Matern Child Health J (2016) 20:613–622
DOI 10.1007/s10995-015-1860-5

Movin' on Up: Socioeconomic Mobility and the Risk of Delivering a Small-for-Gestational Age Infant

Jaime C. Slaughter-Acey[1] · Claudia Holzman[2] · Danuelle Calloway[2] · Yan Tian[2]

Published online: 5 November 2015

Abstract *Objective* Poor fetal growth is associated with increased rates of adverse health outcomes in children and adults. The social determinants of poor fetal growth are not well understood. Using multiple socioeconomic indicators measured at the individual level, this study examined changes in maternal socioeconomic position (SEP) from childhood to adulthood (socioeconomic mobility) in relation to poor fetal growth in offspring. *Methods* Data were from the Pregnancy Outcomes and Community Health Study (September 1998–June 2004) that enrolled women in mid-pregnancy from 52 clinics in five Michigan communities (2463 women: 1824 non-Hispanic White, 639 non-Hispanic Black). Fetal growth was defined by birthweight-for-gestational age percentiles; infants with birthweight-for-gestational age <10th percentile were referred to as small-for-gestational age (SGA). In logistic regression models, mothers whose SEP changed from childhood to adulthood were compared to two reference groups, the socioeconomic group they *left* and the group they *joined*. *Results* Approximately, 8.2 % of women (non-Hispanic White: 6.3 %, non-Hispanic Black: 13.9 %) delivered an SGA infant. Upward mobility was associated with decreased risk of delivering an SGA infant. Overall, the SGA adjusted-odds ratio was 0.34 [95 % confidence interval (CI) 0.17–0.69] for women who moved from lower to middle/upper versus static lower class, and 0.44 (CI 0.28–1.04) for women who moved from middle to upper versus static middle class. There were no significant differences in SGA risk when women were compared to the SEP group they *joined*. *Conclusions* Our findings support a link between mother's socioeconomic mobility and SGA offspring. Policies that allow for the redistribution or reinvestment of resources may reduce disparities in rates of SGA births.

Keywords Small-for-gestational age · Birthweight · Social mobility · Life course socioeconomic position · Intergenerational

Introduction

Infants born small-for-gestational age (SGA) have an increased risk of perinatal morbidity and mortality [1] and later life health problems such as cardiovascular disease, obesity, type 2 diabetes and hypertension in adulthood [2–5], when compared with infants whose weight is considered appropriate-for-gestational age. Research examining socioeconomic position (SEP) at the time of pregnancy in developed countries shows that SEP is inversely associated with the prevalence of adverse birth outcomes, including SGA infants [6]. For example, using family income to represent SEP, Joseph et al. [7] found that women in the lowest family income group in Canada had an SGA rate 34 % higher than that in women from the highest family income group. In a more recent study Shankardass et al. [8] used multiple measures of income and found the risk of delivering an SGA or spontaneous preterm birth infant increased with each decreasing quantile of family income. Studies examining relations between SEP and SGA infants

✉ Jaime C. Slaughter-Acey
jslaughts@gmail.com; jcs396@drexel.edu

1 Present Address: College of Nursing and Health Professions, Drexel University, 245 N 15th St, Mailstop 501, Philadelphia, PA 19102, USA

2 Department of Epidemiology and Biostatistics, College of Human Medicine, Michigan State University, 909 Fee Road Room B601, East Lansing, MI 48824, USA

using other single measures such as maternal education, neighborhood poverty and occupation status have also reported inverse associations [6].

The "American Dream" represents the belief that one can start out at a lower SEP as a child in the United States (US) and climb the socioeconomic ladder through hard work and by taking advantage of available opportunities [9–12]. This concept of climbing the socioeconomic ladder from childhood to adulthood is called socioeconomic mobility; it can be defined as the difference in income, wealth or occupation in adulthood from that of one's family's when he/she was a child [13]. Cross-country comparisons show that the higher the income inequality the lower the socioeconomic mobility across generations [12–14]. Given that the US has higher income inequality than other developed countries children living in Scandinavian countries and Canada have a greater chance of attaining the "American Dream" than children living in the US [9, 12–14].

For women there are multiple theories about how climbing the socioeconomic ladder might or might not affect health and reproductive outcomes. In one framework, exposure to social disadvantage during critical times of growth, i.e. in utero or early childhood, regardless of later exposures, could raise the risk of delivering an SGA infant [15]. A different framework describes exposure to social disadvantage as having a cumulative or additive effect that is ongoing [15]. And yet another framework, the pathways or synergistic model, posits that exposure to poor socioeconomic conditions in later years are probabilistically linked to one's exposure to poor socioeconomic conditions during early years; together these exposures jointly influence the probability of having an adverse birth outcome [15].

While these different frameworks have been debated for some time only a handful of studies have examined associations between maternal socioeconomic mobility and birth outcomes in part due to limitations in accessing data on socioeconomic measures at multiple time points during a woman's life [15]. Consequently, the majority of socioeconomic mobility studies published to date [16–28] are European-based where there exists the ability to link vital and other administrative records over women's lifecourse. Studies conducted in the US [16, 18–22, 26, 29] predominantly use birth files linked across generations and ecological socioeconomic measures obtained from US Census data [19, 20, 22, 29, 30]. These US-based studies overall show that women who reside in an impoverished neighborhood during their childhood, but move upward to a wealthy neighborhood experience better birth outcomes than women with lifelong residence in an impoverished neighborhood. This relationship may vary by race/ethnicity according to some studies.

Investigations of socioeconomic mobility and adverse birth outcomes have focused mainly on low birthweight and preterm birth [16–21, 23–27]. In our review of the literature we found only one study that examined fetal growth. In this study, Love et al. [22] examined the concept of maternal "weathering"—early deterioration in women's physiological health due to cumulative social disadvantage [31, 32]—in the context of neighborhood economic environment over women's lifecourse. Results showed that among African-American women, the risk of delivering an SGA or LBW infant significantly increased as length of time living in an impoverished neighborhood increased. The risk of delivering an SGA or LBW infant decreased as length of time residing in a non-impoverished neighborhood increased.

The rising concern over decreased socioeconomic mobility and the limited information on the relationship between fetal growth and socioeconomic mobility motivated our study's goal to assess whether changes in women's SEP from childhood to adulthood are associated with the risk of delivering an SGA infant. This study expands on previous work in the area of socioeconomic mobility and birth outcomes by using multiple individual-level socioeconomic measures to construct a composite score representing SEP at childhood and adulthood.

Methods

Study Design and Sample

Data are from the Pregnancy Outcomes and Community Health (POUCH) Study, a prospective cohort study that investigated pathways to adverse pregnancy outcomes. The POUCH Study was conducted from September 1998 to June 2004 and approved by the institutional review boards of Michigan State University and nine hospitals located in five Michigan communities. The sampling frame constituted women who received prenatal care from any one of 52 participating community clinics, and were $\geq$15 years old, proficient in English, pregnant with a singleton between 16 and 27 week's gestation with no known birth defects or chromosome anomalies, and not diabetic. Also, women had to have been screened for maternal serum alpha-fetoprotein (MSAFP)—a prenatal screening biomarker that has been consistently linked to risk of preterm delivery. Since MSAFP was of particular interest in the original POUCH study aims [33] all women with unexplained high levels of MSAFP ($\geq$2 multiple of the median) were invited to participate (7 % of final cohort). Women with normal MSAFP levels were stratified by race/ethnicity and randomly sampled into the cohort.

After obtaining written consent POUCH Study participants were interviewed by a trained nurse and given a self-administered questionnaire in order to collect information regarding socio-demographics, psychosocial factors, health behaviors, health status, medical history and the POUCH Study participant's parents background. Medical records were abstracted to collect information on the index pregnancy outcome. A total of 3038 women were enrolled into the study; 19 women were lost to follow-up leaving 3019 women in the final cohort.

In a comparison with birth certificate data for births occurring in the five Michigan communities from which POUCH Study participants were recruited, race/ethnic-specific analyses showed that women in the POUCH Study sample were similar to those in the five communities with respect to sociodemographic characteristics, prior pregnancy history and pregnancy outcomes. The only exception was that the percentage of Black women over 30 years of age was lower in the POUCH Study sample (14 %) than in the community sample (21 %) [34].

Measures

In order to assess socioeconomic mobility three composite measures were created: adulthood SEP, childhood SEP and socioeconomic mobility.

Adulthood SEP

The adulthood SEP composite measure was based on the POUCH Study participant's socioeconomic indicators at the time of enrollment: maternal and paternal education and usual occupation status, maternal annual household income, and maternal Medicaid status. Reported usual occupation was categorized using codes based on the US Census Bureau's 1990 Occupational Classification System. The six socioeconomic indicators (Table 1) were recoded into binary variables and assigned 0 to represent lower SEP or 1 for higher SEP. If paternal education or occupation was missing or unknown, the indicator was assigned a 0 for lower SEP since these values were correlated with lower SEP on the other indicators. The six indicators were summed; the adulthood SEP composite measure ranged from 0 to 6. Women then were classified into three adulthood SEP groups using quartile cut-points from the composite score distribution: lower class (bottom quartile, score = 0), middle class (2nd and 3rd quartiles, score = 1–3) and upper class (top quartile, score $\geq$ 4).

Childhood SEP

The childhood SEP composite measure was based on the POUCH Study participant's self-report of her parents' (maternal grandparents of the baby) socioeconomic indicators which included: maternal mother's and father's highest level of education and usual occupation and whether the family had received public assistance when the POUCH Study participant was a child [35]. The five childhood socioeconomic indicators (Table 1) were recoded into binary variables and combined following the same procedure described above for the adulthood SEP measure. The composite childhood SEP score ranged from 0 to 5. Quartile cut-points were used to create three childhood SEP groups: lower class (bottom quartile, score = 0), middle class (2nd and 3rd quartiles, score 1–2) and upper class (top quartile, score $\geq$ 3).

Socioeconomic Mobility

To create a measure of SEP mobility POUCH Study participants were classified into groups based on whether their SEP changed upward, downward or stayed static from childhood to adulthood. The following categories were created: *Upward Mobility*—(a) lower to middle class, (b) lower to upper class and (c) middle to upper class; *Downward Mobility*—(a) upper to middle class, (b) upper to lower class and (c) middle to lower class; and *Static Mobility*—(a) static lower class, (b) static middle class and (c) static upper class. Very few women went from lower to upper class (<2 %); hence, they were grouped with women who moved from lower to middle class during analysis. Similarly, few women moved from upper to lower class (<2 %); they were grouped with women who moved from middle to lower class.

The dependent variable was SGA. Using the US fetal growth reference (gestational age [GA], singleton, sex-specific) proposed by Alexander et al. [36], GA was based on the date of the woman's last menstrual period (LMP). However, if the LMP-derived GA differed from the ultrasound-based GA estimate by more than 2 weeks then the ultrasound-based GA was used. Infants whose birthweight < 10th percentile for their GA were classified as SGA. Infants with a birthweight for GA $\geq$ 10th percentile served as the reference group.

Covariates that could potentially confound and/or mediate the relationship between socioeconomic mobility and SGA were defined based on previous literature. Variables included maternal age, parity, race and pre-pregnancy body mass index (BMI). Maternal age, race, parity and pre-pregnancy weight (used to calculate pre-pregnancy BMI) were collected via maternal interview. Pre-pregnancy BMI was defined as: underweight (BMI < 19.8), normal weight (BMI 19.8–26.0), overweight (BMI >26.0–29.0) and obese (BMI > 29). Parity and age were both modeled as continuous and categorical variables. In final regression models parity was modeled as a categorical variable and age was continuous and log transformed.

Table 1 Maternal, paternal and maternal grandparents' of the baby socioeconomic indicators

Socioeconomic indicators	0—Lower SEP	1—Higher SEP
Adulthood SEP		
Maternal education	≤High school	>High school
Paternal education	≤High school	>High school
	Missing	
Maternal usual occupation	Sales	Professional
	Clerical	Managerial
	Service	Technical
	Blue collar	
	Homemaker	
	Other	
	Unknown	
Paternal usual occupation	Sales	Professional
	Clerical	Managerial
	Service	Technical
	Blue collar	
	Homemaker	
	Other	
	Unemployed	
	Unknown	
Mother's medicaid status	Yes	No
Mothers annual household income	<$50,000	≥$50,000
Childhood SEP		
Family history of public assistance	Yes	No
Maternal grandmother's education	≤High school	>High school
	Missing	
Maternal grandfather's education	≤High school	>High school
	Missing	
Maternal grandmother of baby usual occupation	Sales	Professional
	Clerical	Managerial
	Service	Technical
	Blue collar	
	Homemaker	
	Other	
	Unknown	
Maternal grandfather of baby usual occupation	Sales	Professional
	Clerical	Managerial
	Service	Technical
	Blue collar	
	Homemaker	
	Other	
	Unemployed	
	Unknown	

SEP socioeconomic position

Statistical Analysis

Statistical analyses were performed using SAS version 9.4 (Cary, NC). The analysis was restricted to women who were non-Hispanic White or non-Hispanic Black since 8.5 % of the POUCH Study sample reported their race as Hispanic, Asian, Native American, or other. Women were excluded if they had missing data for the outcome, SGA (0.3 %), or if they were missing any of the three SEP composite measures (9.5 %). The final analytic sample consisted of 2463 (non-Hispanic White: 1824; non-Hispanic Black: 639) women. Women who were missing one of the SEP composite measures were significantly different from the final analytic sample in that they were more likely to be non-Hispanic Black, <20 years of age, have no prior live births, have a pre-pregnancy BMI <19.8 kg/m^2, and deliver an SGA infant.

The relations among maternal characteristics and SGA were evaluated in bivariate analyses using Chi square tests and ANOVA. To examine associations between socioeconomic mobility and SGA crude and adjusted odds ratios (OR) and 95 % confidence intervals (CI) were calculated using logistic regression models. The covariates maternal age at pregnancy, parity and pre-pregnancy BMI might function as confounders, mediators or both; therefore, three models were created: (1) an unadjusted model; (2) a model adjusted for race only; and (3) a model adjusted for race, age, parity and pre-pregnancy BMI. In addition, all analytic models were repeated after stratifying by race to look for heterogeneity of effects.

Results

In this sample 8.2 % of the 2463 women delivered an SGA infant. Approximately a quarter of the sample was non-Hispanic Black (25.9 %), the mean maternal age was 26.7 years (SD = 5.7) and 41.7 % were first-time mothers. Table 2 presents the SGA rate by childhood SEP, adulthood SEP, socioeconomic mobility and maternal characteristics for the POUCH Study participants. One-fourth of the women moved upward in their SEP, one-fourth moved downward and a little more than half stayed at their childhood SEP. The rate of delivering an SGA infant was highest among non-Hispanic Blacks (13.9 %), women under 20 years of age (15.6 %), first time mothers (10.4 %) and women with normal BMI (9.9 %). Among non-Hispanic Whites the rate of delivering an SGA infant was 6.9 %.

Static Socioeconomic Position and Delivery of an SGA Infant

Among women whose SEP did not change from childhood to adulthood, i.e. the static groups, the rate who delivered an SGA infant was 3.9, 9.3 and 15.9 % for upper, middle and lower class women, respectively (Table 2). The one exception to the inverse relation between SEP and %SGA was observed in a small group of non-Hispanic Blacks with static upper class; their SGA rate was 18.2 % (Table 2).

Upward Socioeconomic Mobility and Delivery of an SGA Infant

Delivery of an SGA infant occurred in 5.8 % of women who went from lower to middle class and in 4.1 % of women who moved from middle to upper class (Table 2). The SGA rates for non-Hispanic White and non-Hispanic Black women moving from lower to middle class were similar, 6.0 and 5.5 % respectively. Non-Hispanic White and non-Hispanic Black women moving from middle to upper class also had similar SGA rates (Table 2).

In comparing the two upwardly mobile groups of women to the SEP group they *left* (Table 3) there was a significant decrease in the probability of delivering an SGA infant. After initial adjustment for race (model 2), the inclusion of maternal age at pregnancy, parity and pre-pregnancy BMI as covariates [model 3]) had minimal influence on the main effect estimates. The model 3 AOR for delivery of an SGA infant was 0.34 (95 % CI 0.17–0.69) for women who moved from lower to middle/upper with static lower class women as the referent, and 0.44 (95 % CI 0.23–0.85) for women who moved from middle to upper class with static middle class as the referent. Analyses that compared upwardly mobile women to women in the SEP they *joined* showed no statistically significant differences in the odds of delivering an SGA infant (Table 3).

Downward Socioeconomic Mobility and Delivery of an SGA Infant

Among women who moved downward in their SEP from childhood to adulthood the SGA rate was 8.4 % for those who moved from upper to middle class and 9.7 % for those who moved from upper/middle to lower class (Table 2). Non-Hispanic White and non-Hispanic Black women who moved downward in their mobility exhibited different rates of SGA (Table 2). For example, the rate of SGA for women who moved from middle to lower class was 6.0 % for non-Hispanic Whites and 13.5 % for non-Hispanic Blacks.

Women in the two downwardly mobile groups were first compared to women in the SEP group they *left*. Those who went from upper class to middle class had higher odds of delivering an SGA infant in unadjusted analyses (OR 2.23, 95 % CI 1.10–4.51); however, there was some attenuation of this effect in the adjusted analyses (Table 3). Next, women who were downwardly mobile were compared to the SEP group they *joined*. The odds of delivering an SGA infant among women who went from upper/middle class to lower class was considerably lower than that of women who remained static in the lower class, AOR 0.60 (95 % CI 0.37–0.96).

Socioeconomic Mobility and Delivery of an SGA Infant by Race

Table 4 presents race-stratified adjusted models; both non-Hispanic Whites (AOR: 0.40, 95 % CI 0.15–1.01) and non-

Table 2 Percent of small-for-gestational age (SGA) in POUCH study by socioeconomic position and maternal characteristics

Maternal characteristics	Overall		Non-Hispanic Whites		Non-Hispanic Blacks	
	Total N (%)	SGA rate (%)	Total N (%)	SGA rate (%)	Total N (%)	SGA rate (%)
Childhood SEP						
Upper class	641 (26.0)	6.2	560 (30.7)	4.3	81 (12.7)	19.8
Middle class	1277 (51.9)	7.9	977 (53.6)	6.5	300 (47.0)	12.7
Lower class	545 (22.1)	11.4	287 (15.7)	9.4	258 (40.7)	13.6
Adulthood SEP						
Upper class	731 (29.7)	4.1	680 (37.3)	3.7	51 (8.0)	9.8
Middle class	1059 (43.0)	8.4	811 (44.5)	7.3	248 (38.8)	12.1
Lower class	673 (27.3)	12.5	333 (9.0)	9.0	340 (53.2)	15.9
Socioeconomic mobility[a]						
Upward mobility						
Middle to upper class	338 (13.7)	4.1	314 (17.2)	4.1	24 (3.8)	4.2
Lower to upper class	37 (1.5)	5.4	32 (1.8)	6.3	5 (0.8)	0
Lower to middle class	206 (8.4)	5.8	133 (7.3)	6.0	73 (11.4)	5.5
Downward mobility						
Upper to middle class	239 (9.7)	8.4	199 (10.9)	6.0	40 (6.3)	20.0
Upper to lower class	46 (1.9)	13.0	27 (1.5)	7.4	19 (3.0)	21.1
Middle to lower class	325 (13.2)	30 (9.2)	184 (10.1)	6.0	141 (22.1)	13.5
Static mobility						
Static upper class	356 (14.5)	3.9	334 (18.3)	3.0	22 (3.4)	18.2
Static middle class	614 (24.9)	9.3	479 (26.3)	8.1	135 (21.1)	13.3
Static lower class	302 (12.3)	15.9	122 (6.7)	13.9	180 (28.2)	17.2
Race						
Non-Hispanic White	1824 (74.1)	6.3	–	–	–	–
Non-Hispanic Black	639 (25.9)	13.9	–	–	–	–
Age (years)						
<20	333 (13.5)	15.6	167 (9.2)	9.6	166 (26.0)	21.7
20–29	1397 (56.7)	8.0	1018 (55.8)	6.9	379 (59.3)	11.1
≥30	733 (29.8)	5.3	639 (35.0)	4.4	94 (14.7)	11.7
Number of prior births						
0 live birth	1026 (41.7)	10.4	786 (43.1)	7.5	240 (37.6)	20.0
1 live birth	834 (33.9)	6.6	636 (34.9)	5.5	198 (31.0)	10.6
>1 live birth	603 (24.5)	6.8	402 (22.0)	5.2	201 (31.5)	10.0
Pre-pregnancy BMI						
Underweight <19.8	0	0	0	0	0	0
Normal weight 19.8–26.0	1156 (46.9)	9.9	889 (48.7)	7.5	267 (41.8)	17.6
Overweight >6.0–29.0	622 (25.3)	5.8	473 (25.9)	4.2	149 (23.3)	10.7
Obese >29.0	685 (27.8)	7.7	462 (25.3)	5.8	223 (34.9)	11.7

BMI body mass index, *POUCH* pregnancy outcomes and community health, *SGA* small-for-gestational age

[a] Socioeconomic mobility groups are all mutually exclusive

Hispanic Blacks (AOR 0.26, 95 % CI 0.8–0.79) who experienced upward mobility from lower to middle/upper class had a reduced probability of delivering an SGA infant when compared to the SEP group they *left*. In comparisons between women who moved upwardly from middle to upper class and the referent, women in the static middle class, only non-Hispanic Whites exhibited a reduced probability of delivering an SGA infant (AOR: 0.43, 95 % CI 0.22–0.87). In analyses comparing upwardly mobile non-Hispanic Whites and non-Hispanic Blacks to their

Table 3 Prevalence, crude and adjusted odds ratios (95 % confidence intervals) for small-for-gestational age

Socioeconomic mobility	SGA rate (%)	Reference	SGA rate (%)	Model 1[a] OR (95 % CI)	Model 2[b] OR (95 % CI)	Model 3[c] OR (95 % CI)
Upward mobility						
Lower to middle/upper	5.8	Static lower[d]	15.9	**0.32 (0.17–0.60)**	**0.34 (0.18–0.64)**	**0.34 (0.17–0.69)**
Middle to upper	4.1	Static middle[d]	9.3	**0.42 (0.23–0.77)**	**0.46 (0.25–0.85)**	**0.44 (0.23–0.85)**
Lower to middle/upper	5.8	Static middle[e]	9.3	0.60 (0.33–1.09)	0.57 (0.31–1.05)	0.61 (0.33–1.12)
Middle to upper	4.1	Static upper[e]	3.9	1.05 (0.49–2.25)	1.04 (0.49–2.22)	1.20 (0.55–2.60)
Downward mobility						
Upper to middle	8.4	Static upper[d]	3.9	**2.23 (1.10–4.51)**	1.75 (0.84–3.63)	1.70 (0.77–3.81)
Upper/middle to lower	9.7	Static middle[d]	9.3	1.05 (0.63–1.58)	0.89 (0.57–1.41)	0.85 (0.53–1.36)
Upper to middle	8.4	Static middle[e]	9.3	0.89 (0.52–1.52)	0.94 (0.55–1.60)	0.95 (0.58–1.57)
Upper/middle to lower	9.7	Static lower[e]	15.9	**0.57 (0.36–0.90)**	**0.62 (0.40-0.99)**	**0.59 (0.36–0.95)**

Bold values indicate $p < 0.05$

BMI body mass index, *CI* confidence interval, *SGA* small-for-gestational age, *OR* odds ratio

[a] Model 1: unadjusted logistic regression model

[b] Model 2: logistic regression model adjusted for race

[c] Model 3: logistic regression model adjusted for race, age at pregnancy, parity, and pre-pregnancy BMI

[d] Reference is the SEP group women *left*

[e] Reference is the SEP group women *joined*

Table 4 Race-stratified crude and adjusted odds ratios (95 % confidence intervals) for small-for-gestational age

Socioeconomic mobility	Reference	Non-Hispanic White		Non-Hispanic Black	
		Model 1[a] OR (95 % CI)	Model 2[b] OR (95 % CI)	Model 1[a] OR (95 % CI)	Model 2[b] OR (95 % CI)
Upward mobility					
Lower to middle/upper	Static lower[c]	**0.40 (0.18–0.90)**	0.40 (0.15–1.01)	**0.26 (0.09–0.76)**	**0.26 (0.08–0.79)**
Middle to upper	Static middle[c]	**0.49 (0.26–0.93)**	**0.43 (0.22–0.87)**	0.28 (0.04–2.22)	0.34 (0.04–3.01)
Lower to middle/upper	Static middle[d]	0.73 (0.36–1.49)	0.76 (0.37–1.59)	0.35 (0.11–1.08)	**0.30 (0.9–0.97)**
Middle to upper	Static upper[d]	1.40 (0.61–3.24)	1.63 (0.69–3.82)	–	–
Downward mobility					
Upper to middle	Static upper[c]	2.08 (0.88–4.09)	1.97 (0.77–5.05)	–	–
Upper/middle to lower	Static middle[c]	0.74 (0.39–1.42)	0.69 (0.35–1.36)	1.09 (0.56–2.12)	1.01 (0.51–2.01)
Upper to middle	Static middle[d]	0.72 (0.37–1.41)	0.70 (0.36–1.39)	1.63 (0.65–4.08)	1.58 (0.61–4.05)
Upper/middle to lower	Static lower[d]	**0.41 (0.19–0.87)**	**0.39 (0.18–0.84)**	0.81 (0.45–1.45)	0.77 (0.42–1.41)

Bold values indicate $p < 0.05$

SEP socioeconomic position, *BMI* body mass index, *CI* confidence interval, *SGA* small-for-gestational age, *OR* odds ratio

[a] Model 1: unadjusted race-stratified logistic regression model

[b] Model 2: race-stratified logistic regression model adjusted for age at pregnancy, parity, and pre-pregnancy BMI

[c] Reference is the SEP group women *left*

[d] Reference is the SEP group women *joined*

racial counterparts in the SEP group they *joined,* no significant difference was found for Whites. However, for non-Hispanic Blacks who moved from lower to middle/upper class the AOR for delivery of an SGA infant was 0.30 (95 % CI 0.09–0.97). Due to the small numbers we do not report on comparisons between non-Hispanic Blacks who moved from middle to upper class and the SEP group they *joined*, the static upper class.

In race-stratified regression models comparing downwardly mobile non-Hispanic Whites and non-Hispanic Blacks to their racial counterparts in the SEP group they *left* no significant differences were found in the odds of delivering an SGA infant. Due to the small numbers of non-Hispanic Blacks in static upper class group we do not report on comparisons between non-Hispanic Black women who moved from Upper to Middle class and the SEP group they *left*. In comparisons to the SEP group *joined*, only non-Hispanic Whites who moved from upper/middle to lower class exhibited reduced odds of delivering an SGA infant when compared to their racial counterparts in the static lower class (AOR 0.39, 95 % CI 0.18–0.84).

Discussion

We found that among women of reproductive age higher SEP and a history of upward socioeconomic mobility were both associated with a lower likelihood of delivering an SGA infant. In further exploration, race-stratified results showed that both non-Hispanic White and non-Hispanic Black women may receive some benefits from upward socioeconomic mobility. These findings are particularly relevant in the context of the US's current political/economic realities. The US is seen as a "land of opportunity" where children have the option to *move-up* the socioeconomic ladder as adults [9–12]. Our findings suggest that among women who *move-up* there are positive health consequences for their offspring. Unfortunately, recent studies by Chetty et al. [9, 10] show that rates of socioeconomic mobility within the US have been stagnant over the past few decades while income inequality has increased and the size of the middle class has decreased. These authors concluded that the parents a child is born to may be more important in today's world than yesterday's [9, 10]. This concept takes on additional meaning if the impact begins in utero and manifests in alteration of fetal growth.

There are several potential explanations for our findings. Using the cumulative stress or *weathering* framework [31, 32] we might infer that women who move upward in SEP do not accumulate the "wear and tear" to their body's allostatic load [37, 38] that is prevalent among women who do not *move-up*. In turn, lower levels of "wear and tear" create more optimal in utero environments for the growing fetus. We also noted that downward mobility from upper/middle to lower class was associated with a lower risk of delivering an SGA infant when compared to the SGA risk of the SEP group *joined*. Upon further inspection, our race-stratified results suggest this relationship was only seen among non-Hispanic White women. One interpretation of our main results is that women retain a health advantage or that a health advantage coincides with a *stronger start* conferred by the higher childhood SEP. Studies with prospectively collected health indicators beginning in childhood could help shed light on the biological basis of critical periods that later translate into maternal impact on fetal growth.

This study contributes to the current literature by investigating the influence of SEP, measured at the individual-level, on fetal growth and extending the inquiry to include socioeconomic mobility up through the period of pregnancy. The majority of studies examining the impact of socioeconomic mobility on pregnancy outcomes have used a single indicator to denote SEP. Our study's use of multiple indicators to denote SEP during childhood and adulthood may have minimized misclassification bias that can occur with temporal changes in the SEP assigned to any single indicator such as occupation [39–41]. While all our SEP indicators were gathered through self-report, and therefore there may be some bias, mothers offered this information in mid-pregnancy before knowing if the infant was or was not SGA. Finally, this study enrolled a socioeconomically diverse population thus permitting us to observe a full range of socioeconomic mobility.

Despite the many strengths discussed above, there are limitations in our study that merit consideration. As mentioned in our description of the POUCH Study sample, the percentage of non-Hispanic Black women over 30 years of age was lower than that in the communities from which POUCH Study participants resided; this may limit the generalizability of our results to this group. While our overall number of women enrolled in POUCH was quite large, our study lacked power in our race-stratified analyses. Hence we were not able to draw meaningful conclusion in some comparisons for non-Hispanic Black women. Our study, as most studies in this area, used birthweight standardized growth curves, which can be biased at early gestations [42, 43]. SGA (<10th percentile) was used as an indicator of poor fetal growth, a common approach in similar studies. Not every infant in this distribution tail experienced poor fetal growth, some are constitutionally small. We used a straightforward approach to building SEP composite measures with equal weighting for each indicator. Also, we broadly grouped measures of SEP into two time points, childhood and adulthood; women's SEP during each of the two periods could have fluctuated. While this level of misspecification is likely to be small and minimally related to fetal growth (non-differential), our approach might have underestimated true effect sizes. Socioeconomic indicators used to create the composite measure for childhood SEP were collected from the POUCH Study participant and not directly from her parents. Though this is a limitation, at least one study [44] examining proxy reporting of SEP showed reasonable concordance in parent and child responses. Perhaps most importantly, causal inferences from socioeconomic mobility studies are challenging in part due to the possibility of indirect selection [45], confounding due to unmeasured individual factors established early in life that may influence both health and SEP across the lifecourse.

Studies examining socioeconomic mobility are rarely if ever be randomized; that leaves us with associations from observational studies and uncertainty as to how much effect is due to selection and how much is explained by benefit/harm of changes in SEP [46]. While causation is difficult to infer, the patterns in observed and descriptive data on fetal growth, SEP and socioeconomic mobility can guide medical and public health resource allocation and levels of medical surveillance or intervention during pregnancy.

Conclusion

Our findings invite future studies that might ask, what are the pathways (e.g., biological, behavioral, psychosocial, social structure) through which upward social mobility could lead to improved birth outcomes for both non-Hispanic White and non-Hispanic Black women? If indirect selection plays some explanatory role for the upward mobile effect, what is it that these women do/experience that provides an advantage for fetal growth? Why do White women who experience downward mobility, on average, retain an advantage when compared to women in the social class they join? Why is this same pattern not observed for Black woman? Would investments in public education and income stability, major contributors to socioeconomic mobility, improve birth outcomes for disadvantaged women? These questions point to fertile areas for future research. Answers to these questions could lead to more effective interventions aimed at reducing poor fetal growth.

Acknowledgments Special thanks to members of the POUCH Study Team for their feedback and critique of this manuscript as it was being developed. The POUCH Study was supported by a Perinatal Epidemiologic Research Initiative Program Grant from the March of Dimes Foundation (Grants 20FY01-38 and 20-FY04-37) the National Institute of Child Health and Human Development and the National Institute of Nursing Research (Grant R01 HD34543), the Thrasher Research Foundation (Grant 02816-7) and the Centers for Disease Control and Prevention (Grant U01 DP000143-01). The lead author was supported by Institution T32 Grant (T32 HD046377) in Perinatal Epidemiology.

Compliance with Ethical Standards

Conflict of interest The authors have no conflicts of interest to disclose.

References

1. McIntire, D. D., Bloom, S. L., Casey, B. M., & Leveno, K. J. (1999). Birth weight in relation to morbidity and mortality among newborn infants. *New England Journal of Medicine, 340*(16), 1234–1238.
2. Harder, T., Rodekamp, E., Schellong, K., Dudenhausen, J. W., & Plagemann, A. (2007). Birth weight and subsequent risk of type 2 diabetes: A meta-analysis. *American Journal of Epidemiology, 165*(8), 849–857.
3. Oken, E., & Gillman, M. W. (2003). Fetal origins of obesity. *Obesity Research, 11*(4), 496–506.
4. Strutz, K. L., Richardson, L. J., & Hussey, J. M. (2012). Preconception health trajectories and birth weight in a national prospective cohort. *Journal of Adolescent Health, 51*(6), 629–636.
5. Barker, D. J. (2006). Adult consequences of fetal growth restriction. *Clinical Obstetrics and Gynecology, 49*(2), 270–283.
6. Blumenshine, P., Egerter, S., Barclay, C. J., Cubbin, C., & Braveman, P. A. (2010). Socioeconomic disparities in adverse birth outcomes: A systematic review. *American Journal of Preventive Medicine, 39*(3), 263–272.
7. Joseph, K. S., Liston, R. M., Dodds, L., Dahlgren, L., & Allen, A. C. (2007). Socioeconomic status and perinatal outcomes in a setting with universal access to essential health care services. *Canadian Medical Association Journal, 177*(6), 583–590.
8. Shankardass, K., O'Campo, P., Dodds, L., Fahey, J., Joseph, K. S., Morinis, J., & Allen, V. M. (2014). Magnitude of income-related disparities in adverse perinatal outcomes. *BMC Pregnancy and Childbirth, 14*(1), 96.
9. Chetty, R., Hendren, N., Kline, P., & Saez, E. (2014). Where is the land of opportunity? The geography of intergenerational mobility in the United States (No. w19843). *National Bureau of Economic Research.*
10. Chetty, R., Hendren, N., Kline, P., Saez, E., & Turner, N. (2014). Is the United States still a land of opportunity? Recent trends in intergenerational mobility (No. w19844). *National Bureau of Economic Research.*
11. Corak, M. (2004). *Generational income mobility in North America and Europe*. Cambridge: Cambridge University Press.
12. Corak, M. (2013). Income inequality, equality of opportunity, and intergenerational mobility. *The Journal of Economic Perspectives*, *27*(3) 79–102.
13. Beller, E., & Hout, M. (2006). Intergenerational social mobility: The United States in comparative perspective. *The Future of Children, 16*(2), 19–36.
14. Björklund, A., & Markus, J. (1997). Intergenerational income mobility in Sweden compared to the United States. *The American Economic Review*, *87*(5) 1009–1018.
15. Colen, C. G. (2011). Addressing racial disparities in health using life course perspectives. *Du Bois Review: Social Science Research on Race, 8*(01), 79–94.
16. Astone, N. M., Misra, D., & Lynch, C. (2007). The effect of maternal socio-economic status throughout the lifespan on infant birthweight. *Paediatric and Perinatal Epidemiology, 21*(4), 310–318.
17. Basso, O., Olsen, J., Johansen, A. M. T., & Christensen, K. (1997). Change in social status and risk of low birth weight in Denmark: Population based cohort study. *BMJ, 315*(7121), 1498–1502.
18. Colen, C. G., Geronimus, A. T., Bound, J., & James, S. A. (2006). Maternal upward socioeconomic mobility and black-white disparities in infant birthweight. *American Journal of Public Health, 96*(11), 2032–2039.
19. Collins, J. W, Jr, David, R. J., Simon, D. M., & Prachand, N. G. (2006). Preterm birth among African American and white women with a lifelong residence in high-income Chicago neighborhoods: An exploratory study. *Ethnicity and Disease, 17*(1), 113–117.
20. Collins, J. W, Jr, Rankin, K. M., & David, R. J. (2011). African American women's lifetime upward economic mobility and preterm birth: The effect of fetal programming. *American Journal of Public Health, 101*(4), 714–719.

21. Collins, J. W., Rankin, K. M., & David, R. J. (2011). Low birth weight across generations: The effect of economic environment. *Maternal and Child Health Journal, 15*(4), 438–445.
22. Love, C., David, R. J., Rankin, K. M., & Collins, J. W. (2010). Exploring weathering: Effects of lifelong economic environment and maternal age on low birth weight, small for gestational age, and preterm birth in African-American and white women. *American Journal of Epidemiology, 172*(2), 127–134.
23. Spencer, N. (2004). Accounting for the social disparity in birth weight: Results from an intergenerational cohort. *Journal of Epidemiology and Community Health, 58*(5), 418–419.
24. Basso, O., Olsen, J., & Christensen, K. (1999). Study of environmental, social, and paternal factors in preterm delivery using sibs and half sibs. A population-based study in Denmark. *Journal of Epidemiology and Community Health, 53*(1), 20–23.
25. Joffe, M. (1989). Social inequalities in low birth weight: Timing of effects and selective mobility. *Social Science and Medicine, 28*(6), 613–619.
26. Kramer, M. R., Dunlop, A. L., & Hogue, C. J. (2014). Measuring women's cumulative neighborhood deprivation exposure using longitudinally linked vital records: A method for life course MCH Research. *Maternal and Child Health Journal, 18*(2), 478–487.
27. Sletner, L., Jenum, A. K., Mørkrid, K., Vangen, S., Holme, I. M., Birkeland, K. I., & Nakstad, B. (2014). Maternal life course socio-economic position and offspring body composition at birth in a multi-ethnic population. *Paediatric and Perinatal Epidemiology, 28*(5), 445–454.
28. Gisselmann, M. D. (2006). The influence of maternal childhood and adulthood social class on the health of the infant. *Social Science and Medicine, 63*(4), 1023–1033.
29. Collins, J. W., Rankin, K. M., & David, R. J. (2015). Downward economic mobility and preterm birth: An exploratory study of Chicago-born upper class white mothers. *Maternal and Child Health Journal, 19*(7), 1–7.
30. David, R., Rankin, K., Lee, K., Prachand, N., Love, C., & Collins, J, Jr. (2010). The Illinois transgenerational birth file: Life-course analysis of birth outcomes using vital records and census data over decades. *Maternal and Child Health Journal, 14*(1), 121–132.
31. Geronimus, A. T. (1991). The weathering hypothesis and the health of African-American women and infants: Evidence and speculations. *Ethnicity and Disease, 2*(3), 207–221.
32. Geronimus, A. T. (1996). Black/white differences in the relationship of maternal age to birthweight: A population-based test of the weathering hypothesis. *Social Science and Medicine, 42*(4), 589–597.
33. Holzman, C., Bullen, B., Fisher, R., Paneth, N., & Reuss, L. (2001). Pregnancy outcomes and community health: The POUCH study of preterm birth. *Paediatric and Perinatal Epidemiology, 15*(s2), 136–158.
34. Gavin, A. R., Holzman, C., Siefert, K., & Tian, Y. (2009). Maternal depressive symptoms, depression, and psychiatric medication use in relation to risk of preterm delivery. *Women's Health Issues, 19*(5), 325–334.
35. Tauiliili, D.S. (2008) *Adult and pre-adult socioeconomic indices and pre-pregnancy overweight and obesity*. Michigan State University, United States-Michgan: Dissertations & Theses @ CIC Institutions; ProQuest.
36. Alexander, G. R., Himes, J. H., Kaufman, R. B., Mor, J., & Kogan, M. (1996). A United States national reference for fetal growth. *Obstetrics and Gynecology, 87*(2), 163–168.
37. McEwen, B. S. (1998). Stress, adaptation, and disease: Allostasis and allostatic load. *Annals of the New York Academy of Sciences, 840*(1), 33–44.
38. McEwen, B. S. (2000). Allostasis and allostatic load: Implications for neuropsychopharmacology. *Neuropsychopharmacology, 22*(2), 108–124.
39. Chen, J. T., Beckfield, J., Waterman, P. D., & Krieger, N. (2013). Can changes in the distributions of and associations between education and income bias temporal comparisons of health disparities? An exploration with causal graphs and simulations. *American Journal of Epidemiology, 177*(9), 870–881.
40. Chen, J. T., Beckfield, J., Waterman, P. D., & Krieger, N. (2013). Chen et al. Respond to "Bias in socioeconomic health disparities—Comments". *American Journal of Epidemiology, 177*(9), 885–886.
41. Talih, M. (2013). Invited commentary: Can changes in the distributions of and associations between education and income bias estimates of temporal trends in health disparities? *American Journal of Epidemiology, 177*(9), 882–884.
42. Hutcheon, J. A., & Platt, R. W. (2008). The missing data problem in birth weight percentiles and thresholds for "small-for-gestational-age". *American Journal of Epidemiology, 167*(7), 786–792.
43. Paneth, N. (2008). Invited commentary: The hidden population in perinatal epidemiology. *American Journal of Epidemiology, 167*(7), 793–796.
44. Straughen, J. K., Caldwell, C. H., Osypuk, T. L., Helmkamp, L., & Misra, D. P. (2013). Direct and proxy recall of childhood socio-economic position and health. *Paediatric and Perinatal Epidemiology, 27*(3), 294–302.
45. Coreil, J., Bryant, C. A., Henderson, J. N., Forthofer, M. S., & Quinn, G. P. (2001). *Social and behavioral foundations of public health*. Thousand Oaks, CA: Sage Publications.
46. Blane, D., Smith, G. D., & Bartley, M. (1993). Social selection: What does it contribute to social class differences in health? *Sociology of Health & Illness, 15*(1), 1–15.