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ORIGINAL RESEARCH

Longitudinal Analysis of the Relationship Between Social Isolation and Hypertension in Early Middle Adulthood

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BACKGROUND: Most studies have used cross-sectional or limited follow-up data to evaluate the relationship between social isolation (SI) and hypertension in older populations. The objective of this analysis was to examine the relationship between longitudinal SI and hypertension in a younger population.

METHODS AND RESULTS: The present analysis used data from waves I to V of the National Longitudinal Study of Adolescent to Adult Health (1994–2018) and logistic regression models to describe the association of timing, duration, and transitional patterns of SI with hypertension in early middle adulthood. Models were adjusted for demographic variables and adolescent socioeconomic and health-related confounders. SI was higher across life stages among individuals with hypertension (adolescence: 38% versus 35%, young adulthood: 52% versus 44%, and early middle adulthood: 61% versus 52%). Individuals who were socially isolated in young adulthood or early middle adulthood had greater odds of hypertension in early middle adulthood than those who were not (odds ratio [OR], 1.30 [95% CI, 1.07–1.56]; OR, 1.42 [95% CI, 1.15–1.76], respectively). Early middle adulthood hypertension was significantly associated with persistent SI across all life stages and for those who moved into persistent SI after adolescence (OR, 1.40 [95% CI, 1.02–1.93]; OR, 1.61 [95% CI, 1.18–2.19], respectively).

CONCLUSIONS: SI in young or early middle adulthood significantly increased the odds of hypertension, as did moving into SI and the accumulation of SI across life stages. Our analysis provides insights regarding timing for effective interventions to reduce hypertension earlier in the life course, which may prevent future adverse cardiovascular-related events.

Key Words: hypertension ■ life course ■ social isolation

Hypertension is an important and prevalent modifiable risk factor that contributes to cardiovascular disease morbidity and mortality.[1] There is substantial risk of adverse cardiovascular outcomes associated with hypertension, with increasing odds of cardiovascular disease–related death as the age of hypertension onset decreases.[2] In adults younger than 40 years, adverse cardiovascular disease events in later life stages are significantly higher for those with elevated blood pressure (BP) and hypertension compared with those with normal BP before the age of 40 years, and independent of current and later risk factors.[3,4]

Despite billions of dollars spent on medical care associated with hypertension, the estimated proportion of adults with controlled BP decreased in recent years to the extent that there was no meaningful difference between the proportion of adults with controlled BP between 2005 to 2006 and 2017 to 2018.[5,6] The lack of return on financial investments in medical care is likely attributable to the finding that social determinants, nonmedical factors that exist outside of the health care ecosystem in the places where people are born, live, work, and age, account for 80% to 90% of health outcomes.[7] The influence of determinants such as socioeconomic status, racism and discrimination,

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CLINICAL PERSPECTIVE

What Is New?

- The results of this study provide new insights regarding the chronic impact of social isolation on cardiovascular health, specifically hypertension, in a younger population.

What Are the Clinical Implications?

- The clinical implications of these findings suggest that earlier attention and interventions to reduce social isolation are of paramount necessity to delay or prevent the development of hypertension.

Nonstandard Abbreviations and Acronyms

Add Health	National Longitudinal Study of Adolescent to Adult Health
JNC 7	Seventh Report of the National Committee on the Detection, Evaluation, and Treatment of High Blood Pressure
SI	social isolation
SNI	Social Network Index

and neighborhood characteristics on BP has been well established.[8]

Relationships are a social determinant manifested through 2 primary constructs: social networks, which describe structural aspects of the relationship, and social support, which reflects the perceived or actual resources an individual receives through the relationship.[9] The importance of this social determinant was highlighted by the COVID-19 pandemic response, with early studies linking the impact of social distancing on several adverse health outcomes; the full effect of these life-saving, though socially disruptive, measures on long-term health outcomes remains to be seen.[10–12] Evidence before the global pandemic regarding the association between social isolation (SI), the absence or weakness of network ties, and BP or hypertension is mixed: some studies have shown that more social ties are detrimental to BP while others have found positive effects of ties based on number and type.[13–15] Beyond the variability in results, methodological limitations of these evaluations include largely cross-sectional data sets or longitudinal data with limited follow-up periods and a focus on older populations where hypertension is more common simply as a function of age.[13,14,16–21] As a result, these studies provide neither direct evidence regarding the long-term impacts of SI nor allow exploration of stages across the life course when individuals may be particularly susceptible to exposure (SI) or outcome (hypertension).

As such, the purpose of this study is to examine the longitudinal relationship between SI and hypertension prevalence in early middle adulthood. Using data from a nationally representative study of adolescents followed into adulthood, the following hypotheses were tested:

1. whether the association between SI in early middle adulthood and hypertension is stronger than the relationship in adolescence;
2. whether individuals who experience persistent SI through early middle adulthood are more likely to have hypertension than those who are socially connected through the same period; and
3. whether individuals who move into SI are more likely to have hypertension than those who have no, or limited, exposure to SI over time.

METHODS

Study Sample

The present study used restricted-use data from Add Health (National Longitudinal Study of Adolescent to Adult Health), a longitudinal cohort study using a multistage stratified cluster design to recruit a nationally representative sample of more than 20 000 adolescents in grades 7 to 12 (aged 12–19 years) in the United States in 1994 to 1995. The cohort has been followed through adolescence and into adulthood with in-home interviews across 5 waves: (wave I), 1996 (wave II), 2001 to 2002 (wave III), 2008 to 2009 (wave IV), and 2016 to 2018 (wave V). Additional details of the Add Health design can be found in previous publications.[22]

The analytic sample of this study includes respondents who participated in each in-home interview across waves I, IV, and V, and provided biomarker data of interest in wave V. The sample was restricted to those with cardiovascular biomarker sample weights in wave V (n=5381) to adjust for the different proportion of individuals who have biomarker data as well as nonresponse and missing data to estimate population-average models.[23,24] Previous studies have found that nonresponses are negligible after incorporating poststratification sampling weights.[25,26] There was 1 respondent with missing data on the outcome measure. After adjusting for missing sampling design information and accounting for the loss of 1 respondent, the final analytic sample contained 5049 observations.

Because of the sensitive nature of the data collected for this study, requests to access the data set

from qualified researchers trained in human participant confidentiality protocols may be submitted through the University of North Carolina's Carolina Population Center at https://data.cpc.unc.edu/projects/2/view.

Independent Variable: SI

The measures of SI were adapted from the Social Network Index (SNI), developed by Berkman and Syme and consistent with previous research using ADD Health data.[27,28] The SNI measures adult social integration as a composite among 4 domains: marital status, connection with others, religious involvement, and civic participation. Marital status is not a valid measure for adolescents (wave I) and may underrepresent meaningful adult relationships reflected by cohabitation; therefore, a variable was created to describe similar relationships in each life stage.[29] Adolescents participating in the Add Health study were not asked directly about their number of close friends; however, numerous studies have used friend nominations to document the number and quality of friendships.[30] Religious attendance was documented using identical questions in each wave. Group participation, much like close friendships, differed between adolescent and adult waves due to differing questions. The definitions and cut points for these variables are displayed in Table 1.

For adolescence (grades 7–12), young adulthood (ages 24 to 32 years), and early middle adulthood (ages 33 to 42 years) waves, independent "life stage" measures of SI were constructed. Each SNI item was assigned 1 point if the respondent met the threshold and summed to create a wave-specific index variable with 0 or 1 being the most socially isolated scores and 2, 3, and 4 representing increasing social connectedness. The wave-specific SNI was then used to create a dichotomous measure of SI where individuals were considered socially isolated if the SNI score was 0 or 1 and, if the SNI score was 2, 3, or 4, not socially isolated. To examine whether SI patterns are associated with hypertension, 8 trajectories were constructed to represent all possible permutations of SI from adolescence to early middle adulthood: persistent SI or connectedness, SI in 1 wave but not the other 2 waves, and SI in 2 waves but not the other 1 wave.

Dependent Variable: Hypertension

Data on cardiovascular disease risk factors were collected for respondents who, at the end of the wave V survey, agreed to participate in the home examination, between 2016 and 2018, when respondents were between 31 and 42 years of age (n=5380). Hypertension, the outcome of interest for this analysis, was constructed from 4 data points collected during the home examination. Respondents were flagged as having evidence of hypertension if the respondent had EITHER a systolic BP/diastolic BP measure classified as hypertension stage 1 or 2 based on the Seventh Report of the National Committee on the Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) guidelines OR took an antihypertensive medication in the past 4 weeks OR had ever been diagnosed with high BP or hypertension.

To construct average BP measures and classify them into stages of hypertension, systolic BP and diastolic BP were measured once respondents had rested with both feet on the floor and their legs uncrossed for 5 min. Three BP measurements were taken at 30-s intervals, with the last two measures used to calculate average BPs. If either of the last two measures were missing, the single available measure was used; in the event both were missing, the first BP measure was used. Based on the average measures, respondents were classified as having stage 1 hypertension if systolic BP was 140–159 mm Hg or diastolic BP was 90–99 mm Hg and stage 2 hypertension if systolic BP was ≥160 mm Hg or diastolic BP was ≥100 mm Hg. A total of 5164 respondents with BP measurements were included in this classification variable.

Respondents were asked "Has a doctor, nurse, or health care provider ever told you that have any of the following? (A) High blood pressure or hypertension" and "Have you taken any prescription medications the past 4 weeks?" to determine hypertension diagnosis status and use of antihypertensive medications. There were 987 and 637 respondents, respectively, who provided positive responses to each question.[31,32]

Confounders

Respondent-level demographic and health variables, along with parent-level socioeconomic status

Table 1. Definitions and Cut Points for SNI Variables

Life stage (wave)	Living arrangements	Close friends	Religious attendance	Group participation
Adolescence (wave I)	Living with 2 parents[29]	≥6 friend nominations	Religious attendance at least once a mo (≥12 times each y)	Participated in any clubs, organizations, or teams at school
Early adulthood (wave IV)	Married or living with romantic or sexual partner	≥6 close friends	Religious attendance at least once a mo (≥12 times each y)	Volunteered at least 1 h in the past 12 mo
Early middle adulthood (wave V)	Married or living with romantic or sexual partner	≥6 close friends	Religious attendance at least once a mo (≥12 times each y)	Volunteered at least 1 h in the past 12 mo

SNI indicates Social Network Index.

indicators, were included as potential confounders. Age (at wave V) was constructed based on complete interview dates and date of birth month and year and 15 as the universal assigned day of birth. Sex was documented by the interviewer during the wave I in-home interview (male=1; female=0). Race or ethnicity categories were created using 2 wave I self-report questions about respondents' Hispanic or Latino origin and race (non-Hispanic White=0; non-Hispanic Black=1; Hispanic=2; non-Hispanic Asian=3; non-Hispanic American Indian/other=4).[33] The variable US nativity (yes=1; no=0) is based on the wave I question, "Were you born in the United States?" Self-reported health in adolescence was categorized by the respondent's response to "In general, how is your health? Would you say…" (excellent, very good, good=1; fair or poor=0). Lack of health insurance was assessed in wave V by asking respondents to describe their current health insurance situation (any health insurance=1; no health insurance=0). Parent-level socioeconomic status was used to describe socioeconomic status in adolescence using the highest level of school completed (less than a bachelor's degree=0; bachelor's degree or higher=1) of the mother or other female head of household and family income (at or below the federal poverty level for a family of 4 in 1995=1; above the federal poverty level=0).

Statistical Analysis

Descriptive characteristics of the analytic sample are presented as means (SE) for continuous variables and counts (percentages) for categorical variables. The association of timing, duration, and transitional patterns of SI with hypertension in early middle adulthood were examined using simple and multiple binary logistic regression models, reporting results using odds ratios (ORs) with 95% CIs. Regression models were used because our primary aim was to investigate how different trajectories affect 1 single outcome (ie, early middle adulthood hypertension). Using multiple trajectories from adolescence to early middle adulthood through regression models considers the dynamic nature of SI and its potential changes over time. This developmental perspective helps in identifying critical periods and transition points where SI may have differential impacts. The statistical power of the analysis is increased by exploring multiple trajectories, an approach particularly relevant when examining interaction effects, which often require larger sample sizes to detect significant effects reliably. Multiple binary logistic regression models were created: unadjusted (model 1); adjusted for demographic variables (model 2); adjusted for both demographic and adolescent socioeconomic variables (model 3); and adjusted for demographic, adolescent socioeconomic, and health-related variables (model 4). Analyses were performed with SAS version 9.4 (SAS Institute Inc), incorporating survey design and unequal probability of selection per Add Health user guidance, specifically stratum, sampling, and survey weight variables and SAS SURVEY procedures.[34] Statistical significance was defined as a P value <0.05, with marginally significant results ($0.05<P\leq0.10$) also reported.

This research was submitted to the Georgia State University's institutional review board, where it was determined to not be human participant research and, thus, institutional review board approval was waived.

RESULTS

The characteristics of the analytic sample are presented in Table 2. Of the total sample, 1526 (30%) had evidence of hypertension. There was a higher proportion of males (60% versus 44%), non-Hispanic Blacks (23% versus 13%), and families living at or below the federal poverty level during the respondent's adolescent years (31% versus 26%) in the hypertension group. Although most respondents in both groups reported excellent, very good, or good health in adolescence, fewer with hypertension did so (90% versus 95%). SI was higher in all life stages among individuals with hypertension (adolescence: 38% versus 35%; young adulthood: 52% versus 44%; and early middle adulthood: 61% versus 52%). Similarly, the hypertension group had lower mean SNI scores in adolescence (0.94 versus 1.03), young adulthood (0.70 versus 0.84), and early middle adulthood (0.55 versus 0.71).

Wave-Specific SI

The results for wave-specific SI and hypertension are presented in Table 3. Neither SI measure in adolescence (wave I) was significant (SNI OR, 0.96 [95% CI, 0.88–1.05]; SI OR, 0.98 [95% CI, 0.80–1.19]). After controlling for potential confounders, increased social connectedness in young adulthood (wave IV) and early middle adulthood (wave V) was associated with less hypertension in early middle adulthood (SNI OR, 0.86 [95% CI, 0.77–0.96]; SNI OR, 0.81 [95% CI, 0.71–0.92], respectively). Similarly, those who were socially isolated in young adulthood or early middle adulthood had greater odds of having hypertension in early middle adulthood than those who were not socially isolated (SI OR, 1.29 [95% CI, 1.07–1.56]; SI OR, 1.42 [95% CI, 1.15–1.76], respectively).

SI Patterns

Results for SI patterns and hypertension in early middle adulthood are presented in Table 4. After controlling for demographic, adolescent socioeconomic, and general health variables, hypertension in early middle adulthood was significantly associated with persistent SI across all life stages: adolescence, young

Table 2. Descriptive Characteristics of Analytic Sample

	Total sample (N=5050)	Respondents without evidence of hypertension (n=3523)	Respondents with evidence of hypertension (n=1526)
Demographic variables			
Age	37 (0.12)	37 (0.13)	38 (0.13)
Male	2006 (49%)	1227 (44%)	778 (61%)
Race or ethnicity			
Non-Hispanic White	3143 (68%)	2233 (71%)	909 (64%)
Non-Hispanic Black	964 (16%)	579 (13%)	385 (23%)
Hispanic	572 (10%)	435 (11%)	137 (9%)
Non-Hispanic Asian	293 (3%)	223 (4%)	70 (3%)
Non-Hispanic Native American/other	70 (2%)	48 (1%)	22 (2%)
US nativity	4754 (95%)	3298 (95%)	1455 (96%)
Adolescent socioeconomic variables			
Parent education—bachelor's degree or higher	3889 (77%)	2746 (78%)	1142 (75%)
Family income—at or below the federal poverty level, 1995 (family of 4; ≤$15000)	1227 (27%)	798 (26%)	428 (31%)
Health-related variables			
Self-reported health in adolescence (good, very good, and excellent)	4710 (93%)	3325 (95%)	1384 (90%)
Health insurance coverage	4670 (92%)	3282 (92%)	1387 (92%)
SI variables			
Wave I			
SNI	1.00 (0.04)	1.03 (0.04)	0.94 (0.04)
SI	1636 (36%)	1105 (35%)	531 (38%)
Wave IV			
SNI	0.80 (0.02)	0.84 (0.03)	0.70 (0.03)
SI	2181 (46%)	1454 (44%)	727 (52%)
Wave V			
SNI	0.66 (0.02)	0.71 (0.03)	0.55 (0.04)
SI	2564 (55%)	1698 (52%)	866 (61%)
Hypertension variables			
Systolic BP	123.66 (0.35)	117.75 (0.27)	135.82 (0.58)
Diastolic BP	80.18 (0.26)	75.70 (0.18)	89.41 (0.43)
Took antihypertensive medication within the past 4 wk	608 (13%)	…	608 (40%)
Has ever been diagnosed with high BP or hypertension	937 (20%)	…	937 (61%)

Values are expressed as number (percentage) or mean (SE). BP indicates blood pressure; SI, social isolation; and SNI, Social Network Index.

adulthood, and early middle adulthood (SI OR, 1.40 [95% CI, 1.02–1.93]). Similarly, individuals who moved into persistent SI after adolescence were significantly more likely to have hypertension in early middle adulthood (SI OR, 1.61 [95% CI, 1.18–2.19]). The relationship between hypertension and movement into SI in early middle adulthood was of marginal significance among all models (SI OR, 1.36 [95% CI, 0.99–1.86]).

DISCUSSION

Using a longitudinal design, the present study identifies SI trends over time and establishes temporal relationships between SI and hypertension in early middle adulthood. The findings broadly support the 3 hypotheses of SI and hypertension in early middle adulthood that the study sought to test: the life stage hypothesis where the effect of SI would be strongest in early middle adulthood, the duration hypothesis in which those with persistent SI would be more likely to have hypertension than those without, and the transitional pattern hypothesis by which movement into SI would be associated with greater odds of hypertension than limited or no SI throughout the life course.

An increase in the prevalence and degree of SI over each life stage is observed, for which there are plausible

Table 3. Associations Between Wave-Specific SI Measures and Evidence of Hypertension

	Model 1	Model 2	Model 3	Model 4
SI measure				
Wave I				
SNI	0.89 (0.81–0.97)*	0.93 (0.85–1.01)	0.94 (0.86–1.02)	0.96 (0.90–1.05)
SI	1.12 (0.93–1.36)	1.03 (0.85–1.24)	1.03 (0.85–1.24)	0.98 (0.80–1.19)
Wave IV				
SNI	0.83 (0.76–0.92)†	0.84 (0.80–0.93)†	0.85 (0.76–0.94)†	0.86 (0.77–0.96)†
SI	1.35 (1.13–1.60)†	1.32 (1.11–1.58)†	1.33 (1.11–1.59)†	1.29 (1.07–1.56)†
Wave V				
SNI	0.79 (0.69–0.89)†	0.79 (0.69–0.89)†	0.80 (0.70–0.91)†	0.81 (0.71–0.92)†
SI	1.48 (1.22–1.81)†	1.48 (1.21–1.82)†	1.46 (1.19–1.80)†	1.42 (1.15–1.76)†

Associations between wave-specific SI and hypertension were estimated using binary logistic regression. Model 1 is unadjusted. Model 2 adjusts for demographic variables (age, sex, race or ethnicity, and US nativity). Model 3 adjusts for variables in wave II and adolescent socioeconomic status (parental education and family income). Model 4 adjusts for variables in both model 2 and 3 along with general health variables (adolescent health status and health insurance coverage). Values are expressed as odds ratios (95% CIs). SI indicates social isolation; and SNI, Social Network Index.

*$P<0.05$.

†$P<0.01$.

life course explanations. On the one hand, individuals tend to self-select into smaller networks as they age, preferring fewer, more meaningful relationships over more contacts.[35] On the other hand, life events associated with specific life stages may necessitate smaller networks (eg, family and career investments occurring during the early and middle adulthood life stages may lead to decreased involvement in activities such as volunteering to maintain or expand their social networks).[36] Even so, future research is warranted to identify factors occurring earlier in the life course that may lead to SI in early middle adulthood.

There is no evidence for an association between hypertension in early middle adulthood and adolescent SI; however, SI and the degree to which individuals are socially isolated in each stage of adulthood is strongly associated with hypertension in early middle adulthood. One plausible explanation for the lack of association between adolescent SI and hypertension in early middle adulthood is the mechanism by which SI, as a chronic stressor, leads to physiological changes in the vasculature (eg, increased total peripheral resistance and, subsequently, arterial stiffness earlier in the life cycle).[37] The lack of association between SI in adolescence and hypertension in early adulthood has been found in other studies using the Add Health data set.[38,39] However, these studies did not find a significant relationship between SI in later life stages and

Table 4. Associations Between SI Patterns* and Evidence of Hypertension

Life stage						
Adolescence	Young adulthood	Early middle adulthood	Model 1	Model 2	Model 3	Model 4
0	0	0	1.00	1.00	1.00	1.00
I	0	0	1.05 (0.75–1.47)	0.96 (0.67–1.36)	1.03 (0.71–1.50)	1.04 (0.71–1.52)
0	I	0	1.09 (0.76–1.57)	1.04 (0.71–1.53)	1.05 (0.72–1.53)	1.06 (0.73–1.55)
0	0	I	1.31 (0.97–1.78)†	1.34 (0.98–1.83)†	1.35 (0.98–1.85)†	1.36 (0.99–1.86)†
I	I	0	1.05 (0.71–1.55)	1.04 (0.71–1.51)	1.06 (0.73–1.55)	1.03 (0.69–1.54)
I	0	I	1.23 (0.83–1.82)	1.18 (0.78–1.78)	1.11 (0.73–1.69)	1.06 (0.70–1.59)
0	I	I	1.53 (1.15–2.05)§	1.58 (1.17–2.14)§	1.60 (1.07–2.01)§	1.61 (1.18–2.19)§
I	I	I	1.64 (1.20–2.23)§	1.48 (1.08–2.03)‡	1.47 (1.07–2.01)‡	1.40 (1.02–1.93)‡

Associations between wave-specific SI and hypertension were estimated using binary logistic regression. Model 1 is unadjusted. Model 2 adjusts for demographic variables (age, sex, and race or ethnicity, and US nativity). Model 3 adjusts for variables in wave II and adolescent socioeconomic status (parental education and family income). Model 4 adjusts for variables in both model 2 and 3 along with general health variables (adolescent health status and health insurance coverage). Values are expressed as odds ratios (95% CIs). SI indicates social isolation.

*0=not isolated, I=isolated.

†$P<0.10$.

‡$P<0.05$.

§$P<0.01$.

hypertension, perhaps because the outcome of interest, hypertension, was measured in wave IV, when Add Health respondents were younger and had lower rates of hypertension, or the variation in SI measures may have diluted the strength of the relationship.

From a life course perspective, 2 duration and transition patterns of SI are significantly associated with the likelihood of hypertension in early middle adulthood: those who were persistently socially isolated throughout adulthood and those who moved from social connectedness in adolescence into SI across both life stages of adulthood (the relationship between SI in early middle adulthood and hypertension reached moderate statistical significance, noted in the results but not warranting substantive explanations). To our knowledge, these results are the first to describe the longitudinal relationship of SI patterns and hypertension in a younger population, as most studies are of limited follow-up or in older populations.[40–42]

There are several limitations to consider when reviewing the findings of this study, the first being residual confounding due to the observational nature of the data. Second, there were insufficient data available in wave III to create repeated SI measures across the life course; as such, the formative years between the ages of 18 to 26 years were not accounted for in this analysis. Third, ORs may overestimate effect size when the outcome is common (eg, >10%). Although the outcome of interest in this study, hypertension, is common, occurring in 30% of the total sample, logistic regression and ORs are appropriate when the direction of the study is from disease status (hypertension) to exposure status (SI). Moreover, similar studies have used logistic regression and ORs to estimate the likelihood of hypertension in relation to some variable using the Add Health data set.[43–45] Fourth, SI was assessed using a validated measure used commonly in social capital research. However, the SNI is largely a measure of structural components and does not measure the quality of existing relationships. It is possible that, even with large networks, individuals may feel lonely and experience adverse health consequences as result. Fifth, SI was evaluated as a composite variable, without considering the independent contributions of each observed variable to the individual SI status. Last, it is possible that individuals classified as having "evidence of hypertension" (n=1621) experienced elevated BPs during the time of measurement due to some transitory cause (eg, social anxiety or white-coat hypertension) that could not be accounted for with repeated BP measurements.

Despite these limitations, the findings from this analysis of a nationally representative sample are both timely and substantive in understanding when and how SI matters to the development of hypertension in early middle adulthood. The insights regarding SI and hypertension could not be more opportune given the extreme SI experienced by millions of young adults across the globe during the COVID-19 pandemic. The results underscore the importance of a life course approach to better delineate how age and development may interact with SI to exert negative health effects. It is clear that an increased understanding and implementation of effective strategies to mitigate the incidence of hypertension and other cardiovascular-related health outcomes related to SI in young and early middle adulthood is of paramount urgency.

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