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Longitudinal Associations Between Health Behaviors and Mental Health in Low-Income Adults

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Abstract

Background—Although there are established relationships between physical and mental health, few studies have explored the relationship between health *behaviors* and mental health over time.

Purpose—To explore rates of health compromising behaviors (HCBs) and the longitudinal relationship between HCBs and depression, anxiety, and stress.

Method—Five waves of data were collected over 1 year from 482 patients at an urban public health clinic (47% female, 68% African American, M_{age} = 28).

Results—Smoking (61%), binge drinking (52%), illegal drug use (53%), unprotected sex with non-primary partners (55%), and fast food consumption (71%) were common, while consumption of fruits or vegetables (30%) and breakfast (17%) were rare. Cross-lagged models identified within-time associations between HCBs and depression/anxiety and stress. Additionally, depression/anxiety and stress predicted later HCBs, but HCBs did not predict later mental health.

Conclusions—Results suggest that targeting mental health may be important to promoting improvements across multiple health behaviors.

Keywords

health behavior; mental health; depression; anxiety; perceived stress

Low socioeconomic status (SES) increases risk for multiple health problems [1-5] that, in turn, increase risk of premature morbidity and mortality [6-9]. Several mechanisms have been proposed to explain how SES "gets under the skin," including downward social drift, increased allostatic load, and poorer health behaviors [10]. Of these, health compromising behaviors, such as poor dietary habits [e.g., 11, 12, 13], lower levels of physical activity [e.g., 14], and higher rates of smoking [e.g., 15, 16], explain approximately half of the SES differences in mortality [17-19].

Health compromising behaviors (HCBs) arise from multiple causes, including genetic vulnerability and environmental exposure as well as familial and other psychosocial factors. An important but understudied psychosocial correlate of HCB is poor mental health. Research shows that HCBs are more common among people living with stress, depression, and anxiety [20-25]. This relationship has been found for a variety of health behaviors,

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including substance use (tobacco, alcohol, and illegal drugs) [23, 24, 26, 27]; sedentary behavior and high body mass index (BMI) [28]; sexual behavior [29, 30], and sleep quality [31, 32].

Implicit in much of the research on the association between mental health and health behaviors is the notion that HCBs function as coping strategies; that is, HCBs are often used to cope with negative affect and other mental health problems [33]. For example, the stress-coping model [33, 34] suggests that alcohol, nicotine, and other drugs may be used to manage negative affect resulting from problems and stressors. This form of avoidant coping is generally maladaptive because it does not help individuals to address their stressors or to manage emotions resulting from these stressors, leading to unresolved problems and a continuation of distress [33]. Other HCBs such as the consumption of fatty and high caloric foods or engagement in sexual risk behavior may similarly be used as avoidant coping mechanisms; the pleasure associated with engaging in these behaviors may temporarily relieve some of the negative emotions associated with stressors [35, 36].

HBCs may also cause (or exacerbate) mental health problems. Smoking, drinking, inadequate sleep, and physical inactivity can increase inflammation, anxiety, and other stress indicators [37-39]. Use of HCBs as avoidant coping strategies (i.e., strategies that allow individuals to temporarily forget about their stressors or problems) may also lead to regret and anxiety [40], which can worsen the precipitating mental health symptoms [41]. In this way, HBCs may give rise to, or exacerbate, mental health problems [36, 42-45]. The relation between HCBs and mental health problems may even be bi-directional, with individuals who are experiencing anxiety, depression, or stress using HCBs as avoidant coping strategies, leading to regret and an exacerbation of mental health problems and then to increased use of HCBs for avoidant coping.

The extant literature reveals associations between SES and health behaviors, and between mental health and health behaviors. However, fewer studies have connected these related literatures by examining the health behavior-mental health relationship in the context of socioeconomic disadvantage. Therefore, the purpose of the current research was to examine the relationship between HCBs and depression/anxiety and stress in a low-income sample in order to better understand the nature of their association over a 1-year period. To improve upon prior work, we use a methodologically sophisticated approach (viz., cross-lagged models) in large, low-income, urban sample. This study fills a gap in the literature by determining whether mental health problems lead to subsequent HCBs (as has been assumed in much prior research), whether HCBs lead to subsequent mental health problems, or whether there is a bidirectional association between mental health and HCBs. We examine a range of HCBs, including substance use, risky sexual behavior, poor diet, sedentary behavior, and lack of or excessive sleep, to address two hypotheses: (1) Depression/anxiety and stress will lead to HCBs, and (2) HCBs will also contribute to depression/anxiety and stress. In addition to testing these hypotheses, we explore rates of HCB and associations among multiple HCBs in this vulnerable population sub-group.

Method

Participants

Participants were 482 patients (47% female, 68% African American, 20% White, 8% mixed race, M_{age} = 28.40 years, SD_{age} = 9.63, 50% with family income < $15,000/year) receiving care at a publicly-funded sexually transmitted infection (STI) clinic who participated in a sexual risk reduction randomized controlled trial (RCT). Inclusion criteria for the RCT were: (a) age 16 or older; and (b) sexual risk behavior in the past 3 months. Patients were excluded from the RCT if they were (a) infected with HIV; (b) impaired (e.g., due to substance use);

(c) receiving inpatient substance abuse treatment; or (d) planning to move out of the area within the next year. Participants in the RCT (*N* = 973) received either a sexual risk reduction intervention or a general health promotion intervention. We included only RCT participants who did not receive the general health promotion intervention (*N* = 482, 50% of the total sample) in the current analysis so that our models would represent associations between health behavior and mental health in the absence of an intervention promoting a healthy diet, physical activity, and reductions in substance use.

Procedures

Eligible patients who provided written consent were asked to complete an audio-computer assisted self-interview (ACASI) on a laptop computer. All participants were reimbursed for their time. At 3, 6, 9, and 12 months post-intervention, participants completed an ACASI and were again reimbursed. The protocol was approved by the Institutional Review Boards of the participating institutions and, to protect participant privacy, a Federal Certificate of Confidentiality was obtained.

Measures: Health Compromising Behaviors

Our selection of HCBs (as well as categorizations for binge drinking, smoking, physical activity, and the dietary indicators) was informed by previous research on multiple health behaviors [e.g., 46, 47]. To increase the scope of research on HCBs, we also included behaviors rarely included in previous research on multiple health behaviors, including illegal drug use, unprotected sex, and excessive time spent sitting. All HCBs were dichotomously coded and then summed to create an index of HCBs. To minimize respondent burden in this public health setting, we selected brief measures that we and others have used in previous research.

Substance use behaviors—As a measure of (a) *binge drinking*, participants reported their frequency of drinking four or more drinks (women) or five or more drinks (men) in a single day during the past 3 months on a scale from 0 (never) to 9 (every day); those participants who had consumed four or five drinks at least once during the past 3 months were coded as engaging in binge drinking [48]. Participants reported their frequency of using (b) *cigarettes or other tobacco products* during the past 3 months on a scale from 0 (never) to 5 (about every day); participants were coded as smokers if they ever used tobacco products. As a measure of (c) *illegal drug use*, participants reported their frequency of using marijuana and their frequency of using crack cocaine or cocaine powder during the past 3 months on scales from 0 (never) to 5 (about every day); these substances were identified in prior research in this setting [49, 50] as the two most frequently used illegal drugs. Participants who used either of these substances in the past 3 months were coded as engaging in illegal drug use. None vs. some coding for binge drinking, tobacco use, and illegal drug use is in line with how statistics related to these behaviors are reported by the CDC [51] as well as with goals set by Healthy People 2020 (HP2020) [52].

Sexual behaviors—As a measure of risky sexual behavior, participants reported the number of times they had engaged in (d) *unprotected sex* (sex without a condom) with a non-primary partner during the past 3 months; this variable was recoded to indicate whether participants had engaged in any unprotected sex with non-primary partners. We focused specifically on non-primary partners because hormonal contraception often replaces condom use as primary partnerships progress [53].

Exercise behaviors—As a measure of (e) *physical activity*, participants reported their frequency of engaging in vigorous activity for ≥20 minutes and their frequency of engaging in moderate activity for ≥30 minutes during the past 3 months on a scale from 0 (never) to 3 (nearly every day). Government guidelines [54] suggest exercising at least several times per week; therefore, participants who reported engaging in either vigorous or moderate activity never or rarely (0 or 1) were coded as engaging in a lack of exercise behavior. Participants also reported their (f) *time spent sitting* in hours and minutes. Because research suggests that more than 8 hours of sitting per day may compromise health [55], participants who spent more than 8 hours per day sitting on average were coded as engaging in excessive sitting.

Dietary behaviors—Participants reported their frequency of eating (g) *breakfast* during the past week from 0 to 7 days; participants who ate breakfast on 5 or fewer days per week were coded as having irregular breakfast consumption. Participants reported their frequency of consuming (h) *fast food* on a scale from 0 (never) to 7 (every day); participants who consumed fast food once or more per week (4 or higher) were coded as engaging in regular fast food consumption. Participants also completed six diet-related items from the National Health and Nutrition Examination Survey (NHANES) dietary screener [56], reporting their frequency of consuming vegetables (raw, cooked, canned, or frozen); fruit (fresh, frozen, or canned); regular soda; red meat (e.g., beef, pork, ham, or sausage); processed meat (e.g., bacon, deli meats, or hot dogs); and fried foods (e.g., french fries, fried chicken, or fried fish) on a scale from 0 (never) to 4 (daily: once a day or more). We coded participants for (i) *infrequent fruit and vegetable consumption* (less than daily consumption of both fruits and vegetables), (j) *daily soda consumption*, and a (k) *high-fat diet* (red meat, processed meat, or fried food daily). We created dietary indicators similar to those utilized by Heinrich et al. [46].

Sleep behavior—Participants reported how many (l) *hours of sleep* they got on average each night during the past 4 weeks. Participants who slept fewer than 7 hours or more than 9 hours per night were coded for poor sleep, to reflect the guidelines for sleep of the National Sleep Foundation [57].

Index of HCBs—Because of our interest in looking at health behaviors as a group, we created an overall index of HCBs. Consistent with prior studies that have calculated indices of health and risk behaviors [58-61], we summed the number of HCBs to create a single indicator that could range from 0 to 12. This indicator was used in the cross-lagged models.

Measures: Mental Health Indicators

Depression/anxiety—Participants completed four items from the Patient Health Questionnaire for Depression and Anxiety [the PHQ-4; 62], reporting their frequency of four symptoms of depression and anxiety (e.g., “feeling down, depressed, or hopeless” and “feeling nervous, anxious, or on edge”) in the last 2 weeks on a scale from 0 (not at all) to 3 (nearly every day). These items were averaged (αs at each time point = .87-.89). A higher score indicated more symptoms of depression/anxiety. The PHQ-4 predicts impaired functioning nearly as well as longer measures of depression and anxiety and has high internal reliability [62].

Perceived stress—Participants completed 4 items from the Perceived Stress Scale (PSS) [63], reporting their frequency of indicators of stress in the last month (e.g., “How often have you felt you were unable to control the important things in your life?”) on a scale from 0 (never) to 4 (very often). These items were averaged (αs = .59-.63). A higher score indicated greater perceived stress.

Measures: Demographic Controls

At baseline, participants reported their sex, race/ethnicity, income, and age. Dummy variables were created indicating male sex, white race, mixed race, family income less than $15,000 per year, and age over 25; these variables served as controls in cross-lagged models.

Data Management and Analysis

Missing data—There were three main sources of missing data in the current study. First, the design of the RCT involved one-half of participants (randomly-selected) completing intensive sexual health measures while the other half completed general health measures. All demographic variables, all mental health variables, and the majority of HCBs included in the current study were assessed for the entire sample. However, several HCBs (including the NHANES items, the measure of sitting, and the measure of binge drinking) were assessed only in the one-half of the sample completing general health measures. Thus, these few measures were missing completely at random (MCAR) from one-half of the sample (N = 239, 50%). Second, rolling enrollment in the RCT resulted in participants completing their follow-up assessments at different times, and a number of participants had not yet completed all follow-up assessments. Third, due to the longitudinal follow-ups and high-risk sample, some attrition occurred. Rolling enrollment and attrition resulted in 73% of participants (N = 351) being included at 3 months, 56% of participants (N = 268) at 6 months, 48% of participants (N = 232) at 9 months, and 40% of participants (N = 191) at 12 months. Rolling enrollment accounted for approximately 43% of the missing data at 3 months, 58% at 6 months, 69% at 9 months, and 81% at 12 months. To explore whether those missing follow-up assessments differed from those with complete data, we compared participants missing and not missing data at each time point on demographic characteristics as well as HCBs and mental health measures at baseline. There were no differences in any key study variables (including HCBs, depression, anxiety, and stress). Younger participants were slightly more likely than older participants to be missing data at the 3-month follow-up, $\chi^2(1) = 4.75$, $p < .05$, and mixed race participants were less likely than other participants to be missing data at the 12-month follow-up, $\chi^2(1) = 5.12$, $p < .05$. There were no other demographic differences.

The nature of the missing data (MCAR and missing at random [MAR]) [64] made multiple imputation (MI) highly suitable. MI, which is preferred over traditional approaches to missing data analysis (Schafer, 1999), allows for the entire sample to be maintained. We imputed 100 complete datasets [65] using the R program Amelia [66]. All study variables (including demographics, HCBs, and mental health measures) along with other variables thought to inform the imputation (including additional demographic and health behavior variables) were included in the imputation. Analyses were conducted with all 100 datasets, and parameter estimates were pooled using the imputation algorithms in Mplus 5 [67].

Analysis plan—The primary study analyses were conducted using an autoregressive cross-lagged panel model approach [68], allowing us to test associations within and across time. Cross-lagged path analysis is often used to infer causal associations in data from longitudinal research designs. These analyses were conducted with Mplus 5 using the maximum likelihood (ML) estimator. We modeled depression/anxiety and stress as latent constructs with items of the PHQ and PSS scales serving as indicators. We applied equality constraints in cross-lagged models to impose stationarity; factor loadings, autoregressive paths (paths from a given variable at one time point to the same variable at the next time point), lagged paths (paths from a given variable at one time point to a different variable at the next time point), and within-time correlations between variables were constrained to be equal over time. The primary variables of interest (HCBs, depression/anxiety, and stress) were modeled over time. Several covariates were included in the models to rule out alternative explanations for the association between HCBs and mental health, including sex, race, income, and age. Paths that were highly non-significant ($T < 1$) were constrained to zero to increase model parsimony and stabilize estimates.

Results

Rates of Health Compromising Behaviors

Overall rates of the HCBs at baseline are shown in Table 1. Of the 12 HCBs, participants engaged in an average of 6.2 ($SD = 2.3$). The majority of participants engaged in some binge drinking (52%), smoking (61%), illegal drug use (53%), and unprotected sex with non-primary partners (55%). Additionally, few participants regularly consumed breakfast (27%) or fruits and vegetables (30%); participants were likely to regularly consume fast food (71%). The majority of participants (57%) reported too little or too much sleep. Although these HCBs were common, participants were fairly active, with the majority reporting regular physical activity (65%) and less than half reporting more than 8 hours of sitting per day (45%). Participants were also unlikely to report daily consumption of high-fat foods (25%) or soda (17%).

Associations among Diverse HCBs

We explored associations between the 12 HCBs by examining odds ratios (ORs). There were relatively few significant associations among the diverse HCBs; we mention only the significant ORs. Participants who smoked were more likely to engage in binge drinking, OR = 1.91, CI [1.20,3.04], $p < .01$, and participants who engaged in illegal drug use were more likely to binge drink, OR = 2.39, CI [1.52,3.77], $p < .001$, and to use tobacco, OR = 3.88, CI [2.63,5.73], $p < .001$. Additionally, participants who engaged in binge drinking were more likely to have unprotected sex with outside partners, OR = 1.58, CI [1.02,2.44], $p < .05$. Participants who consumed fast food regularly also consumed breakfast infrequently, OR = 1.72, CI [1.05,2.80], $p < .05$. Finally, participants who reported too little or too much sleep were more likely to engage in unprotected sex, OR = 1.56, CI [1.07,2.26], $p < .05$, and to consume breakfast infrequently, OR = 2.66, CI [1.63,4.34], $p < .001$.

Demographic Predictors of HCBs and Mental Health Indicators

Linear regressions were used to explore the association of demographic characteristics with HCBs, depression, anxiety, and perceived stress. Very low-income participants (those earning less than $15,000 per year) reported a higher number of HCBs, $\beta = .74$, 95% CI [.37,1.11], $p < .001$, compared to higher-income participants. Very low-income participants also reported more symptoms of depression/anxiety, $\beta = .19$, 95% CI [.04,.34], $p < .05$, and higher levels of stress, $\beta = .23$, 95% CI [.09,.37], $p < .001$. Men reported fewer symptoms of depression/anxiety, $\beta = -.18$, 95% CI [−.33,−.03], $p < .05$, and stress, $\beta = -.19$, 95% CI [−.33,−.06], $p < .01$, than did women. There were no racial or ethnic differences or age differences in HCBs or mental health indicators. Demographic characteristics were controlled for in cross-lagged models.

Longitudinal Associations between HCBs and Depression/Anxiety

The cross-lagged model (Figure 1) provided a good fit to the data, $\chi^2(247) = 272.71$, $p = .12$, CFI = .99, TLI = .99, RMSEA = .02. The 3-month autoregressive coefficients for HCBs (i.e., the paths from HCBs at one time point to HCBs at the next time point) were significant, Bs = 0.37-0.39, $ps < .001$, indicating continuity in HCBs (i.e., that those who engaged in more HCBs at one time point were likely to engage in more HCBs at the next time point as well). Additionally, there was longer-term continuity in HCBs, with HCBs at one time point predicting HCBs 6 months later, Bs = 0.23-0.25, $ps < .001$. The 3-month autoregressive coefficients for depression/anxiety were also significant, Bs = 0.42-0.58, *p*s < .001, as were the 6-month autoregressive effects, Bs = 0.20-0.25, *p*s < .001, indicating continuity in symptoms of depression/anxiety. Additionally, HCBs and depression/anxiety were significantly correlated at each time point, Bs = 0.09-0.24, *p*s < .001, indicating that those who engaged in more HCBs at each time point also reported more symptoms of depression/anxiety.

Finally, as hypothesized (Hypothesis 1), there were significant lagged effects of depression/anxiety on HCBs, Bs = 0.09-0.10, *p*s < .01, indicating that individuals who reported more symptoms of depression/anxiety at one time point engaged in more HCBs at the next time point. However, contrary to Hypothesis 2, there were no significant lagged effects of HCBs on depression/anxiety, Bs = 0.02, *p*s = .47, indicating that those who engaged in more HCBs at one time point did not report more symptoms of depression/anxiety at the next time point.

Longitudinal Associations between HCBs and Perceived Stress

The cross-lagged model (Figure 2) was a good fit to the data, $\chi^2(245) = 301.47$, $p < .01$, CFI = .96, TLI = .95, RMSEA = .02. The 3-month autoregressive coefficients for stress were significant, Bs = 0.53-0.62, $p < .001$, as were the 6-month autoregressive effects, Bs = 0.28-0.31, *p*s < .001, indicating that levels of stress at one point were positively associated with levels of stress both 3 and 6 months later. Additionally, HCBs and stress were significantly correlated at each time point, Bs = 0.12-0.20, *p*s < .001, indicating that those who engaged in more HCBs at each time point also reported higher levels of stress.

Finally, as hypothesized (Hypothesis 1), there were significant lagged effects of stress on HCBs, Bs = 0.11-0.12, *p*s < .001, indicating that individuals who reported higher levels of stress at one time point engaged in more HCBs at the next time point. However, contrary to Hypothesis 2, there were no significant lagged effects of HCBs on stress, Bs = 0.04, *p*s = .18, indicating that those who engaged in more HCBs at one time point did not report higher levels of stress at the next time point.

Longitudinal Associations Between Subsets of HCBs and Mental Health

Although our primary interest was in a comprehensive index of HCBs, we tested two subsets of HCBs to see whether associations with depression/anxiety and perceived stress differed for different HCBs. The two subsets of HCBs were diet and activity (including the five dietary indicators as well as lack of exercise and excessive sitting) and risk behaviors (including the three substance use variables and unprotected sex).

Cross-lagged models showed that there were significant within-time associations between diet- and activity-related HCBs and depression/anxiety, Bs = 0.08-0.14, *p*s < .01, indicating that those with poorer diets and less activity at each time point also reported more symptoms of depression/anxiety at the same time point. Additionally, there were significant lagged effects of depression/anxiety on diet- and activity-related HCBs, Bs = 0.09-0.11, *p*s < .001, indicating that individuals who reported more symptoms of depression/anxiety at one time point reported poorer diets and lower activity levels at the next time point. There were no within-time associations between diet- and activity-related HCBs and stress, Bs = 0.04-0.11, *p*s = .15-.20, indicating that individuals engaging in more diet- and exercise-related HCBs at each time point did not report higher or lower levels of stress at the same time point. However, there were significant lagged effects of stress on diet- and exercise-related HCBs, Bs = 0.12, *p*s < .001, indicating that individuals who reported higher levels of stress at one time point reported poorer diets and lower activity levels at the next time point. As in the model including all HCBs, there were no lagged effects of diet- and activity-related HCBs on depression/anxiety or stress, indicating that those with poorer diets and lower activity

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levels at one time point did not report more symptoms of depression/anxiety or higher levels of stress at the next time point.

Cross-lagged models also showed that there were significant within-time associations between risk behaviors and depression/anxiety, Bs = 0.06-0.12, *p*s < .01, indicating that those who engaged in more risk behaviors at each time point also reported more symptoms of depression/anxiety at the same time point. However, there were only marginal lagged effects of depression/anxiety on risk behaviors, Bs = 0.04-0.05, *p*s < .10, indicating that individuals who reported more symptoms of depression/anxiety at one time point were only marginally more likely to report substance use and unprotected sex at the next time point. There were also significant within-time associations between risk behaviors and stress, Bs = 0.07-0.21, *p*s < .05, indicating that those who engaged in more risk behaviors at each time point also reported higher levels of stress at the same time point. However, there were no lagged effects of stress on risk behaviors, Bs = 0.04-0.05, *p*s = .11, indicating that those reporting higher levels of stress at one time point were not more likely to report risk behaviors at the next time point. As in the model including all HCBs, there were also no lagged effects of risk behaviors on depression/anxiety or stress.

Exploratory Analyses: Indirect Effects of Income on HCBs

Given that very low income (<$15,000/year) predicted both depression/anxiety and stress, we tested whether low income had indirect effects on HCBs via depression/anxiety and stress (i.e., whether depression/anxiety and stress mediated effects of income on HCBs). There was a significant indirect effect of low income on HCBs via depression/anxiety, $\beta = .05$, CI[.001,.10], $p < .05$, as well as a significant indirect effect of low income on HCBs via stress, $\beta = .08$, CI[.01,.14], $p < .05$, indicating that very low income individuals reported more HCBs partially as a result of increased depression/anxiety and stress. Notably, low income was also associated directly with HCBs.

Discussion

The current research showed that HCBs, including substance use, unprotected sex, poor diet, and insufficient or excessive sleep, were common among patients attending an urban public health clinic. Rates of substance use were quite high in this population, with 61% reporting smoking in the past 3 months (as compared to 24% current smokers in nationally representative samples [69]), 52% reporting binge drinking in the past 3 months (as compared to a past-month prevalence of 24% in national samples [70]), and 53% reporting illegal drug use in the past 3 months (as compared to a past-month prevalence of 9% in national samples [70]). Additionally, many participants in the current sample did not consume either fruit or vegetables on a daily basis (70%, as compared to 25% who do not consume vegetables and 62% who do not consume fruit on a daily basis nationally [71]). Regular breakfast consumption was rare (17%, as compared to 82% eating breakfast in the past day nationally [72]), while regular fast food consumption was common (71%, as compared to 41% in a large, representative community sample [73]). The majority of participants also engaged in unprotected sex with non-primary partners (55%) and did not get the recommended amount of sleep (57%) [57]. More encouragingly, relatively few participants in our sample reported daily soda consumption (17%), daily consumption of high-fat foods (25%), or a sedentary or nearly-sedentary lifestyle (35%). Very low-income participants engaged in more HCBs than did higher-income participants. Interestingly, there were very few associations between the various HCBs.

The key finding of this research is that symptoms of depression and anxiety as well as perceived stress predict later levels of HCB after controlling for both demographic factors and earlier HCBs. In contrast, we found no evidence that HCBs predict later mental health.

Results were quite similar for depression/anxiety and stress. Researchers have suggested that poor mental health may contribute to HCBs because HCBs serve as coping mechanism for dealing with negative feelings and emotions [33, 36, 42-45]. The current study clearly suggests that HCBs follow depression/anxiety and stress; however, HCBs do not serve to reduce future mental health difficulties, indicating that HCBs are not effective coping mechanisms. This is consistent with previous research on stress and coping, which indicates that avoidant coping is ineffective and associated with later depressive symptoms [74, 75]. Additionally, the current study showed indirect effects of low income on HCBs via depression/anxiety and stress, indicating that very low income may lead to increased engagement in HCBs by increasing mental health symptoms. This adds to a literature showing indirect effects of low income on poor health outcomes (specifically, high blood pressure) via increased obesity and resting heart rate [4, 5]—poor mental health may be another mechanism by which low income impacts physical health outcomes. Notably, exploratory analyses of subsets of HCBs showed within-time associations between depression/anxiety and stress and both diet/exercise-related HCBs and risk behaviors (i.e., substance use and unprotected sex), but depression/anxiety and stress more strongly predicted future diet/exercise-related HCBs than they did future risk behaviors. Future research should continue to explore subsets of HCBs.

The current study is unique in that we recruited a low-income urban sample engaging in high levels of HCBs and used a 5-wave longitudinal design. Limitations of this study include use of a brief measure of depression/anxiety to reduce participant burden, although the PHQ has been shown to be valid [62] and was reliable in the current sample. Additionally, although we used dietary items from a national survey [56], items did not map directly on to national dietary guidelines. We created an index of health behaviors in order to examine these behaviors broadly, but the behaviors we included, while important predictors of morbidity and mortality, are only a subset of all possible HCBs. Additionally, although our study assessed an important population (i.e., urban, low income, African American men and women) that suffers from numerous health disparities, participants were recruited from an STD clinic, and therefore findings may not generalize to non-clinic populations or to individuals not seeking sexual health services. There was some attrition from the study, although the attrition was relatively modest. In addition, rolling enrollment and study design also resulted in missing data; MI was used to retain all participants and to avoid biasing results. Finally, although we assessed HCBs and mental health longitudinally and used cross-lagged analyses to try to disentangle the direction of effects, because data are correlational, we cannot rule out all other possible explanations.

Implications: Practice

Results of the current research show that depression, anxiety, and stress contribute to HCBs, suggesting that targeting mental health may be important to promoting improvements across multiple health behaviors. Indeed, a growing literature on "syndemics" suggests that health-damaging behaviors often cluster, especially among disadvantaged population sub-groups such as those who are economically disadvantaged as well as racial, ethnic, and sexual minorities [76-78]. Syndemics theory suggests that comorbid conditions may interact to result in worsened health outcomes, and that these comorbid conditions cannot be treated in isolation; syndemics theory also draws attention to the importance of social conditions (e.g., poverty) in heightening risk for the comorbid conditions that drive the syndemic. For example, researchers have suggested there is a syndemic of substance abuse, violence, and AIDS [79]; these three conditions frequently co-occur and the interactions between these conditions magnifies the overall negative physical and mental health consequences. Our findings suggest that there may be a syndemic of stress, mental health, and HCBs; further, the finding that poverty had direct and indirect effects on HCBs suggests that poverty may, in part, drive this syndemic.

Clinicians and practitioners should recognize that there may be high rates of depression, anxiety, and stress, as well as HCBs, in low-income populations, and they should assess mental health as well as HCBs. Brief screenings such as the PHQ and PSS could be administered in a clinic or primary care context to identify those at high risk of poor mental health, possibly using handheld devices to reduce clinician burden. Because our findings suggest that poor mental health leads to HCBs, it may be important to provide referrals for mental health counseling or stress reduction techniques in order to improve health behaviors and, in the longer term, physical health. Another option is to “bundle” these services [80]. Bundling involves aggregating diverse health services to increase the effectiveness of these services—for example, by reaching high-risk individuals who may not seek out separate care. In this case, providing mental health counseling in primary care clinics, STI clinics, or substance abuse programs may aid in decreasing HCBs.

Implications: Research

More research is needed on multiple health behaviors in low-income populations. For example, it would be valuable to better understand the low associations between diverse health behaviors in this population. Longer-term longitudinal studies assessing the interplay between HCBs and mental health and studies assessing health behavior changes following mental health interventions would also contribute to our understanding of ties between mental and physical health. If associations between mental health and HCBs prove robust, research might test the cost-effectiveness of mental health treatments to address HCBs (versus targeting these behaviors directly). Additionally, future research should further explore pathways between mental health and HCBs to better understand why depression, anxiety, and stress contribute to these behaviors; identifying mediators of this association may suggest important targets for interventions to reduce HCBs. Although HCBs did not improve future mental health in our sample, associations between HCBs, various forms of mental health, and physical health are likely to be complex and should be further explored in future studies. For example, Jackson and colleagues [81, 82] have suggested that the use of HCBs as coping mechanisms for stress may be especially common among low-income African Americans; associations between mental health, HCBs, and physical health may vary based on race/ethnicity or SES.

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Implications

Practice: To improve health behaviors and physical health, clinicians and practitioners should assess mental health and perceived stress, and provide referrals for mental health counseling or stress reduction techniques when indicated. **Policy:** Policymakers should consider the role that access to mental health services might play in addressing health behaviors. **Research:** Mental health intervention studies should assess changes in health compromising behaviors as outcomes.

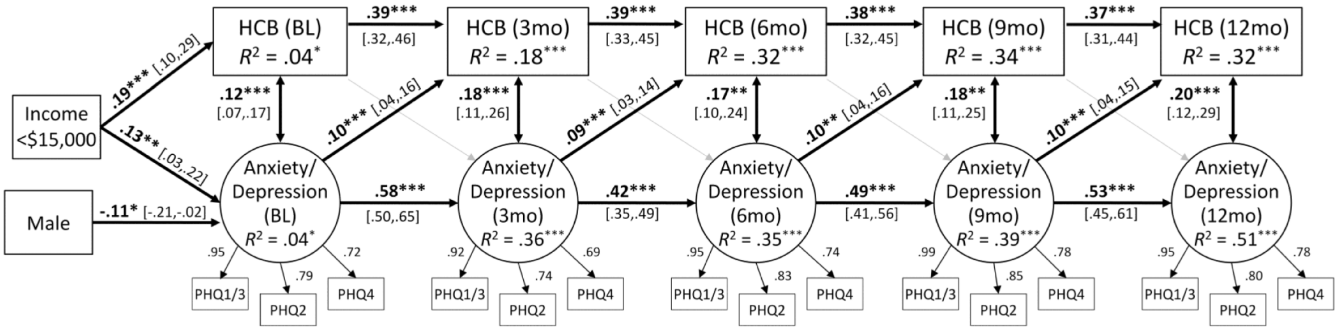

Figure 1.

Cross-lagged model showing associations between health compromising behaviors (HCBs) and symptoms of anxiety/depression over 1 year. The four items from the Patient Health Questionnaire for Depression and Anxiety (PHQ-4) serve as indicators for the latent anxiety/depression construct; items 1 and 3 were averaged at each time point to create the first indicator. Standardized regression coefficients are reported. Control variables included sex, race, income, and age. Factor loadings, autoregressive paths, lagged paths, and within-time correlations between variables were constrained to be equal over time, although standardized values differ slightly. Long-term (6-month) autoregressive effects for HCBs and depression/anxiety were also significant. Gray arrows represent non-significant paths. Average fit indices across 100 multiply imputed data sets: $\chi^2(247) = 272.71$, $p = .12$, CFI = .99, TLI = .99, RMSEA = .02.

* $p < .05$; ** $p < .01$; *** $p < .01$

Notes. HCB = health compromising behaviors, BL = baseline, 3mo = 3 months after baseline, 6mo = 6 months, 9mo = 9 months, 12mo = 12 months.

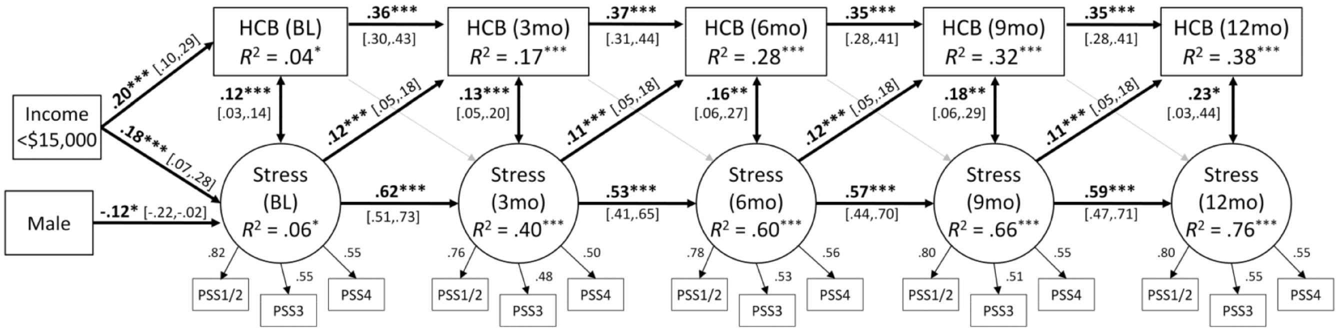

Figure 2.

Cross-lagged model showing associations between health compromising behaviors (HCBs) and stress over 1 year. The four items from the Perceived Stress Scale (PSS) serve as indicators for the latent stress construct; items 1 and 2 were averaged at each time point to create the first indicator. Standardized regression coefficients are reported. Control variables included sex, race, income, and age. Factor loadings, autoregressive paths, lagged paths, and within-time correlations between variables were constrained to be equal over time, although standardized values differ slightly. Long-term (6-month) autoregressive effects for HCBs and stress were also included in the model. Gray arrows represent non-significant paths. Average fit indices across 100 multiply imputed data sets: $\chi^2(245) = 301.47$, $p < .01$, CFI = .96, TLI = .95, RMSEA = .02.

* $p < .05$; *** $p < .01$

Notes. HCB = health compromising behaviors, BL = baseline, 3mo = 3 months after baseline, 6mo = 6 months, 9mo = 9 months, 12mo = 12 months.

Table 1

Descriptive Statistics for Health Compromising Behaviors and Mental Health Indicators

Health Compromising Behavior (HCB)	***M (SD)***
Total Number of HCB (0-12)	6.2 (2.3)
Substance Use Behaviors	**%**
Binge Drinking (Past 3 Months)	52%
Smoking (Past 3 Months)	61%
Illegal Drug Use (Past 3 Months)	53%
Sexual Behaviors	**%**
Unprotected Sex (Past 3 Months)	55%
Physical Activity Behaviors	**%**
Lack of Physical Activity (Past 3 Months)	35%
Excessive Sitting (Past Week)	45%
Dietary Behaviors	**%**
Infrequent Breakfast Consumption (Past Week)	83%
Regular Fast Food Consumption	71%
Infrequent Fruit/Vegetable Consumption (Past Month)	70%
High-Fat Diet (Past Month)	25%
Daily Soda Consumption (Past Month)	17%
Sleep Behaviors	**%**
Too Little or Too Much Sleep (Past 4 Weeks)	57%
Mental Health	***M (SD)***
Depression (PHQ; 0-3; Past 2 Weeks)	0.8 (1.2)
Anxiety (PHQ; 0-3; Past 2 Weeks)	1.0 (1.1)
Perceived Stress (PSS; 0-4; Past Month)	1.6 (0.8)