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Family income from birth through adolescence: Implications for positive youth development

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ABSTRACT

This study took a life course approach to examine associations among family income from birth to age 15, and adolescent health and well-being. Utilizing latent growth mixture modeling, we identified four distinct family income trajectories based on changes in low-income status (family income ≤200% of the federal poverty line) over 15 years, which in turn related to their outcomes in adolescence. More specifically, youth living in a consistent state of higher income from birth to age 15 *(Consistent Higher Income)* reported better health and behavioral outcomes than youth in the *Consistent Low Income*, *Increasing Income*, or *Decreasing Income* groups. Furthermore, despite tending to have relatively high-income levels at the beginning of life, the *Decreasing Income* group showed several risky behavioral and health patterns, including more sexual risk-taking and high blood pressure. Results underscore the importance of studying changes in family income across childhood and adolescence.

Introduction

Childhood economic conditions have far-reaching associations with later social, psychological, and physical health outcomes. Family income affects the environments that children live in and the many factors that contribute to positive development, including access to healthy foods, safe spaces, medical care, and high-quality childcare and education (Sallis & Glanz, 2006; Votruba-Drzal & Lindsay Chase-Lansdale, 2004). In particular, low-income parents may have less time to invest in their children given that they are more likely to work nonstandard hours, have less flexible work schedules, and be single parents (Brooks-Gunn, Han, & Waldfogel, 2010; Duncan, Magnuson, & Votruba-Drzal, 2014). Overall, it is well established that children from middle or upper class backgrounds fare better compared to children from lower class backgrounds, but scientists and policy makers are still trying to understand how duration, timing, and sequencing of economic deprivation across childhood affects later well-being (Wagmiller, Lennon, Kuang, Alberti, & Aber, 2006).

Drawing from developmental neurobiology, periods of neural plasticity in early childhood are presumed to increase responsivity to environmental input accompanying this "sensitive period." Accordingly, income could have the greatest effect during children's first few years, when their brains and other systems are developing rapidly (Johnson, 2005; Kishiyama, Boyce, Jimenez, Perry, & Knight, 2009). Indeed, there is a long tradition of research suggesting that income interventions during early childhood may be the most important for improving long-term outcomes (Brooks-Gunn & Duncan, 1997; Campbell et al., 2014; Heckman, 2008). However, maturation of the brain regions responsible for higher cognitive functioning continues throughout childhood and adolescence, and thus the window for potential neural plasticity may extend further than originally hypothesized (Dahl, Allen, Wilbrecht, & Suleiman, 2018; Fuhrmann, Knoll, & Blakemore, 2015; Sowell et al., 2003). Furthermore, older children and adolescents may be more aware of their family's economic circumstances, which could influence their aspirations and behaviors, with direct implications for their health and well-being (Guo, 1998). The current study takes advantage of a longitudinal dataset, the National Institute of Health and Human Development Study of Early Child Care and Youth Development (NICHD SECCYD), to explore the relations among empirically derived income trajectories from birth through adolescence on psychosocial well-being (i.e., internalizing and externalizing behaviors), risk-taking (i.e., problem behaviors and sexual risk-taking), and physical functioning (i.e., BMI and blood pressure) at age 15.

Relations among income over time and youth outcomes

There is now a significant body of experimental and quasi-experimental research examining the consequences of acute economic

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downturns (e.g., The Great Recession; Brooks-Gunn, Schneider, & Waldfogel, 2013; Lee, Brooks-Gunn, McLanahan, Notterman, & Garfinkel, 2013), random shocks due to changes in programs or polices (e.g., payouts from casino profits; Akee, Copeland, Keeler, Angold, & Costello, 2010), or conditional cash transfers (Miller et al., 2016). However, life course and family systems theory suggest that the effects of economic conditions on children and adolescents' health and development are likely to be cumulative (Bor et al., 1997; Cox & Paley, 2003; Elder, 1998). For instance, persistent family poverty throughout childhood and adolescence may be associated with worse social, behavioral, and health outcomes compared to youth from families experiencing only intermittent or no economic hardship (Evans & Cassells, 2014; NICHD Early Child Care Research Network, 2005a). On the other hand, economic dips at certain critical stages may lead to particularly maladaptive outcomes compared to economic declines at other stages. Furthermore, increases, decreases, or instability in income may influence healthy development, independent of average income level (Gennetian, Wolf, Hill, & Morris, 2015; Hill, Morris, Gennetian, Wolf, & Tubbs, 2013). Overall, this body of literature suggests that both overall income levels, as well as changes in income from birth to adolescence, may have important implications for individual well-being given the dynamic relationship between environment and development over time.

Along these lines, a host of large-scale longitudinal studies have been used to capture trajectories of family poverty/income from birth through adolescence (e.g., National Longitudinal Survey of Youth (NLSY); Panel Study of Income Dynamics (PSID); NICHD SECCYD). Most of this work has focused on academic and socioemotional outcomes using cumulative approaches (e.g., proportion of time in poverty) or pre-determined groups (e.g., always poor, never poor) to characterize children's economic experiences over time. For instance, early work by Shanahan, Davey, and Brooks (1998) used the child supplement of the NLSY to examine how children's poverty histories predicted psychosocial adjustment (i.e., externalizing and internalizing symptoms, antisocial behavior, and anxiety-depression). They found that the proportion of time spent in poverty since birth was associated with higher antisocial behavior and anxiety-depression at age 4–6 years. In addition, poverty transitions (i.e., moving into or out of poverty), controlling for duration, predicted an increase in the rate of anxiety-depression across eight years. In another NLSY study, Comeau and Boyle (2018) focused on mental health outcomes and created five conceptual classes of poverty from birth to age 14: always poor, never poor, a single transition into poverty, a single transition out of poverty, or repeated fluctuations in and out of poverty. They concluded that stable patterns of poverty exposure had a more pronounced impact on child mental health than changing patterns.

Several studies have also averaged income or poverty within a specific time period (e.g., poverty during early childhood versus adolescence) to explore the relative contribution of income across developmental time points. For example, using the NLSY, Guo (1998) found that poverty during childhood (between ages 3–8) was more strongly associated with cognitive ability than poverty in early adolescence (between ages 9–14); in contrast, poverty experienced in adolescence was associated with achievement outcomes. Duncan, Yeung, Brooks-Gunn, and Smith (1998) used the PSID to isolate the specific impact of early childhood poverty (0–5) on later life outcomes, controlling for middle childhood (6–10) and adolescent (11–15) family income (Duncan et al., 1998). They found that income increments in the first five years of life for children in poor families were associated with the largest gains in completed schooling; and at the high end of the socioeconomic scale, high parental income during adolescence was associated with college entry. Lastly, using the NICHD SECCYD, a study compared children from families who were never poor, poor only during the child's infancy (0–3 years of age), poor only after infancy (4–9 years of age), and chronically poor, and found that any experience of poverty was associated with worse child cognitive and social outcomes in third grade; being poor later (ages 4–9) tended to be more detrimental than early poverty (NICHD Early Child Care Research Network, 2005a).

Importantly, there are a set of papers that have taken an empirical approach to identifying classes of children with similar childhood experiences of economic hardship. That is, instead of determining income groups a priori (e.g., never poor, a single transition into poverty), these studies empirically derive the trajectories of income based on naturally occurring variation in the data. For instance, using the PSID, Wagmiller et al. (2006) identified four latent classes in a mixture modeling framework: long-term poor, moving out of poverty, moving into poverty, and non-poor. They found that children raised in families with deteriorating economic circumstances (moving into poverty) had worse educational achievement than children raised in families with improving finances (moving out of poverty); however, persistent poverty was the strongest predictor of high school graduation. In addition, Kendzor, Caughy, and Owen (2012) used the NICHD SECCYD to identify family income trajectories based on whether families were above or below 200% of the federal poverty line (FPL) during childhood as predictors of adiposity. They found that those who experienced downward mobility or stable low income from birth through age 15 had greater adiposity relative to more advantaged or upwardly mobile children (Kendzor et al., 2012).

Motivation for studying adolescent health outcomes

There is growing recognition that adolescence represents an important stage for identifying precursors to psychopathology and disease, especially since disease onset has shifted down the age spectrum into younger ages for a number of crucial health conditions including depression, substance abuse, sexually transmitted infections, obesity, and high blood pressure/hypertension (Avenevoli, Swendsen, He, Burstein, & Merikangas, 2015; Forhan et al., 2009; Hales, Carroll, Fryar, & Ogden, 2017; McNiece et al., 2007). In particular, adolescence is a period of life marked by major biological and social reorganization starting around the onset of puberty, which plays an important role in the formation of early health behaviors. For instance, there are well-documented developmental changes in risk-taking during this period, which are hypothesized to result from an overactive reward system in the adolescent brain (Braams, van Duijvenvoorde, Peper, & Crone, 2015). Recent evidence also suggests the importance of screening for high blood pressure earlier in the lifecourse, as the rate of diagnosis of hypertension in adolescents is increasing (Al Kibria, Swasey, Sharmeen, & Day, 2019), likely due in part to the increasing prevalence of childhood obesity (i.e., it is estimated that one in five adolescents in the U.S. are obese) and population changes in diet, physical activity, and sedentary behaviors (Hales et al., 2017; Ogden et al., 2016). Socioeconomic and racial/ethnic divergences in high blood pressure also begin in adolescence (Harding et al., 2010) and data from diverse populations show evidence for blood pressure tracking from childhood into adulthood (Chen & Wang, 2008).

Theoretical work from a range of developmental and health perspectives, including the fetal origins hypothesis (Barker & Martyn, 1992), lifecourse health development (Halfon, Larson, Lu, Tullis, & Russ, 2014), and social determinants of health (Berkman, 2009), support the hypothesis that living in a low-income household at birth (i.e., economic deprivation during the prenatal period), or experiencing poverty (including fluctuations into or out of poverty) throughout childhood, may affect long-term health. For instance, several studies on the early origins of disease have uncovered the negative effects of subtle (e.g., market changes) and severe (e.g., famine) economic shocks during pregnancy on fetal health, with implications for long-term well-being (Almond & Currie, 2011). This body of work suggests that the prenatal environment “programs” the metabolic characteristics of the fetus through exposure to maternal nutrition, smoking, drinking, or stress, among other factors. While these characteristics may remain latent for

many years, they can lead to future obesity, diabetes, and cardiovascular problems in adolescence and adulthood.

Moreover, lifecourse perspectives (Halfon et al., 2014) and related work on the social determinants of health and health disparities (Berkman, 2009; Viner et al., 2012), suggest that living in a low-income household throughout childhood and adolescence may affect a wide range of contextual factors that could influence both psychosocial well-being and physical health. For instance, low-income parents may not have the time or assets to provide constant child supervision or high quality after school activities, which could increase the likelihood that youth may associate with deviant peers, spend more time in sedentary states, and experiment with illicit substances. Additionally, youth from low-income families may not have access to safe spaces, healthy foods, and medical care, with clear implications for both mental and physical health. Overall, understanding the economic factors that contribute to risky behaviors and physiological functioning in adolescence are an important, but understudied area of research.

Current study

Overall, the current study builds on past work by empirically estimating economic trajectories from birth through adolescence and the relation to health and well-being outcomes at age 15. To set the stage for this work, we first investigate whether being born into a low-income household (i.e., exposed to poverty during the prenatal period), and spending a larger average amount time in a low-income household from birth through adolescence, predicts psychosocial and physical health at age 15. Based on work on the importance of early adversity (Brooks-Gunn & Duncan, 1997; Campbell et al., 2014; Heckman, 2008) and cumulative risk (Bor et al., 1997; Cox & Paley, 2003; Elder, 1998), we hypothesized that low-income status (at birth and throughout development) would be associated with worse outcomes at age 15. However, this traditional approach does not capture how timing, duration, and instability in economic deprivation can influence developmental trajectories.

Therefore, the major aim of the study was to use a person-centered analytic approach (Laursen & Hoff, 2006) to identify distinct subgroups of youth based on income patterns from birth to age 15 using empirically derived income profiles based on naturally occurring variation across development. We then explore the extent to which the income profiles relate to age 15 outcomes. We hypothesize that trajectories characterized by relatively consistent or increasing income across development will be associated with fewer internalizing and externalizing behaviors, less risk-taking, lower body mass index (BMI), and lower blood pressure at age 15. This offers a unique approach to studying social determinants of health by exploring the effect of income level, timing, and (in)stability across childhood and adolescence on multiple indicators of healthy adolescent development.

Method

Participants and procedures

Participants for the current study come from the NICHD SECCYD (1991–2007). At baseline, 1364 mothers and their infants were recruited from 10 hospital sites across the United States and followed for 15 years. In the current study, we included 13 assessment points (i.e., all assessments with income data): 1, 6, 15, 24, 36, and 54 months, kindergarten, grades 1, 3, 4, 5, 6, and age 15 years. We excluded any participant missing data on all income reports ($n = 8$). Details of recruitment methodology and sampling plan are available elsewhere (NICHD Early Child Care Research Network, 2005b).

At baseline, our sample was half male, and 77.1% non-Hispanic White, 11.9% African-American, 5.9% Hispanic, and 6.8% other race/ethnicity. Median household income for the NICHD SECCYD in 1991 was $30,000. This is comparable to the national Current Population Survey (CPS) median household income estimate of $30,126 in 1991. Of note, the NICHD SECCYD sample becomes less representative over time, with a median reported income of $75,000 in 2006 (when most participants were 15) in comparison to CPS reporting a median household income of $48,201.

We performed an attrition analysis to examine how the composition of our sample changed over time, from baseline ($n = 1356$) to age 15 (i.e., those with at least one age 15 outcome, $n = 989$). Participants who remained in the study were less likely to be male, and their mothers were significantly older, more likely to be married, and more likely to work outside of the home. They also came from families with more years of maternal education and higher mean income at baseline. Overall, this aligns with previous reports from the NICHD SECCYD that youth from low SES backgrounds were more likely to attrite than those from higher SES backgrounds (Sabol & Hoyt, 2017; Vandell, Belsky, Burchinal, Steinberg, & Vandergrift, 2010).

Outcome measures

Outcome measures were selected to represent a broad range of healthy adolescent development including psychosocial well-being (i.e., internalizing and externalizing behaviors), risk-taking (i.e., problem behaviors and sexual risk-taking), and physical functioning (i.e., BMI and blood pressure) at age 15.

Psychosocial wellness

Externalizing (33 items assessing aggression and disruption; $\alpha = 0.91$) and internalizing (31 items measuring withdrawal and anxiety/depressive symptoms; $\alpha = 0.87$) behaviors were assessed using the two main subscales from the Child Behavior Checklist (CBCL) based on maternal report (Achenbach, 1991). All items were rated on a 3-point Likert scale (0 = not true, 1 = somewhat true or sometimes true, 2 = very true or often true) and summed, with higher scores reflecting more problem behaviors.

Risk-taking

Problem behaviors were assessed by a 50-item risky behavior questionnaire developed for the NICHD SECCYD study, adopted from previous research (Conger & Elder, 1994; Halpern-Felsher, Cornell, Kropp, & Tschann, 2005). Youth reported on specific behaviors over the previous year, including the extent to which they used alcohol or drugs, behaved in ways that threatened their safety, or damaged property. Ratings were summed to create a total composite problem behavior score ($\alpha = 0.89$).

Sexual risk-taking was assessed by 4 items measuring sexual behavior (Halpern-Felsher et al., 2005). Youth reported on how many different partners they had in their lifetime, different sexual experiences they had (i.e., oral sex and vaginal sex), and whether or not they had a sexually transmitted infection. Ratings were summed to create a total composite of sexual risk-taking ($\alpha = 0.93$).

Physical functioning

Physical health at age 15 was assessed by BMI and blood pressure. Trained site personnel measured height and weight during the age 15 laboratory visit. BMI was calculated as the ratio of weight in kilograms over height in meters squared. Nurse practitioners measured systolic and diastolic blood pressure using a cuff and stethoscope while participants were seated. Staff took five blood pressure readings at 1-min intervals. The last three available readings were used to create scores for average systolic and diastolic blood pressure. A high blood pressure indicator was calculated as anyone with mean systolic blood pressure of 120 mmHg or above or mean diastolic blood pressure of 80 mmHg or above (i.e., pre-hypertension or hypertension) (Al Kibria et al., 2019).

Family income measures

At each time point, respondents were asked to report both mother's total earnings and father or other resident partner's earnings. They were also asked to report funds received through multiple public assistance programs, investments, rental properties, child support/alimony, and any other sources of income. For earnings, they were asked to report their best estimate of either annual or monthly income at each time point; for other sources of financial assistance, they were asked to estimate the monthly amount received from each source. These values were then summed to estimate total annual family income for each assessment period. Participants also reported a list of every person who lived with them in their home, starting at the one month assessment. For each time point, total family income and the total number of individuals living in the home were used to calculate an income-to-needs ratio by dividing total family income by that year's FPL for a family of its size (National Institute of Child Health and Human Development Early Child Care Research Network, 2005a, 2005b). An income-to-needs ratio of 1.0 signifies that a family was living at the FPL.

For our profile analyses, we dichotomized each income-to-needs ratio into low income (income-to-needs ratio ≤ 2) or higher income (income-to-needs ratio > 2), an approach commonly used in previous research with the SECCYD data (Kendzor et al., 2012; Nader, Bradley, Houts, McRitchie, & O'Brien, 2008; National Institute of Child Health and Human Development Early Child Care Research Network, 2005a) and other longitudinal datasets (Comeau & Boyle, 2018). This cut-point (i.e., 200% of the FPL) also has practical applications, given that state eligibility thresholds for most government assistance programs are below this cut-point (e.g., the cut-point for Head Start was 100% of the FPL until 2007; Women, Infants, & Children/WIC was up to 185% of the FPL; the Supplemental Nutrition Assistance Program/SNAP was up to 200% of the FPL; and Medicaid ranged from 100 to 200%, with a few state-specific exceptions). We created this low-income indicator for each of the 13 time points, from baseline (i.e., one month visit) to age 15.

Covariates

Mothers reported their child's sex and race/ethnicity (dichotomized as Non-Hispanic Anglo-American or "Other"). We also included an indicator for preterm birth (< 38 weeks). Additional covariates included the total number of children living in the household and maternal characteristics including: age in years, marital status (married or not married), years of education, and employment status (employed or not employed, with employed including on maternity leave, other leave, or vacation). All covariates were measured at baseline.

Analytic plan

To test the effect of income on age 15 outcomes, we first examined the relation among income-to-needs at baseline, and average income-to-needs across development, using a traditional multiple regression analysis controlling for the full set of child and family characteristics (described above). We performed multiple imputation (n = 10) to address missing data on covariates (ranging from 0.14% for maternal marital status to 6% on income-to-needs at baseline) using chained equations (Royston & White, 2011). The sample size for each model was based on total available data for each outcomes variable (range: n = 843 to n = 974).

In the main approach, latent growth mixture modeling (LGMM) was utilized to estimate distinct family income trajectories from birth to age 15 (using the low-income indicators from all 13 time points). LGMM uses a person-centered approach to classify individuals into groups based on individual response patterns (Jung & Wickrama, 2008). The LGMM models were estimated using MPlus software version 7 with full information maximum likelihood (FIML) to account for missing values (Enders & Bandalos, 2001; Muthén & Muthén, 1998). Models with 1–5 classes were estimated starting with the simplest model (i.e., one class model). Fit for each model was determined by the following model fit indices: (1) Bayesian Information Criterion (BIC), (2) Lo, Mendel, Rubin (LMR) statistic, and (3) entropy values (Jung & Wickrama, 2008). Generally, models with smaller absolute BIC values suggest better model fit; non-significant LMR statistics suggest that the preceding model with one fewer class provides a better fit to the data; and, while there is no standard threshold to evaluate entropy, values closer to 1.0 are desirable (Ram & Grimm, 2009). In the final step of LGMM analysis, youth were classified into a most probable family income trajectory based on their highest level of posterior probability (i.e., the probability of each child belonging to each group).

Once class membership was identified for each youth, Chi-square and ANOVA tests were used to assess associations between profiles and categorical demographic and family variables (e.g., race/ethnicity, mother's years of education). Then, a series of regression analyses were conducted to determine whether health outcomes differed by family income profile, with a second model controlling for the full set of child and family covariates (as above, using multiple imputation to address missing data on baseline covariates with sample size determined by available data for each outcomes variable).

Results

Sample characteristics

Characteristics of the sample are presented in Table 1. At baseline, families had a mean income-to-needs ratio of 2.86, with relatively large variability (SD = 2.61); the average income-to-needs ratio from birth to age 15 was 3.74 (SD = 3.00). Table 1 also presents descriptive information for all outcome variables.

Early income or average income and age 15 outcomes

Table 2 presents the multiple regression analysis results for the relation between income-to-needs at birth with age 15 outcomes, controlling for child and family covariates. Income-to-needs at birth was not significantly associated with any of the adolescent outcomes; there was one marginal association between higher income-to-needs and lower BMI ($\beta = -0.18$, $p < .10$, CI = −0.38, − 0.01).

We also tested the association between mean income-to-needs from

Table 1
Descriptive statistics for the sample.

	Percent or mean (SD)	N
Income-to-needs (ITN) ratio		
ITN ratio at birth	2.86 (2.61)	1356
Mean ITN ratio from birth to age 15	3.74 (3.00)	1356
Baseline characteristics		
Female	48.5%	1356
Non-Hispanic White	76.3%	1356
Preterm birth	10.0%	1356
Mother married	87.1%	1356
Mother education level (less than high school)	10.2%	1356
Mother employed (or on maternity leave)	60.8%	1356
Mother's age (years)	28.1 (5.6)	1356
Number of children in household	1.9 (1.1)	1356
Adolescent outcomes		
Internalizing behaviors	0.16 (0.17)	974
Externalizing behaviors	5.40 (6.53)	957
Problem behaviors	5.89 (5.35)	908
Sexual risk-taking	0.23 (0.58)	949
Body mass index (BMI)	23.18 (5.16)	843
High blood pressure (pre-hypertensive or hypertensive)	0.27 (0.44)	856

Table 2
Multiple regression analyses of family income on adolescent outcomes.

	Internalizing symptoms	Externalizing symptoms	Problem behaviors	Sexual risk-taking	Body mass index	High blood pressure
	(n = 974)	(n = 957)	(n = 908)	(n = 949)	(n = 843)	(n = 856)
Income-to-needs (ITN)[a] ratio						
ITN ratio at birth	−0.001 (−0.01–0.004)	0.02 (−0.17–0.22)	−0.14 (−0.30–0.03)	−0.002 (−0.02–0.02)	−0.18† (−0.38–0.006)	0.99 (0.91–1.08)
Mean ITN ratio from birth to age 15	−0.002 (−0.006–0.003)	−0.14 (−0.32–0.04)	−0.24** (−0.39 - -0.09)	−0.007 (−0.02–0.008)	−0.23** (−0.39 - -0.08)	0.97 (0.89–1.04)
Baseline covariates[b]						
Male sex (vs. female)	0.03** (−0.01–0.05)	0.09 (−0.74–0.91)	1.85** (−2.53 to −1.17)	0.001 (−0.07–0.07)	−0.21 (−0.90–0.47)	0.25** (0.18–0.36)
Non-Hispanic White race/ethnicity (vs. non-White)	0.04* (0.006–0.06)	0.84 (−0.26–1.95)	−1.96** (−2.86 to −1.06)	−0.08 (−0.17–0.02)	−0.43 (−1.34–0.48)	−0.75 (0.18–0.36)
Preterm at birth	−0.01 (−0.05–0.02)	−1.14† (−2.51–0.21)	−0.78 (−1.92–0.36)	−0.07 (−0.19–0.06)	0.14 (−1.00–1.28)	1.38 (0.83–2.29)
Mother's age (years)	−0.002 (−0.005–0.001)	−0.13** (−0.22 to −0.03)	−0.02 (−0.09–0.06)	−0.001 (−0.009–0.006)	−0.08* (−0.15 to −0.001)	1.01 (0.97–1.04)
Mother married (vs. not married)	−0.007† (−0.001–0.01)	0.28† (0.01 to −0.55)	0.14 (−0.08–0.35)	0.04** (−0.03–0.001)	0.13 (−0.08–0.35)	1.01 (0.91–1.11)
Mother's years of education	−0.001 (−0.001–0.004)	−0.30** (−0.51 to −0.09)	−0.13 (−0.30 to −0.04)	−0.02† (−0.03–0.001)	−0.27** (−0.44 to −0.09)	0.99 (0.91–1.08)
Mother employed (vs. not employed)	0.004 (−0.03–0.02)	−0.10 (−1.00–0.79)	−0.07 (−0.80–0.66)	0.04 (−0.04–0.12)	−0.09 (−0.82–0.65)	0.73† (0.52–1.03)
Male sex (vs. female)	0.03** (−0.01–0.05)	0.09 (−0.74–0.91)	1.85** (−2.53 to −1.17)	0.001 (−0.07–0.07)	−0.21 (−0.90–0.47)	0.25** (0.18–0.36)

Note. 95% confidence intervals in parentheses.
* $p < .05$.
** $p < .01$.
† $p < .10$ (marginal).
[a] Both models include the full set of baseline charracteristics listed below.
[b] Coefficients for baseline characteristics were run in a separate model.

Table 3
Indicators of model fit in the growth mixture analysis (N = 1365).

Classes	BIC[a]	Entropy[b]	LMR[c]
1 Class solution	16,922.47	N/A	N/A
2 Class solution	11,461.88	0.90	$p < .001$
3 Class solution	10,691.37	0.84	$p < .001$
4 Class solution[d]	**10,516.394**	**0.83**	$\boldsymbol{p = .02}$
5 Class solution	10,437.47	0.79	$p = .46$

[a] BIC = Baysian Information Criterion. Lower values imply better fit.
[b] Entropy values closer to 1 imply better fit.
[c] LMR = Lo, Mendel, Rubin statistic; the emergence of a non-significant p value suggests that the preceding model with one fewer class has better fit.
[d] The four-class model (in bold) was chosen as the final version of the trajectory model based on fit characteristics and interpretability.

birth to age 15. We found that a higher average income-to-needs ratio was associated with fewer problem behaviors (β = −0.24, $p < .01$, CI =. -0.39, −0.09) and lower BMI (β = −0.23, $p < .01$, CI = −0.39, −0.08).

Income profiles from birth to adolescences and relations to age 15 outcomes

Table 3 displays the fit statistics that we evaluated to determine the appropriate number of latent classes among respondents in our sample. BIC values declined with the addition of each additional class. Although entropy values continued to decrease with the addition of more classes (i.e., class 1: 0.90 vs. class 4: 0.79), the LMR statistic remained significant through classes 1–4, suggesting that more classes were preferable to fewer classes. The five-class model converged, but the LMR statistic was not significant ($p = .46$). Further, a visual inspection of the profiles suggested that the four-class solution provided the most adequate fit of the data as it included many of the expected and theoretically important income trajectories (i.e. increasing, decreasing and consistent trajectories).

Profiles were labeled based on low-income status (≤ *200% of the FPL*) across at all 13 time points from birth to age 15 (see Fig. 1); descriptive information about the profiles is presented in Table 4. The first profile, *Consistent Higher Income* included the majority (53%) of families; had the highest income-to-needs ratio (4.05) at baseline; and were unlikely to be low income at any point across development. The second profile, *Consistent Low Income*, included 23% of our sample, and represented the lowest income-to-needs ratio at birth (0.95), the most racial/ethnic minority families, and the most unmarried mothers. These youth tend to be low income (≤ 200% of the FPL) across development.

The third profile, *Increasing Income*, included 17% of the sample who were characterized as having a relatively low income-to-needs ratio at birth (1.44), but were likely to move into the higher income category later in development. Finally, the fourth profile, *Decreasing Income*, comprised 7% of the sample. Individuals in this profile had the second highest family income-to-needs ratio at birth (2.44), but were likely to end up with low-income status over the course of the study period. Both the *Consistent Higher Income* and *Decreasing Income* profiles included a high percentage of youth from two-parent, married households (92–98%) and older mothers (aged 27–30 years at birth). The individuals in the *Consistent Higher Income* profile had the highest levels of maternal education (i.e., 2–4 more years than the rest of the sample).

The final set of regression analyses (Table 5) showed that youth in the *Consistent Higher Income* group had the most positive adolescent outcomes. In comparison to the *Consistent Low Income* group, these youth demonstrated significantly fewer internalizing and externalizing behaviors, lower BMI, and significantly fewer risk-taking behaviors (both problem behaviors and sexual risk-taking). There were also distinct patterns comparing the *Consistent Higher Income* group to both those with *Decreasing Income* (who had a similarly high proportion of families who were low income at birth, but then declined in income

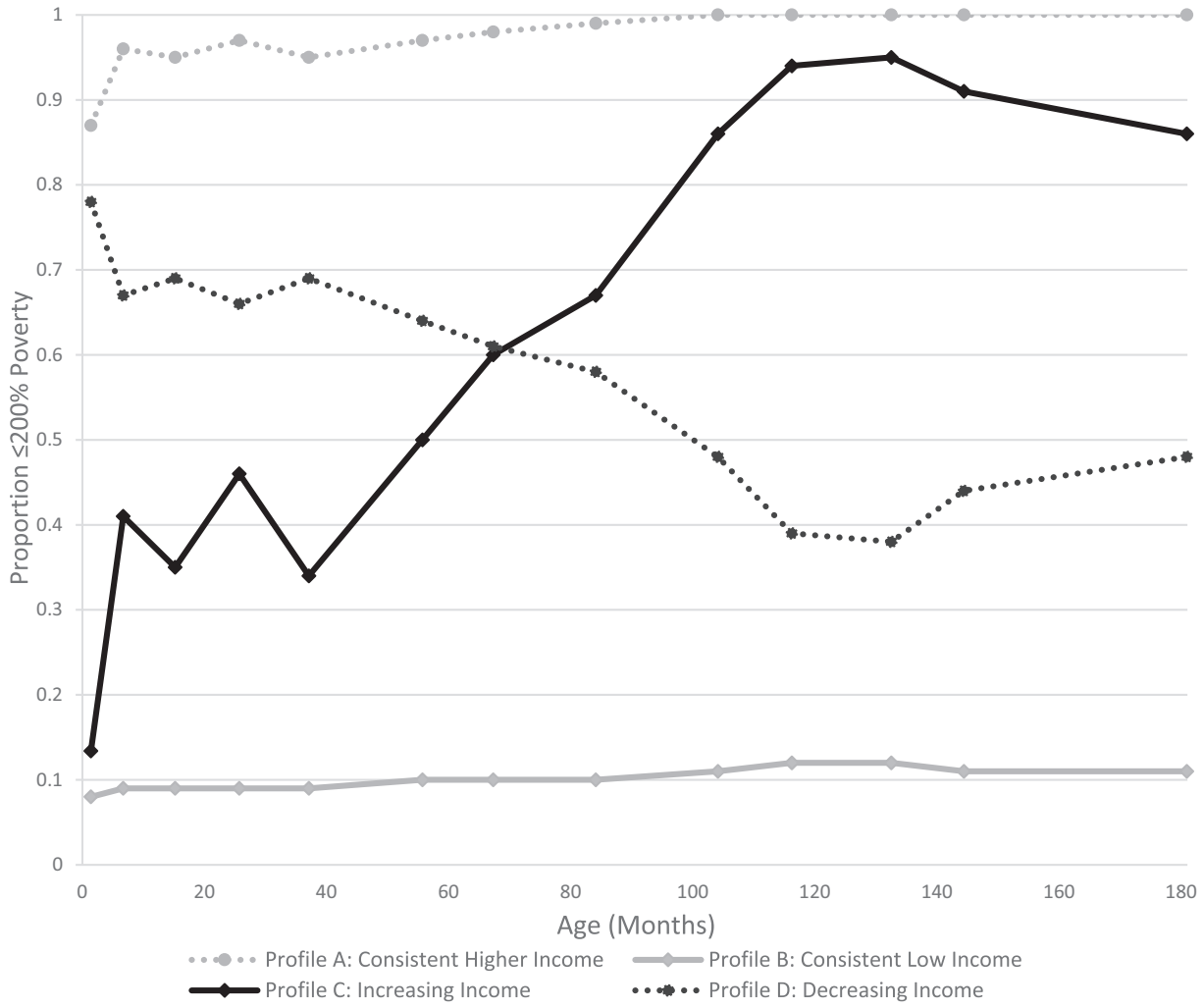

Fig. 1. Trajectories of low-income status from birth to age 15.

over time) and *Increasing Income* (who had a small proportion of low-income families at birth, but a similar a proportion of families who had higher income in middle childhood and adolescence). More specifically, those with *Consistent Higher Income* demonstrated significantly fewer internalizing and externalizing behaviors, and lower BMI compared to the *Decreasing Income* and *Increasing Income* groups. In addition, the *Consistent Higher Income* group had lower rates of problem behaviors and sexual risk-taking compared to the *Decreasing Income* group, and marginally significantly lower blood pressure compared to the *Increasing Income* group.

The *Decreasing Income* group showed several additional poor outcomes compared to the *Increasing Income* group, including higher rates of problem behaviors and higher blood pressure (i.e., being pre-hypertensive or hypertensive). Notably, the *Decreasing Income* group also had marginally higher odds of high blood pressure compared to the *Consistent Low Income* group. Finally, the *Increasing Income* group had significantly fewer externalizing behaviors than the *Consistent Low Income* group.

Notably, all findings held after controlling for a set of baseline child and family characteristics. Yet, several covariates were associated with adolescent outcomes. For instance, boys had lower internalizing behaviors, higher risk-tasking behaviors, were more likely to be overweight or obese and had higher risk for high blood pressure age 15 compared with girls; pre-term infants had fewer externalizing behaviors compared to on-time infants; older maternal age was associated with fewer externalizing behaviors and lower BMI; marital status (i.e., unmarried mother) was associated with more sexual risk-taking, higher maternal education was associated with lower adolescent externalizing behaviors, less sexual risk-taking and lower BMI.

Discussion

It is widely recognized that family income is an important predictor of healthy development. However, few studies examine trajectories of family income levels from birth to adolescence, given that longitudinal studies rarely track family income across a variety of childhood stages (Braveman et al., 2005) and even fewer examine a myriad of outcomes in adolescence, particularly related to health behaviors and physiological functioning. The current study examined the prospective associations between income trajectories from birth to middle adolescence. Our income profile analysis revealed that youth living in a consistent state of higher income *across* childhood and adolescence *(Consistent Higher Income* group) reported better health and behavioral outcomes in adolescence than any other group. Furthermore, despite tending to have relatively high-income levels at the beginning of life, which is thought to be protective, the *Decreasing Income* group showed several negative health outcomes, including more sexual risk-taking and high blood pressure.

A growing body of evidence shows that early life conditions are tied to long-term health outcomes. In particular, it is widely believed that risk factors for poor health are biologically embedded during sensitive periods in the first few years of life when the developing brain is more

Table 4
Descriptive information for family income profiles.

	Profile A	Profile B	Profile C	Profile D	Group differences
	Consistent Higher Income	*Consistent Low Income*	*Increasing Income*	*Decreasing Income*	
	n = 720 (53.1%)	*n* = 314 (23.2%)	*n* = 225 (16.6%)	n = 97 (7.2%)	
Baseline characteristics					
					Chi square
Male (51.5%)	51%	50%	59%	45%	*p* = .07
Non-Hispanic White race/ethnicity (76.3%)	88%[b,c,d]	51%[a,c,d]	75%[a,b]	73%[a,b]	*p* = .001
Preterm at birth (10%)	10%	11%	7%	11%	*p* = .47
Mother married (85.7%)	98%[b,c]	57%[b,c,d]	83%[a,b]	92%[b]	*p* = .001
Mother employed (60.8%)	74%[b,c,d]	31%[b,c,d]	61%[a,b]	58%[a,b]	*p* = .001
					ANOVA
ITN ratio at one month (M = 2.86, SD = 2.61)	4.05 (2.81)[b,c,d]	0.95 (1.00)[a,d]	1.44 (0.97)[a,d]	2.44 (1.49)[a,b,c]	*p* < .001
Mother's years of education (M = 14.23, SD = 2.51)	15.51 (2.16)[b,c,d]	12.19 (1.91)[a,c,d]	13.35 (2.04)[a,b]	13.40 (2.04)[a,b]	*p* < .001
Mother's age in years (M = 28.1 SD = 5.62)	30.71 (4.36)[b,c,d]	23.74 (5.14)[a,c,d]	26.09 (5.40)[a,b,d]	27.84 (5.20)[a,b,c]	*p* < .001
Number of children in household (M = 1.93 SD = 1.09)	1.71 (0.80)[b,c]	2.31 (1.32)[a,d]	2.07 (1.26)[a]	1.95 (1.30)[b]	*p* < .001
Time-varying family descriptive information					
Mother marital status (M = 0.80, SD = 0.32)	0.92 (0.17)[b,c,d]	0.51 (0.40)[a,c,d]	0.80 (0.29)[a,b]	0.75 (0.29)[a,b]	*p* < .001
Mother employment status (M = 0.74, SD = 0.30)	0.80 (0.27)[b,d]	0.57 (0.32)[a,c,d]	0.79 (0.25)[b,d]	0.70 (0.28)[a,b,c]	*p* < .001
Number of children in household (M = 2.2, SD = 0.88)	1.99 (0.69)[b,d]	2.57 (1.13)[a,c]	2.16 (0.81)[b]	2.36 (0.95)[a]	*p* < .001

Note: ITN = income-to-needs; M = mean; SD = standard deviation.
[a] Significantly different than Profile A.
[b] Significantly different than Profile B.
[c] Significantly different than Profile C.
[d] Significantly different than Profile D.

Table 5
Multiple regression analyses of income trajectories on adolescent outcomes.

	Internalizing symptoms	Externalizing symptoms	Problem behaviors	Sexual risk-taking	Body mass index	High blood pressure
	(*n* = 974)	(*n* = 957)	(*n* = 908)	(*n* = 949)	(*n* = 843)	(*n* = 856)
Income trajectories[e]						
Profile A: *Consistent High Income* (comparison group)	–	–	–	–	–	–
Profile B: *Consistent Low Income*	.06[a,**] (0.01–0.01)	3.02[a,**, c,*] (1.49–4.56)	1.50[a,*] (0.22–2.78)	.11[a,†] (−0.02–0.25)	1.75[a,**] (0.47–3.04)	0.92 (0.50–1.67)
Profile C: *Increasing Income*	.04[a,*] (0.002–0.07)	1.43[a,*,b,*] (0.13–2.71)	.86[d,†] (−0.20–1.94)	0.04 (−0.08–0.16)	1.20[a,*] (0.11–2.29)	.62[a,†, d,**] (0.36–1.06)
Profile D: *Decreasing Income*	.04[a,*] (0.001–0.08)	2.35[a,**] (0.78–3.91)	2.11[a,c,†,**] (0.78–3.34)	.15[a,*] (0.004–0.29)	1.43[a,*] (0.11–2.75)	1.61[c,**] (0.89–2.93)
Baseline covariates[f]						
Male sex (vs. female)	0.03[**] (−0.01–0.05)	0.09 (−0.74–0.91)	1.85[**] (−2.53 to −1.17)	0.001 (−0.07–0.07)	−0.21 (−0.90–0.47)	0.25[**] (0.18–0.36)
Non-Hispanic White race/ethnicity (vs. non-White)	0.04[*] (0.006–0.06)	0.84 (−0.26–1.95)	−1.96[**] (−2.86 to −1.06)	−0.08 (−0.17–0.02)	−0.43 (−1.34–0.48)	−0.75 (0.18–0.36)
Preterm at birth	−0.01 (−0.05–0.02)	−1.14[†] (−2.51–0.21)	−0.78 (−1.92–0.36)	−0.07 (−0.19–0.06)	0.14 (−1.00–1.28)	1.38 (0.83–2.29)
Mother's age (years)	−0.002 (−0.005–0.001)	−0.13[**] (−0.22 to −0.03)	−0.02 (−0.09–0.06)	−0.001 (−0.009–0.006)	−0.08[*] (−0.15 to −0.001)	1.01 (0.97–1.04)
Mother married (vs. not married)	−0.007[†] (−0.001–0.01)	0.28[†] (0.01 to −0.55)	0.14 (−0.08–0.35)	0.04[**] (−0.03–0.001)	0.13 (−0.08–0.35)	1.01 (0.91–1.11)
Mother's years of education	−0.001 (−0.001–0.004)	−0.30[**] (−0.51 to −0.09)	−0.13 (−0.30 to −0.04)	−0.02[†] (−0.03–0.001)	−0.27[**] (−0.44 to −0.09)	0.99 (0.91–1.08)
Mother employed (vs. not employed)	0.004 (−0.03–0.02)	−0.10 (−1.00–0.79)	−0.07 (−0.80–0.66)	0.04 (−0.04–0.12)	−0.09 (−0.82–0.65)	0.73[†] (0.52–1.03)

[**] $p < .01$.
[*] $p < .05$.
[†] $p < .10$ (marginal). 95% confidence intervals in parentheses.
[a] Significantly different than Profile A.
[b] Significantly different than Profile B.
[c] Significantly different than Profile C.
[d] Significantly different than Profile D.
[e] Both models include the full set of baseline charracteristics listed below.
[f] Coefficients for baseline characteristics were run in a separate model.

receptive to environmental influences (Johnson, 2005; Kishiyama et al., 2009). However, converging lines of evidence suggest that the rise in pubertal hormones at the onset of adolescence initiates a second sensitive period of steroid-dependent brain activation and organization, presenting opportunities for both risk and resilience (Fuhrmann et al., 2015; Schulz, Molenda-Figueira, & Sisk, 2009; Sisk & Zehr, 2005). Youth in low-income homes, without strong psychosocial resources, may experience psychological and physiological stress, leading to significant risk for internalizing and externalizing behaviors, as well as poor cardiometabolic outcomes (Lehman, Taylor, Kiefe, & Seeman, 2009; Sheidow, Henry, Tolan, & Strachan, 2014; Steeger, Cook, & Connell, 2017). Indeed, our results suggest that family income *throughout childhood and adolescence* continues to play an important role in the establishment of healthy behavioral and physiological functioning.

Taken together, the analyses presented in this paper highlight the importance of measuring duration, timing, and sequencing of family income across childhood and adolescence in order to understand long-term implications of early economic deprivation. Interestingly, income-to-needs at birth was not significantly associated with any adolescent outcome. This was somewhat surprising given the well-known association between early poverty and adult morbidity and mortality (Hayward & Gorman, 2004; Non et al., 2014). However, it is possible that the latent effects of income at the beginning life would emerge later in adulthood (e.g., crime, low adult SES, higher rates of chronic disease). When you consider the duration of economic deprivation, higher mean income-to-needs from birth to adolescence was associated with fewer problem behaviors and lower BMI. Still, these traditional measures of economic deprivation fail to differentiate between low-income status at different stages in childhood and do not take into account change over time.

To account for these gaps, our main analysis used latent growth mixture modeling to capture both overall level of economic disadvantage, as well as the timing and sequencing of low-income status over time. We identified four distinct family income profiles in this sample: two relatively consistent groups of lower income (*Consistent Low Income*) and higher income (*Consistent Higher Income*) families, and two groups with distinct patterns of change from birth to adolescence – increasing and decreasing. The *Consistent Higher Income* group had the most positive outcomes across all domains, including fewer internalizing and externalizing behaviors and lower BMI than any other youth, accounting for the fact that these youth had older and more educated mothers, on average, and more married parents at baseline. In other words, consistently living above the FPL *across childhood and adolescence* has a significant effect on a young person's health above and beyond baseline income and family characteristics.

Perhaps most notably, children in the *Consistent Higher Income* group had relatively better psychosocial and health outcomes compared to children in the *Increasing Income* or the *Decreasing Income* groups. (Importantly, children in the *Decreasing* group had a similar proportion of families with income levels over 200% of the FPL as the *Consistent Higher Income* group at birth and youth in the *Increasing* group had a relatively similar proportion of families with income levels over 200% of the FPL compared to the *Consistent Higher Income* group starting in middle childhood and continuing through age 15.) There is a large body of research that demonstrates that persistent poverty (averaged over time) is associated with deleterious outcomes for children in both adolescence and adulthood (Evans & Cassells, 2014; Power, Manor, & Matthews, 1999). However, our results are consistent with past literature that fluctuations in income, independent of overall income level, uniquely predict later well-being (e.g., Gennetian et al., 2015; Shanahan et al., 1998). Further, these results suggest that being low income at any point in the lifecourse can have significant effects on health and well-being, even when children experience higher income at earlier or later stages.

There was one significant difference between the *Increasing/Decreasing* income profiles. The *Decreasing Income* group had significantly increased odds of high blood pressure (i.e., being pre-hypertensive or hypertensive) compared to the *Increasing Income* group, despite similarities between youth in these two profiles on key demographic factors (e.g., race/ethnicity; mother's marital status, employment, education level). The greater impact of later economic deprivation in the *Decreasing Income* group (i.e., low-income status later in childhood and adolescence) may be tied to key developmental changes during adolescence. For instance, adolescents experience increasing independence from one's family, develop new relationships with peers, and begin to make their own choices (in healthy or unhealthy ways) – with implications for physical well-being (Harris, 2010). In particular, health behaviors, such as diet and physical activity, are thought to be increasingly shaped by environmental factors outside the home as children get older, such as access to physical activity resources and peer relationships (Franzini et al., 2009; Harris, 2010). Therefore, the impact of negative environmental exposures (e.g., poor neighborhoods, under-resourced schools, associating with less healthy peers) may compound around the transition to adolescence.

Lastly, despite somewhat larger effect sizes, overall, the *Consistent Low Income* group was not significantly worse off than youth in the *Increasing* or *Decreasing* groups. This underscores the idea that living in a low-income household at any point in development may have long-term detrimental effects. There was one exception: the *Consistent Low Income* group had significantly more externalizing symptoms than youth in the *Increasing Income* group, suggesting that family income in middle childhood or adolescence may have a more direct effect on externalizing behaviors than income in previous periods. Interestingly, baseline SES-related variables (e.g., mother's years of education, mother's marital status, mother's age) were also significant predictors of externalizing symptoms at age 15. Maternal education, in particular, implies that certain aspects of parenting (e.g., parent-child communication skills, cognitive ability) may be especially important in predicting externalizing symptoms during adolescence.

Despite the methodological and conceptual contributions, several limitations should be noted. First, the NICHD SECCYD had non-random attrition over time and is not fully representative of children from low-income backgrounds. This may limit our ability to generalize our findings and distinguish unique middle and lower class income trajectories. Second, data points were not equally distributed across the study period (e.g., we only had one measure of income in middle adolescence). Further, while we control for a host of relevant covariates, we do not have precise measures of maternal employment status, neighborhood safety, or residential mobility, which will be vital to examine in future research. It will also be important to capture national or state-specific policy shifts over time, including paid family leave for both mothers and fathers. Additionally, future research with a more contemporaneous birth cohort should assess potential similarities or differences in income profiles, particularly in light of the financial crisis in 2007–2008, which lead to greater economic instability in its aftermath. Finally, while the prospective longitudinal design allowed us to explore the association between family income and adolescent outcomes, more experimental research is needed to causally link health outcomes to economic deprivation early in life (Duncan, Magnuson, & Votruba-Drzal, 2017).

In spite of the correlational design, the current study has important implications for future research, policy, and practice. For instance, had we only focused on family income at birth, we would have only found a marginal association with BMI. Examining a composite measure of income over childhood and adolescence suggested significant associations between income and both BMI and problem behaviors. Yet, our income trajectory profiles, which includes family income at birth as a starting point while also accounting for changes in income through age 15, revealed many more interesting associations with adolescent outcomes that would have been missed had we only examined mean family income across the same time period.

Collectively, our results suggest that associations between income and psychosocial and physical well-being are not defined at birth, but levels of (and changes in) family income can impact health across development. While government resources for low-income pregnant mothers and very young children are important and can produce potentially large benefits (e.g., Early Head Start, WIC), these early investments should be combined with social and educational support throughout childhood and adolescence. In particular, programs providing safe spaces to spend unstructured time, healthy food, opportunities for physical activity, and tools for navigating new peer relationships (including romantic relationships) for low-income youth during middle childhood and adolescence are vital to promote positive youth development. Further, with a better awareness and understanding of the effects of income on youth, school administrators, social workers, and healthcare professionals can assess the financial stability of families, link families to resources, and coordinate care with community partners that may have direct impacts on key developmental outcomes.

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Declaration of Competing Interest

None.

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