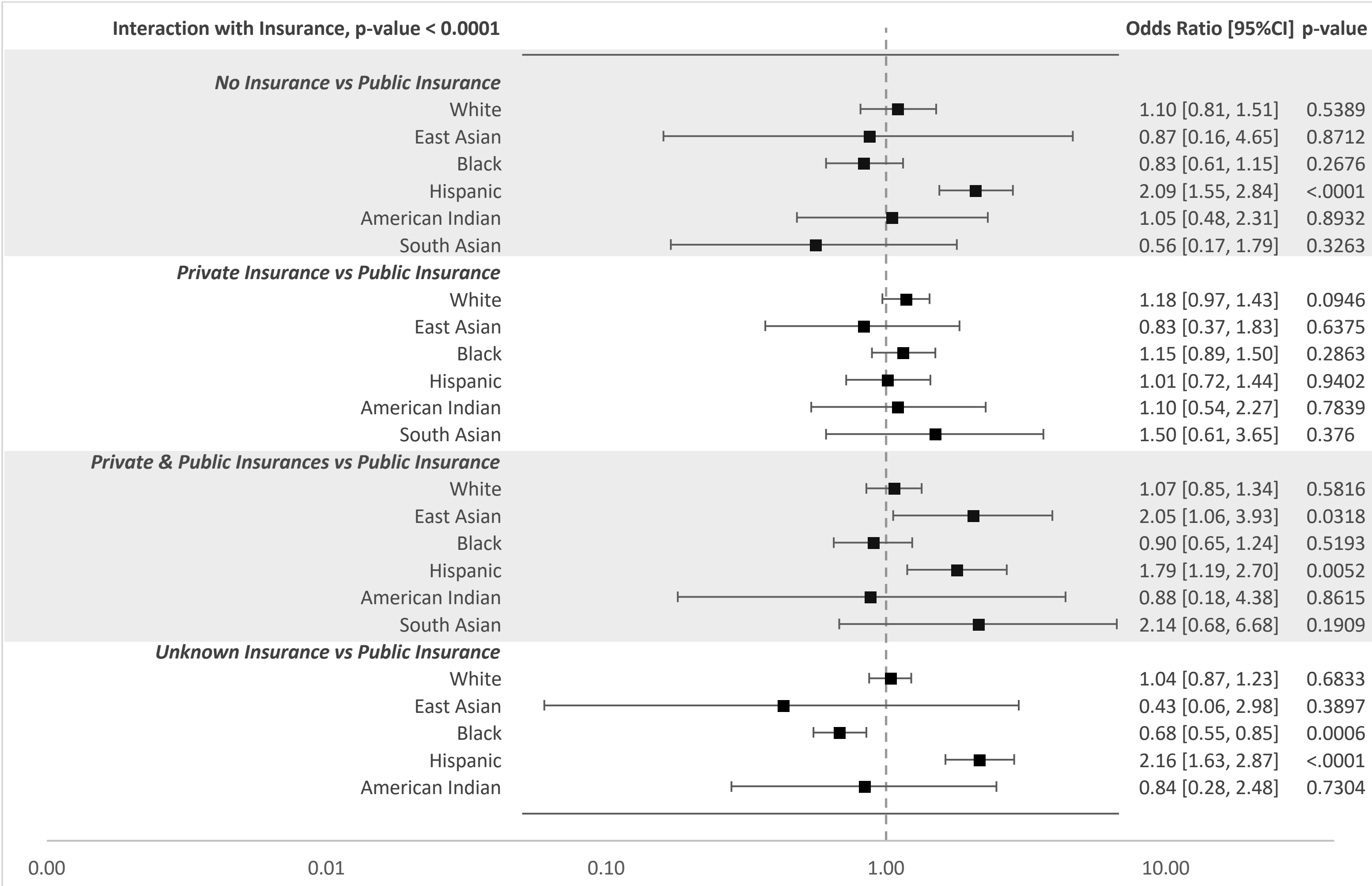


Figure 5. Forest plot of associations of insurance with self-reported resilience by race and ethnicity



For Unblinded Manuscript

Acknowledgment

Access to pooled C4R data is regulated by the C4R Study's publications and presentations policy, which is available on the C4R website (https://c4r-nih.org). Data are made available for analyses in the C4R Analysis Commons for investigators with manuscript proposals approved by the C4R publications and cohort coordinating committees, as well as by each cohort included in a given proposal. Once harmonization and related quality control have been completed, C4R common data elements will be transferred as a limited data set for public access on BioData Catalyst, in accord with cohort-specific consents and commitments.

We thank the participants in each cohort study for their dedication. We thank the staff and participants of the Jackson Heart Study. We also thank the MESA investigators and the staff and participants of the REGARDS Study for their valuable contributions. In addition, we acknowledge the dedication of the Framingham Heart Study participants, without whom this research would not have been possible.

Funding

The Collaborative Cohort of Cohorts for COVID-19 Research (C4R) Study is supported by National Heart, Lung, and Blood Institute (NHLBI)–Collaborating Network of Networks for Evaluating COVID-19 and Therapeutic Strategies (CONNECTS) grant OT2HL156812, with cofunding from the National Institute of Neurological Disorders and Stroke (NINDS) and the National Institute on Aging (NIA). The Atherosclerosis Risk in Communities Study has been funded in whole or in part by the NHLBI, National Institutes of Health (NIH), US Department of Health and Human Services, under contracts 75N92022D00001, 75N92022D00002, 75N92022D00003, 75N92022D00004, and 75N92022D00005. Neurocognitive data are collected under grants U01 2U01HL096812, 2U01HL096814, 2U01HL096899, 2U01HL096902, and 2U01HL096917 from the NHLBI, the NINDS, the NIA, and the National Institute on Deafness and Other Communication Disorders. Ancillary studies funded additional data elements. The Blood Pressure and Cognition Study is supported by the NINDS (grant R01 NS102715). The Coronary Artery Risk Development in Young Adults (CARDIA) Study is conducted and supported by the NHLBI in collaboration with the University of Alabama at Birmingham (contracts HHSN268201800005I and HHSN268201800007I), Northwestern University (contract HHSN268201800003I), the University of Minnesota (contract HHSN268201800006I), and the Kaiser Foundation Research Institute (contract HHSN268201800004I). The Genetic Epidemiology of COPD (COPDGene) Study was supported by awards U01 HL089897 and U01 HL089856 from the NHLBI. COPDGene is also supported by the COPD Foundation through contributions made to an industry advisory board comprised of AstraZeneca AB (Cambridge, United Kingdom), Boehringer-Ingelheim (Ingelheim am Rhein, Germany), Genentech, Inc. (South San Francisco, California), GlaxoSmithKline plc (London, United Kingdom), Novartis International AG (Basel, Switzerland), Pfizer, Inc. (New York, New York), Siemens AG (Berlin, Germany), and Sunovion Pharmaceuticals Inc. (Marlborough, Massachusetts). The Framingham Heart Study has received support from the NHLBI (grant N01-HC-25195, contract HHSN268201500001I, and grant 75N92019D00031). The Hispanic Community Health Study/Study of Latinos (HCHS/SOL) is a collaborative study supported by contracts between the NHLBI and the University of North Carolina (contract HHSN268201300001I/N01-HC-65233), the University of Miami (contract HHSN268201300004I/N01-HC-65234), Albert Einstein College of Medicine (contract HHSN268201300002I/N01-HC-65235), the University of Illinois at Chicago (contract HHSN268201300003I/N01-HC-65236 (Northwestern University)), and San

Diego State University (contract HHSN268201300005I/N01-HC-65237). The following institutes/centers/offices have contributed to the HCHS/SOL through a transfer of funds to the NHLBI: the National Institute on Minority Health and Health Disparities, the National Institute on Deafness and Other Communication Disorders, the National Institute of Dental and Craniofacial Research, the National Institute of Diabetes and Digestive and Kidney Diseases, the NINDS, and the NIH Office of Dietary Supplements. The Jackson Heart Study is supported by and conducted in collaboration with Jackson State University (contract HHSN268201800013I), Tougaloo College (contract HHSN268201800014I), the Mississippi State Department of Health (contract HHSN268201800015I), the University of Mississippi Medical Center (contracts HHSN268201800010I, HHSN268201800011I, and HHSN268201800012I), the NHLBI, and the National Institute on Minority Health and Health Disparities. The Mediators of Atherosclerosis in South Asians Living in America (MASALA) Study was supported by grant R01HL093009 from the NHLBI, the National Center for Research Resources, and the National Center for Advancing Translational Sciences, NIH, through University of California, San Francisco–Clinical and Translational Science Institute grant UL1RR024131. The Multi-Ethnic Study of Atherosclerosis (MESA) and the MESA SNP Health Association Resource (SHARe) are conducted and supported by the NHLBI in collaboration with the MESA investigators. Support for MESA is provided by grants and contracts 75N92020D00001, HHSN268201500003I, N01-HC-95159, 75N92020D00005, N01-HC-95160, 75N92020D00002, N01-HC-95161, 75N92020D00003, N01-HC-95162, 75N92020D00006, N01-HC-95163, 75N92020D00004, N01-HC-95164, 75N92020D00007, N01-HC-95165, N01-HC-95166, N01-HC-95167, N01-HC-95168, N01-HC-95169, R01-HL077612, R01-HL093081, R01-HL130506, R01-HL127028, R01-HL127659, R01-HL098433, R01-HL101250, and R01-HL135009 from the NHLBI; grant

R01-AG058969 from the NIA; and grants UL1-TR-000040, UL1-TR-001079, and UL1-TR-001420 from the National Center for Advancing Translational Sciences. Funding for SHARe genotyping was provided by NHLBI contract N02-HL-64278. This publication was developed under Science to Achieve Results (STAR) research assistance agreements RD831697 (MESA Air) and RD-83830001 (MESA Air Next Stage), awarded by the Environmental Protection Agency. Whole genome sequencing for the Trans-Omics in Precision Medicine (TOPMed) Program was supported by the NHLBI. Whole genome sequencing for the MESA component of the TOPMed Study (Database of Genotypes and Phenotypes accession no. phs001416.v1.p1) was performed at the Broad Institute of MIT and Harvard (grant 3U54HG003067-13S1). Centralized read mapping and genotype calling, along with variant quality metrics and filtering, were provided by the TOPMed Informatics Research Center (grant 3R01HL-117626-02S1 and contract HHSN268201800002I) (Broad RNA Seq, Proteomics HHSN268201600034I, UW RNA Seq HHSN268201600032I, USC DNA Methylation HHSN268201600034I, Broad Metabolomics HHSN268201600038I). Phenotype harmonization, data management, sample-identity quality control, and general study coordination were provided by the TOPMed Data Coordinating Center (grants 3R01HL-120393 and U01HL-120393 and contract HHSN268180001I). The provision of genotyping data was supported in part by the National Center for Advancing Translational Sciences, Clinical and Translational Science Institute grant UL1TR001881, and National Institute of Diabetes and Digestive and Kidney Diseases Diabetes Research Center grant DK063491 to the Southern California Diabetes Endocrinology Research Center. The NHLBI Pooled Cohorts Study was supported by grants R21HL153700, K23HL130627, R21HL129924, and R21HL121457 from the NIH/NHLBI. The Northern Manhattan Study was supported by grants R01 NS29993 and R01 NS48134 from the NINDS and grant R01 AG066162 from the NIA. The Prevent Pulmonary Fibrosis cohort study was established in 2000 and has been supported by NIH awards Z01-ES101947, R01-HL095393, RC2-HL1011715, R21/33-HL120770, R01-HL097163, Z01-HL134585, UH2/3-HL123442, P01-HL092870, UG3/UH3-HL151865, and DoD W81XWH-17-1-0597. The Reasons for Geographic and Racial Differences in Stroke (REGARDS) Study is supported by cooperative agreement U01 NS041588, cofunded by the NINDS and the NIA. Research by the principal and co–principal investigators of the Severe Asthma Research Program was funded by the NIH/NHLBI (grants U10 HL109164, U10 HL109257, U10 HL109146, U10 HL109172, U10 HL109250, U10 HL109168, U10 HL109152, and U10 HL109086). Additional support was provided through industry partnerships with the following companies: AstraZeneca, Boehringer-Ingelheim, Genentech, GlaxoSmithKline, MedImmune, Inc. (Gaithersburg, Maryland), Novartis, Regeneron Pharmaceuticals, Inc. (Tarrytown, New York), Sanofi S.A. (Paris, France), and Teva Pharmaceuticals USA (North Wales, Pennsylvania). Spirometers used in Severe Asthma Research Program III were provided by nSpire Health, Inc. (Longmont, Colorado). The Subpopulations and Intermediate Outcome Measures in COPD Study (SPIROMICS) has been funded by contracts with the NIH/NHLBI (contracts HHSN268200900013C, HHSN268200900014C, HHSN268200900015C, HHSN268200900016C, HHSN268200900017C, HHSN268200900018C, HHSN268200900019C, and HHSN268200900020C) and grants from the NIH/NHLBI (grants U01 HL137880 and U24 HL141762) and supplemented through contributions made to the Foundation for the NIH and the COPD Foundation by AstraZeneca, MedImmune, Bayer Corporation (Whippany, New Jersey), Bellerophon Therapeutics (Warren, New Jersey), Boehringer-Ingelheim, Chiesi Farmaceutici S.p.A. (Parma, Italia), the Forest Research Institute, Inc. (Jersey City, New Jersey), GlaxoSmithKline, Grifols Therapeutics, Inc. (Research Triangle Park, North Carolina), Ikaria, Inc. (Hampton, New Jersey), Novartis, Nycomed Pharma GmbH (Zurich, Switzerland), ProterixBio, Inc. (Billerica, Massachusetts), Regeneron, Sanofi, Sunovion, Takeda Pharmaceutical Company (Tokyo, Japan), Theravance Biopharma, Inc. (South San Francisco, California), and Mylan N.V. (White Sulphur Springs, West Virginia). The Strong Heart Study has been funded in whole or in part by the NHLBI (contracts 75N92019D00027, 75N92019D00028, 75N92019D00029, and 75N92019D00030). The Strong Heart Study was previously supported by research grants R01HL109315, R01HL109301, R01HL109284, R01HL109282, and R01HL109319 and cooperative agreements U01HL41642, U01HL41652, U01HL41654, U01HL65520, and U01HL65521.

The views expressed in this manuscript are those of the authors and do not necessarily represent the views of the National Heart, Lung, and Blood Institute; the National Institutes of Health; or the U.S. Department of Health and Human Services.

Conflict of Interest

None of the other authors have any potential conflicts of interest to declare.

Supplemental Material

Title: Correlates of Self-reported Resilience during the COVID-19 Pandemic: The C4R Study

Supplementary Methods

Cohort Descriptions

Atherosclerosis Risk in Communities (ARIC)[1]: The ARIC study began in the mid 1980s with initial aims for its cohort component being to describe the presence of subclinical atherosclerosis (mainly via carotid ultrasound), the progression of atherosclerosis to clinical cardiovascular disease (CVD), and the association of novel risk factors with CVD. ARIC recruited its cohort of 15,792 men and women aged 45-64 in 1987-89 from four communities: Forsyth County, NC; Jackson, MS; suburban Minneapolis, MN; and Washington County, MD. The investigators used probability sampling to obtain a community wide sample, exclusively sampling African Americans in Jackson and oversampling African Americans in Forsyth County. ARIC conducted a baseline examination of cohort participants and up to eight subsequent examinations prior to the pandemic, with additional follow-up ongoing; performed annual or semi-annual telephone follow-up interviews; and throughout has identified and validated incident CVD and other outcomes, particularly cognitive decline in recent years.

Coronary Artery Risk Development in Young Adults (CARDIA)[2]: CARDIA is a study examining the development and determinants of clinical and subclinical CVD and their risk factors. It began in 1985-1986 with a cohort of 5115 Black and White men and women aged 18-30 years. The participants were selected so that there would be approximately the same number of people in subgroups of race (Black and White), gender (women and men), education (high school or less and more than high school) and age (18-24 and 25-30 years) in each of 4 field centers: Birmingham, AL; Chicago, IL; Minneapolis, MN; and Oakland, CA. These same participants were asked to participate in follow-up examinations during 1987-1988 (Year 2), 1990-1991 (Year 5), 1992-1993 (Year 7), 1995-1996 (Year 10), 2000-2001 (Year 15), 2005-2006 (Year 20), 2010-2011 (Year 25), 2015-2016 (Year 30), and 2020-2022 (Year 35). A majority of the group has been examined at each of the follow-up examinations (91%, 86%, 81%, 79%, 74%, 72%, 72%, 71%, and 67% [despite the impact of the COVID-19 pandemic on Year 35], respectively). While the specific aims of each examination have varied, data have been collected on a variety of factors believed to be related to heart disease. These include conditions with clear links to heart disease such as blood pressure, cholesterol and other lipids, and glucose. Data have also been collected on physical measurements such as weight and body composition as well as lifestyle factors such as dietary and exercise patterns, substance use (tobacco and alcohol), behavioral and psychological variables, medical and family history, and other chemistries (e.g., insulin). In addition, subclinical atherosclerosis has been measured via echocardiography during Years 5, 10, 25, and 30, a chest CT scan during Years 15, 20, 25, and 35, an abdominal CT scan during Years 25 and 35, and carotid ultrasound during Year 20. A brain MRI was performed on a subset of participants at Years 25, 30, and 35. The CARDIA cohort, born between 1955 and 1968, has been influenced substantially by the obesity epidemic at ages younger than participants in other established NHLBI cohorts. Further investigation of the mechanisms linking obesity to derangements in cardiovascular structure and function and the etiology of clinical events promises to generate important new knowledge to inform health promotion and disease prevention efforts.

Genetic Epidemiology of COPD (COPDGene)[3]: COPDGene is a non-interventional, multicenter, longitudinal, case-control study at 21 US sites of smokers with a ≥10 pack-year history with and without COPD and healthy never smokers. The goal was to characterize disease-related phenotypes and explore associations with susceptibility genes. COPDGene research participants were extensively phenotyped with the use of comprehensive symptom and comorbidity questionnaires, spirometry, chest CT scans, and genetic and biomarker profiling. The study enrolled 10,198 participants. COPDGene has had 3 exams that include spirometry, diffusing capacity, lung CT scans and other measures; its current exam is ongoing. COPDGene examines the influence of age, sex, and race on the natural history of COPD, and the impact of comorbid conditions, chronic bronchitis, exacerbations, and asthma/COPD overlap.

Framingham Heart Study (FHS):[4] FHS was initiated in 1948. Researchers recruited 5,209 men and women between the ages of 30 and 62 from the town of Framingham, Massachusetts, and began the first round of extensive physical examinations and lifestyle interviews that they would later analyze for common patterns related to CVD development. Since 1948, the subjects have returned to the study every two years for an examination consisting of a detailed medical history, physical examination, and laboratory tests, and in 1971, the study enrolled a second-generation cohort – 5,124 of the original participants' adult children and their spouses – to participate in similar examinations. The second examination of the Offspring cohort occurred eight years after the first examination, and subsequent examinations have occurred approximately every four years thereafter. In April 2002 the Study entered a new phase: the enrollment of a third generation of participants, the grandchildren of the original cohort. The first examination of the Third Generation Study was completed in July 2005 and involved 4,095 participants. Thus, the FHS has evolved into a prospective, community-based, three generation family study. In addition to research studies focused on risk factors, subclinical CVD and clinically apparent CVD, Framingham investigators have also collaborated with leading researchers from around the country and throughout the world on projects involving some of the major chronic illnesses in men and women, including dementia, osteoporosis and arthritis, nutritional deficiencies, eye diseases, hearing disorders, and chronic obstructive lung disease.

Hispanic Community Health Study/Study of Latinos (HCHS/SOL)[5–7]: HCHS/SOL is an ongoing population based prospective cohort study of 16,415 community dwelling Hispanic/Latino adults aged 18-74 years at baseline, recruited from four urban field centers with large populations of Hispanics/ Latinos (Bronx, NY; Chicago, IL; Miami, FL; and San Diego, CA). A two-stage area probability sample of households was selected, with stratification and over-sampling at each stage to ensure a diverse and representative sample.[5] Participants self-identified as Hispanic/Latino and of Cuban, Dominican, Mexican, Puerto Rican, Central American, South American, or other/more than one heritage. Study participants underwent an extensive clinic exam and assessments to determine baseline risk factors (2008-2011),[6] and annual telephone follow-up interviews for ascertainment of cardiovascular and pulmonary events. A second clinic visit was conducted in 2014-2017, and a third clinic visit is now in process (2020-2022). The overall retention rate as of December 2019 was 81.9%. The primary goals of the HCHS/SOL are to describe: (1) the prevalence and incidence of cardiovascular, pulmonary, and other major chronic conditions (2) the risk and/or protective factors associated with these conditions; and (3) the relationships between the initial sociodemographic and health profiles and future health events in the target population. The study to date has revealed a high prevalence of cardiovascular risk factors, with significant variability by Hispanic/Latino heritage and sociodemographic factors such as income and time in the United States.[7]

Jackson Heart Study (JHS)[8–10]: The JHS is a community-based cohort study evaluating risk factors for cardiovascular and related diseases among adult African Americans residing in the three counties (Hinds, Madison, and Rankin) that make up the Jackson, Mississippi metropolitan area. Data and biologic materials have been collected from 5,306 participants, including a nested family cohort of 1,498 members of 264 families. The age at enrollment for the unrelated cohort was 35-84 years; the family cohort included related individuals >21 years old. Participants have provided extensive medical and psychosocial histories and had an array of physical and biochemical measurements and diagnostic procedures during a baseline examination (2000-2004) and two follow-up examinations (2005-2008 and 2009-2012). Samples for genomic DNA were collected during the first two examinations. Annual follow-up interviews and cohort surveillance of cardiovascular events and mortality are continuing and a fourth examination is in progress.

Mediators of Atherosclerosis in South Asians Living in America (MASALA) study[11,12]: South Asians comprise almost one-quarter of the world's population and are the second fastest growing ethnic group in the US. The MASALA Study is a prospective cohort of South Asians called the MASALA study, which is closely tied to the Multi-Ethnic Study of Atherosclerosis (MESA), for valid cross-ethnic comparisons.[11] MASALA enrolled 906 South Asians in 2010-2013 and then added a new wave of 258 South Asian participants from 2017-2018, for a full cohort size of 1,164.[12] The original MASALA cohort has been followed for approximately 8.5 years, and completed a second clinical exam in early 2018. A third MASALA clinical exam is planned for 2022-2024. 75 papers have been published from MASALA to date, and the findings clearly show that the US South Asian population has a distinct phenotype compared to the other four race/ethnic groups studied in MESA. Major findings have included a higher prevalence of diabetes, ectopic adiposity and coronary artery calcium compared to MESA. The MASALA study findings have influenced guidelines for diabetes screening, lipid management, and raised awareness of South Asian CVD risk. MASALA is filling a large gap in scientific knowledge about CVD in a large, growing Asian American subgroup.

Multi-Ethnic Study of Atherosclerosis (MESA)[13]: MESA is a study of the characteristics of subclinical CVD (disease detected non-invasively before it has produced clinical signs and symptoms) and the risk factors that predict progression to clinically overt cardiovascular disease or progression of the subclinical disease. MESA researchers study a diverse, population-based sample of 6,814 men and women aged 45-84 without known clinical cardiovascular disease. Thirty-eight percent of the recruited participants are white, 28 percent African-American, 22 percent Hispanic, and 12 percent of Chinese descent. Participants were recruited from six field centers across the United States: Wake Forest University, Columbia University, Johns Hopkins University, University of Minnesota, Northwestern University and University of California – Los Angeles. At baseline, each participant received an extensive physical exam and determination of coronary artery calcification, ventricular mass and function, flow-mediated endothelial vasodilation, carotid intimal-medial wall thickness and presence of echogenic lucencies in the carotid artery, lower extremity vascular insufficiency, arterial wave forms, electrocardiographic (ECG) measures, standard coronary risk factors, sociodemographic factors, lifestyle factors, and psychosocial factors. Selected repetition of subclinical disease measures and risk factors at follow-up visits allows study of the progression of disease. Blood samples have been assayed for putative biochemical and genetic risk factors and stored for case-control studies. Participants are being followed for identification and characterization of cardiovascular disease events, including acute myocardial infarction and other forms of coronary heart disease (CHD), stroke, and heart failure; for CVD interventions; and for mortality. The first examination took place over two years, from July 2000 – July 2002. It has been followed by six examination periods that were 17-20 months in length. Participants have been contacted every 9 to 12 months throughout the study to assess clinical morbidity and mortality.

Northern Manhattan Study (NOMAS)[14]: NOMAS began in 1993 as a population-based incidence and case-control study. In 1998 (cycle 2) the study evolved into a prospective cohort study of 3,298 stroke-free, tri-ethnic, community subjects followed annually to detect stroke, MI, and death. Starting in 2003 (cycle 3), subclinical measures (brain MRI & carotid ultrasound) and the first complete neuropsychological (NP) battery were collected on 1290 members (MRI cohort). The project has remained productive through subsequent cycles. As the cohort aged, the specific aims grew to include not only vascular determinants of stroke but also cognitive decline, mild cognitive impairment (MCI) and dementia. NOMAS participates in collaborative studies on genetics, stroke, MRI markers, Alzheimer Disease and neurodegenerative diseases. One of the major interests of the study has been the exploration of inflammatory and infectious contributors to stroke risk, subclinical atherosclerotic and cerebrovascular disease, and cognitive decline. The NOMAS community cohort of 3,298 subjects was assembled from a population-based, random sample based on the following criteria: (1) resident of at least 3 months of Northern Manhattan; (2) randomly derived from a household with a telephone; (3) age 40 or older at baseline (changed to age 55 in 1998); and (4) no history of stroke. The 1,290 subjects in the MRI cohort (median age 70 at MRI; 60% women, 15% non-Hispanic White, 17% non-Hispanic Black, 66% Hispanic, 2% Other) were evaluated with a standardized brain MRI and NP battery between 2003-08. The cohort has been prospectively followed with annual telephone contacts, including the Telephone Interview for Cognitive Status (TICS), and 3 in depth neuropsychological evaluations at 5 year intervals in the MRI cohort. The aging cohort is representative of an elderly, urban, diverse community at risk for cognitive decline. A wealth of data was collected during baseline enrollment and at time of MRI and 1st NP visit, including socio-demographics, psychosocial and socioeconomic status (education, occupational attainment, insurance status), medical history, medications, risk factors, family history and other health data, behavioral/environmental factors, subclinical vascular measures, serum biomarkers (infectious burden, neuroimmune markers using a novel multiplex assay, HOMA index for insulin resistance, adiponectin, CRP, homocysteine), carotid imaging, echocardiographic imaging (LV, LA size), ambulatory BP and cardiac rhythm monitoring, brain MRI biomarkers (regional brain volumes, regional white matter lesion burden, hippocampal volumes, cortical thickness, covert infarcts, cerebral microbleeds, perivascular spaces, brain arterial diameters), and genetic markers (GWAS, ApoE4). Fasting blood was collected and stored at baseline and at MRI. Subjects had complete blood count, chemistry profile, total protein, albumin, calcium, markers of mineral metabolism (fibroblast growth factor 23, parathyroid hormone, 1,25OH and 25OH vitamin D, and phosphate), CRP, TNF receptor levels, IL-6, and serologies against some viral and bacterial pathogens. Fasting plasma levels were assayed for total and HDL cholesterol, lipoprotein (a), HDL particle size, triglycerides, lipoprotein-associated phospholipase A2, homocysteine, serum insulin levels, and adiponectin. Buffy coats and DNA were stored on 2433 subjects and ApoE4 genotype is available on the MRI cohort. We continue to follow the cohort with annual telephone contacts and a 4th NP assessment to track cognitive trajectories and adjudicate MCI and dementia. Cognitive, functional, quality of life, and social situation questions are assessed annually. The National Death Index is consulted periodically for those with unknown vital status. An I surveillance system at CUIMC detects hospitalizations, ED visits, and clinical visits. Remarkably, only 3 (0.38%) subjects are lost, and 11 (1.4%) have withdrawn from active participation.

Prevent Pulmonary Fibrosis (PrePF): PrePF has been investigating the clinical, physiologic and genetic phenotypes of interstitial lung disease (ILD) by focusing on families with two or more cases of ILD and individuals with sporadic IPF. It has recruited over 1200 families with two or more cases of pulmonary fibrosis. These families with pulmonary fibrosis include 2837 individuals with probable or definite idiopathic interstitial pneumonia (IIP) and 2404 unaffected FDRs. In addition, PrePF recruited over 10,000 individuals with sporadic idiopathic pulmonary fibrosis (IPF).

REasons for Geographic and Racial Differences in Stroke (REGARDS)[15]: the REGARDS cohort is one of the nation's largest, most comprehensive population-based cohorts, its innovative home- and telephone-based data collection is nimble and cost-efficient. REGARDS centrally recruited and initially examined 30,239 non-Hispanic Black and White men and women aged ≥45 years in 2003-7 by telephone and in participant homes across the 48 contiguous US states (62% of US counties). Over 17 years, REGARDS has collected follow-up data by computer-assisted telephone interviews (CATI), participant collaboration in at-home tasks (i.e., actigraphy), and a 2nd in-home visit. REGARDS oversampled Black individuals and residents of the southeastern United States known as the Stroke Belt and 17% reside in rural areas. REGARDS currently follows ~11,000 surviving participants. Comprehensive available data include adjudicated health events, social determinants of health (SDOH), cognition, biomarkers and genomics. Participants currently have mean age 76.9 (range 57-105), are 37% Black, have high cardiovascular risk, and 54% reside in the southeast — all factors associated with COVID-19 risk and adverse outcomes. Participants are geocoded, and linked to administrative data such as EPA and Medicare. Biorepositories were assembled in 2003-2007 and 2013-2016.

Severe Asthma Research Program (SARP)[16]**:** SARP has been investigating the clinical, physiologic and molecular phenotypes of asthma since 2000. It is currently following ~400 deeply phenotyped asthma patients (60% severe), most with sputum samples, bronchoscopies, lung CTs, allergy status, spirometry and biobanking.

Subpopulations and Intermediate Outcome Measures in COPD Study (SPIROMICS)[17]: SPIROMICS is a multi-center, observational, longitudinal case-control study designed to guide future development of therapies for COPD by 1) providing robust criteria for sub-classifying COPD participants into groups most likely to benefit from a given therapy during a clinical trial, thereby improving the chances of successful outcome; and 2) identifying biomarkers and phenotypes that can be used as intermediate outcomes to reliably predict clinical benefit during therapeutic trials. The baseline exam included morphometric measures, spirometry, six-minute walk, an inspiratory and expiratory chest CT, and a set of standardized questionnaires. Biospecimens, including plasma, serum, DNA, urine and induced sputum, have been collected and stored. SPIROMICS has recruited 2,983 COPD cases and controls, 40-80 years old with 20+ or <1 pack-years of smoking at 12 US sites in 2010–2015.SPIROMICS has a baseline and 4 follow-up exams, that include spirometry, lung CT scans, sputum induction and, in a subset, bronchoscopies; its current exam is ongoing.

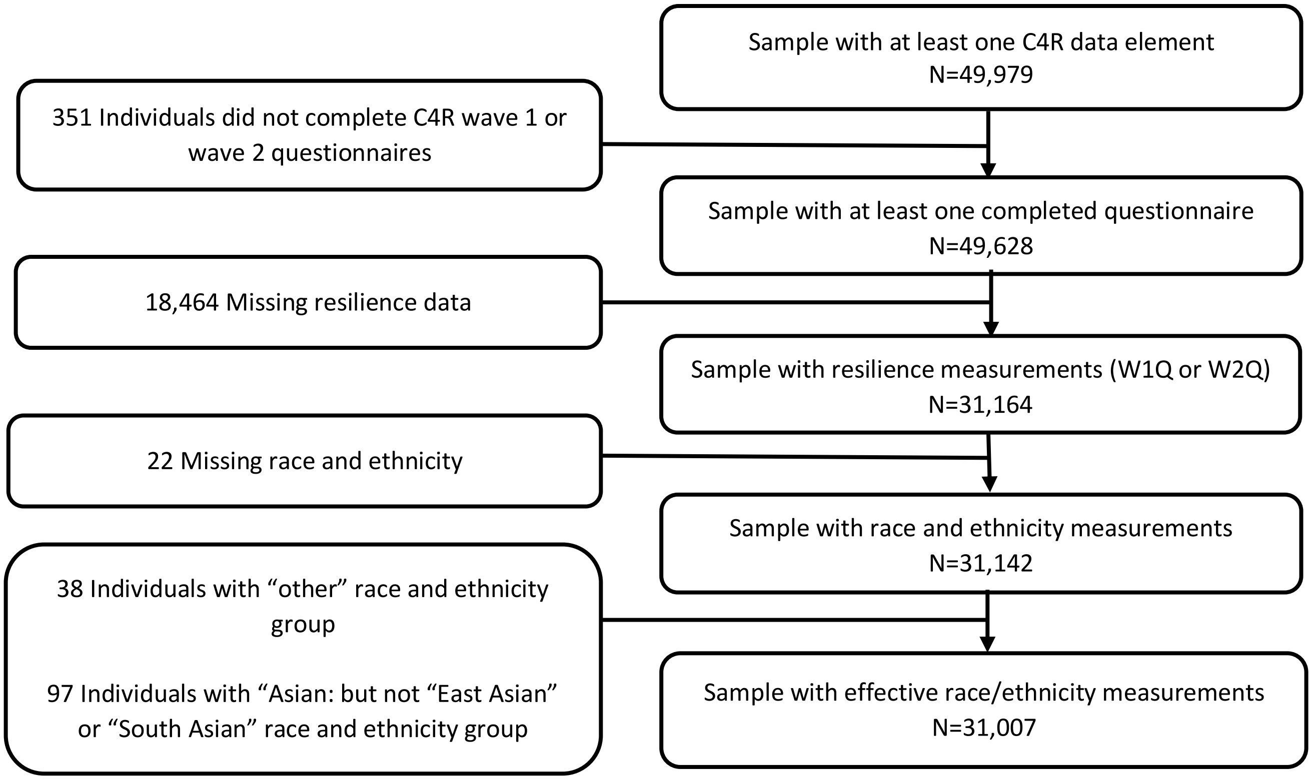
Strong Heart Study (SHS)[18,19]: SHS was designed to respond to the recommendations from the Subcommittee on Cardiovascular and Cerebrovascular Disease of the Secretary of Health and Human Service's Task Force on Black and Minority Health that concluded that information on cardiovascular disease (CVD) in American Indians was inadequate. In its initial stages, the SHS included three components. The first was a survey to determine cardiovascular disease mortality rates from 1984 to 1994 among tribal members aged 35-74 years of age residing in the 3 study areas (the community mortality study). The second was the clinical examination of 4,500 eligible tribal members. The third component is the morbidity and mortality (M&M) surveillance of these 4,500 participants. SHS has completed three clinical examinations of the original Cohort in Phase I 1989-1991; Phase II: 1993-1995; 1998-1999, respectively. In Phases III-V, SHS expanded to include genetic epidemiologic studies and family-based genetics studies due to the importance of genetics in the occurrence of CVD. Phase VI was a surveillance of the original SHS cohort and of the SHS family study participants to better understand CVD, cancer, liver disease, and inflammation in American Indians. Phase VII is currently underway with continued surveillance beginning February 2019 for a seven-year duration. The SHS Phase VII exam serves as a platform for in-depth ancillary studies that are funded outside of the SHS contracts.

Multiple Imputations

Multiple imputation was used to account for missing covariate data and permit the inclusion of all available C4R participants with non-missing outcome and exposure information. The multiple imputation procedure was performed using the fully conditional specification method, also known as chained equations, which imputes missing values for each variable iteratively based on a specified set of predictor variables. The imputation model included all variables used in the analysis models, as well as auxiliary variables that were predictive of missingness or the outcome variable. We assumed that data were missing at random. The imputation was conducted using the "mice" package in the R statistical software.[20] Results across 20 imputed datasets were combined by Rubin's Rule.

As a sensitivity analysis, findings from the multiple imputed datasets were compared to a complete case analysis without imputation to assess the impact of missing data on the results. Predicted probabilities were calculated from the pooled logistic models to estimate absolute resilience risk differences across racial and ethnic groups.

Supplemental Figure 1. CONSORT Diagram of Participants Included in the Analyses



Supplemental Table 1. Participant characteristics by self-reported resilience status using complete case data

	Response to "I tend to bounce back quickly after hard times"		
Sample characteristics [a]	**Agree or strongly agree, "Resilient" (%)** [b]	**Neutral, disagree, or strongly disagree, "Not Resilient" (%)**	**Total**
Classified events, n	17642	5839	23481
Race and ethnicity (exposure) [c]			
White	8635 (48.9)	2983 (51.1)	11618 (49.5)
American Indian	174 (1.0)	95 (1.6)	269 (1.1)
Black	3957 (22.4)	1226 (21.0)	5183 (22.1)
East Asian	158 (0.9)	128 (2.2)	286 (1.2)
Hispanic	4310 (24.4)	1276 (21.9)	5586 (23.8)
South Asian	408 (2.3)	131 (2.2)	539 (2.3)
Age group			
<65 years	6177 (35.0)	2009 (34.4)	8186 (34.9)
≤ 65 − *<75 years*	4514 (25.6)	1531 (26.2)	6045 (25.7)
≤ 75 − *<85 years*	5029 (28.5)	1612 (27.6)	6641 (28.3)
>85 years	1922 (10.9)	687 (11.8)	2609 (11.1)
Sex			
Female	10423 (59.1)	3688 (63.2)	14111 (60.1)
Male	7219 (40.9)	2151 (36.8)	9370 (39.9)
BMI [d]			
Underweight	129 (0.7)	49 (0.8)	178 (0.8)
Healthy	3923 (22.2)	1435 (24.6)	5358 (22.8)
Overweight	6739 (38.2)	2086 (35.7)	8825 (37.6)
Obesity	5849 (33.2)	1893 (32.4)	7742 (33.0)
Severe obesity	1002 (5.7)	376 (6.4)	1378 (5.9)
Smoking status			
Never	9481 (53.7)	3126 (53.5)	12607 (53.7)
Former	6497 (36.8)	2070 (35.5)	8567 (36.5)
Current	1664 (9.4)	643 (11.0)	2307 (9.8)
Diabetes	3905 (22.1)	1429 (24.5)	5334 (22.7)
Hypertension	10985 (62.3)	3696 (63.3)	14678 (62.5)
Vaccination status at completion of C4R survey	15046 (85.3)	4989 (85.4)	20035 (85.3)

COVID-19 infection at completion of C4R survey	2696 (15.3)	840 (14.4)	3536 (15.1)
Education			
< high school	2071 (11.7)	805 (13.8)	2876 (12.2)
High school	3680 (20.9)	1296 (22.2)	4976 (21.2)
Some college	3355 (19.0)	1174 (20.1)	4529 (19.3)
College +	8536 (48.4)	2564 (43.9)	11100 (47.3)
Marital status			
Single	1836 (10.4)	655 (11.2)	2491 (10.6)
Married/living as married	11598 (65.7)	3676 (63.0)	15274 (65.0)
Widowed	1371 (7.8)	486 (8.3)	1857 (7.9)
Divorced/Separated	2837 (16.1)	1022 (17.5)	3859 (16.4)
Employed	7844 (44.5)	2949 (50.5)	10793 (46.0)
Health insurance			
No insurance	1532 (8.7)	470 (8.0)	2002 (8.5)
Private insurance only	4781 (27.1)	1345 (23.0)	6126 (26.1)
Public insurance only	775 (4.4)	321 (5.5)	1096 (4.7)
Private and public insurances	1176 (6.7)	399 (6.8)	1575 (6.7)
Unknown type of insurance[e]	9378 (53.2)	3304 (56.6)	12682 (54.0)
Household Income[f]			
< $50,000	8781 (49.8)	3214 (55.0)	11995 (51.1)
$50,000 – 100,000	4363 (24.7)	1379 (23.6)	5742 (24.5)
> $100,000	4498 (25.5)	1246 (21.3)	5744 (24.5)
Study			
ARIC	2946 (16.7)	757 (13.0)	3703 (15.8)
CARDIA	1309 (7.4)	428 (7.3)	1737 (7.4)
COPDGene	626 (3.5)	153 (2.6)	779 (3.3)
FHS	1206 (6.8)	490 (8.4)	1696 (7.2)
HCHS	3961 (22.5)	1155 (19.8)	5116 (21.8)
JHS	953 (5.4)	241 (4.1)	1194 (5.1)
MASALA	408 (2.3)	131 (2.2)	539 (2.3)
MESA	1376 (7.8)	499 (8.5)	1875 (8.0)
NOMAS	0 (0.0)	0 (0.0)	0 (0.0)
PrePF	0 (0.0)	0 (0.0)	0 (0.0)
REGARDS	4693 (26.6)	1897 (32.5)	6590 (28.1)
SARP	0 (0.0)	0 (0.0)	0 (0.0)

SHS	164 (0.9)	88 (1.5)	252 (1.1)
SPIROMICS	0 (0.0)	0 (0.0)	0 (0.0)

[a] All counts and column percentages come from complete case dataset.

[b] W1Q measurement of resilience is favored when the participants have both W1Q and W2Q measures. We adopted the first record of resilience. Additionally, we combined the original “Strongly Disagree,” “Disagree” and “Neutral” groups into the new “Disagree” group, the original “Strongly Agree” and “Agree” groups into the new “Agree” group.

[c] Asian participants in cohorts other than MASALA or MESA were dropped due to unclear race and ethnicity measurements and small sample sizes.

[d] The BMI categories are underweight (<18.5,) healthy weight (18.5-24.9,) overweight (25.0-29.9,) obesity (30.0-39.9) and severe obesity (>40.0.)

[e]Participants have insurance, but the exact insurance type is unknown

[f]Income is standardized into 2020 dollars using customer price index (CPI, CPI_{2020} = 258.811.)

Supplemental Table 2. Multivariable-adjusted associations with self-reported resilience using complete case data

Variable (reference)	**Model 1**		**Model 2**	
Race and ethnicity (White)	OR (95% CI)	p-value	OR (95% CI)	p-value
American Indian	**0.63 (0.49, 0.81)**	**0.0003**	**0.64 (0.49, 0.83)**	**0.0009**
Black	**1.14 (1.06, 1.23)**	**0.0008**	**1.26 (1.16, 1.37)**	**<.0001**
East Asian	**0.42 (0.33, 0.54)**	**<.0001**	**0.46 (0.36, 0.60)**	**<.0001**
Hispanic	**1.22 (1.12, 1.32)**	**<.0001**	**1.75 (1.58, 1.94)**	**<.0001**
South Asian	1.11 (0.90, 1.36)	0.33	0.90 (0.73, 1.12)	0.33
Age group (Age <65)				
$\leq$ 65 *and* <*75*	1.01 (0.93, 1.09)	0.79	**1.18 (1.08, 1.28)**	**0.0003**
$\leq$ 75 *and* <*85*	**1.11 (1.02, 1.20)**	**0.01**	**1.34 (1.21, 1.48)**	**<.0001**
Age>85	1.00 (0.90, 1.12)	0.96	**1.22 (1.07, 1.40)**	**0.003**
Sex (Male)				
Female	**0.83 (0.78, 0.88)**	**<.0001**	**0.88 (0.83, 0.94)**	**0.0002**
BMI (Healthy)				
Underweight			1.05 (0.75, 1.47)	0.78
Overweight			**1.13 (1.04, 1.22)**	**0.003**
Obesity			**1.10 (1.01, 1.20)**	**0.03**
Severe obesity			1.01 (0.88, 1.16)	0.88
Smoking status (Never)				
Former			1.05 (0.98, 1.12)	0.16
Current			0.90 (0.81, 1.00)	0.05
Diabetes status (No)				
Yes			**0.90 (0.83, 0.97)**	**0.005**
Hypertension status (No)				
Yes			0.95 (0.89, 1.03)	0.20
Vaccine status at completion of C4R survey (No)				
Yes			0.96 (0.88, 1.04)	0.32
COVID-19 infection at completion of C4R survey (No)				
Yes			1.04 (0.95, 1.14)	0.40
Education (< high school)				
High school			**1.20 (1.07, 1.33)**	**0.001**
Some college			**1.24 (1.11, 1.39)**	**0.0002**
College +			**1.33 (1.19, 1.48)**	**<.0001**
Marital status (Married/living as married)				
Single			0.90 (0.81, 1.00)	0.05
Widowed			1.11 (0.99, 1.25)	0.08
Divorced/Separated			0.93 (0.85, 1.01)	0.09
Occupation (Employed)				
Other than employed			**0.80 (0.75, 0.86)**	**<.0001**
Health insurance (Public insurance only)				
No insurance			1.05 (0.88, 1.26)	0.57
Private insurance only			1.16 (0.99, 1.35)	0.06
Private and public insurances			1.07 (0.89, 1.28)	0.48
Unknown type of insurance			0.93 (0.81, 1.08)	0.33

Income (< $50,000)				
$50,000 – 100,000			**1.13 (1.04, 1.22)**	**0.005**
> *$100,000*			**1.33 (1.21, 1.46)**	**<.0001**

Bold: Statistically significant at p<0.05; Ref. Reference; p-value: the association between race and ethnicity group and the outcome variable, self-identified resilient or not.

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