Analysing Gaps in Child Health in the U.K.: a "Weathering" Hypothesis Perspective

Alice Goisis (LSE) and Wendy Sigle-Rushton (LSE)[1]

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[1] A.Goisis@lse.ac.uk (corresponding author); W.Sigle-Rushton@lse.ac.uk

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Introduction

Over the past four decades, as the mean age at first birth in the United States and Europe has been increasingly delayed (Taylor, Cohn, Livingston, Wang, & Dockterman, 2010), at least by more advantaged women, a body of evidence showing an association between teenage childbearing and poor outcomes both for mothers and their children began to emerge. Seen as more than a symptom of disadvantage and poverty, evidence showing an association between teenage childbearing and poor outcomes was often interpreted as causal, and early childbearing, teenage motherhood in particular, was increasingly framed as a social problem (Nathanson, 1991). The argument that early childbearing causes/is associated with poor child outcomes reflects the commonly made assumption that maternal age variables reflect a universal biologic and psychosocial developmental process (Geronimus & Thompson, 2004).

Other biosocial explanations, such as the "weathering" hypothesis (Geronimus, 1992, 1996a) challenge the idea that maternal age reflects a universal "developmental" process by arguing that the context (to which one is exposed to) might change the meaning of chronological age. According to this framework, developed and applied to the U.S. context, maternal age could also be conceptualized as a marker of exposure to disadvantage. Namely, the "weathering" hypothesis predicts that the health of (disadvantaged) African American mothers deteriorates faster than that of White and advantaged women. Poorer health trajectories for African American women imply that their children's health outcomes worsen with increasing maternal age (Geronimus & Thompson, 2004). A range of empirical evidence is consistent with these predictions. For example, Black/White gaps in low birth weight are found to widen with increasing maternal age (Geronimus, 1996).

The extant (demographic) literature discussing the consequences of childbearing postponement for child wellbeing has largely relied on a "developmental" conceptualization of maternal age, treating it as an indicator of psychosocial maturity and parenting quality. To the extent that older mothers are socially advantaged and better prepared to take on the responsibilities of parenthood, childbearing postponement is expected to accrue benefits to children (Martin, 2004b). This perspective is (implicitly) incorporated in the argument that families and their children, in post-modern times, follow "diverging destinies", a term first introduced by McLanahan (2004). Mothers of one group of children follow a trajectory characterized by gains in resources derived from childbearing postponement and rises in maternal employment (in professional occupations); conversely, teenage childbearing interrupts education and employment investments and increases the risk of parental dissolution, both of which reduce the level and stability of parental resources (McLanahan, 2004).

This suggests that our knowledge of the consequences of childbearing postponement depends to a large extent on the assumption that it reflects a universal process for all women. In order to reach a more comprehensive understanding, these arguments need to be revisited by adopting a framework of analysis in line with that of the "weathering" hypothesis. We contribute to this line of research by investigating whether in the U.K. maternal age is differently associated with child health across subpopulation groups. In particular, we look at whether gaps in child health vary, with increasing maternal age, to a different extent for White and Black mothers and for mothers living in relatively disadvantaged and advantaged settings.

Background

The "weathering" hypothesis is a framework developed and applied to the U.S. context linking exposure to disadvantage to health deterioration for ethnic minority groups. Conversely, in the U.K. an early timing of childbearing has been discussed according to a social class perspective by sociobiological/evolutionary arguments. Although the arguments expressed by the sociobiological literature are much less explicit than those by the "weathering" hypothesis, the views expressed in the U.S. and U.K. contexts can be seen as part of a general framework which links an early timing of childbearing to exposure to disadvantage. However, as the review of these literature which follows makes clear, although overlapping in many respects, the arguments posited by these two streams of research are comparable to a certain extent.

The "weathering" hypothesis in the U.S. context

The "weathering" hypothesis predicts that social inequality leads to differential health trajectories and that ethnic minority and disadvantaged populations experience "weathering", namely a more rapid deterioration of their health compared to Whites and advantaged individuals. The plausible explanations of health deterioration are multiple. Exposure to poverty is likely to reduce access to high quality health care, which in the U.S. is not universal. Patterns of residential segregation might also be linked to relatively poor environmental conditions such as living in noisy areas and less access to healthy food (Thoits, 2010). Poorer health and differential health trajectories may also be driven by differences in the level of "allostatic load" (Geronimus, Hicken, Keene, & Bound, 2006). The allostatic load refers to the price the body pays for being forced to adapt to adverse psychosocial or physical situations and it represents either the presence of too much stress or the inefficient operation of the stress hormone response system. McEwen (1998, 2000), used the concept of allostatic load to describe the long term effect of repeated physiological response to stress, the biological process which links poverty to health deterioration.

In addition, behavioural responses to stress may reinforce the negative effects of a high allostatic load. For example, individuals who are more likely to live in disadvantaged areas characterized by high levels of criminality and those who experience relatively high levels of stress may smoke or drink as a coping mechanism (Geronimus, Neidert, & Bound, 1993). African American women are disproportionately likely to be exposed to these sorts of disadvantages and since the effects of these insults to their health are costly and cumulative, they may be more likely and quicker to develop chronic conditions (such as diabetes and hypertension) which result in increased health risks. Because poorer health conditions decrease reproductive health as women age, the "weathering" hypothesis suggests that Black/White gaps in child health widen with increasing maternal age at birth and that early motherhood might ensuring that at least some childbearing takes place before the mother's health deteriorates.[3]

A conclusive test of the "weathering" hypothesis is, of course, impossible in an observational study. Even with detailed longitudinal information on women and mothers' exposure to poverty and their health trajectories, it is impossible to determine what women's health outcomes would have looked like had they postponed their (first) births. Nonetheless, a range of empirical evidence is consistent with the key tenets and predictions of the "weathering" hypothesis. Previous research in the U.S. shows that compared to White women, the health of African American women deteriorates more rapidly as they age and they are reported to have higher levels of allostatic loads than White women at any age, and

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[3] The "weathering" hypothesis literature has been largely preoccupied with comparing African Americans to Whites. A few papers have also looked at "weathering" amongst other ethnic groups (mainly Mexicans) and the findings reveal mixed evidence (Khoshnood, Wall, & Lee, 2005; Meadows, Beckett, Elliott, & Petersen, 2009; Wildsmith, 2002).

in particular from age 35 onwards (Chyu & Upchurch, 2011; Geronimus, et al., 2006). This includes an elevated risk of health conditions such as hypertension that can complicate pregnancy and that are likely to negatively affect foetal development (Geronimus, 1996a; Rich-Edwards, Buka, Brennan, & Earls, 2003). Ethnic gaps in neonatal mortality, pre-term birth and low birth weight (LBW) have also been shown to increase with maternal age (Geronimus, 1986, 1996a; Holzman et al., 2009; Rauh, Andrews, & Garfinkel, 2001; Reichman & Pagnini, 1997; Rich-Edwards, et al., 2003; Shmueli & Cullen, 1999). Moreover, African American women residing in low income areas (as opposed to more advantaged areas) are found to experience, with increasing maternal age, a more rapid deterioration of their health and worse child outcomes (Geronimus, 1996a; Love, David, Rankin, & Collins, 2010).

Based on the available (indirect) evidence in line with the "weathering" hypothesis, Geronimus (1992) has argued that teenage pregnancy for disadvantaged African American women might actually represent an "adaptive" reproductive strategy to early health deterioration. This argument, however, has been criticized by Furstenberg (1992), who argues that early childbearing is not predetermined by an adaptive rationale to maximize reproductive health. Furstenberg argues that relatively few of those who become parents during their teens think that having children at that age is desirable. Existing evidence related to these conflicting arguments is inconclusive. On one side, recent work by Meadows et al. (2009) looking at whether daughters' fertility decisions incorporate information on the health status of their mothers finds that adolescent girls with mothers who have a worse self-rated health are more likely to have an early non-marital birth. This effect is, however, *contrary* to what the "weathering" hypothesis would predict, stronger amongst non-Hispanic Whites and adolescents of other race/ethnic status than amongst African Americans. On the other, qualitative work undertaken by Geronimus (1996b) reveals that African Americans teen mothers (to be) express concerns about older parenthood with arguments related to physical limitations and early morbidity/mortality. This aspect of the "weathering" hypothesis needs further investigation before it can be argued that early childbearing is a rational process for (disadvantaged) Black women.

The argument that forms the crux of the "weathering" hypothesis is that in the U.S. the health of minority ethnic (Blacks in particular) women deteriorates faster than the health of White women because of increased exposure to social inequality and poverty. Existing U.S. evidence reveals that African American mothers exposed, as children and/or adults, to poorer environments experience a more rapid increase in rates of LBW with increasing maternal age at birth. The same pattern does not hold for White women who grew up and live as adult in low income neighbourhoods (Love, et al., 2010). This finding might suggest that ethnic minority status has a modifying effect in the association between exposure to social inequality and health deterioration. This could occur because discrimination reduces access to employment opportunities, recognition of human capital investments (Smith, Chaturvedi, Harding, Nazroo, & Williams, 2000; D. Williams & Mohammed, 2009) and leads to health deterioration (Johnston & Lordan, 2012); race bias may affect medical care and prevention and societal stigma can have long-lasting consequences for health (D. R. Williams, 1999). Empirical evidence reveals that racial differences in adult health outcomes often persist even at "equivalent" levels of socioeconomic status (SES), suggesting that racism may be an added burden for minority populations (D. R. Williams, 1999). Similarly, self-reported experiences of discrimination (3 times or more over a 7 years follow-up period) are found to be associated with the risk of preterm delivery and LBW even after adjustments for socioeconomic factors (Mustillo et al., 2004).[4] For these reasons, controlling for standard

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[4] Sample was not representative of the general population and the mean age of the mothers was 34 years.

socioeconomic indicators (measured at the individual level) might be problematic when comparing (health) outcomes for ethnic groups as SES measures are not equivalent across racial groups: for example, for a given level of education, there are racial differences in income returns (Pearson, 2008). These findings contribute to question the argument that "weathering" is solely the outcome of socioeconomic disadvantage disproportionately experienced by African American mothers. The evidence suggests that relationships between individual characteristics and health are likely to be complex and interacting rather than additive and separable.

Sociobiological theories in the U.K. context

Sociobiological and evolutionary arguments have been used to explain high rates of teenage childbearing among (white) working class women in the U.K. Researchers have suggested that people living in poorer parts of the U.K. follow a "fast" life history given that they face increased risk of premature mortality and morbidity (Johns, Dickins, & Clegg, 2011; Nettle, 2010; Nettle, Coall, & Dickins, 2010). A "fast" life history strategy is seen as a comprehensible response to the ecological context of poverty and this body of research argues that humans (often) adjust their life histories to contextual conditions in a manner that will enhance reproductive outcomes (Belsky, Steinberg, & Draper, 1991; Nettle, 2009; Wilson & Daly, 1997). Early childbearing is thus thought to reflect a coherent strategic response to the deprived context in which people live characterized by fewer guarantees of experiencing a successful future (Johns, 2011). Namely, the lower a female's life expectancy at birth, the earlier her reproduction should begin (Low, Hazel, Parker, & Welch, 2008). However, differently from the "weathering" hypothesis literature, reproductive outcomes in these studies are often more explicitly conceptualised in evolutionary terms. Early childbearing is predominantly interpreted as a strategy that maximizes lineage persistence as, *ceteris paribus*, the more members a lineage has, the safer it is from extinction (Liu & Lummaa, 2011). For example, it has looked at the number of grandchildren an individual has. This measurement of reproductive outcomes is relevant for historical and pre-demographic transition populations with high early mortality (even at younger ages). It is, however, hard to generalize to current situations in developed countries where there is a really high chance to survive to reproductive ages. Age gradients in child health across deprived (and advantaged) contexts and whether an early timing of childbearing maximises reproductive outcomes from a child wellbeing perspective are not well explored in this literature.[5] This body of research has thus far not examined the same outcomes as we find in the U.S. literature (e.g. child health, such as low birth weight). It has rather adopted an "adult" perspective, whereby disadvantage is linked to an early timing of childbearing where individuals' reproductive and parenting opportunities would be limited by an early occurring death or disability (Johns, 2011).

The present study

The "weathering" hypothesis literature has focused on ethnicity in the U.S. context and it has provided both an "adult" and "child" perspective (i.e. by looking at how ethnic gaps in child health vary as maternal age at birth increases). Studies adopting a sociobiological perspective have, instead, analysed early childbearing schedules in the U.K. context trough a

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[5] Nettle argues that an early reproductive strategy (which is adaptive to the environmental context in which poor individuals live) entails specific costs for children as cognitive performance for deprived children is on average lower than for advantaged children. Nettle doesn't, however, provide any evidence regarding how outcomes for deprived and advantaged children respectively look like at different parental ages at child birth.

social class lens and they have predominantly adopted an "adult" perspective. The fact that ethnicity hasn't been included into the framework adopted by sociobiological discourses is an oversight since the U.K. is characterized by high levels of racial segregation and disadvantage (Hills et al., 2010). [6] There is (epidemiological) research documenting ethnic differentials in child health in the U.K., but these gaps have not been analysed according to a "weathering" hypothesis lens, namely by looking at age trajectories. Different studies report ethnic/racial gaps in child birth weight and prevalence of LBW, but they have failed to fully establish socioeconomic and behavioural explanations for ethnic differences in child birth weight (Teitler, Reichman, Nepomnyaschy, & Martinson, 2007). For example, Kelly et al. (2009) reveal that differences in birth weight across ethnic groups remain after adjustments for different socioeconomic and behavioural indicators have been made. Moreover, notwithstanding universal access to health care and minimum guaranteed income in the U.K. (Muennig & Murphy, 2011), which should be protective of child health, racial and ethnic disparities in child health exist (Teitler, et al., 2007). Finally, Nazroo (2003) shows that in the U.K. ethnic inequalities in adult health are found to widen with age, especially from the mid-30s onwards, suggesting that the "weathering" hypothesis could be an appropriate framework to adopt in this context.

This paper aims at revealing *whether* the association between maternal age and child wellbeing varies across subgroups of the population in the UK. By building on existing research, this is done by introducing a new perspective to the U.K. context (i.e. "weathering" hypothesis) and by extending an existing one (i.e. sociobiological) which is, as far as child health is concerned, limited in scope. In particular, the research question which this paper aims to address is whether gaps in child health widen with maternal age according to patterns consistent with the "weathering" hypothesis and consistent with a "fast" life history strategy. In addition, this paper intends to *intersect* the "weathering" and "sociobiological" perspectives by revealing evidence which rejects or fails to reject the hypothesis (already brought forward by the existing literature) that ethnic minority status represents an added and modifying burden in the association between social inequality and reproductive outcomes. We expect the findings not only to provide evidence which may/may not suggest that we should think more carefully when discussing the process and outcome of childbearing postponement, but also to shed light on the complex dynamics between social inequality, ethnic minority status and (reproductive) health deterioration.

Method

Data

The analyses are based on the ONS Longitudinal Study (LS). The LS is a data set comprising anonymised census records for individuals living in England and Wales together with data for various events such as deaths, births, emigration and cancer registrations. Individuals qualify as members of the LS if their birth date falls into one of four days in each year, namely the LS 'birth dates', which are confidential. Therefore, the LS relates to a sample of around 1% of the population of England and Wales. Losses to the sample occur because of LS members' death and out-migration, while the sample is maintained through addition of immigrants and new births with LS (confidential) 'birth dates'. LS members' demographic characteristics are retrieved from the census data (for censuses collected from 1971 to 2001), while information about their vital events (e.g. births) is retrieved via vital

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[6] This is, at least partially, motivated by the recent arrivals of migrant populations in the U.K. (compared to the U.S.) and lack of suitable data which, until quite recently, has limited analyses (of health outcomes) by ethnicity.

registration systems. LS members are linked from one census to the other and to vital registration systems.[7]

Measures

Child health is measured using low birth weight (LBW), a binary indicator which takes the value 1 when the child's birth weight is below 2.5 kg. This indicator has been extensively used in the literature analysing ethnic gaps in child health, including the "weathering" hypothesis literature. The analyses focus on Black and White LS female members. This is done in order to increase comparability with the U.S. literature that has been largely preoccupied with analysing Black/White disparities. U.S. born Blacks have a similar lineage to the native-born Black Caribbean in the U.K. (Muennig & Murphy, 2011) and it would have been ideal to restrict our attention to Black Caribbean only or, alternatively, to consider women of Black African and Caribbean origin separately. However, because of sample size issues, women of Black African and Caribbean origin are grouped into a unique category. The prevalence of teenage births in the U.K. has been found to be almost identical between White and Black African women; the prevalence of teenage births is higher for Black Caribbean than for Whites, but differences are smaller (across the entire fertility schedule) than between White and South Asian Muslim (Pakistani or Bangladeshi) women (Robson & Berthoud, 2006). Indians, on the contrary, differ from Whites in that they have very few births at young ages. The similar distribution of first births for Blacks and Whites is a distinctive feature of the U.K. context and it differentiates it from the U.S. setting. In the U.S., African Americans and Whites have very different first births distributions as the former tend to concentrate their (first) births at earlier ages to a much larger extent than the latter (Geronimus, 1996a). Indeed, in the U.S. the interpretation of the causes and consequences of differentials in the timing of first births across ethnic groups was a key motivating factor underlying the development of the "weathering" hypothesis. This contrast between the U.K. and U.S. makes the former an interesting context where to assess the arguments posited by the "weathering" hypothesis and a more appropriate context where to discuss childbearing postponement and its consequences for child wellbeing. This is because in the U.K., compared to the U.S., selection issues related to different fertility schedules across ethnic groups should be reduced. Reducing selection may be desirable as it may interfere with the investigation of evidence which rejects/fails to reject the "weathering" hypothesis. If the distribution of births were skewed towards childbearing ages where maternal (reproductive) health is most favourable this could result in a lower incidence of negative birth outcomes at older ages and a less pronounced or no indication of patterns consistent with the "weathering" hypothesis.

In order to analyse age gradients in child health according to residential area characteristics, we classify individuals as living in relatively disadvantaged/advantaged areas. This is done by using the Carstair Index based on individuals' place of residence in the (1991/2001) census. The Carstair Index is an unweighted combination of four census variables: unemployment, overcrowding, car ownership and low social class (Morgan & Baker, 2006). The scores are computed for ward boundaries as used in the census (average ward population size is 5000 individuals). Wards are grouped into quintiles by ranking areas from least deprived to most deprived. Throughout the analyses, we categorize individuals as relatively disadvantaged if living in the 20% poorest wards of England and Wales and as relatively advantaged if living in the 20% richest wards of England and Wales.[8]

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[7] More information on the ONS Longitudinal Study can be found at http://celsius.lshtm.ac.uk/ and by consulting Hattersley and Creeser (1995).

[8] The most deprived quintile has a mean score of +6.70, while the least deprived quintile has a mean score of -3.30 (Morgan & Baker, 2006).

The analyses focus on first births and exclude higher order births. As population sub-groups have different timing and spacing of childbearing, looking at age gradients in child health on all parity births would produce results potentially confounded by aspects other than reproductive health deterioration related to exposure to poverty and social inequality. Moreover, research reveals that the association between birth order and birth weight is not uniform across racial group (Swamy, Edwards, Gelfand, James, & Miranda, 2010). Swamy et al. (2010) show that although the mean birth weight increases with parity for all race groups, the increase is not as steep for African Americans as it is for other racial groups. Because of the nature of the LS, there is a degree of uncertainty regarding the identification of first time mothers. An LS female member "first" birth in the LS doesn't necessarily correspond with her first biological birth. For the group of women who are part of the LS since birth and never left the country, it is very unlikely that any of their birth hasn't been recorded in the vital registration system and consequently in the LS. However, for those who weren't born in England/Wales and for those who emigrated and then returned, there is a degree of uncertainty. If their first birth registered in the LS is "legitimate" (i.e. within marriage), the birth registration form includes information of whether they had any previous birth (live or still). If, conversely, their first birth registered in the LS occurs outside of marriage, this information is not available (Hattersley & Creeser, 1995). Excluding LS members who are having their first LS birth outside of marriage would not represent a sensible strategy. We would disproportionately drop mothers conceiving at early ages (as they are more likely to conceive outside of marriage), which, given our research question, would compromise our analyses. We therefore restrict our attention to England and Wales born women and to those who were born abroad but are registered in the LS by age 15, identified as a threshold age for the beginning of a woman's reproductive history.[9] Although far from perfect, this strategy considerably reduces the probability of including into our analyses mothers conceiving births other than first order.

Analytical Plan

The research questions are addressed by showing the prevalence of LBW by maternal age for Black and White mothers and for mothers living in relatively disadvantaged/advantaged areas through logistic models. Graphs showing predicted probabilities (of LBW) allow us to assess whether and to what extent we observe a widening of the gap in child health across population subgroups. Finally, in order to investigate how ethnicity *intersects* with disadvantage, we compare age gradients in LBW for Black and White mothers who are recorded as living in the relatively most disadvantaged areas (i.e. 20% of the poorest wards based on the Carstair index) of England and Wales. A comparison of relatively advantaged Black and White mothers is prevented by sample size issues.

One of the clear advantages of the LS is that it provides many years of data such that we can obtain a large enough sample to carry out analyses stratified by ethnicity and residential area characteristics. The decision on which years of data to focus our attention on is dictated both by sample size issues and consistency of our strategy. The analyses introducing the "weathering" perspective in the U.K. context are based on first births occurring to Black (n=708) and White (n=45148) mothers from 1989 to 2009, the last available year when this research was conducted. The analyses which are meant to expand the sociobiological perspective are restricted to births occurring between 1999 and 2004. Mothers are categorized as living in relatively disadvantaged (n=3415) and advantaged areas (n=1520) through the Carstair Index, using information on their area of residence in the 2001 census. In order to have a perfect match between the context to which a mother is exposed to while she is pregnant/gives birth and her child health, we should restrict our attention to births

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[9] Registration into the LS occurs via registration to NHS.

occurring around 2001. Due to sample size issues we have however to expand the temporal window a few years before and after 2001 (i.e. 1999-2004). Finally, in order to carry out the analyses intersecting ethnicity with disadvantage, we select first births occurring between 1999 and 2004 to Black and White disadvantaged mothers. As the number of disadvantaged births to disadvantaged Black mothers is small, we add to the analyses first births occurring to disadvantaged Black and White mothers between 1989 and 1994. Amongst these births, we select mothers living in the 20% most disadvantaged wards of England and Wales by constructing the Carstair Index based on their place of residence in the 1991 census. The result is a subsample of births for relatively disadvantaged White (n=7334) and Black (n=260) mothers.

In the regression models, maternal age is measured continuously and logistic models include linear, quadratic and cubic terms for age. The choice to adopt this functional form of age is taken on the basis of both substantive and model fit justifications. Substantively, we believe that a cubic specification is more appropriate as it is more flexible in describing the shape of the age gradients and consistent with what we know about physical development and reproductive risk from biology. The "weathering" hypothesis shows that the risk of poor child health, for African American mothers, is reduced at young maternal ages, but the medical literature argues that births at extremely young (teenage) ages are conducive of higher pregnancy risks (Amini, Catalano, Dierker, & Mann, 1996). A cubic term allows the age gradient to fall and rise and to be more consistent from a biological perspective. Model fit tests support this choice as they show that adding a cubic term for age significantly improves the model fit when estimating the models. Our results are robust to different functional forms of age (e.g. quadratic and discrete age categories) and results are available upon request. Models are estimated separately for Black/White mothers and for those living in relatively advantaged/disadvantaged mothers. The models include an additional control for migration status (reference England and Wales born) in order to account for the fact that mothers have had different length of exposures to the U.K. environmental and social context. One would expect "weathering" to be more marked among E&W born Blacks because of lifelong exposure to social inequality. The models also include controls for basic child characteristics, namely gender and whether the child is a twin. The model introducing the "weathering" hypothesis includes five years' time dummies (2005-2009 is the reference category). The model intersecting ethnicity and disadvantage includes a control for births occurring between 1989-1994 (births occurring between 1999-2004 is the reference category).

Results

Introducing the "weathering" perspective

We assess whether in the U.K. patterns consistent with the tenets of the "weathering" hypothesis are observed by analysing age gradients in LBW for Black and White mothers conceiving their first birth between 1989 and 2009. Table 1 reports the prevalence of LBW and the distribution of first births across maternal age categories for Black (which groups together Black African and Caribbean) and White mothers. The distribution of first births for the two ethnic groups is similar, a pattern consistent with the findings of Robson and Berthoud (2006) using the U.K. Labour Force Survey (1992-2000 inclusive). Maternal age is divided into 3 categories based on the overall distribution of first births in E&W between 1999 and 2009. The mean age at first birth in E&W has risen from 26.4 in 1999 to 27.6 in 2009 (ONS, 2010). Therefore, age 30 has been chosen as the lower cut-off for the 'older' age category as it is well above the mean age at first birth. Conversely, age 23 is chosen as the upper cut off for births occurring at 'younger' ages, as it is well below the mean age at childbearing over the considered period of time. The middle age group refers to births

occurring between ages 23 to 29. The mean LBW is considerably higher for Blacks (10%) than for Whites (7%), a pattern similar to what is found in the U.S. and that is consistent with existing evidence on the U.K. context (Teitler, et al., 2007). The prevalence of LBW for Black mothers shows a marked age gradient, whereby the increase between the young/middle and older age group is almost two-fold. The pattern for Whites is instead fairly flat and shows a minor decrease and then increase with rising maternal age. Results not shown here reveal that, although the mean prevalence of LBW is higher for Black Caribbean than for Black Africans, for both groups the prevalence of LBW markedly increases with maternal age. These patterns support the decision to group Black Caribbean and Black African together in our analyses.

Table 1 Distribution of first births and prevalence of LBW by maternal age (first births 1989-2009)

Maternal age	White		Black	
	% Birth	% LBW	% Birth	% LBW
18-22	28.8	7.4	27.5	7.7
23-29	40.7	6.6	39.1	6.5
30+	30.6	7.5	33.3	15.7
Mean LBW	7.1		9.9	
Migrant	4.2		30.2	
Total N	45148		708	
Pearson Chi2	Chi(2)=13.33 Pr. = 0.001		Chi(2)=13.5 Pr. = 0.001	

Table 2 reports the results of logistic models, which compare Black/White age gradients in LBW, while controlling for year dummies, basic child characteristics and migration status. Table 2 shows that the age terms are statistically significant (at the 5% level) for the model estimated for Blacks but not for Whites. For both ethnic groups, twin births are significantly more likely to be LBW; for Whites only, girls are significantly more likely to be born LBW. Consistent with the "weathering" hypothesis, E&W born Black mothers are more likely (significant at the 1% level) to have a LBW child than their counterparts who migrated to E&W prior to age 15 (recall we dropped other migrants from the sample), while migration status is not associated with LBW for White mothers. This could be explained by the fact that White migrants are more likely to come from other European or OECD countries and are more similar (in health status) to E&W born Whites. In order to ease interpretation of the age terms, Figure 1 shows the predicted probabilities of LBW based on the regression coefficients. In line with the descriptive results, Figure 1 shows that the risk of having a LBW child markedly increases with age for Blacks but not for Whites. The Black/White gap in LBW slightly decreases between ages 18 and 20, is around 0 between ages 20-22 and gradually increases from age 23. Both relative to Blacks and in absolute terms, the age gradient for Whites is fairly flat showing slightly higher predicted probabilities at extreme ages. The flatness of the age profile for Whites might suggest that the, average, higher social status of older White mothers (Rendall, Ekert-Jaffé, Joshi, Lynch, & Mougin, 2009) compensates for the health complications of later childbearing, an argument consistent with a developmental perspective.

We have also estimated an alternative model which includes both White and Black mothers. In this regression, the binary indicator for "Black" is interacted with the linear, quadratic and cubic age terms. A Wald test is then performed in order to determine whether the binary indicator for "Black" and its interaction with the age coefficients are jointly

significant. The results, not reported here but available upon request, reveal that the age gradient of Black mothers is significantly different from that of White mothers. [10]

Consistent with predictions set out by the "weathering" hypothesis literature, the Black/White gap in LBW widens with maternal age, in particular from the mid-20s onwards. The predicted probability of conceiving a LBW child for Black mothers is, however, not monotonically increasing with age.

Table 2 Odds ratio of LBW for Black and White mothers (first births 1989-2009)

	White	Black
	Exp(β)	Exp(β)
Mother age	0.794*	0.182**
	(0.103)	(0.133)
Mother age^2	1.005	1.059**
	(0.005)	(0.028)
Mother age^3	1.000	0.999**
	(0.000)	(0.000)
Girl	1.152***	1.433
	(0.044)	(0.387)
Twin	22.509***	21.603***
	(1.886)	(13.594)
Migrant	0.891	0.403***
	(0.088)	(0.140)
1989-1994	1.228***	1.506
	(0.067)	(0.600)
1995-1999	1.179***	0.809
	(0.068)	(0.359)
2000-2004	1.250***	0.975
	(0.073)	(0.418)
N	45,148	708

note: *** p<0.01, ** p<0.05, * p<0.1; standard errors provided in parenthesis

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[10] Chi2(4)=11.5 Prob>chi2= 0.0211

Figure 1 Predicted Probabilities of LBW for White and Black mothers (first births 1989-2009)
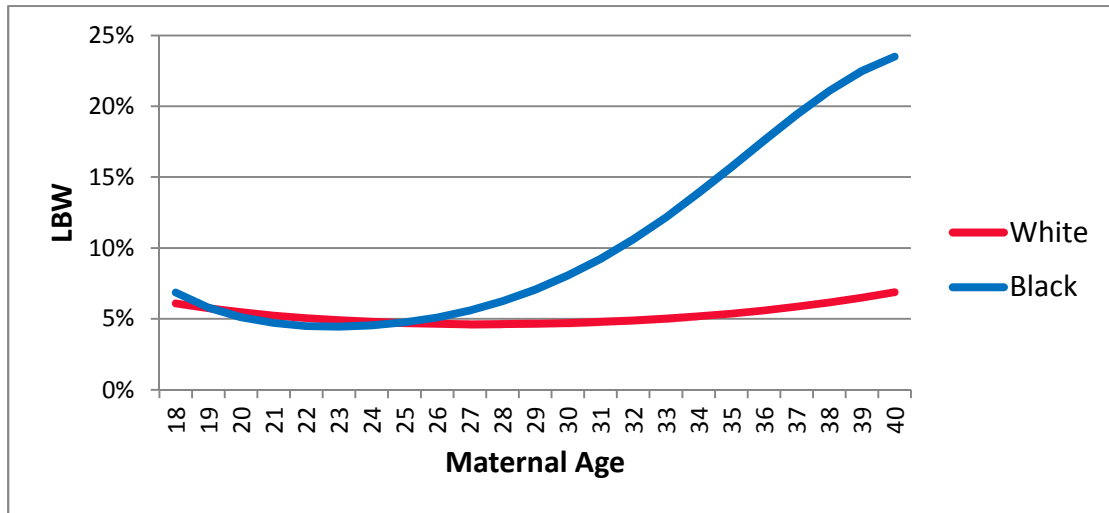
Extending the sociobiological perspective

The arguments posited by the sociobiological literature are tested by analysing age gradients in LBW for (Black and White) mothers living in relatively disadvantaged and advantaged areas conceiving their first birth between 1999 and 2004. Classification of mothers as living into relatively disadvantaged vs. advantaged residential areas is done on the basis of the Carstair Index based on the 2001 census (details are provided in the "Methods" section).

Table 3 shows the distribution of first births and prevalence of LBW for mothers living in relatively advantaged and disadvantaged areas by maternal age categories. Contrary to what we observe in Table 1, there is a quite marked difference in fertility schedules amongst mothers living in relatively disadvantaged/advantaged areas. Namely, the distribution of first births for mothers living in relatively advantaged areas is highly skewed towards older ages, while the distribution of first births for disadvantaged wards is skewed towards younger ages. .While differences in the timing of childbearing between Whites and Blacks represent (one of) the key driving factor behind the development of the "weathering" hypothesis, these results help to understand why the sociobiological literature has instead focused on social class when attempting to explain early childbearing in the UK. Similarly to what the "weathering" hypothesis literature has documented in the U.S. context for African American mothers, disadvantaged mothers in the U.K. tend to concentrate their first births at younger ages. As discussed earlier, the sociobiological literature has primarily adopted an "adult" perspective and the aim of what follows is to extend this perspective to child health outcomes. The average proportion of LBW births is higher for individuals living in relatively disadvantaged areas than in relatively advantaged ones. The age gradients are not as clear-cut as they are for the Black/White comparison, however. Namely, the proportion of LBW births is characterized by a negative and then positive age gradient for mothers living in relatively disadvantaged areas. Conversely, for individuals residing in relatively advantaged areas we observe only a negatively sloped age gradient. The descriptive results reveal that, with increasing maternal age, there is a modest widening of the gap between relatively disadvantaged and advantaged areas.

Table 3 Prevalence of LBW and distribution of first births for mothers living in relatively disadvantaged as opposed to advantaged areas by maternal age (first births Black and White mothers 1999-2004)

Maternal age	Disadvantaged		Advantaged	
	% Birth	% LBW	% Birth	% LBW
18-22	40.76	8.55	12.37	8.51
23-29	33.09	7.26	33.88	6.6
30+	26.15	8.73	53.75	6.98
Mean LBW	8.2		7.0	
Migrant	4.5		5.4	
Total N	3415		1520	
Pearson chi2	Chi(2)=0.78 Pr. = 0.678		Chi(2)=1.9 Pr.=0.386	

Table 4 presents the results of logistic models and Figure 2 shows predicted probabilities of conceiving a LBW child obtained through the regression coefficients. The age terms for neither advantaged nor disadvantaged mothers are statistically significant. The graph showing the predicted probabilities reveals a widening of the gap in LBW for (Black and White) mothers residing in relatively disadvantaged and advantaged areas towards older ages (around age 31). This occurs because the trend is increasing for disadvantaged mothers and decreasing for advantaged ones. However, the increasing age gradient for

relatively disadvantaged women is clearly less marked than the one observed for Black mothers in Figure 1. This could be, at least in part, due to the fact that there is a concentration of disadvantaged births at younger ages where maternal health is higher resulting in only a minor widening of the gap with increasing age. The results of a Wald test on the joint significance of the coefficients nevertheless reveal that the age gradient for mothers living in relatively disadvantaged is significantly different to that of mothers living in relatively advantaged areas.[11]

By comparing Figures 1 and 2, we can argue that the widening of the Black/White gap in LBW with increasing maternal age is clearly more marked than the widening of the gap in LBW for mothers living in disadvantaged as opposed to advantaged areas. From a child health perspective, these results provide limited support for the idea of a "fast" life history strategy whereby individuals living in relatively disadvantaged areas conceive at early ages in order to maximize reproductive outcomes. Conversely, for mothers living in relatively advantaged areas the predicted probability of conceiving a LBW child decreases with maternal age, suggesting that their higher (than average) socioeconomic status more than compensates for the risks involved with conceiving at an older age.

Table 4 Odds ratio of LBW for mothers living in relatively disadvantaged and advantaged areas (first births Black and White mothers 1999-2004)

	Disadvantaged	Advantaged
	Exp(β)	Exp(β)
Mother age	0.318	1.042
	(0.285)	(0.410)
Mother age^2	1.043	0.994
	(0.034)	(0.014)
Mother age^3	0.999	1.000
	(0.000)	(0.000)
Girl	1.081	1.072
	(0.235)	(0.138)
Twin	36.963***	21.100***
	(13.512)	(6.703)
Migrant	0.733	1.096
	(0.402)	(0.326)
Number of observations	1,520	3,415

note: *** p<0.01, ** p<0.05, * p<0.1

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[11] Chi2(4)= 11.5 Prob>chi2=0.021. Similarly to what we do in the previous section, we estimate a regression model which includes both advantaged and disadvantaged mothers and we test the joint significance of the coefficients for the references group i.e. relatively advantaged mothers.

Figure 2 Predicted probabilities of LBW for mothers residing in relatively disadvantaged and advantaged areas (first births Black and White mothers 1999-2004)
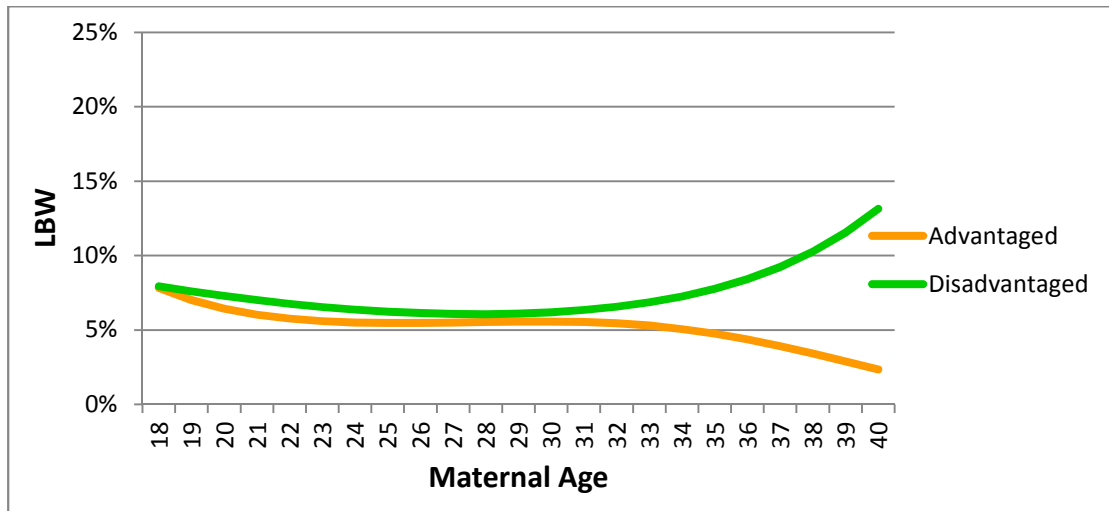
Interacting "weathering" & "sociobiological" perspectives

The last set of analyses in order to examine whether and in what ways ethnic minority status and socioeconomic disadvantage interact in the production of health (inequalities), we estimate Black/White gaps in LBW for a sub-sample of mothers who live in the 20% poorest wards of England and Wales. This set of analyses focus on first births that occur around the 1991 and 2001 census years, namely between 1989-1994 and 1999-2004 (further information in the "Methods" section).

Table 5 presents data on the distribution of first births and prevalence of LBW by maternal age categories for Black and White mothers living in relatively disadvantaged areas.[12] Compared to the results in Table 1, the distribution of first births for relatively disadvantaged Blacks looks fairly similar to the overall pattern, while that of relatively disadvantaged Whites looks more skewed towards younger ages, similarly to the overall distribution of first births for disadvantaged mothers presented in Table 3. The concentration of first births at earlier ages for disadvantaged White as opposed to Black mothers provides an even stronger explanation for sociobiological literature's focus on *white* working class women. Surprisingly, the mean prevalence of LBW is lower for this subset of Black mothers than for the overall mean presented in Table 1 (mean LBW 9.9%). However, we should highlight that, by focussing on this subset of disadvantaged Blacks, the sample is considerably smaller and we should therefore treat these results cautiously, especially when comparing them to Table 1.[13] Conversely, the prevalence of LBW for disadvantaged Whites is higher than the one presented in Table 1 and increasing with maternal age.

Table 5 Prevalence of LBW and distribution of first births by maternal age (first births Black and White mothers 1989-1994 and 1999-2004)

Maternal age	White		Black	
	% Birth	% LBW	% Birth	% LBW
18-22	40.91	7.9	30.77	6.1
23-29	38.68		38.46	
30+	20.41	8.22	30.77	16.25
Mean LBW	7.9		9.2	
Migrant	4.1		29.6	
Total N	7334		260	
Pearson chi2	Chi(2)=2.23 Pr. = 0.328		Chi(2)=7.01 Pr. = 0.030	

Table 6 shows the odds ratio of LBW for Black and White mothers who were enumerated as living in relatively disadvantaged areas in 1991 or 2001. Similarly to Table 2, the age terms are statistically significant for Black (at the 5% level) but not for White mothers. Figure 3 shows the predicted probabilities of LBW obtained through regression coefficients. The probabilities are predicted up until age 35 as among disadvantaged Black mothers there is virtually no birth occurring after this age. The age gradient for Whites is still fairly flat, but with higher predicted probabilities than in Figure 1. The flatness of the age gradient for Whites could be, in part, the result of the fact that the distribution of first births for disadvantaged Whites, compared to that of disadvantaged Black mothers, is skewed towards young childbearing ages where maternal (reproductive) health might be higher.

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[12] Because of disclosure control on cell size, the first two age categories have to be grouped together.

[13] In order to work with a larger sample of disadvantaged Black mothers, we could have sub-selected disadvantaged mothers by the pool of first births occurring between 1989 and 2009 (i.e. not only those occurring between 1989-1994 and 1999-2004). However, this would have implied less precision concerning the context to which a mother is exposed to while she is pregnant/gives births and her child health, which we hold in only two time points (i.e. 1991 and 2001). We have ultimately decided to work with a smaller sample but more consistent with the hypothesis we are trying to test.

Table 5 shows, however, that the same proportion of births for disadvantaged Black and White mothers occurs between ages 23-29 and while the gradients increases for the formers it doesn't for the latter. The shape of the age gradient for Blacks in Figure 3 is similar to the one presented in Figure 1, but the predicted probabilities of conceiving a LBW child are lower (at any age). While the predicted probability of conceiving a LBW child is lower for Black mothers than it is for White ones until the mid-20s, the gap then reverses and increases with maternal age. One possible explanation of the higher predicted probability of conceiving a LBW child at younger ages for disadvantaged White than Black mothers is that the nature and degree of social stigma attached to early childbearing differs across the two groups (Whitley & Kirmayer, 2008).

Compared to Figure 1, the widening of the Black/White gap in LBW is less marked but nonetheless reveals that, when the age gradient for disadvantaged mothers is stratified by ethnicity, it differs for Blacks and Whites. The results (not reported here) of a Wald test on the joint significance of the coefficients, confirm that the age gradient for relatively disadvantaged Black mothers is significantly different than the one of relatively disadvantaged White mothers (at the 10% level).[14]

Although we are not able to directly test the role that minority status plays in the association between social inequality and health deterioration, the evidence we present in this last set of analyses seems to fail to reject the hypothesis that minority status represents an added burden. While comparing a subset of White and Black mothers living (close to the time of birth) in disadvantaged contexts, there is still evidence of a widening (albeit smaller than in Figure 1) of the Black/White gap in LBW with increasing maternal age. This suggests that differences in the age gradients of LBW amongst Black and White mothers are not entirely explained by differences in socioeconomic disadvantage. In order to identify disadvantaged mothers we have however used a unique point in time close to when the mother has her first birth. It could be that these results reflect the fact that Black mothers have experienced lifelong exposure to poor environmental conditions to a larger extent than Whites. In this respect, Love et al. (2010) have shown that Whites exposed as both children and adults to poverty do not experience "weathering" to the same extent as African American mothers. It could be that Black mothers are the most disadvantaged or live in the more disadvantaged end of the distribution in disadvantaged areas, something we (and Love et al.) cannot entirely control for in the models. In this respect, Phuong Do et al. (2012) reveal the importance of using long-term (as opposed to one point in time) measures of SES when comparing health outcomes for Blacks and Whites. Nonetheless, ethnic minority status could be associated with residence in segregated areas and psychosocial stress derived from experiences of racial discrimination that could represent an added and modifying burden in the association between disadvantage and health (deterioration). Testing these hypotheses is clearly beyond the scope and limits of this analysis, but the results (in line with those presented by Love et al. (2010)) nevertheless reveal that the mechanisms and dynamics, which lead to a more rapid deterioration of health for ethnic minorities, requires further study.

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[14] Chi2(4)=6.62 Prob>chi2=0.0714. Similarly to what we do in the previous analyses, we estimate a regression model with both White and Black mothers and we test the joint significance of the coefficients for the reference group i.e. Black disadvantaged mothers.

Table 6 Odds ratio of LBW for relatively disadvantaged White and Black mothers (first births 1989-1994 and 1999-200)

	White	Black
	Exp(β)	Exp(β)
Mother age	0.877	0.039**
	(0.267)	(0.053)
Mother age^2	1.001	1.128**
	(0.011)	(0.059)
Mother age^3	1.000	0.999**
	(0.000)	(0.001)
Girl	1.142	1.475
	(0.101)	(0.694)
Twin	21.623***	27.258***
	(4.970)	(29.105)
Migrant	0.961	0.543
	(0.220)	(0.316)
1989-1994	0.996	2.014
	(0.090)	(1.072)
N	7,334	260

note: *** p<0.01, ** p<0.05, * p<0.1

Figure 3 Predicted probabilities of LBW for relatively disadvantaged Black and White mothers (first births 1989-1994 and 1999-2004)
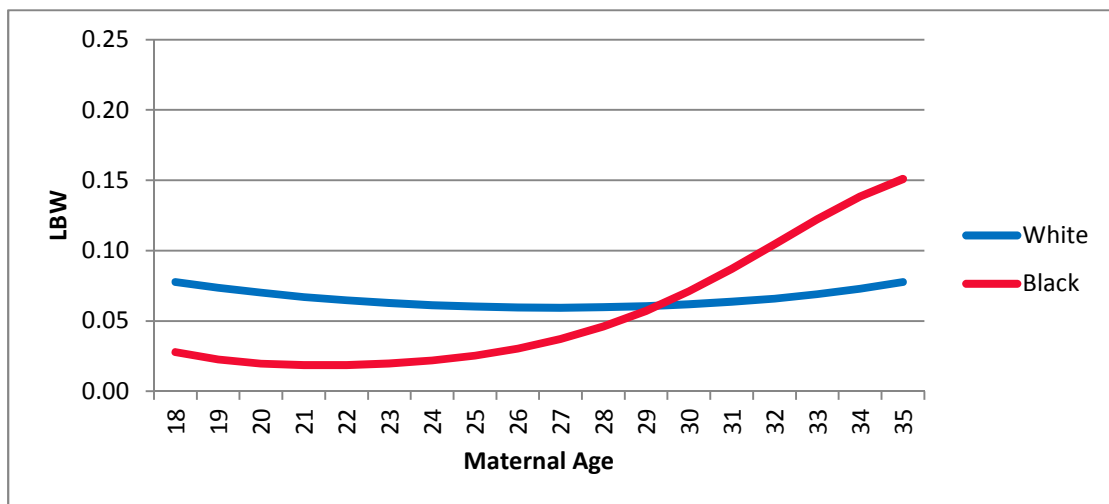
Discussion

This paper researches whether, in the U.K., gaps in child health vary with increasing maternal age in a way that is consistent with the tenets and predictions of the "weathering" hypothesis and sociobiological theories. Results reveal that the Black/White gap in LBW significantly widens with maternal age. This pattern is consistent with the prediction of the "weathering" hypothesis literature and with the fact that in the U.K. ethnic inequalities in adult health are found to widen with age, especially from the mid-30s onwards (Nazroo, 2003). Conversely, when we look at age gradients from a sociobiological perspective, the results reveal a much smaller widening of the gap in LBW between mothers living in relatively disadvantaged as opposed to advantaged areas. Finally, the last set of analyses interacting the "weathering" and "sociobiological" perspectives show that when comparing disadvantaged Black and White mothers, the gap is reduced but not entirely extinguished at older ages. The findings of this study contribute both to discourses (re)considering the consequences of childbearing postponement for child wellbeing and to (policy oriented) research analysing ethnic gaps in (child) health in the U.K. (and implicitly in the U.S.).

Our findings are concordant with an argument whereby the meaning of age and fertility timing are framed as context/group dependent. While the predominant view in the extant literature (according to a developmental perspective) has been that maternal age should be seen as an indicator of both biological and psychosocial maturity (Geronimus, 1996a), our results suggest that this interpretation may be more relevant for some groups of women than for others. By portraying childbearing postponement as a universal process, its benefits may have been overstated for other groups of women. Indeed, based on our results, this perspective seems to reflect the experiences of White (and) advantaged women; in contrast, the fact that the risk of conceiving a LBW child increases with maternal age so markedly for Black mothers runs counter to the notion that postponement is beneficial for child wellbeing. In the U.K, the first births distribution of Black and White women look very similar, but their outcomes look very different, which question the idea that postponement is necessarily driven by the same processes for all groups of women. In this respect, Meron et al. (2002) find that poorly qualified women in France, when facing difficulties in obtaining secure employment, delay entry to motherhood as much as women with higher qualification levels suggesting that the trajectories which lead to an older age at first childbearing may be multiple. Ultimately, the results suggest that there is a need to move beyond the assumption that childbearing postponement is expected to bring benefits to children as, on average, it is associated with higher (family) income and education. Maternal age could, as argued under a "weathering" hypothesis lens, also be seen as a marker of exposure to different forms of disadvantage.

The results also suggest that the interplay between maternal age and being a Black mother plays an important role in the U.K. The "weathering" hypothesis literature offers an appropriate theoretical framework to researchers who are interested in examining and explaining Black/White (and possibly more generally ethnic) gaps in (child) health in the U.K. Conversely, the results reveal that adopting a social class perspective *strictu sensu* may not enable to fully represent the experiences of mothers and their children in the current U.K. context, an ethnically diverse and segregated society. The minor widening of the age gradient in child health for relatively disadvantaged and advantaged mothers might suggest that a social class perspective should be dismissed all together. However, the last set of results suggest that being a Black and disadvantaged mother may reflect experiences that are unique and different than those of a White and disadvantaged mother. This indicates that both dimensions of disadvantage (ethnic minority and social class) may be relevant when attempting to understand and describe how patterns of inequality are produced.

The evidence that we reveal together with that of the existing literature (Love et al., 2010) suggest that the relationship between individual characteristics and health

(deterioration) are likely to be complex and interacting rather than additive and separable, suggesting future work (using data which provides extensive measures of socioeconomic status) should be directed at intersecting these perspectives.

These results provide interesting insights when implicitly compared to those revealed in the U.S. context. Notwithstanding the fact that the U.K. provides universal health care and minimum guaranteed income and that it is not as institutionally racist and segregated as the U.S. (Muennig & Murphy, 2011), we still observe the Black/White gap in LBW to widen with increasing maternal age. Moreover, the last set of results show that age gradients of disadvantaged Black and White mothers depart at older ages. Observing these patterns in a context that should be (more) protective of Black mothers' health puts a dent on the argument that this is solely the result of the fact that Black mothers are more likely to be exposed to social disadvantage and less likely to receive health care. Conversely, the results do not reject the hypothesis, already put forward in the literature, that the association between ethnic minority status and health (deterioration) may be confounded by experiences of racism and discrimination. Indeed, in the U.K. there is evidence that Blacks are more likely to be disadvantaged in terms of employment, income, housing and location (Hills, et al., 2010). Existing studies report cases of discrimination in the labour market (Bhopal, 1998; Muennig & Murphy, 2011; Smith, et al., 2000). Moreover, Bécares et al. (2011) suggest that Caribbean people tend to report more experiences of interpersonal racism (such as physical attacks, property damaged or being the victim of verbal abuses for reasons to do with their race or colour) than other ethnic groups. In the U.K., Blacks are also more likely (than Whites and Asians) to be stopped and searched by the police (Bowling & Corretta, 2003). But if a race conscious society forces ethnic minorities to experience high levels of psychosocial stress, the burden could also fall onto high(er) SES ethnic minority individuals and affect their health status. Although limited, existing U.S. evidence seems to support the idea that upward socioeconomic mobility may not necessarily translate into improved health for Black women compared to White women (Geronimus, et al., 2006). Geronimus et al. (2006) have demonstrated that Black/White gaps in allostatic load are more marked for the non-poor than for the poor and other U.S. research has revealed that higher socioeconomic status is not association with improved birth outcomes for children of African American mothers (Colen, et al., 2006). For example, among a population of college graduates, African American women are found to have statistically significant increased odds of preterm delivery and LBW (McGrady, Sung, Rowley, & Hogue, 1992) compared to White college graduates. Examining age gradients in (child) health for disadvantaged Black and White mothers would be a significant contribution towards the understanding of the (confounding) role of discrimination. Because of statistical power issues, we haven't been able to compare age gradients in LBW for relatively advantaged Black and White mothers. Nonetheless, our results together with those of the extant literature, point to the need of investigating whether high(er) SES is protective of or rather reinforces "weathering" processes for ethnic minority individuals.

This research has several limitations. First of all, the analyses are unable to provide a test of these theories i.e. they are limited to show evidence which is/isn't consistent with them. Namely, while we are able to show that the association between maternal age and child wellbeing varies between Blacks and Whites, we are not able to say (in any way) why this is the case. Testing these theories is very difficult and data intensive, but research describing the profiles of mothers who postpone childbearing and how those may vary (not only according to income and education but also more broadly) is certainly a move in the right direction. Finally, the analyses neglect other ethnic minority groups. In the U.K. Blacks are, however, not the only group experiencing worse health profiles and discrimination. Over the last decade, South Asian Muslims (Pakistani and Bangladeshi) have been exposed to increasing racism and discrimination which have been found to lead to health deterioration

(Johnston & Lordan, 2012). As mentioned in the data section, South Asians Muslims (Pakistani and Bangladeshi) are very different from Whites in terms of fertility schedules and they tend to have smaller babies (regardless of their health status): both factors pose problems when comparing their age gradients in child health to those of Whites. A "weathering" perspective could, however, usefully inform research looking into their age gradients in adult health outcomes.

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