Head Injuries in Early Childhood in the UK, Is There a Social Gradient?

Alejandra Letelier[a b], PhD, Richard G. Watt[c], Prof, and Anja Heilmann[c], PhD.

Affiliations: [a]Instituto de Odontoestomatología, Facultad de Medicina, Universidad Austral de Chile: Valdivia - Chile and [b]Department of Epidemiology and Public Health, UCL: London - UK.

Address correspondence to: Alejandra Letelier, Los Manzanos 375, Región de los Ríos, Valdivia, Chile, [e-mail: alejandra.letelier.12@ucl.ac.uk], +56 930350564.

Word count: 3154 words

Key Words: early childhood, early life, head injuries, socioeconomic indicators, social gradient

Abbreviations: IMD - Indices of Multiple Deprivation; MCS - Millennium Cohort Study; NS-SEC - National Statistics Socio-economic Classification; NVQ - National Vocational Qualification; OECD - Organization for Economic Co-operation and Development.

What's is already known on this subject

- Head injury is the most frequent injury during childhood.
- Research has identified a social gradient in general injuries.
- Very few studies have explored how early life head injuries are distributed between socioeconomic groups.

What This Study Adds

- Using longitudinal data and a very large sample generalizable to the whole UK population, this study found no evidence of a social gradient associated with early life head injuries in the UK.
- Further studies would help to elucidate if this is the case in other populations.
- At younger ages children from most deprived areas have higher risk of head injuries but the risk changes at older ages.

Abstract

Objectives: To examine if there is a social gradient in early childhood head injuries among UK children.

Methods: Cross-sectional study, using data from the UK Millennium Cohort Study. The second, third, and fourth sweeps of the MCS were analysed separately, when children were 3, 5 and 7 years old. Logistic regression models were used to explore the associations between head injuries and family socioeconomic position (social class, household income, maternal education and area deprivation).

Results: The unadjusted analyses showed different associations with socioeconomic indicators at different ages. At age 3 and 5, head injuries were associated with higher area deprivation, lower household income, and parents not being in work or in the routine social class. At age 5 head injuries were also associated with lower maternal education. At age 7 only associations with area deprivation and maternal education were found. In adjusted analyses (mutually adjusted for all four socioeconomic indicators, maternal age, child age and child sex) the following associations were observed: at ages 3 and 5, higher levels of area deprivation were related to higher odds of head injuries. At age 3 only, lower levels of maternal education were related to lower odds of head injuries. No social gradients were observed. At age 7, there were no significant associations between head injuries and any of the SEP measures.

Conclusion: We observed no social gradients in early childhood head injuries. However, at ages 3 and 5, head injuries were more frequently reported for children living in more deprived areas.

INTRODUCTION

Injuries are among the most common reasons for child morbidity and mortality worldwide[1-2]. The UK is no exception, with unintentional injury the leading cause of mortality in children aged one to nine years[3]. Head injury is the most prevalent type of injury during childhood, as the face is the body area affected most frequently.

Head injuries can have major and long-lasting impacts on a child's life, potentially affecting basic functions such as speech, vision, breathing, swallowing and chewing[1, 4]. However, it has been widely recognized that injury prevention is an achievable aim[3].

The existing literature on head injury risk among children has shown that the incidence of injuries is highest among children aged one to four years; and males have at least double the risk than females[5–9]. However, child characteristics such as age and sex do not explain all variation in injury risk, and there is consensus that to prevent childhood injuries it is important to understand the role of the social context[10-11].

A vast amount of evidence indicates that social differences have a direct effect on population health. Socioeconomic inequalities also exist for overall injury risk[10, 12]. However, the subject of early childhood head injuries and their relationship with social inequalities has received insufficient attention from the scientific community. There is a very small number of studies exploring the existence of a social gradient in early childhood head injuries. This is quite surprising given that small children are among the groups most vulnerable to unintentional head injuries[13–15].

So far only one study has explored how paediatric facial injuries are distributed between socioeconomic groups in the UK, conducted by Rhouma et al.[8] in Scotland. This study found a social gradient in relation to residential area deprivation; with increasing levels of area deprivation the risk of suffering facial injuries also increased. However, the study sample included both adolescents and young children. Previous studies have shown differences in socioeconomic disparities by age group[16]; some studies exploring general injuries have suggested that disparities by socioeconomic groups are stronger among younger children[10, 17]. Therefore, the analysis of associations between socioeconomic factors and head injuries should take age group / life stages into account. The aim of this study was to examine whether early childhood head injuries are socially graded among children living in the UK. We hypothesized that children from more disadvantaged backgrounds would present a higher risk of experiencing head injuries.

METHODOLOGY

This study is based on the secondary analysis of data from The Millennium Cohort Study (MCS). The MCS is a UK prospective study that follows the lives of approximately 19000 children born between 2000-2002[18]. The MCS sample was carefully constructed to represent the whole UK population. The study over-sampled areas of high child poverty, areas with a high proportion of ethnic minorities, and the three smaller countries of the UK. The survey was applied by trained interviewers in the children's homes, and in most cases to both parents. The MCS obtained ethical approval from the London and the Yorkshire Multi-Centre Research Ethics Committee of the NHS in September 2004, December 2005 and February 2008[19].

This is a cross-sectional analysis of data collected at the second, third and fourth survey, when children were three, five and seven years of age respectively. We excluded twins and triplets (n=426 at sweep 2, n=417 at sweep 3, and n=361 at sweep 4), leaving three samples of: 15382; 15042 and 13682 children.

Following the approach adopted by Galarza et al.[20], head injuries were defined as injuries from the neck and above. Injury incidence was understood as occurrence of at least one injury per child within the two years of observation. Mothers were asked whether during the time period since the last survey the child had experienced any injuries for which they were taken to the doctor, health centre or hospital. Those who reported an accident since the last interview (during the last two years), were asked to classify the most severe accident or injury from a list of options; we extracted those that answered: injury to head, mouth, tooth, nose or other injury on the face. Head injury was used as a dichotomous variable, measuring whether the child had experienced any head injuries during the time since the last survey.

Four measures of family socioeconomic position were considered: social class, maternal education, household income and area deprivation. Social class was based on parental occupational class and measured using the five category version of the National Statistics Socioeconomic Classification (NS-SEC). This classification allocates occupations accounting for employment relations and conditions. For two-parent families, the variable was coded according to the partner with the higher social class. The categories were: (1) managerial and professional occupations, (2) intermediate workers, (3) small employers and own account workers, (4) lower supervisory and technical occupations, (5) semi-routine occupations[20]; and (6) no parent in work or on leave. Maternal education was measured by asking the mothers about their highest qualification achieved. The MCS derived a five category variable based on a combination of the highest National Vocational Qualifications (NVQ) and the highest academic qualification achieved[22]. We used a six category variable: (1) Highest qualifications (NVQ level 5 and 4; higher degree, first degree or diploma in higher education; professional qualification); (2) level 3 qualifications (NVQ level 3; A/ S/ AS level); (3) level 2 qualifications (NVQ level 2; O Level/ GCSE grade A-C, trade apprenticeships); (4) lowest qualifications (NVQ level 1; GCSE grades D-G); (5) no qualifications; (6) qualification acquired overseas. Income level was measured using the Organization for Economic Co-operation and Development (OECD) income quintiles; this measure considers the joint income and number of people living in the household, which adjusts weekly household income data according to size, composition, and resource needs. Finally, area deprivation was assessed using the Indices of Multiple Deprivation (IMD) measured at the small area level[23]. The IMDs are constructed for each UK country separately, but in a very similar way. They include several domains such as: health levels, crime, living environment, among others. IMD rank quintiles were analysed.

The covariates considered were: child sex, child age and maternal age. The rationale behind the selection of those variables came from the literature review. Sex was a binary variable (male vs. female). Child and maternal age were used as a continuous variables in regression models. Maternal age has been proposed in the literature as a risk factor for childhood trauma, with injury risk decreasing as the age of the mother increases[24-25]. Maternal age was collected and used in years. Child age was collected in days and was scaled to be expressed in years.

Analyses were based on complete cases and weighted to account for the unequal probability of being sampled as well as the geographical clustering of the data. Fewer than one percent of children had missing data for head injuries in any of the sweeps. Parents / families of children with missing data were more likely to live in more deprived areas, to be unemployed or working in semi-routine occupations, and to have lower levels of education. All analyses were performed with the statistical software STATA version 12[26]. The distribution of head injuries was explored via cross-tabulations with each predictor variable, using chi-square tests for binary covariates (sex) and chi-square tests for trend for ordinal covariates (social class, maternal education, income, area deprivation and maternal age). For descriptive analyses maternal age was used as a categorical variable. Logistic regression models were then estimated. Model 1 assessed the unadjusted associations between head injury and each socioeconomic indicator separately (social class, maternal education, income, and area deprivation) and the demographic factors maternal age, child sex, and child age. Model 2 included all the predictor variables (mutually adjusted). Statistical significance of the crude and adjusted associations was defined at the 0.05 level. For all logistic regression odds ratios are presented with their 95% confidence intervals.

RESULTS

The analytical samples comprised 15162 children at sweep two (age three), 14893 children at sweep three (age five) and 13589 children at sweep four (age seven). Head injury incidence decreased with age. The highest incidence (weighted) was at age three (15%; n=2260) while among five and seven years old it was 12% (n=1710) and 8% (n=1137) correspondingly (Table 1). Boys ($p<0.001$) and children with younger mothers ($p<0.05$) had a higher risk of head injury (Table 2). The mean age of children at the interview was: 3.14 (SD 0.21; min: 2.65 and max: 4.57), 5.22 (SD 0.25; min: 4.41 and max: 6.13) and 7.23 (SD 0.25; min: 6.34 and max: 8.15) respectively. In all three sweeps, for approximately 97% of the children the main respondent of the survey was the natural mother. Most children lived with both natural parents (approximately 75%). The mean age of mothers at birth of the cohort member was 28 years

(SD 0.05). The percentage of mothers with no qualifications decreased over the sweeps (13.8%; 12.9%; 11.4%).

The associations between socioeconomic indicators and head injury experience differed by age (Table 2; Figure 1). At age three, the unadjusted analysis suggested that children with parents not in work (OR 1.17, 95% CI 1.01-1.34), from families with the lowest incomes (OR 1.27, 95% CI 1.06-1.52) and from the most deprived areas were more likely to suffer head injuries than their peers from more advantaged backgrounds. However, no clear social gradients were observed. After mutual adjustment for socioeconomic and demographic factors, the observed associations with social class and family income were no longer statistically significant. The association with area deprivation was attenuated; only children from the most deprived quintile were significantly more likely to experience a head injury than those from the least deprived areas (OR 1.33, 95%CI 1.11-1.61). This model showed that children with less educated mothers had a lower risk of head injury than children whose mothers had the highest education level (lowest qualifications: OR 0.75, 95%CI 0.59-0.96; no qualifications: OR 0.71, 95%CI 0.58-0.87).

At age five, similar to age three, the unadjusted analysis showed significant associations between head injuries and social class, family income and area deprivation, in the same direction - although the observed associations were stronger. No social gradient was found in relation to social class and area deprivation. A slight gradient was observed with family income, suggesting that the incidence of head injuries increases as income level decreases (confirmed by chi square test for trend p=0.004). Even so, the observed estimates were very similar providing insufficient evidence for a graded relationship. At age five, the risk of head injury increased as maternal education level decreased (level 2 qualifications OR 1.21 95%CI 1.02-1.42; level 3 qualifications OR 1.32 95%CI 1.14-1.52, lowest qualifications OR 1.39 95%CI 1.13-1.72). After adjustment, only the associations with area deprivation and maternal education remained statistically significant, but were attenuated. Children from more deprived areas were more likely to suffer a head injury than children from the least deprived areas, but again no clear social gradient was observed. Children whose mothers reported intermediate level qualifications (level 2) were more likely to have had a head injury (OR 1.18 95%CI 1.01-1.39) than children whose mothers were the most educated.

At age seven, the unadjusted analysis showed no associations between head injury and either social class or household income. Children from the most deprived areas were more likely to experience a head injury than children from the least deprived areas (OR 1.27, 95%CI 1.00-1.61). Furthermore, children whose mothers had the lowest educational qualifications were more likely to have experienced a head injury than children whose mothers were the most educated (OR 1.47 95%CI 1.11-1.95). After mutual adjustment, these associations did not remain statistically significant. Lastly, at age seven child age was significantly associated with head injuries; as child age increased the risk of head injury also increased even after adjustment (OR 1.52 95%CI 1.16-2.01).

Table 1. Incidence of head injuries, by socio-demographic characteristics at sweep 2- age 3 (n=15162), sweep 3- age 5 (n-14893) and sweep 4 - age 7 (n=13589). Percentages %

	3 years		**5 years**		**7 years**	
	Individual	**Head Injuries***	**Individual**	**Head Injuries***	**Individual**	**Head Injuries***
Sex						
Male	51.1	17.9	51.3	13.5	50.8	10.7
Female	48.9	11.8	48.7	9.7	49.2	6.5
Mothers age						
16 to 19	0.8	18.8	0.1	0.0	0.0	0.0
20 to 29	33.0	17.6	24.6	14.7	16.7	9.4
30 to 39	56.8	14.3	57.4	10.6	53.8	8.8
40+	9.3	12.2	18.0	10.8	29.6	7.8
Family Social Class						
Managerial and prof	40.5	14.4	41.1	10.7	43.3	8.4
Intermediate	12.1	15.6	11.8	12.1	11.9	9.0
Small-employer or self-employed	7.2	13.0	8.2	11.0	8.9	8.6
Low supervisory or technical	7.0	16.0	6.7	12.0	6.3	8.3
Semi routine or routine	14.2	15.2	13.6	12.7	13.5	9.2
Both parents not in work	18.9	16.3	18.6	12.9	16.3	8.8
OECD Income						
Highest quintile	17.8	13.6	17.5	10.0	18.9	7.8
Fourth quintile	18.8	14.9	19.1	11.1	19.4	9.0
Third quintile	19.7	15.0	19.5	12.1	20.2	8.5
Second quintile	21.9	15.4	21.5	12.5	20.7	9.0
Lowest quintile	21.8	16.7	22.4	12.4	20.6	9.0
Maternal Education						
Highest qualifications	32.2	15.1	34.4	10.2	37.1	8.0
Level 3 qualifications	14.7	14.9	14.8	12.0	15.2	9.4
Level 2 qualifications	28.2	15.4	27.3	13.0	26.4	8.6
Lowest qualifications	8.0	14.3	7.6	13.6	7.0	11.4
No qualifications	13.8	13.6	12.9	11.1	11.4	7.2
Overseas	3.1	14.5	3.0	9.9	2.9	10.9
IMD quintiles						
Least deprived area	17.2	12.9	17.9	9.1	18.8	7.8
2nd least deprived area	14.8	15.2	15.7	12.0	16.5	8.6
Median deprived area	17.6	14.9	17.4	11.2	17.7	8.4
2nd most deprived area	21.6	15.3	21.2	13.4	20.8	8.6
Most deprived area	28.9	16.7	27.9	12.5	26.1	9.7

** Head injury is the only variable weighted to allow comparison, and to be extrapolated to the whole UK.*
OECD: Organization for Economic Co-operation and Development; IMD: Indices of Multiple Deprivation.

Table 2. Logistic Regression; unadjusted and adjusted head injuries OR (95% C.I.)

	Model 1			Model 2		
	3 years	**5 years**	**7 years**	**3 years**	**5 years**	**7 years**
Family Social Class						
Managerial and prof	1	1	1	1	1	1
Intermediate	1.11 (0.94-1.30)	1.14 (0.95-1.37)	1.08 (0.86-1.35)	1.06 (0.89-1.24)	0.99 (0.81-1.22)	0.99 (0.78-1.25)
Small-employer or self-employed	0.91 (0.73-1.13)	1.02 (0.79-1.32)	1.02 (0.79-1.31)	0.88 (0.71-1.09)	0.92 (0.71-1.19)	0.94 (0.71-1.24)
Low supervisory or technical	1.15 (0.96-1.37)	1.14 (0.89-1.45)	0.98 (0.69-1.38)	1.05 (0.87-1.28)	0.95 (0.73-1.22)	0.86 (0.60-1.24)
Semi routine or routine	1.09 (0.93-1.27)	**1.21 (1.04-1.42)**	1.1 (0.88-1.37)	0.99 (0.83-1.19)	1.01 (0.84-1.21)	0.96 (0.75-1.25)
Both parents not in work	**1.17 (1.01-1.34)**	**1.23 (1.06-1.43)**	1.05 (0.85-1.29)	1.01 (0.83-1.23)	1.09 (0.87-1.35)	0.89 (0.67-1.20)
OECD Income						
Highest quintile	1	1	1	1	1	1
Fourth quintile	1.12 (0.94-1.33)	1.12 (0.91-1.40)	1.16 (0.93-1.44)	1.09 (0.91-1.31)	1.02 (0.81-1.27)	1.13 (0.91-1.43)
Third quintile	1.12 (0.93-1.34)	**1.24 (1.03-1.49)**	1.1 (0.88-1.38)	1.07 (0.87-1.31)	1.06 (0.86-1.31)	1.01 (0.78-1.29)
Second quintile	1.16 (0.98-1.37)	**1.29 (1.07-1.55)**	1.16 (0.94-1.43)	1.08 (0.88-1.34)	1.03 (0.82-1.29)	1.04 (0.81-1.32)
Lowest quintile	**1.27 (1.06-1.52)**	**1.28 (1.05-1.55)**	1.16 (0.93-1.44)	1.15 (0.88-1.51)	0.95 (0.73-1.25)	1.08 (0.79-1.25)
Maternal Education						
Highest qualification	1	1	1	1	1	1
Level 3 qualification	0.98 (0.83-1.17)	**1.21 (1.02-1.42)**	1.19 (0.97-1.54)	0.87 (0.73-1.03)	1.08 (0.92-1.28)	1.13 (0.91-1.38)
Level 2 qualification	1.02 (0.89-1.18)	**1.32 (1.14-1.52)**	1.08 (0.89-1.29)	0.89 (0.76-1.04)	**1.18 (1.01-1.39)**	1.03 (0.84-1.24)
Lowest qualification	0.94 (0.75-1.19)	**1.39 (1.13-1.72)**	**1.47 (1.11-1.95)**	**0.75 (0.59-0.96)**	1.17 (0.93-1.47)	1.35 (0.99-1.84)
No qualifications	0.89 (0.75-1.07)	1.09 (0.90-1.33)	0.89 (0.67-1.18)	**0.71 (0.58-0.87)**	0.93 (0.75-1.16)	0.82 (0.61-1.12)
Overseas	0.95 (0.69-1.30)	0.97 (0.66-1.45)	1.39 (0.84-2.07)	0.79 (0.58-1.09)	0.85 (0.57-1.26)	1.32 (0.87-2.05)
IMD quintiles						
Least deprived area	1	1	1	1	1	1
2nd least deprived area	1.21 (0.99-1.48)	**1.38 (1.12-1.69)**	1.11 (0.88-1.40)	1.21 (0.99-1.48)	**1.35 (1.09-1.66)**	1.1 (0.87-1.38)
Median deprived area	1.29 (0.99-1.45)	**1.28 (1.04-1.56)**	1.09 (0.85-1.39)	1.77 (0.98-1.42)	1.19 (0.98-1.47)	1.07 (0.82-1.37)
2nd most deprived area	**1.23 (1.02-1.64)**	**1.56 (1.29-1.89)**	1.12 (0.86-1.44)	1.19 (0.98-1.45)	**1.44 (1.17-1.76)**	1.1 (0.83-1.44)
Most deprived area	**1.38 (1.16-1.64)**	**1.45 (1.19-1.76)**	**1.27 (1.00-1.61)**	**1.33 (1.11-1.61)**	**1.32 (1.06-1.63)**	1.25 (0.95-1.64)
Sex						
Male	1	1	1	1	1	1
Female	**0.62 (0.56-0.68)**	**0.69 (0.60-0.78)**	**0.59 (0.51-0.68)**	**0.62 (0.56-0.68)**	**0.69 (0.60-0.78)**	**0.59 (0.51-0.68)**
Mother's age	**0.98 (0.96-0.99)**	**0.98 (0.97-0.99)**	**0.98 (0.97-0.99)**	**0.98 (0.96-0.99)**	**0.98 (0.97-0.99)**	**0.99 (0.98-0.99)**
Child's age	1.19 (0.92-1.53)	0.98 (0.76-1.25)	**1.52 (1.16-2.01)**	1.16 (0.89-1.49)	1.01 (0.79-1.30)	**1.52 (1.16-2.01)**

All values are weighted. Model 1: unadjusted analysis. Model 2: mutual adjustment for socioeconomic factors and controlling for maternal age, child's age and sex.
OECD: Organization for Economic Co-operation and Development; IMD: Indices of Multiple Deprivation
Figures in bold are significant at the p<0.05 level

DISCUSSION

Using a large, nationally representative sample of children living in the UK, the current study found no clear social gradients in the associations between socioeconomic factors and the incidence of head injuries at ages three, five and seven. However, some associations with socioeconomic indicators were found. At ages three and five, social class, family income and area deprivation were all associated with head injury incidence, with children growing up in less advantaged families being more likely to experience head injuries. After mutual adjustment for socioeconomic factors and controlling for maternal age, child age and child sex, the associations with social class and income were no longer statistically significant, while associations with area deprivation and maternal education remained.

Regarding area deprivation, a threshold seems to exist. Similar to this study, Rhouma et al.[8] reported that children from more deprived areas were more likely to experience head injuries than children from less deprived areas. However, whereas Rhouma et al.[8] found a social gradient, we did not. Our study suggests that after a certain level of area deprivation, children are at higher risk of experiencing a head injury, independently of financial resources at household level, as the relationship between head injury and IMD was only slightly attenuated after the inclusion of the other socioeconomic factors, suggesting that neighbourhood factors might play a role in head injury incidence. Several other studies on childhood general injuries have reported similar findings[27-28]. An earlier review[10] showed that area deprivation play a role in childhood injury risk, independent of individual characteristics. One possible mechanism could be related to potential hazards in the physical environment. For example, it might be that children from more deprived areas lack access to gardens or safe playgrounds[29]. Other factors may operate at a family level, such as access to safe and affordable child care[28].

Pearce et al.[12] used a younger sample from the MCS (children aged between nine month and three years old) to report associations between general injuries, social class, and maternal education. Children from more disadvantaged socioeconomic backgrounds were more likely to have been injured than children from most advantaged backgrounds. Similarly to this study, there were no social gradients.

We found that at age three, children whose mothers had the highest level of education were more likely to experience head injuries than children whose mothers were the least educated. However, at age five the direction of the association was reversed, and children with mid-level educated mothers were more likely to experience head injuries than children with the most highly educated mothers. The direction of the association with maternal education at age three was unexpected. A possible explanation might be the nature of the MCS question: mothers were asked to report only those injuries for which their child was taken to a general practitioner or a hospital. There is some evidence that parents from higher socioeconomic backgrounds are more likely to take their preschool children to A&E departments for a minor injury than those who are less advantaged[30]. If that is the case, it would also mean that the inequalities observed in this study are underestimated.

In addition, it is interesting that at age seven there is little evidence for an association between head injury experience and socioeconomic disadvantage, confirming age-based differences in socioeconomic inequalities[31]. However, it was found that head injury risk was associated with child age at age 7. It might be that as children grow, the environment out of home becomes more important. Even when the age difference with previous sweeps is narrow big changes happens at that life stage. Children at the age of seven spend more time at school and less time at home, reducing the association with family-related socioeconomic factors. Furthermore, it could be that they get involved in sports increasing their risk to suffer head injuries due factors not considered in this study. Therefore, our results emphasize the importance of studying head injury risk separately at different stages of life.

Additionally, the results of this study confirm that boys and children with younger mothers had a higher incidence of head injury, consistent with previous published studies[5–9, 24-25]. They also confirm that head injuries are more frequent at younger ages[7-8, 32] , which may be due to the lack of coordination corresponding to this age.

The principal strength of this study is the use of large-scale and nationally representative survey data. The MCS is a unique dataset that includes high-quality information for a representative sample of children living in the UK. In addition, robust measures were used, considering different levels of deprivation that can be separately measured. The response rates were very favourable in every sweep, being close to 76%, reducing the possibility of selection bias.

Most likely, the greatest limitation of this study is that the survey question asked to report only the most severe injury that occurred during the time between sweeps. Therefore, this study might underestimate the real incidence of early childhood head injury. In addition, the MCS question about injuries is somewhat vague, which might have led to measurement error.
However, Rhouma et al.[8] found similar proportions of facial injuries among children at the same ages in a Scottish study that collected data from hospital records, and Trefan et al.[33] reported similar distributions using data from 216 UK hospitals records. Lastly, as the data were obtained retrospectively through maternal recall, the information collected could include

some recall bias. The use of parent report of childhood injury is a common approach in similar studies, but it may be subject to under-reporting. However, studies have suggested that in most cases, the mother's recall coincides with medical records; researchers have agreed that the parent's report is an acceptable resource for most research purposes with considerable reliability on most severe injuries[34-35].

Although it was beyond the scope of the present study, further studies should include other determinants that could have an effect on head injuries risk. More research is needed in relation with factors such as social mobility: MCS families social status could change from one sweep to other, which could underestimate a social gradient; the role of ethnicity is still unclear, there is no clear limit between ethnicity and social adversities[36-37].

Summarizing, the findings reported in this paper suggest that public health interventions at the area-level should be considered to reduce head injuries incidence in early childhood. Policies targeting specific needs of subgroups within a population have been shown to be effective in reducing health inequalities. For example, in Canada the implementation of a policy upgrading the safety of playground areas in the poorest neighbourhoods was effective in reducing the association between area deprivation and general children injury rates[38].

Conclusion

Contrary to the research hypothesis, no social gradients in early childhood head injury were observed. However, the findings suggest that children from the most deprived backgrounds were more likely to suffer head injuries. Area deprivation showed the strongest association, suggesting a threshold effect. Therefore, public health actions targeting the improvement of the neighbourhoods in the most deprived areas may be important to reduce inequalities in early childhood head injuries. Further studies with other populations would help to better elucidate how head injuries are distributed across the socioeconomic groups.

Funding Source: This study used publicly available data from the UK Millennium Cohort Study, no funding was secured for this study.

Financial Disclosure: The authors have no financial interests relevant to this article to disclose.

Conflict of Interest: The authors have no conflict of interest to disclose.

Acknowledgment: We are grateful to the Centre for Longitudinal Studies (CLS), UCL Social Research Institute, for the use of these data and to the UK Data Service for making them available. However, neither CLS nor the UK Data Service bear any responsibility for the analysis or interpretation of these data.

REFERENCES

1 Krug EG, Sharma GK, Lozano R. The global burden of injuries. *Am J Public Health* 2000;90(4):523-526. doi:10.2105/AJPH.90.4.523

2 United Nations Children's Fund (UNICEF). A League Table of Child Deaths by Injury in Rich Nations. Florence; 2001. doi:88-85401-71-6

3 Wolfe I, Macfarlane A, Donkin A, et al. Why Children Die: Death in Infants, Children, and Young People in the UK Part A. London; 2014. doi:10.1016/j.joms.2003.05.013

4 Carvalho TBO, Cancian LRL, Marques CG, et al. Six years of facial trauma care: an epidemiological analysis of 355 cases. *Braz J Otorhinolaryngol* 2010;76(5):565-574. doi:10.1590/S1808-86942010000500006

5 Gassner R, Tuli T, Hächl O, et al. Craniomaxillofacial trauma in children: a review of 3,385 cases with 6,060 injuries in 10 years. *J oral Maxillofac Surg* 2004;62(4):399-407. doi:10.1016/j.joms.2003.05.013

6 Kidd AJ, Beattie TF, Campbell-Hewson G. Facial injury patterns in a UK paediatric population aged under 13 years. *Emerg Med J* 2010;27(8):603-606. doi:10.1136/emj.2009.075127

7 Laflamme L, Eilert-Petersson E. Injuries to pre-school children in a home setting: patterns and related products. *Acta Paediatr*. 1998;87(2):206-211. doi:10.1111/j.1651-2227.1998.tb00977.x

8 Rhouma O, McMahon AD, Conway DI, et al. Facial injuries in Scotland 2001-2009: Epidemiological and sociodemographic determinants. *Br J Oral Maxillofac Surg* 2013;51(3):211-216. doi:10.1016/j.bjoms.2012.04.267

9 Ryan ML, Thorson CM, Otero CA, et al. Pediatric Facial Trauma. *J Craniofac Surg* 2011;22(4):1183-1189. doi:10.1097/SCS.0b013e31821c0d52

10 Laflamme L, Hasselberg M, Burrows S. 20 Years of Research on Socioeconomic Inequality and Children's-Unintentional Injuries Understanding the Cause-Specific Evidence at Hand. *Int J Pediatr* 2010:1-23. doi:10.1155/2010/819687

11 Haddon WJ. The changing approach to the epidemiology, prevention, and amelioration of

trauma: the transition to approaches etiologically rather than descriptively based. *Am J Public Health Nations Health* 1968;58(8):1431-1438.
12 Pearce A, Li L, Abbas J, et al. Does the home environment influence inequalities in unintentional injury in early childhood? Findings from the UK Millennium Cohort Study. *J Epidemiol Community Heal* 2012;66:181-188. doi:doi:10.1136/jech.2011.139626
13 Arakaki K, Liang F, Nimura H, et al. Home environment and minor facial trauma in preschool children with an emphasis on soft tissue injuries. *J Oral Maxillofac Surgery Med Pathol* 2014;26(1):11-13. doi:10.1016/j.ajoms.2012.08.008
14 Naidoo S. A profile of the oro-facial injuries in child physical abuse at a children's hospital. *Child Abuse Negl* 2000;24(4):521-534. doi:10.1016/S0145-2134(00)00114-9
15 Lalloo R. Risk factors for major injuries to the face and teeth. *Dent Traumatol* 2003;19(1):12-14. doi:10.1034/j.1600-9657.2003.00139.x
16 Sengoelge M, Leithaus M, Braubach M, et al. Are There Changes in Inequalities in Injuries? A Review of Evidence in the WHO European Region. *Int J Environ Res Public Health* 2019;16(4):653. doi:10.3390/ijerph16040653
17 Hughes K, McHale P, Wyke S, et al. Child injury: Using national emergency department monitoring systems to identify temporal and demographic risk factors. *Inj Prev* 2014;20(2):74-80. doi:10.1136/injuryprev-2013-040816
[dataset] 18 University of London, Institute of Education, Centre for Longitudinal Studies. Data from: Millennium Cohort Study: Fourth Survey, 2008. [data collection]. 8th Edition. UK Data Service. SN: 6411, doi: 10.5255/UKDA-SN-6411-8
19 Hansen K, Johnson J, Calderwood L, et al. Millenium Cohort Study, A Guide to the Datasets (Eighth Edition), First, Second, Third, Fourth and Fifth Surveys. London; 2014.
20 Galarza M, Gazzeri R, Barceló C, et al. Accidental head trauma during care activities in the first year of life: a neurosurgical comparative study. *Child's Nerv Syst* 2013;29(6):973-978. doi:10.1007/s00381-013-2051-6
22 Office for National Statistics (ONS). The National Statistics Socio-economic classification (NS-SEC).
https://www.ons.gov.uk/methodology/classificationsandstandards/otherclassifications/thenationalstatisticssocioeconomicclassificationnssecrebasedonsoc2010. Accessed May 6, 2019.
22 Rosenberg R. Millennium Cohort Study MCS2: Guide to Derived Variables. London; 2012.
23 Niggebrugge A, Haynes R, Jones A, et al. The index of multiple deprivation 2000 access domain: a useful indicator for public health? *Soc Sci Med* 2005;60(12):2743-2753. doi:10.1016/J.SOCSCIMED.2004.11.026
24 Taylor B, Wadsworth J, Butler NR. Teenage mothering, admission to hospital, and accidents during the first 5 years. *Arch Dis Child* 1983;58(1):6-11. doi:10.1136/adc.58.1.6
25 Hjern A, Ringbäck-Weitoft G, Andersson R. Socio-demographic risk factors for home-type injuries in Swedish infants and toddlers. *Acta Paediatr* 2001;90(1):61-68. doi:10.1111/j.1651-2227.2001.tb00257.x
26 StataCorp. Stata Statistical Software: Release 12. 2011.
27 Edwards P, Green J, Lachowycz K, et al. Serious injuries in children: variation by area deprivation and settlement type. *Arch Dis Child* 2008;93(6):485-489. doi:10.1136/adc.2007.116541
28 Durkin MS, Davidson LL, Kuhn L, et al. Low-income neighborhoods and the risk of severe pediatric injury: a small-area analysis in northern Manhattan. *Am J Public Health* 1994;84(4):587-592.
29 Mackay M, Vincenten J. Children's Right to Safety: Inequity in Child Injury in Europe. Birmingham; 2014.
30 Walsh SS, Jarvis SN. Measuring the frequency of "severe" accidental injury in childhood.

J Epidemiol Community Health 1992;46(1):26-32. doi:10.1136/jech.46.1.26
31 Kendrick D, Mulvaney C, Burton P, et al. Relationships between child, family and neighbourhood characteristics and childhood injury: A cohort study. *Soc Sci Med* 2005;61(9):1905-1915. doi:10.1016/j.socscimed.2005.04.003
32 Zerfowski M, Bremerich A. Facial trauma in children and adolescents. *Clin Oral Investig* 1998;2(3):120-124.
33 Trefan L, Houston R, Pearson G, et al. Epidemiology of children with head injury: A national overview. *Arch Dis Child*. 2016;101(6):527-532. doi:10.1136/archdischild-2015-308424
34 Pless CE, Pless IB. How well they remember; The accuracy of parent reports. *Arch Pediatr Adolesc Med* 1995;149(5):553-558. doi:10.1001/archpedi.1995.02170180083016
35 Cummings P, Rivara FP, Thompson RS, et al. Ability of parents to recall the injuries of their young children. *Inj Prev* 2005;11(1):43-47. doi:10.1136/ip.2004.006833
36 Panico L, Nazroo. The social and economic circumstances of mixed ethnicity children in the UK: findings from the Millennium Cohort Study. *Ethn Racial Stud* 2011;34(9):1421-1444. doi: 10.1080/01419870.2011.556745
37 Hawley C, Wilson J, Hickson C, et al. Epidemiology of paediatric minor head injury: Comparison of injury characteristics with Indices of Multiple Deprivation. *Injury* 2013;44(12):1855–1861. doi:10.1016/j.injury.2013.07.021
38 Macpherson AK, Jones J, Rothman L, et al. Safety standards and socioeconomic disparities in school playground injuries: a retrospective cohort study. *BMC Public Health* 2010;10:542. doi:10.1186/1471-2458-10-542