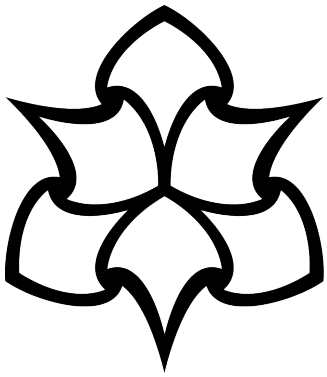

Title: Exposure to multiple childhood social risk factors and adult body mass index trajectories from ages 20 to 64 years

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Abstract

Background: While childhood social risk factors appear to be associated with adult obesity, it is unclear whether exposure to multiple childhood social risk factors is associated with accelerated weight gain during adulthood.

Methods: We used the MRC National Survey of Health and Development, a British population-based birth cohort study of participants born in 1946, height and weight were measured by nurses at ages 36, 43, 53, and 60-64 and self-reported at 20 and 26 years. Nine childhood socioeconomic risk factors and eight binary childhood psychosocial risk factors were measured, with 13 prospectively measured at age 4 years (or at 7 or 11 years if missing) and three were recalled when participants were age 43. Multilevel modeling was used to examine the association between the the number of childhood social risk factors and changes in BMI with age.

Results: Increasing exposure to a higher number of childhood socioeconomic risk factors was associated with higher mean BMI across adulthood for both sexes and with a faster increase in BMI from 20 to 64 years, among women but not men. Associations remained after adjustment for adult social class. There was no evidence of an association between exposure to childhood psychosocial risk factors and mean BMI in either sex at any age.

Conclusions: Strategies for the prevention and management of weight gain across adulthood may need to tailor interventions in consideration of past exposure to multiple socioeconomic disadvantage experienced during childhood.

Keywords: BMI; trajectories; childhood social disadvantage

Introduction

The epidemic of overweight and obesity presents a major challenge to health,[11] and has been fuelled by social inequalities.[2] These social inequalities can develop through childhood and may potentiate the spread of the overweight and obesity epidemic in adulthood. Children experiencing social disadvantage which is either socioeconomic (e.g. low parental occupation, low parental education level and economic distress) or psychosocial (e.g. lack of care and abuse) have been individually associated with obesity or higher body mass index (BMI) in adulthood.[3–10] However, children may be exposed to multiple social disadvantages.[11] The confluence of socioeconomic and psychosocial risk factors may play a particularly important role in weight gain over time. Most of the research on multiple exposures of childhood social disadvantage and BMI have been cross-sectional and relied predominantly on retrospective reporting childhood social disadvantage or measurement of BMI at a single time point.[4, 5, 11]

We used the Medical Research Council (MRC) National Survey of Health and Development (NSHD), a British birth cohort of males and females born in 1946, to assess the prospective association between multiple exposure to childhood social risk factors in relation to the trajectory of BMI from young adulthood through to early old age (20-64 years).

Methods

Sample

The UK Medical Research Council (MRC) National Survey of Health and Development (NSHD) is based on a social class stratified sample (n=5,362) of all singleton births that occurred within 1 week in March 1946 in England, Scotland and Wales, with regular follow-up across life. At the assessment at 60–64 years (2006–2010), eligible cohort members (those known to be alive and with a known address in England, Scotland or Wales) were invited for an assessment at one of the six clinical research facilities (CRFs) or to be visited by a research nurse at home. Invitations were not sent to those who had died (n=778, 14.5% of the original cohort), who had emigrated (570, 10.6%), who were lost to follow-up (594, 11.1%) and who had previously withdrawn from the study (564, 10.5%). Of the 2856 cohort members invited, 1690 (59.2%) attended a CRF for full examination and 539 (18.9%) were examined at home by a trained nurse. At ages 36, 43, and 53 teams of trained nurses visited participants in their homes for interviews and assessments. The study has received relevant ethical approval and obtained participant consent.

Childhood socioeconomic and psychosocial risk factors

We use the term socioeconomic to reflect the factors that influence the positions individuals or groups will hold within the structure of a society.[12–15] This also includes

housing characteristics and amenities as markers of material circumstances[16] and children's living conditions related to parent's financial resources.[17, 18] Although there is no agreed definition of psychosocial risk,[19] a psychosocial risk factor can be defined as a measurement that relates psychological phenomena to the social environment and/or to pathophysiological changes.[20] This broad definition reflects the wide variety of psychosocial variables which have been studied in the etiology of adult health.[5] The nine binary childhood factors reflecting socioeconomic disadvantage (low maternal education, low father occupational social class, private landlord owned home, poor household amenities, overcrowding, poorly repaired house, unclean child, poorly cleaned house, and poor state of child's clothes and shoes) and eight childhood factors reflecting psychosocial disadvantage (maltreatment, low parental concern for their child's education, parental psychiatric history, parental divorce, mother's affectionless control, father's affectionless control, parent death and maternal separation) were used to create two summed scores.

A description of the seventeen childhood social risk factors used in analyses is given in table 1. Thirteen of these were prospectively measured at age 4 years or at 7 or 11 years if missing (1950-1957) and three were recalled when participants were age 43 (1989).[21]

The nine binary childhood socieoconomic risk factors and eight binary childhood psychosocial risk factors were each summed separately to create two summed scores. Scores of three and above were combined for analyses, due to the small number of

participants in higher categories of the psychosocial variable (n=27 in 4 and above), resulting in variables with 4 categories (0, 1, 2 and ≥3).

Adult BMI

Height and weight were self-reported at ages 20 and 26 years, and measured at 36 and 43 years, 53 and 60-64 years (mm and 0.1 kg) according to standard protocols by trained nurses. BMI at each age was calculated as weight/height^2 (kg/m^2).

Adult social class

We based adult social class on the head of household's occupation at age 53 years. Occupational was based on the Registrar General's social class classification and categorised into six groups: I professional, II intermediate, III skilled non-manual, III skilled manual, IV semi-skilled, V unskilled.

Statistical analysis

Multilevel modeling was used to examine the association between the the number of childhood social risk factors and changes in BMI with age. We fitted models with random intercepts and random slopes. Such models take account of the correlation between the repeated measures of BMI on the same individual and enable inclusion of participants

with some missing outcome data under a missing at random assumption. Participants with only one record were excluded because they contribute no information about change in BMI. As the association between BMI and age was known to be non-linear[21] we modeled BMI as a cubic function using age, age^2 and age^3. Since the patterning of BMI gain differs between the sexes,[22] and previous analyses have shown associations between childhood social class and BMI to vary according to sex, [23] we conducted our main analyses separately for men and women. We also carried out tests for interaction between each summed score and sex in combined models.

We first considered the associations between the number of childhood socioeconomic and psychosocial risks separately. The summed score was included in the BMI trajectory and we assessed whether any association with BMI was non-linear using the likelihood ratio test, comparing the model with the summed score included as a continuous variable with a model including it as categorical. We assessed whether the summed score was associated with change in BMI by including interactions with the linear age term, and then with the higher order polynomial age terms. When there was no evidence of interaction ($p>0.05$), these terms were dropped from the final model. To examine the potential mediating role of adult social class we adjusted the model for adult social class including relevant adult social class and social class by age term interactions. We then fitted a model which included both summed scores and their relevant interactions with age to assess whether these represented independent associations and subsequently adjusted for adult social class.

Missingness in the covariates was handled using a multiple imputation with chained equations approach. This approach allows for uncertainty about missing data by creating several different plausible imputed data sets and appropriately combining results obtained from each of them. Imputation models contained all the variables included in the analysis models including the outcomes. A total of 20 imputed data sets were obtained via chained equations. We present results based on the 3991 eligible study members excluding those with ≤2 of the 6 BMI measurements (n=1350) and who had missing information on ≥12 out of the 17 childhood social risk factors (an additional 21). Of these, 3376 had full information for the socioeconomic risk score analysis and 2095 for the psychosocial risk. Details of missing data are provided in supplementary table 1.

We carried out sensitivity analyses excluding father's social class from the summed score of childhood socioeconomic risk factors and then fitting a model including both this score and father's social class to assess whether the summed score of childhood socioeconomic risk factors adds to previous findings in NSHD showing that manual father's social class is associated with higher adult BMI and greater increases in BMI across adulthood.[22, 23] All statistical analyses were done with STATA version 13.

Results

Characteristics of participants in childhood

The prevalence of each childhood socioeconomic and psychosocial risk factor is shown in table 1.

The childhood socioeconomic risk factor with the lowest prevalence was children with unclean clothes and shoes (2.3%) and the highest prevalence being low maternal education (62.7%). The childhood psychosocial risk factor with the lowest prevalence was children living with parents with a psychiatric disorder (2.4%) and the highest prevalence being children with a neglectful father or mother(30% for both). The overall prevalence of exposure to 3 or more childhood socioeconomic risk factors was 26.7% (27.2% in males and 26.2% in females) and 9.7% (9.7% in males and 9.8% in females) for exposure to 3 or more childhood psychosocial risk factors (Figure 1).

Multiple exposure to childhood socioeconomic risk factors and BMI trajectories

Among men, mean BMI increased linearly with increasing exposure to childhood socioeconomic risk factors (p for trend <0.001) (supplementary table 2 model 1). There was no evidence that the summed score of childhood socioeconomic risk factors was associated with rate of change in BMI [summed socioeconomic risk-by-age interaction for linear (p= 0.4)]. This association, constant across all ages (Figure 2), remained, albeit

somewhat weakened, after adjustment for adult social class (supplementary table 2 model 2). Similar to men, women's mean BMI increased with greater exposure to childhood socioeconomic risk factors (p for trend <0.001) (supplementary table 2). However, there was also evidence that the summed score of childhood socioeconomic risk factors was associated with BMI increases over time with interactions between both linear (p= <0.001) and quadratic (p=0.002) terms (supplementary table 1). These interactions indicate that a greater exposure to childhood socioeconomic risk factors was associated with more rapid increases in BMI during midlife (Figure 2). Thus the mean difference between those with a score of 0 and a score of 3 is 0.8kg/m^2 at age 20, increasing to 2.0kg/m^2 at age 62. After adjustment for adult social class, the associations were somewhat but not completely attenuated (supplementary table S2).

Multiple exposure to childhood psychosocial risk factors and BMI trajectories

There was no evidence of an association between the summed score of childhood psychosocial risk factors and BMI or rate of change in BMI in either men or women (p= 0.4) (supplementary table 3). There was no change after adjustment for adult social class (Supplementary table 3).

In both men and women when both summed scores were included in the same model, findings remained similar (supplementary table 4) compared to the main analyses. Adjusting for adult social class again attenuated the association with the summed score of childhood socioeconomic risk factors in both sexes (supplementary table 4).

Using a summed score of childhood socioeconomic risk factors that excluded father's social class, associations remained similar (supplementary table 5) and were only slightly attenuated after addition of father's social class (supplementary table 5). In these mutually adjusted models, low father's social class also showed associations with higher BMI and, in women, with greater BMI change.

Discussion

Using extensive information on both socioeconomic and psychosocial risk factors in childhood and repeated longitudinal measures of adult BMI in a nationally representative British birth cohort study, we have showed exposure to a greater number of childhood socioeconomic risk factors among women but not men, was associated with a faster increase in adult BMI from 20 to 64 years. This association was present even with adjustment for adult social class. Among both sexes, there was no evidence of an association between increasing exposure to childhood psychosocial risk factors and mean BMI.

Previous research has examined experiences of multiple childhood psychosocial risk factors and BMI trajectories across childhood.[24–26] To our knowledge, this is the first study to evaluate the number of childhood social risk factors by type (socioeconomic and psychosocial) with BMI trajectories across adulthood. Senese et al. reported that childhood socioeconomic position (usually measured by a single indicator such as parental social class) is inversely associated with adult obesity in females, with findings in males being weaker and less consistent.[8] Findings from NSHD have also reported associations between lower father's social class and higher adult BMI (up to age 53) which were stronger in women than men; the association in women also strengthened with increasing age at BMI measurement).[21, 22] However, our results show that exposure to multiple childhood socioeconomic risk factors on BMI across adulthood is not driven solely by father's social class.

The present study's findings are in contrast with previous studies that showed exposure to multiple childhood psychosocial risk factors to be associated with higher BMI[5, 11] or greater weight change over time.[6] The Adverse Childhood Experiences study of US adults aged 25 years and older registered with the Kaiser Permanente's San Diego Health Appraisal Clinic between 1995-1996 showed that exposure to an increasing number of childhood psychosocial risk factors was associated with a greater prevalence of BMI ≥35 kg/m.[2, 5] Similarly, in a nationally representative sample of adults aged 18-70 years from England, exposure to multiple childhood psychosocial risk factors was reported to be associated with a greater likelihood of having a BMI ≥ 40 kg/m.[2, 4] In the Americans' Changing Lives Survey, among women (aged 24-96) in 1986, those with higher numbers of childhood psychosocial risk factors were more likely to have greater weight gain over a 15 year period.[6] The difference between these studies and the null associations seen in our study may be for several reasons. Both these studies used BMI cut-points indicating obese or morbidly obese whereas we examined BMI as a continuous outcome. It may therefore be that the impact of psychosocial risk factors is only seen at the extreme end of the BMI distribution. In all of the previous studies all childhood psychosocial risk factors were based on retrospective reports whereas in our study the majority of childhood psychosocial risk factors were prospectively reported. Associations between retrospectively reported psychosocial childhood risk factors and BMI can be upwardly biased due to recall failure or current state of mind; and early adversity has been shown to be related to poorer mental health in NSHD and other cohorts.[27, 28] Whereas, associations between prospectively reported psychosocial

childhood risk factors from long-term cohort data may be downwardly biased due to systematic sample attrition. In our study, the retrospective and prospective childhood psychosocial risk factors examined did not measure the same psychosocial risk factors and we are unable to make direct comparisons between reporting methods. These studies all had very wide age ranges and were from different birth cohorts,[5, 6, 11] and most[5, 6]but not all[11] were in different geographic areas. Another difference is that the other studies[5, 6, 11] focused on sexual, physical and emotional abuse. We may not have captured this accurately with our single item on maltreatment.

A major strength of this study is that we utilised the oldest and longest running British birth cohort to emphasise the adverse long-term association of accumulated child socioeconomic disadvantage on weight gain in adulthood. Additionally we examined both childhood socioeconomic and psychosocial risk factors. However, there are several limitations to the current analysis. BMI may not be the optimal measure of adiposity, but the utility of BMI is well acknowledged in large epidemiological studies.[29] There was missing data on both childhood socioeconomic and psychosocial risk exposures. We addressed this using a common and valid missing data approach,[28] although uncertainty in estimates may be a particular concern for psychosocial risk exposures given the higher rates of missingness in some of those indicators. Missing data on BMI were dealt with in the multilevel modelling approach that uses all available data in the estimation of model parameters. In addition to examining multiple childhood social disadvantages on the basis of exposure to the sum of individual risk factors occurring in the household, we were unable to examine what happens to adult BMI trajectories when children are

exposed to risk factors across different domains of risk. For example, future research could estimate adult BMI trajectories for the domains of household and neighbourhood separately, and then examine BMI trajectories for children with risk in no single domain, risk in one domain, or risk in both domains. Neighbourhood risk factors may include socioeconomic conditions, food outlet abundance and fitness and recreational assets.[30, 31] The majority of participants in NSHD are of white ethnic origin, while the UK is becoming increasingly ethnically diverse.[32] Certain ethnic groups are most likely to live in low income and material deprivation. Understanding childhood socio□economic patterns in adult BMI trajectories across ethnic groups is therefore important, particularly when there are promising culturally tailored interventions that could potentially address issues such as socioeconomic disadvantage.[33]

Children who experienced multiple social disadvantages may be embedded with life conditions where they are more likely to confront a wider array of risk factors for weight gain throughout the lifecourse than less disadvantaged children. They may also experience a greater paucity of social resources that might otherwise provide some buffering to their obesogenic environment. We found that women who experienced a greater childhood social disadvantage were more likely to have faster weight gain over a across adulthood than men. Coping with the repercussions of socioeconomic disadvantage from childhood may be gender specific. Women's copying style tends to be more emotion-focused,[34] and they may be more likely to increase the amount they eat as a way of coping.[35] Men are more likely to engage in other less weight-related coping strategies such as isolation.[6]

There is some evidence that primary care delivered tailored weight loss programmes targeted at low-income women appears to be effective at least in the short term.[36] In the context of rising childhood socioeconomic disadvantage in the UK,[37] an outstanding question is whether weight reduction interventions across adulthood can also demonstrate effectiveness among adults who have experienced multiple childhood socioeconomic disadvantages.

Conclusion

Our findings suggest that exposure to a greater number of socioeconomic risk factors during childhood was associated with higher adult BMI and in females but not males, with a faster increase in BMI over a 44 year period. Prevention and management of adult weight gain needs to take into consideration accrued socioeconomic disadvantage during childhood.

Conflict of interest

None declared.

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Key points

• Children may be exposed to multiple social disadvantages which can either reflect socioeconomic disadvantage or psychosocial disadvantage.

• Exposure to a greater number of childhood socioeconomic risk factors is associated with higher adult BMI and in women only, with a faster increase in BMI over a 44 year period.

• An outstanding question is whether early interventions that prevent or buffer the effects of childhood socioeconomic disadvantage can reduce accelerated weight gain later in adulthood, particularly among women.

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