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# Life Course Social Mobility and Reduced Risk of Adverse Birth Outcomes

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## Abstract

**Introduction—**Higher adult socioeconomic position (SEP) is associated with better birth outcomes. However, few studies incorporate life course or intergenerational SEP, which may inform etiology and targeted prevention efforts. This study tested whether life course social mobility from childhood was associated with lower risk of adverse birth outcomes.

**Methods—**Data were from the Life-course Influences of Fetal Environments (LIFE) retrospective cohort study among black women, 2009–2011, in metropolitan Detroit, MI. This study (analyzed in 2014–2016) examined whether social mobility was associated with two primary birth outcomes: small for gestational age (SGA) and preterm birth (PTB). Childhood and adulthood SEP were measured by survey in adulthood, for two constructs, measured ordinally: educational attainment and perceived financial sufficiency (subjective income/wealth). Social mobility was calculated as the difference of adulthood minus childhood SEP.

**Results—**In covariate-adjusted Poisson regression models, 1-SD improved educational social mobility from childhood to adulthood was protective for SGA (adjusted risk ratio, 0.76; 95% CI=0.64, 0.91); this association remained after adjusting for financial mobility. Upward financial social mobility from early childhood was marginally protective for SGA (adjusted risk ratio, 0.85; 95% CI=0.72, 1.02), but became nonsignificant after controlling educational mobility. There were no overall associations of social mobility with PTB or low birth weight, although sensitivity analyses identified that improved financial mobility was associated with 16% marginally lower

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risk of spontaneous PTB and 28% marginally lower risk of low birth weight among upwardly mobile/stable women only.

**Conclusions—**Improved life course social mobility is associated with reduced risk for SGA and spontaneous PTB among black women.

## INTRODUCTION

Adverse birth outcomes, such as being born too early, or too small, have consequences for children and families both short term and throughout life.[1–3] Lower socioeconomic position (SEP) has been consistently linked to worse health outcomes, including birth outcomes.[4] Although evidence is consistent among white women, it is less consistent for Hispanic and black women,[4,5] the latter of whom experience greater risk of adverse birth outcomes and deprivation.[6,7] Therefore, the trajectory of SEP may play a role in explaining disparities in birth outcomes.[8,9]

Although prolonged exposure to disadvantaged SEP may be more important for patterning birth outcomes than SEP at the time of the birth,[10] published evidence is predominantly cross-sectional.[4,8] Few studies adopt a lifecourse perspective. Examining how changing SEP throughout life may impact poor health outcomes could inform the etiologic period of exposure or policy prioritization at certain time points (e.g., as the Women, Infants, and Children (WIC) program prioritizes low-income families with young children for nutritional supplementation).[11]

Although a body of evidence links SEP at the time of pregnancy to birth outcomes, research examining whether social mobility from childhood to adulthood is associated with adverse birth outcomes is much smaller.[12–21] Those studies that do investigate this relationship predominantly focus on birth weight or low birth weight (LBW),[13–19] likely because of ease of measurement and data availability.[22] However, LBW conflates two mechanisms by which being born too light is harmful: restricted growth for a given gestational age (small for gestational age [SGA]), and early delivery (preterm birth [PTB]). Though SGA and PTB share overlapping determinants,[23] distinguishing between the two may be informative if determinants and sequelae differ.[24] This study tested whether better social mobility from childhood was associated with reduced risk of adverse birth outcomes for black women.

## METHODS

The Life-course Influences of Fetal Environments (LIFE) study is a retrospective cohort study of self-reported black/African American women aged 18–45 years who have just given birth to a singleton baby in a Detroit, MI suburban hospital. This hospital was selected because it attracted a diverse patient population. Recruitment was restricted to black women to facilitate examining social factors for adverse birth outcomes that are unique to black women (e.g., racism). Women were recruited from the hospital's labor and delivery and postpartum unit logs, with enrollment from June 2009 to December 2011. Women were excluded from the study if they: did not speak English; had an intellectual disability, serious cognitive deficits/mental illness; or were incarcerated. All eligible women were approached for enrollment and interviewed during postpartum hospitalization, and written informed consent was obtained for all enrollees (71% participation rate, N=1,410). The LIFE sample composition was comparable to other U.S. black women giving birth in 2010 (Appendix Table 1). Women participated in structured interviews with trained interviewers in their hospital room. A $50 gift card to a local store was provided as an incentive. Additional information was obtained via medical record abstraction by trained study staff. The study was approved by Wayne State University and the hospital IRBs.

## Measures

**Outcomes—**In this study, PTB was defined as <37 completed weeks gestation (versus ≥37 weeks). Estimates of gestational age (GA) were abstracted from the medical record. GA ranged from 23 to 43 weeks; there were few extremely/very PTBs (GA <32 weeks, *n*=46) but results were comparable after excluding them (Appendix Table 2). GA based on early ultrasound (6–20 weeks gestation) was prioritized as the gold standard (*n*=692). If unavailable, the last menstrual period was used (*n*=464). When early ultrasound was missing and last menstrual period estimate was missing or implausible, GA based on later ultrasound (after 20 weeks gestation, *n*=169), clinician's estimate at birth (*n*=62) or, if all else was missing, GA from the medical record at birth (*n*=21) was used. Spontaneous PTB (used in sensitivity models) excluded medically indicated PTB.

Defined as birth weight <10th percentile (versus above), SGA was determined by comparing an infant's birth weight for a given week of GA to the most recent sex-specific U.S. National Fetal Growth Curve by Talge et al.[25]

Low birth weight was defined as <2,500 grams at birth, versus above, abstracted from the medical record, modeled in sensitivity analyses.

**SEP measures—**A woman's own education (her adulthood SEP) was operationalized as the highest degree earned and number of grades completed in school. Additionally, for childhood SEP, women reported the educational attainment for her biological mother (85%) or the woman who raised her. Responses were categorized into a four-level ordinal education variable:

1. <12 years of school, no GED;
2. 12 years of school or GED;
3. "some college" or 13–15 years of school; and
4. ≥16 years of school.

Interviewers asked women to report the sufficiency of her family's perceived finances currently (adulthood SEP), as well as during two periods from her childhood (retrospectively): from birth to age 10 years (early childhood SEP), and from age 10 to 18 years (middle childhood SEP). Five Likert responses included: (1) *very poor, not enough to get by*; (2) *barely enough to get by*; (3) *enough to get by but no extras*; (4) *more than enough to get by*; and (5) *well-to-do*. Higher values indicated better financial sufficiency.[26]

**Mobility measures—**Within life course epidemiology, three distinct hypotheses have been advanced to understand how SEP influences later-life health across time, which informed the social mobility measures used in this study. The critical or sensitive period hypothesis proposes that early-life SEP influences later-life health via specific windows of development. The accumulation of risk hypothesis posits that effects of adverse SEP gradually accumulate across one's life to affect health. The social mobility hypothesis posits that change in SEP between different life stages influences health.[27] This study tested social mobility hypotheses, based on relative measures of social position, or social distance, capturing intergenerational mobility.[28]

Educational mobility scales were created to assess women's educational attainment in adulthood compared with (subtracting) her mother's educational attainment, based on the ordinal education variables described above. Education scales ranged from −3 to +3, with negative values indicating that the woman exhibited downward social mobility (less education than her mother), and positive values indicating upward social mobility. Zero indicated stable intergenerational education (Appendix Figure 1). Sensitivity analyses (not shown) confirmed the assumption that a woman's mother's education was completed on average by her daughter's mid-childhood (age 10 years).

Measures were constructed to capture mobility (change) in perceived financial sufficiency from each of the two childhood periods to adulthood based on the ordinal financial SEP variables described above. Childhood SEP was subtracted from adulthood SEP to represent the following periods:

1. early childhood (birth to age 10 years) to current/adult; and
2. middle childhood (age 10–18 years) to current/adult.

Financial mobility scales ranged from −4 to +4, with similar interpretation as educational mobility. To improve interpretability and comparability among models, social mobility regression coefficients were rescaled so a 1-point difference corresponded to a 1-SD change.

**Covariates—**Potential confounders included the women's childhood SEP, and her age and parity at the time of the index pregnancy, which were identified either a priori (e.g., childhood SEP, an absolute indicator of SEP, anchors the relative measure of mobility) or by stepwise addition in regression to assess multidimensional confounding. Childhood SEP was operationalized by childhood financial SEP or maternal education (described above), and aligned with the social mobility indicator in the model (e.g., adjusting for maternal education in educational mobility models). Age was obtained from the medical record, modeled linearly; parity was measured as first live birth versus higher.

## Statistical Analysis

The SEP and social mobility variables were evaluated in bivariate analysis (crosstabulations, correlations). Multiple Poisson regression with robust SEs estimated risk ratios (RRs) with 95% CIs, between social mobility and birth outcomes given their common prevalence[29]; logistic regression generated comparable results, with estimates farther from the null (not shown). Model 1 was bivariate; Model 2 adjusted for childhood SEP, age, and parity; and

Model 3 additionally adjusted for the other form of social mobility. Analyses explored whether social mobility associations with birth outcomes were modified by childhood SEP, but found no substantive interactions. Sensitivity models examined whether the social mobility measures operated similarly for upwardly mobile as downwardly mobile, and whether PTB associations were stronger when restricted to spontaneous PTB. Analyses tested for non-linear trends with preliminary categorical mobility specifications; quadratic specifications were implemented to accommodate potential nonlinearities, but all were nonsignificant.

Few (≤5%) data were missing; nonetheless, multivariate imputation by chained equations was implemented in Stata/SE, version 13.0, generating 20 imputed data sets. Diagnostics for variance explained (McFadden's pseudo $R^2$) and model fit (Akaike information criterion, AIC) were output for unimputed models, because multiple imputation precludes such diagnostics. Two women were excluded owing to missing outcome data; the final analytic sample size was 1,408.

## RESULTS

Table 1 describes the demographic characteristics of the LIFE study. Women's age ranged from 18 to 45 years (mean, 27.3 years). Women reported their average current and childhood financial situation as middle to upper SEP (Table 1, Appendix Tables 3–4). Fifteen percent of infants were SGA, 16% were PTB, and PTB and SGA were uncorrelated (tetrachoric correlation rho, −0.02, $p$=0.84).

Social mobility variables were distributed approximately normally (Appendix Figure 2). The two financial mobility measures were strongly correlated (rho=0.67), but only weakly (yet significantly) associated with educational mobility (rho range, 0.10–0.12). Social mobility was not associated with birth outcomes in bivariates (Model 1, Table 2).

After adjusting for age, parity, and childhood SEP with Poisson regression, women who experienced improved educational social mobility from childhood to adulthood gave birth to infants with lower risk of SGA (Figure 1). A 1-SD improvement in educational mobility was associated with a 24% lower risk of SGA in her infant (RR=0.76, 95% CI=0.64, 0.91, Model 2); this association was robust to mutual adjustment for financial mobility (RR=0.77, 95% CI=0.65, 0.93, Table 2, Model 3). Diagnostics indicated that Model 3 explained the most variance (Appendix Table 5). Yet, educational mobility was not associated with PTB (Figure 2, Table 2).

In adjusted Poisson models, better financial social mobility was associated with marginally beneficial effects on SGA risk, for each financial mobility measure. For example, a 1-SD larger improvement in financial status from early childhood to adulthood was associated with 15% lower SGA risk (RR=0.85, 95% CI=0.72, 1.02, Figure 1, Model 2). Measuring financial mobility from middle childhood achieved comparable SGA associations. However financial mobility–SGA associations became weaker and nonsignificant after adjusting for educational mobility (Table 2, Model 3). Financial mobility was not associated with PTB overall (Figure 2, Table 2).

In sensitivity models, SGA associations with educational mobility were similar in the entire sample, as among the upwardly or downwardly mobile subsamples (note that regression coefficients are interpreted as a 1-SD comparison difference in improved social mobility magnitude). However SGA, spontaneous PTB, and LBW associations for financial mobility were often stronger for the upwardly versus downwardly mobile (Appendix Tables 6–7). Sensitivity analyses revealed stronger associations for spontaneous PTB than overall PTB, for example, marginally significant protective associations between improved financial mobility from middle childhood for spontaneous PTB (RR=0.84, 95% CI=0.69, 1.03, Model 2, Appendix Table 8), whether or not educational mobility was controlled.

## DISCUSSION

This study found that upward social mobility from childhood to adulthood, particularly based on education, was associated with reduced SGA risk. Some prior studies found contingent associations for PTB,[12] whereas the current study only documented marginally significant results for improved social mobility with spontaneous PTB but not for PTB overall; nonetheless, these results are broadly consistent with prior studies that tested outcomes based on birth weight and vital records,[13–18] and those testing or documenting associations of birth outcomes with upward mobility among only lower childhood SEP samples.[12,13,15,19]

In sensitivity analysis, the current study tested LBW (Appendix Table 9) to compare with prior studies among blacks, which have been mixed. Like one prior study,[13] the current study found no associations for social mobility with LBW overall; however, financial mobility from early childhood was marginally protective for LBW among the upwardly mobile/stable group (Appendix Table 7). The current study aligns with one prior study documenting lower risk of LBW for infants born to women who experienced upward mobility from an impoverished childhood,[19] as well as with another prior study documenting social mobility associations for blacks' and whites' SGA.[21] In the current study, improved financial mobility was associated with marginally lower odds of spontaneous PTB, suggesting spontaneous PTB may be more sensitive than causes underlying medically indicated PTB to experiences like financial strain, captured by financial mobility.

However, the study results overall suggest that SGA may be the most sensitive of these birth outcomes to lifecourse social mobility among blacks, aligning with one prior study.[21] What underlies this sensitivity is unclear, as prior literature identifying differences between risk factors for SGA versus PTB, even within the same cohort, is inconsistent[30] or overlapping.[23,31,32] However, strong conclusions cannot be made given the few studies.

In this study, educational-based measures of social mobility exhibited stronger associations with SGA than those based on perceived financial sufficiency, particularly after mutual adjustment. Prior social mobility literature, to the authors' knowledge, has not assessed childhood SEP with subjective measures of income, wealth, or finances, which may capture something unique from objective measures including psychosocial stress arising from financial insecurity.[33]

Financial mobility was comparably related to SGA and overall PTB when anchored from early versus middle childhood in this study. If results had differed vastly, that could signal etiologic relevance of SEP in one period of childhood for adverse birth outcomes. Results for mobility do coalesce with other evidence using SEP at the time of the birth, which is commonly operationalized.[12,14,18–20]

As supported by the cumulative pathway life course model, improved social mobility may improve birth outcomes by decreasing risk to adverse exposures over the lifecourse. There are several mechanisms through which this may occur. Prolonged exposure to infections and social and environmental stressors, such as economic hardship, violence, and environmental toxins, may increase poor perinatal outcomes.[8,9] Consequently, improved social mobility may decrease one's prolonged exposure to these factors. Further, reducing adverse health behaviors (e.g., smoking) may play a role, given strong influences by SEP.[34] This study's key finding is interpreted as "improved educational mobility reduces SGA risk," although conversely, downward educational mobility also could be interpreted as increasing SGA risk, as the measure includes upwardly and downwardly mobile participants, and sensitivity analyses documented equally strong educational mobility–SGA associations in both subsamples. Both interpretations have implications for translation; policies intended to improve education may promote intergenerational social mobility, although other educational policy decisions (e.g., dismantling school desegregation plans) may result in downward mobility.[35]

This study contributes to the existing literature for several reasons. First, use of medical record abstraction improves operationalization of GA to probe birth outcome mechanisms beyond those available in vital records. This study's measures modeled both upward and downward social mobility trends, unlike prior studies modeling only upward mobility. This study examined social mobility among black women, among whom evidence is mixed, and the LIFE cohort has highest generalizability to middle-class suburban black populations.

Social mobility was operationalized by two separate SEP measures of educational attainment and subjective finances. Prior studies often operationalized only one measure, and four of the nine prior studies examining birth outcomes have used proxies to calculate childhood SEP. For example, Collins and colleagues[12,19,20] used area-based neighborhood income to proxy individual level income, and Colen et al.[13] used data to extrapolate predicted income given occupation and education. Though not unusual,[36] proxy measures generate measurement error. Social mobility was also anchored in this study by two different periods in childhood, to move beyond prior literature operationalizing social mobility from birth,[12,14,16,18–20] from adolescence/early adulthood,[13,16] or only in adulthood.[37–39]

## Limitations

This study also has several limitations. Although prospectively collected administrative data may be the gold standard for measuring childhood SEP, such data were not available. This study instead used retrospective measures of childhood SEP, reported by the adult participant about her childhood circumstances. This is a common way of reporting childhood SEP and some evidence finds good agreement with prospective collection,[40] although other studies find more measurement error or discordant agreement in retrospective measures.[26,41] Because the LIFE sample is of reproductive age, the period of recall is shorter than other studies (among elders).[40] As young women (particularly teenagers) have had less time to achieve adult SEP, this could bias effects, but restricting to older women finds comparable results (Appendix Table 10).

The education measure was classified ordinally for comparability across generations. Although this models conceptually important (degree-earning) thresholds of education and represents a conservative bias, it may result in loss of information.[42] The operationalization of social mobility also assumes that each point on the original SEP scales is comparable.

A population-based reference was used for calculating SGA, which, although common, is not personalized for differential maternal height or demographics, and does not account for PTB infants being smaller than in utero counterparts at the same gestational week, thereby generating measurement error compared with using references of peers born at the same gestational week.[25] Data were collected on a limited number of early-life confounders of the social mobility–birth outcome association, thereby limiting causal inference, including grandmaternal health/behaviors during/preceding her pregnancy.[15] However, a recent systematic review criticized studies that overadjusted for variables on the SEP–birth causal pathway.[4]

## CONCLUSIONS

In sum, this study found that improving SEP, particularly education, from childhood to adulthood may improve the next generation's health. Manipulating SEP is feasible and common via social policy.[43] Such policy efforts may be necessary to complement medical care and health behavior change efforts to change social position explicitly, to achieve improvements and reduce disparities in population health.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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TLO conceived of the hypotheses, participated in designing and conducting the Life-course Influences of Fetal Environments (LIFE) study as a Co-investigator, interpreted the findings, wrote the manuscript, directed and oversaw analyses, literature reviews, and revisions. JS-A contributed to conducting the literature review, interpreting and framing findings, and editing the manuscript. RK conducted analyses and literature reviews, interpreted findings, and edited the manuscript. DM directed the LIFE study as Principal Investigator, interpreted the findings, and framed and edited the manuscript.

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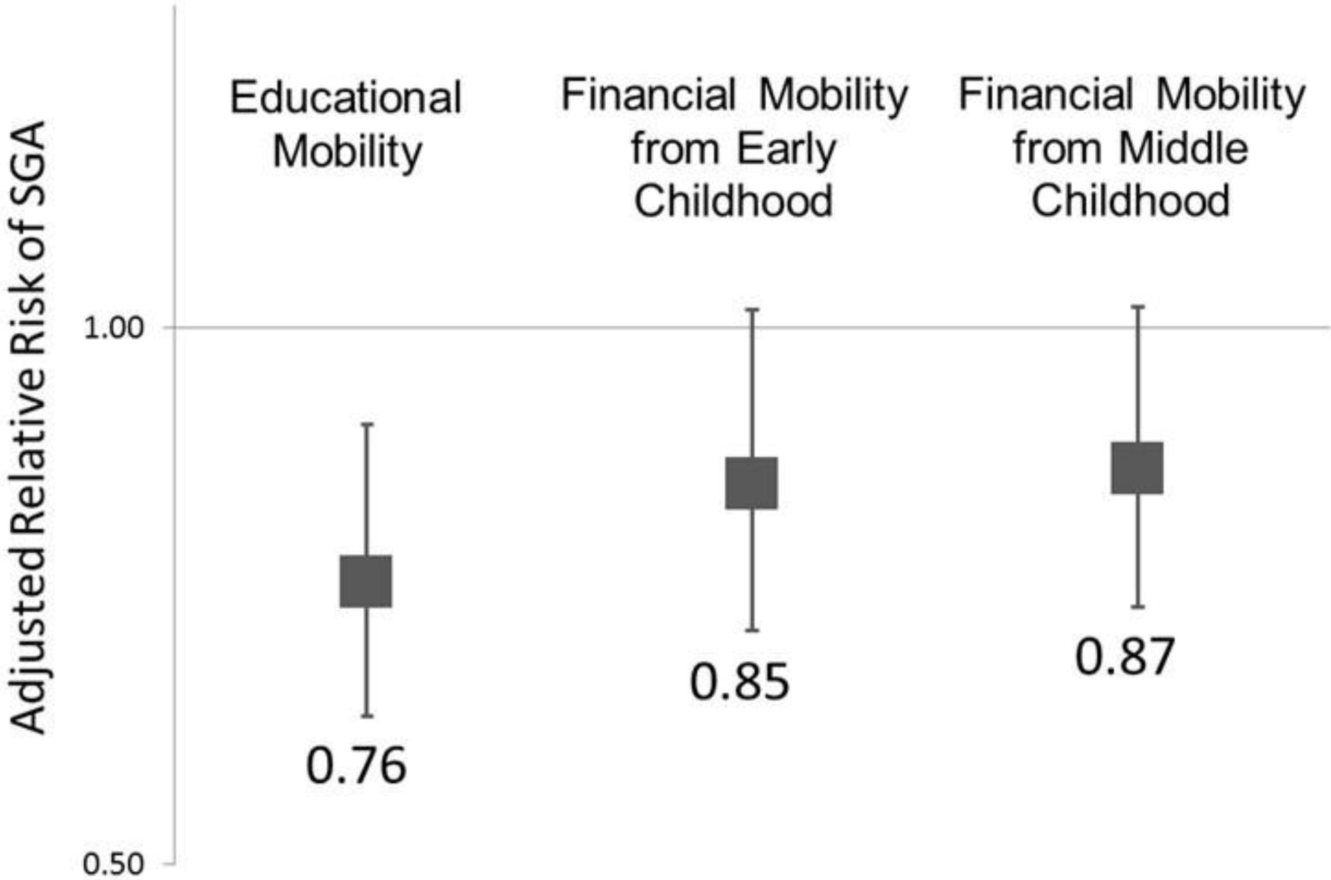


**Figure 1.**
Adjusted risk ratios and their 95% CIs, for a 1-SD increase in social mobility from childhood to adulthood on risk of small for gestational age.
*Notes:* Models adjusted for age, childhood SEP, and parity. Risk ratios calculated from Poisson regression models. Missing data were imputed using multiple imputation by chained equations. N=1,408.
SEP, socioeconomic position; SGA, small for gestational age

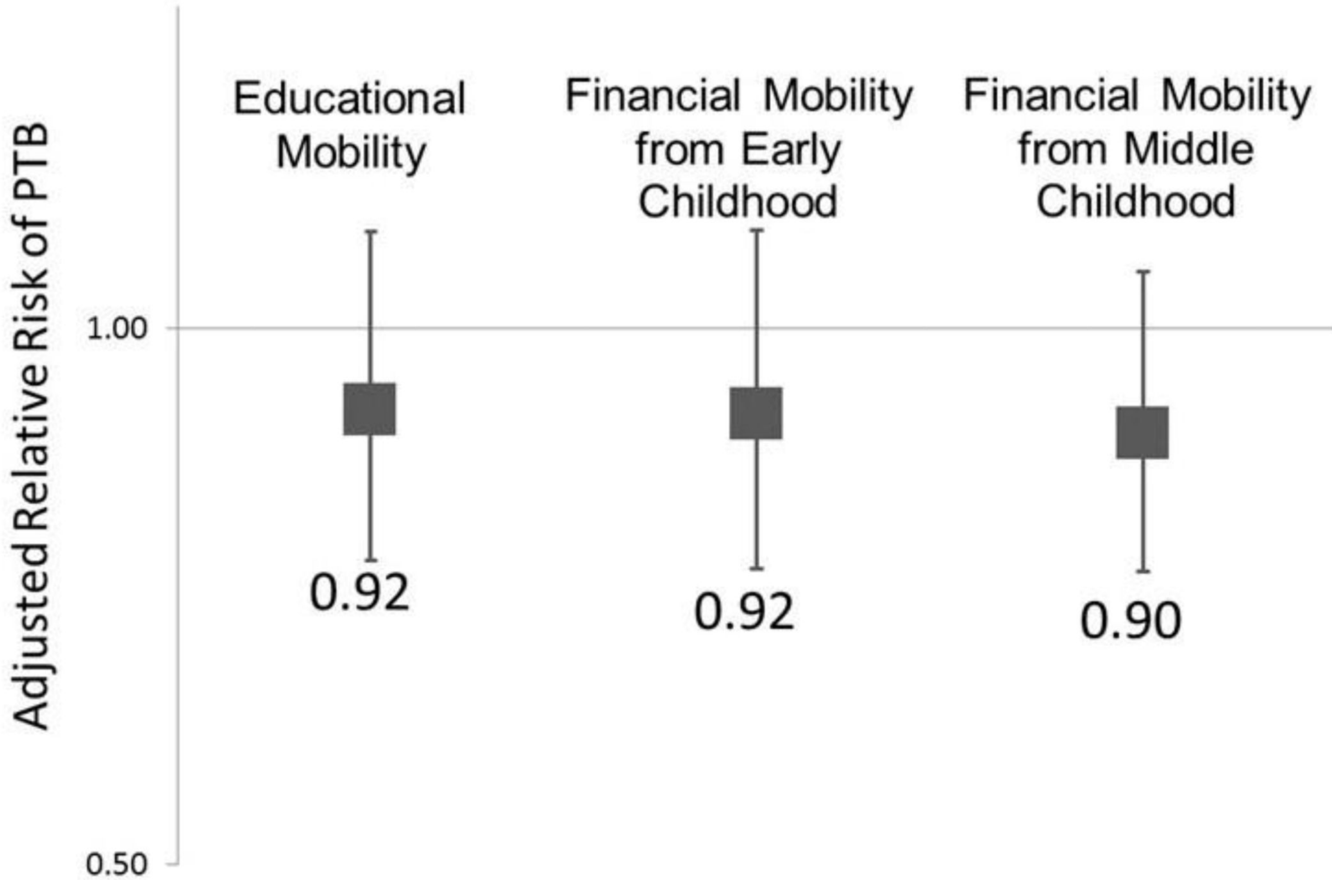


**Figure 2.**
Adjusted risk ratios and their 95% CIs, for a 1-SD increase in social mobility from childhood to adulthood on risk of preterm birth.
*Notes:* Models adjusted for age, childhood SEP, and parity. Risk ratios calculated from Poisson regression models. Missing data were imputed using multiple imputation by chained equations. N=1,408.
SEP, socioeconomic position; PTB, preterm birth

## Table 1

LIFE Sample Characteristics, N=1,408

| Variable | Mean/N | SD/% | Range | % Missing |
|---|---|---|---|---|
| Age (mean/SD) | 27.31 | 6.2 | 18 to 45 | 0% |
| Financial situation (mean/SD) | | | | |
| Current (adulthood SEP) | 3.42 | 0.81 | 1 to 5 | 0% |
| Birth to age 10 (early childhood SEP) | 3.65 | 0.96 | 1 to 5 | 1% |
| Age 10 to 18 (middle childhood SEP) | 3.63 | 0.9 | 1 to 5 | 0% |
| Educational attainment (mean/SD) | | | | |
| Woman’s own (adulthood SEP) | 2.84 | 0.88 | 1 to 4 | 0 % |
| Woman’s mother’s (childhood SEP) | 2.67 | 0.96 | 1 to 4 | 5% |
| First birth (N/%) | 602 | 43% | | 0% |
| Financial mobility (mean/SD) | | | | |
| From early childhood: Birth to current | −0.22 | 1.15 | −4 to 4 | 2% |
| From middle childhood: Age 10 to current | −0.21 | 1.02 | −4 to 3 | 1% |
| Educational mobility (mean/SD) | 0.2 | 1.1 | −3 to 3 | 6% |
| Low birth weight infant (N/%) | 179 | 13% | | 0% |
| Small for gestational age infant (N/%) | 205 | 15% | | 0% |
| Preterm birth infant (N/%) | 230 | 16% | | 0% |

LIFE, Life-course Influences of Fetal Environments Study; SEP, socioeconomic position

**Table 2**

Associations of Improved Social Mobility Trajectories and Birth Outcomes, Bivariate, Multivariate, and Multivariate Mutually Adjusted for Educational and Financial Social Mobility

| Social mobility measure | Model | Small for gestational age | | | | | Preterm birth | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | B | SE | *p*-value | RR | 95% CI | B | SE | *p*-value | RR | 95% CI |
| **Educational mobility trajectory** | | | | | | | | | | | |
| Mother to daughter | | | | | | | | | | | |
| | Model 1 | −0.097 | 0.069 | 0.157 | 0.907 | (0.793, 1.038) | −0.051 | 0.060 | 0.388 | 0.950 | (0.845, 1.068) |
| | Model 2 | −0.272 | 0.091 | 0.003 | 0.762 | (0.638, 0.910) | −0.079 | 0.084 | 0.347 | 0.924 | (0.783, 1.090) |
| | Model 3 | −0.254 | 0.094 | 0.007 | 0.776 | (0.646, 0.932) | −0.068 | 0.086 | 0.429 | 0.934 | (0.790, 1.106) |
| **Financial mobility trajectory** | | | | | | | | | | | |
| Early childhood to current | | | | | | | | | | | |
| | Model 1 | −0.063 | 0.064 | 0.324 | 0.939 | (0.829, 1.064) | −0.011 | 0.062 | 0.865 | 0.990 | (0.876, 1.118) |
| | Model 2 | −0.158 | 0.089 | 0.077 | 0.854 | (0.717, 1.017) | −0.083 | 0.087 | 0.339 | 0.920 | (0.776, 1.092) |
| | Model 3 | −0.112 | 0.090 | 0.215 | 0.894 | (0.749, 1.067) | −0.079 | 0.090 | 0.378 | 0.924 | (0.775, 1.101) |
| Middle childhood to current | | | | | | | | | | | |
| | Model 1 | −0.045 | 0.061 | 0.461 | 0.956 | (0.848, 1.078) | −0.091 | 0.061 | 0.133 | 0.913 | (0.811, 1.028) |

| Social mobility measure | Model | Small for gestational age | | | | | Preterm birth | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | B | SE | *p*-value | RR | 95% CI | B | SE | *p*-value | RR | 95% CI |
| | Model 2 | −0.141 | 0.082 | 0.084 | 0.868 | (0.740, 1.019) | −0.103 | 0.079 | 0.190 | 0.902 | (0.773, 1.053) |
| | Model 3 | −0.105 | 0.082 | 0.198 | 0.900 | (0.767, 1.057) | −0.097 | 0.080 | 0.226 | 0.907 | (0.775, 1.062) |

*Notes:* Model 1 is bivariate; Model 2 is adjusted for age, childhood SEP, and parity; Model 3 is adjusted for age, childhood SEP, parity, and for the other form of social mobility (e.g., models for educational mobility controlled for financial mobility from early childhood; models for financial mobility controlled for educational mobility). All social mobility measures are scaled so that a one-unit change corresponds with a one-SD change. Missing data were imputed using multiple imputation by chained equations. N=1,408.

B, Beta; RR, risk ratio; SEP, socioeconomic position