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Pathways maintaining physical health problems from childhood to young adulthood: The role of stress and mood

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Abstract

Objective—Poor physical health in childhood is associated with a variety of negative health-related outcomes in adulthood. Psychosocial pathways contributing to the maintenance of physical health problems from childhood to young adulthood remain largely unexamined, despite evidence that factors such as negative mood and stress impact physical health.

Design—The current study tested the direct and indirect effects of ongoing health, chronic stress, health-related chronic stress, and depressive symptoms at age 20 on the link between health problems in childhood and young adulthood (age 21) in a longitudinal sample (n = 384).

Main Outcome Measures—The hypotheses were tested using a multiple mediation path analysis framework; the primary outcome measure was a composite index of health status markers in young adulthood.

Results—The proposed model provided an adequate fit for the data, with significant total indirect effects of the four mediators and significant specific indirect effects of health-related chronic stress and depressive symptoms in maintaining health problems from childhood into young adulthood.

Conclusions—Health problems are maintained from early childhood into young adulthood in part through psychosocial mechanisms. Depressive symptoms and health-related chronic stress have significant, unique effects on the relationship between health problems in early childhood and young adulthood.

Keywords

chronic stress; depressive symptoms; childhood; young adulthood; physical health

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Introduction

Poor physical health in childhood is associated with a variety of negative health-related outcomes in adolescence and adulthood including high blood pressure, high cholesterol, obesity, and chronic disease (Case, Fertig, & Paxson, 2005; Currie, Stabile, Manivong, & Roos, 2010). Childhood health problems, including markers of chronic disease and general indicators of poor health, that persist into adulthood come at an enormous cost to both individuals' quality of life and to society in terms of healthcare costs and utilization (Delaney & Smith, 2012). The number of children with chronic health conditions, such as asthma and obesity, in the United States has increased considerably over the past few decades (Perrin, Bloom, & Gormaker, 2007; Van Cleave, Gortmaker, & Perrin, 2010), making this a growing area of public health concern. Nonetheless, the specific pathways by which childhood physical health problems predict adolescent and adult physical health problems remain unclear.

Existing research on the relationship between health problems in childhood and young adulthood has focused largely on physical mechanisms that might maintain and/or exacerbate such problems. Physical effects of childhood illness and/or health status that been demonstrated to impact adult health include impaired growth and development, cardiometabolic syndrome and cardiovascular risk, and proinflammatory changes and vascular alterations in anatomy (Allcock, Gardner, & Sowers, 2009; Groner, Joshi, & Bauer, 2006; Turkel & Pao, 2007). Psychosocial factors that contribute to the maintenance of health problems over time are less well understood, despite evidence that physical health problems and psychosocial factors such as stress and mood are strongly related. For example, obesity and diabetes in childhood and adolescence are associated with higher levels of internalizing symptoms and disorders and lower quality of life (e.g., Nardi et al., 2008; Pulgarón, 2013). Furthermore, early stressful experiences such as abuse and neglect predict both mental and physical health outcomes in adulthood (Herrenkohl et al., 2013; Miller, Chen, & Parker, 2011). Despite a robust body of literature supporting bidirectional relationships between physical and psychological health in childhood and adolescence, the role of stress and mood in maintaining poor health over time has been largely neglected. Explication of these pathways is crucial to the development of interventions that alleviate the long-term impact of childhood physical health problems.

A variety of factors could account for the association between health problems in childhood and young adulthood. In part, health problems in adulthood might reflect ongoing or chronic conditions that began in childhood. Additionally or alternatively, childhood health problems might be maintained into adulthood through psychosocial mechanisms such as stress and negative mood. It is important to test potential psychosocial mediators of the relationship between health problems in childhood and adulthood as such information will yield important advances in interventions that might ameliorate the long-term effects of childhood health problems. The proposed study will investigate the combined and unique roles of ongoing health, depressive symptoms, and chronic and health-related stress in the effects of childhood health problems on health problems in young adulthood. The justification for each of the four proposed mediators is provided below.

First, childhood health status might serve as an indicator of ongoing or recurrent health problems that persist into adolescence and young adulthood. There is evidence in support of a persistence or recurrence of health problems with several health risk factors and chronic illnesses. For example, childhood body mass index (BMI), asthma, physical pain, and risk factors for coronary heart disease persist into adulthood (Lynch & Smith, 2005; Sears et al., 2003). It is important to note, however, that not all health problems that exist in childhood, even those considered "chronic" diseases such as obesity and asthma, remain entirely constant throughout the course of childhood and adolescence; instead fluctuations in disease and symptom presence are common (Van Cleave, Gortmaker, & Perrin, 2010).

Childhood health problems often occur in the context of early psychosocial adversities such as low socioeconomic status and parental psychopathology (Chen, Martin, & Matthews, 2006; Turney, 2011). For example, maternal depression has been associated with poor infant sleep profiles, as well as youth internalizing disorders and negative affect (Goodman et al., 2011; Hughes, Gallagher, & Hannigan, 2015). Low socioeconomic status is associated with adolescent depression and obesity in population-based samples (Goodman, Slap, & Huang, 2003). A question that has not been sufficiently addressed in the literature is whether the association of early and later health problems might be propagated in part by the continuation of exposure to psychosocial risk factors. For example, it is known that college students with childhood-onset asthma exhibit poorer social and emotional functioning than their peers without a history of asthma (Fedele et al., 2009). Children with frequent and severe headaches exhibit higher levels of impairment in emotional, conduct, and peer domains than those who do not (Strine, Okoro, McGuire,& Balluz, 2006). Childhood health problems might predict higher levels of chronic stress across a variety of domains via restrictions to and impairments in areas such as academic and social functioning in adolescence and young adulthood. Chronic stress is in turn predictive of a variety of poor health outcomes, including cardiovascular and respiratory diseases and mortality (Schneiderman, Ironson, & Siegel, 2005). Chronically stressful conditions produce repeated activation of the body's sympathetic-adrenal-medullary (SAM) and hypothalamic-pituitary-adrenocortical (HPA) axes, which over time increases susceptibility to illness and health problems (Juster, McEwen, & Lupien, 2009). Previous researchers have pointed out that the cumulative effect of ongoing stressors can influence coping and illness differently than individual, acute stressful events (Segerstrom & O'Connor, 2012). Health problems in early childhood might yield elevated levels of chronic stress throughout childhood and adolescence, which in turn contribute to the maintenance of health problems in young adulthood through biological mechanisms.

In considering the potential role of chronic stress in maintaining health problems over time, it is important to consider the relative effects of chronic stress and impairment across important relational and academic/career roles, compared to health-specific stress and impairment. Health-related stress includes chronically stressful conditions such as dysfunction and impairment due to illness and utilization of healthcare services, and is reflective of demands related to health status, including adjustments and adaptations to psychosocial situations (De Civita et al., 2005). Previous researchers have argued in favor of distinguishing between health-related and general quality of life in studying health and disease burden among children and adolescents (Wilkins et al., 2004). Furthermore, health-

related chronic stress is reflective of limitations related to health status or problems and is therefore related to, but distinct from, health problems per se. Meta-analytic investigations support the idea that health status/problems and quality of life are distinct constructs (Smith, Avis, & Assmann, 1999); however, health-related chronic stress as a distinct domain has not been thoroughly examined. While general and health-specific chronic stress are undoubtedly related, it is conceptually important to disentangle their relative effects on the maintenance of health problems over time, as different interventions would be warranted in each case.

A fourth pathway by which early childhood physical health problems might predict physical health problems in adulthood is via negative mood. A growing body of evidence supports bi-directional relationships between mental and physical health throughout the life course. Physical health problems in childhood, including obesity and asthma, are associated with depression in adolescence and adulthood (Hommel, Chaney, Wagner, & McLaughlin, 2002; Raikkonen et al., 2004). In a population-based sample, parental reports of offspring's global physical health at ages 3 and 6 were predictive of offspring self-reported depressive symptoms in young adulthood (Raikkonen et al., 2004). Depression, in turn, is known to predict a variety of negative health outcomes, including cardiovascular disease and obesity (Luppino et al., 2010, Van der Kooy et al., 2007). Adolescent depression is associated with subsequent poor health and functional impairment (Jaycox et al., 2009). Several mechanisms by which depressive symptoms impair physical health have garnered empirical support, including altered HPA axis functioning and negative changes to health behaviors such as diminished exercise and increased substance use (Goldston & Baillie, 2008; Whooley et al., 2008). Early childhood physical health problems might be maintained in part by depressive symptoms in adolescence and young adulthood, which are demonstrated to be predicted by and predictive of physical health problems.

The current study aims to explore the roles of ongoing physical health, general chronic stress, health-related chronic stress, and depressive symptoms at age 20, in maintaining physical health problems from childhood (ages 0–5) to young adulthood (age 21) in a longitudinal sample. The current study will utilize a path analysis framework to test a multiple meditation model of the effects of childhood physical health problems on young adulthood physical health problems. Age 20 depressive symptoms, chronic stress, health-related chronic stress, and ongoing physical health will be tested as mediators of the relationship between physical health problems in childhood and young adulthood, as each has previously been demonstrated to be predicted by early physical health, and predictive of subsequent physical health outcomes.

It is predicted that childhood physical health problems (up to age 5) will predict physical health problems at age 21. Furthermore, it is predicted childhood physical health problems will predict general physical health, chronic stress, health-related stress, and depressive symptoms at age 20, which will in turn predict physical health problems at age 21. A multiple mediation framework will be used in order to assess and compare indirect effects of general chronic stress, health-related chronic stress, depressive symptoms, and ongoing physical health in maintaining physical health from early childhood to young adulthood. The proposed design will allow for tests of unique effects of each of the four mediators, over and above the others. Importantly, this will allow for testing the independent role of depressive

symptoms and subtypes of chronic stress in the maintenance of health problems from childhood to young adulthood using a prospective design. Previous research on specific mechanisms by which health problems persist over time is sparse, and the potential roles of chronic stress, chronic health-related stress, and mood have been largely neglected. Results will bear important implications for intervention in a growing area of public health concern.

Methods

Participants

The current study includes 384 young adults (50.3 % male and 49.7% female) drawn from a sample of 815 mother-child pairs participating in a longitudinal birth cohort study in Queensland, Australia who were over-selected for history of maternal depression at youth age 15 (for further information pertaining to the original birth cohort study see Keeping et al., 1989; see Hammen & Brennan, 2001 for sampling procedures pertaining to the sample of 815). The present study utilized data related to health, stress, and mood measured at participant ages 0–5, 20, and 21. Although this sample was not initially designed to address questions related to physical health outcomes, the longitudinal nature of the data, interview measure of chronic stress, and over-selection for maternal depression provide a unique opportunity to explore the effects of stress and mood in perpetuating health problems over time. The current sample (N =384) includes participants from the age 20 sample (N = 705) who had relevant health and stress measures at ages 5 and 20. Of the 384 participants included in the present sample participating at age 20, 221 participated and had relevant data at age 21.

Participants included in the present sample (N = 384) did not differ from those not selected from the larger sample of 815 with regards to childhood physical health problems ($t(506) = -.09$, $p = .93$), maternal depression history by youth age 15 ($\chi^2(1,815) = .90$, $p = .64$), depressive symptoms at age 20 ($t(631) = -1.96$, $p = .05$), physical health at age 20 ($t(628) = 1.10$, $p = .27$), total chronic stress at age 20 ($t(699) = -.51$, $p = .61$), health-related chronic stress at age 20 ($t(703) = .17$, $p = .87$), or gender ($\chi^2(1, 815) = .03$, $p = .88$).

Participants retained at age 21 (N = 221) did not differ from those participating at age 20 and not included at age 21 (N = 163) with regards to childhood physical health problems ($t(382) = -.81$, $p = .42$), maternal depression history by youth age 15 ($\chi^2(1,384) = .16$, $p = .69$), depressive symptoms at age 20 ($t(326) = 1.37$, $p = .17$), physical health at age 20 ($t(325) = -.05$, $p = .96$), total chronic stress at age 20 ($t(380) = -1.08$, $p = .28$), or health-related chronic stress at age 20 ($t(382) = -1.44$, $p = .15$). Youth not retained at age 21 were more likely to be male ($\chi^2(1, 384) = 27.13$, $p < .01$) than those retained at age 20.

The sample was predominantly white (93% white, 3% Asian, 4% other/not reported). Median family income fell in the working/lower middle class.

Procedure

Mothers completed questionnaires immediately after birth, at youth age six months and again at youth age 5, which included questions regarding offspring physical health and healthcare utilization. Youth and their mothers completed additional questionnaires and

interviews at youth age 20 (average age of youth 20.32 years) in participants' homes or locations convenient to both the participants and interviewers. At age 21 (average age of youth 21.33 years), youth completed questionnaires regarding physical and psychosocial functioning and biological assessments in a laboratory setting. All procedures were approved by Institutional Review Boards of the University of Queensland, University of California, Los Angeles, and Emory University. Participants provided written informed consent (or assent in the case of minors) and were compensated for their time.

Measures

Childhood Physical Health Problems—Childhood physical health problems were measured as a composite score of six health indicators reported by mothers by youth age 5. At 3–4 days post-birth, mothers indicated whether offspring had experienced medical difficulties during or since birth; offspring experiencing "moderate" or "major" medical problems were coded as having post-natal medical difficulties. At 6 months after birth, mothers indicated whether offspring had experienced a number of physical health problems (e.g., diarrhea, colds, colic, feeding problems) and the highest third of the sample were coded as having health problems. At six months after birth, mothers reported how often they had sought medical attention for their offspring; the highest third of the sample were coded as being high in healthcare utilization. At offspring age 5, mothers reported on the presence or absence of the following in their offspring: multiple hospitalizations, limitations to daily activities due to physical health problems (checklist), and any chronic illness (e.g., asthma, diabetes). Coefficient alpha for the measures included in this composite scale was 0.65; notably, while these measures are expected to demonstrate some concordance, these individual items are not theorized to indicate a unitary construct, therefore high reliability is not expected. Full measure details are described elsewhere (Raposa, Hammen, Brennan, & Najman, 2014).

Chronic Stress, age 20—Chronic stress in the past six months was measured using the UCLA Life Stress Interview (LSI; Hammen, Henry, & Daley, 2000), a semi-structured interview assessing factual indicators of ongoing stress across several content domains at youth age 20 (friend, family, romantic relationship, school and/or work, and finances). Interviewers included postgraduate students trained to appropriately conduct and reliably score the interviews. Ratings based on objective features of the circumstances ranged from 1 (no stress; superior circumstances) to 5 (severe stress; major ongoing difficulties), with half-points permitted. Interrater reliabilities across domains in the present sample ranged from 0.76 to 0.82. A total chronic stress score was calculated for each participant by summing across all domains.

Health-related stress, age 20—Ongoing stress related to physical health was also measured using the LSI at youth age 20. The ratings were based not on the severity of the illness or health problem itself, but on the personal, financial, and social circumstances associated with impairment and consequences, nature and impact of the treatment regimen, and barriers to treatment or impediments to recovery. Interviewers probed participants' experiences with health-related stress and assigned objective severity ratings on a 5-point scale (1 indicating excellent health with no resulting stress; 5 indicating extreme stress

related to health problems; half points permitted), reflective of conditions over the past 6 months. For example, a score of 3 would be given to an individual who experiences chronic, but not life-threatening, asthma that requires some ongoing treatment (generally not hospitalizations) and causes occasional absences from or restrictions to planned activities. The inter-rater reliability of the health-related stress subscale was .77.

Physical Health, age 20—The physical health summary subscale of the SF-36, a multi-purpose, short-form health survey, was used to assess general health and disease burden. The physical health summary consists of 21 items and includes subscales assessing physical functioning, physical role, bodily pain, and general health, with higher scores indicating better physical health in these domains. Sample items include "During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?" with response options such as "Cut down on the amount of time you spent on work or other activities." The SF-36 has demonstrated good reliability and validity in the assessment of general health and disease burden, including among young adult samples (Ware, 2004). Coefficient alpha for the physical health subscale of the SF-36 in the present sample was .83.

Youth Depressive Symptoms, age 20—Self-reported depressive symptoms at age 20 were assessed using the 21-item Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996), a well-validated and widely used measure of severity of depressive symptoms. Coefficient alpha for the current sample was 0.93 at age 20.

Young Adult Physical Health Problems—The outcome variable, physical health problems at age 21, was an index of 17 health indicators, each coded as present or absent. These included self-reported history of illnesses/ health problems (diabetes, hypertension, eczema, asthma, migraine, tension headache, liver disease, gall bladder disease, sleep apnea, frequent cigarette use, and frequent alcohol use), sleep problems three or more nights per week in the past month (waking during the night, restless sleep, daytime drowsiness, and poor sleep quality) and health status markers measured in the laboratory (high blood pressure and BMI falling in the overweight/obese categories). Each health indicator was coded as being present or absent and a total score was calculated for each participant, with higher scores indicating more physical health problems. Coefficient alpha for the current sample was 0.61; notably, as in the case of the childhood physical health scale, while these measures are expected to demonstrate some concordance, these individual items are not theorized to indicate a unitary construct, therefore high reliability is not expected.

Maternal Depression Diagnoses—Given that the current sample was over-selected for exposure to maternal depression, maternal depression status was included as a covariate in the model, to control for the possibility that youth depressive symptoms and ongoing stress were an artifact of maternal depression and its consequences (Hammen, Shih, & Brennan, 2004). Maternal depression was measured using the Structured Clinical Interview for DSM-IV Axis-I Disorders, Patient Edition (SCID; First, Spitzer, Gibbon, & Williams, 1995), a reliable and well-validated semi-structured clinical interview. Mothers' lifetime and current depressive disorders (Major Depressive Disorder and dysthymia; weighted kappas = 0.87

and 0.84, respectively) at youth age 15 defined maternal depression history. In the present sample, 169 (44%) had histories of major depressive disorder or dysthymia by youth age 15; 215 (56%) had no history of depression.

Data Analytic Procedures

A path analysis framework was used to examine the effects of childhood physical health problems on young adult physical health problems directly and indirectly through chronic stress, health-related chronic stress, depressive symptoms, and ongoing physical health at age 20 (see Figure 1). Mediation analyses were conducted using bootstrapping, a nonparametric re-sampling procedure that does not require normality of the sampling distribution (Preacher & Hayes, 2008). Contrasts between specific indirect effects were used to compare the unique effects associated with each of the mediators in the model.

Full-information maximum likelihood estimation (FIML) methods were used to account for missing data (Allison, 2012). This approach was selected in light of evidence that data was missing at random (MAR); specifically, data missingness was predicted by gender, which was also included in the model (see Table 1 for further information on missing data). FIML is appropriate for use with data that are MAR and produces unbiased and efficient parameter estimates in structural equation models (Enders & Bandalos, 2001). All analyses were carried out in MPlus version 6 (Muthén & Muthén, 1998–2010).

The errors associated with each of the age 20 variables (chronic stress, chronic health stress, depressive symptoms, and physical heath) were allowed to correlate in the model in light of established relationships amongst these constructs (Hammen, 2005; Keenan-Miller, Hammen, & Brennan, 2007). Youth gender was controlled for in paths predicting each of the age 20 mediators and the age 21 outcome variable, as prior research suggests higher rates of depressive symptoms, chronic stress, and self-reported physical health impairment among women than men (Nolen-Hoeksema, 2001; Wilson, Pritchard, & Revalee, 2004). The effects of maternal depression history by youth age 15 were controlled for in paths predicting youth chronic stress and depressive symptoms at age 20 and health outcomes at age 21 as maternal depression history has well-documented effects on offspring mood and stress (Hammen, Shih, & Brennan, 2004). Overall model fit was evaluated using the likelihood ratio chi-square test, the comparative fit index (CFI), the Tucker Lewis Index (TLI; Bentler, 1990; Hu & Bentler, 1999), the root-mean-square error of approximation (RMSEA; Browne & Cudeck, 1993), and the standardized root mean-square residual (SRMR; Hu & Bentler, 1998). CFI and TLI close to 0.95, RMSEA less than .06, and SRMR less than .08 are considered indicative of good model fit (Hu & Bentler, 1999).

Results

Model Fit

Descriptive statistics and intercorrelations for study variables are provided in Table 1. Eighty percent of the sample had at least one indicator of childhood health problems, and eighty-four percent had at least one indicator of young adult physical health problems. Fit indices revealed that the hypothesized model provided an adequate fit for the data: $\chi2$ (df= 3,

N=384) = 10.63, p = .01; CFI = 0.98; TLI = 0.86; RMSEA = .08 (90% CI .03, .14); SRMR = .04 (see Figure 1).

In the model, physical health problems at age 21 were significantly predicted by childhood physical health problems (standardized β = .12, p < .01), age 20 chronic health stress (standardized β = ..31 p < .01), and age 20 depressive symptoms (standardized β = .27, p < .01), controlling for effects of maternal depression and gender. Physical health at age 21 was not predicted by ongoing physical health at age 20 (standardized β = −.09, p = .28) or chronic stress at age 20 (standardized β = .04, p = .06). Childhood physical health problems were significantly predictive of age 20 chronic stress (standardized β = .15, p < .01), chronic health-related stress (standardized β = .15, p <.01), depressive symptoms (standardized β = .16, p =01), and physical health (standardized β = −.14, p =.02), controlling for effects of maternal depression history and gender.

Mediation

The total indirect effect of the age 20 mediators on the relationship between physical health problems in childhood and young adulthood indicated significant mediation of the age 20 variables taken together (standardized β = 0.11, SE = .03, p <.01). Tests of the specific indirect effects of each mediator (considered over and above the others) indicated that age 20 health-related chronic stress and depressive symptoms, but not general chronic stress and ongoing physical health, achieved significance as unique mediators of the relationship between childhood and young adult physical health (see Table 2 for results of mediation analyses). In order to compare the effects of the two significant unique mediators, bootstrapped, bias-corrected, 95% confidence-interval contrasts of the indirect effects of health-related chronic stress and depressive symptoms were calculated. The contrasts indicated that these effects did not differ significantly from one another (Standardized Point Estimate = −.02 (95% CI: −.13, .17; SE = .05), p = .65). In order to measure effect sizes associated with the mediators, the product of the partial correlations associated with the paths from the predictor to the mediator ('a' paths) and the mediator to the outcome ('b' paths) were calculated (Kenny, 2015; Preacher & Kelley, 2011). These squared partial correlations were then compared to the squared traditional effect size metrics, as has been recommended by Kenny (2015; hence a small effect size is .01, medium is .09, and large is .25). Using this calculation, the three psychosocial mediators (chronic stress, chronic health related stress, and depressive symptoms), yield a medium effect (r = .10) when considered together. Taken individually, depressive symptoms (r = .05) and health-related chronic stress (r = .04) yield small effect sizes.

Model fit among groups

In light of prior evidence of an influence of both gender and maternal depression on various aspects of mood and stress (e.g., Hammen, Shih, & Brennan, 2004; Nolen-Hoeksema, 2001; Wilson, Pritchard, & Revalee, 2004), two Wald Tests were conducted to test whether model fit changed when moderated by gender and maternal depression history. The Wald Test evaluates whether model fit deteriorates significantly when the model is constrained to be the same across groups; a significant Wald's Test would suggest differential relationships of the observed variables among the groups (in this case, among men among women, and youth

with and without a history of maternal depression). The results of the Wald Test of Parameter Constraints indicated no significant differences of the model among youth with and without a history of maternal depression (value = 12.64, df =6, p = .05). The results of the Wald Test of Parameter Constraints indicated no significant differences of the model among men and women (value = 7.54, df = 6, p = 0.27).

Effect of Socioeconomic Status

A second model was run in which the effects of family income at the time of the childhood assessment were controlled for in paths predicting health problems in young adulthood, in order to test whether the findings were independent of childhood socioeconomic status. This model provided an adequate overall fit to the data (χ^2 (df= 7, N=367) = 29.10, $p < .01$; CFI = 0.95; TLI = 0.79; RMSEA = .09 (90% CI .06, .13); SRMR = .05). The patterns of significance for all direct and indirect paths remained the same as in the original model, with the exception that the indirect effect of childhood health on health in young adulthood through depressive symptoms at age 20 became marginally significant (b = 0.04, p = 0.057).

Discussion

The present study sought to examine psychosocial pathways maintaining physical health problems from childhood to young adulthood. The hypothesized structural equation model provided an adequate fit for the data. As predicted, physical health problems at age 5 significantly predicted physical health problems at age 21 as well as higher depressive symptoms, general chronic stress, health-related stress, and ongoing physical health problems at age 20. Also as hypothesized, youth depressive symptoms and chronic health-related stress were positively predictive of physical health problems at age 21. Youth general chronic stress and ongoing physical health at age 20 were not significantly predictive of health problems at age 21 when included in the model. The age 20 variables taken together significantly mediated the relationship between physical health problems at age 5 and 21. Individually, only health-related chronic stress and depressive symptoms exhibited unique effects over and above the other mediators in perpetuating health problems over time.

Results were generally supportive of study hypotheses, and suggest that health problems in early childhood are maintained into young adulthood in part through psychosocial mechanisms, chiefly depressed mood and health-related stress. These results are in keeping with prior research that highlights the negative psychosocial consequences of early childhood physical health problems, such as worsened interpersonal functioning and impaired relationships, and emotional distress (Case, Fertig, & Paxson, 2005; Raikkonen et al., 2004). Critically, the present study extends this research to suggest that not only are increased stress and depressive symptoms consequences of early physical health problems; they also serve to perpetuate or maintain physical health problems into the young adult years. Importantly, multiple mediation models tend to attenuate specific indirect effects of the individual mediators (Preacher & Hayes, 2008) and thus the present results may, if anything, downplay the unique effects of the proposed mechanisms. Furthermore, while ongoing chronic stress and physical health at age 20 were not predictive of age 21 physical health problems when included in the model with the other mediators and predictors, they

were predictive of this outcome independently (see Table 1). This suggests that while these constructs are prospectively predictive of physical health, their effects in this model were overshadowed by the stronger relationships amongst the other variables (health-specific chronic stress, depressive symptoms, and childhood health problems) and adult health problems.

The present results suggest that health professionals should attend to children's and adolescents' health-related stress and impairment, as these factors appear to be specific and unique pathways maintaining health problems, over and above ongoing health and mood. This is consistent with studies demonstrating positive effects of interventions aimed at increasing coping skills for youth with chronic illness. For example, adolescents who undergo intensive diabetes management (IDM) combined with coping skills training focused on social problem-solving for health-related issues such as food choices with friends exhibit improved metabolic control and health-related quality of life one year later as compared to youth who had IDM only (Grey, Boland, Davidson, & Tamborlane, 2000). Depressive symptoms also achieved significance as a unique mediator of the relationship between health problems in early childhood and early adulthood in the present model. These findings suggest that interventions targeting the source of dysphoric mood (e.g, social skills or problem-solving training when warranted, Cognitive Behavioral Therapy interventions for depressive disorders) may help reduce the impact of early childhood physical health problems on health problems in adolescence and young adulthood, which is consistent with a small body of evidence that treatment of adult depression is associated with improved physical health outcomes (Farmer Teh, Zaslavsky, Reynolds, & Cleary, 2010). Targeting health-related chronic stress and depressive symptoms in youth may lessen the extent to which early physical health problems are maintained into young adulthood.

The study is strengthened by its use of a longitudinal design, concurrent maternal reports of childhood physical health, and use of an objective, interview-based measure of chronic stress that differentiates general and health-specific chronic stress in young adulthood. The present study is unique in its consideration of the simultaneous and relative roles of chronic stress (total and health-specific), depressive symptoms, and ongoing physical health in the maintenance of health problems over time.

Several important limitations of the current study should be acknowledged. While the present study advances understanding of the role of psychosocial factors in maintaining physical health problems, it does not account for inflammatory or biological processes that might maintain or underlie physical and mental health problems. Additionally, the present study is limited by its measurement of physical health problems in childhood and young adulthood, which were operationalized as composite scores of various facets of health, including self/maternal report of presence of chronic disease, physical ailments, and healthcare utilization. These measures do not capture the full range of possible physical health problems at these ages and would be improved by verification with medical reports. Additionally, the age 21 measures included participants' histories of various illnesses, the precise onset/timing of which were not assessed. While this is a limitation, and future research should consider more precisely the timing associated with interrelationships between mood, stress, and physical health, it is likely these are transactional processes that

unfold over time. The present study demonstrates support for one model of directionality amongst these variables over the first 21 years of life, however, multiple interactions and interrelationships between these constructs during this time period are plausible. In the future, assessments of youth stress, mood, and physical functioning at multiple time points would be helpful in explicating the timing associated with these processes. It is also important to bear in mind that the current sample had relatively few ongoing health problems; it would be important to test similar models in samples with higher rates of physical health problems and chronic illnesses. Future research should consider the role of mood and health-related stress in maintaining specific physical health problems or chronic diseases such as asthma, obesity, and diabetes.

The present study advances understanding of the maintenance of health problems over time, and provides evidence that psychosocial factors contribute uniquely to the persistence of health problems from childhood to young adulthood. Specifically, results indicate that not only do early childhood health problems portend elevated health-related chronic stress and depressive symptoms in young adulthood, but that these risk factors in turn contribute to continued physical health problems. Although further research and replication of these findings is needed, the present results suggest that physicians and medical professionals attend to the psychosocial impairments associated with childhood physical illness, as such impairments contribute uniquely to the maintenance of poor physical health into young adulthood.

Acknowledgments

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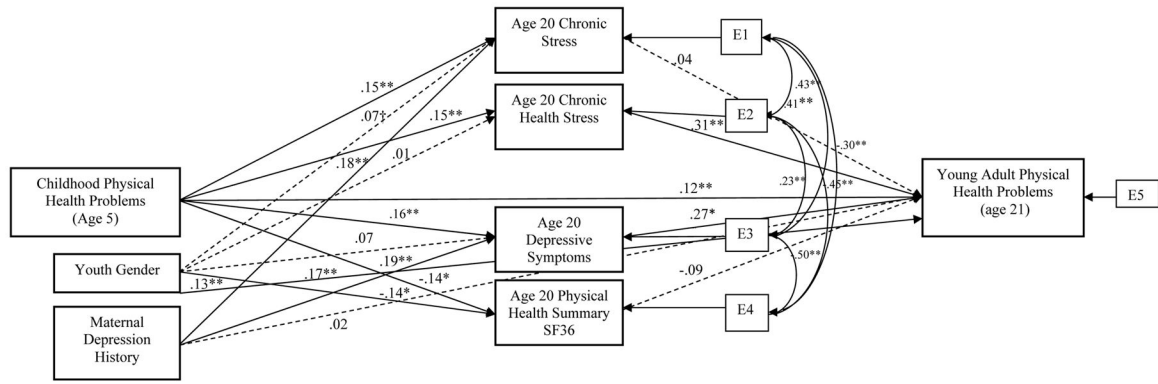
Figure 1.
Schematic of the structural equation model testing the direct and indirect effects of childhood physical health on physical health at age 21 via chronic stress, chronic health stress, depressive symptoms, and physical health at age 20. Standardized path coefficients are presented. Non-significant paths are represented by dotted lines.

* p < .05, **p <.01

Table 1

Zero-order correlations, means, standard deviations, and ranges of primary study variables.

	Mean	SD	Possible Range	Observed Range	Percent Missing	1	2	3	4	5
1. Age 20 Chronic Stress	20.20	4.34	7–36	10–33.50	<1%					
2. Age 20 Depressive Symptoms	6.43	8.29	0–63	0–52.00	15%	.47 **				
3. Age 20 Chronic Health Stress	2.31	.61	1–5	1.00–4.50	0%	.44 **	.25 **			
4. Age 20 Physical Health (higher is better)	56.48	5.85	23–84	34.00–65.50	15%	−.33 **	−.52 **	−.45 **		
5. Childhood Physical Health Problems	1.51	1.20	0–6	0 – 6.00	0%	.17 **	.17 **	.15 **	−.12 *	
6. Age 21 Physical Health Problems	2.60	2.30	0–17	0–10.00	42%	.37 **	.49 **	.47 **	−.45 **	.25 **

*
p<.05,

**
p<.01

Table 2

Mediation of the Effect of Early Childhood Physical Health Problems on Young Adult Physical Health Problems Through Depressive Symptoms, Chronic Stress, Health-Related Chronic Stress, and Ongoing Health

	Standardized Point Estimate	Product of Coefficients			Bootstrapping	
					BC Percentile 95% CI	
		SE	Z	P value	Lower	Upper
Indirect Effects						
Depressive Symptoms	0.04	0.02	2.10	0.04	.003	0.08
Chronic Stress	0.01	0.01	0.48	0.32	−0.02	0.03
Health-Related Chronic Stress	0.05	0.02	2.33	0.02	0.01	0.09
Physical Health	0.01	0.01	1.00	0.32	−0.01	0.04
TOTAL	0.11	0.03	3.28	0.00	0.04	0.17