

Association of maternal risk factors with infant maltreatment: an administrative data cohort study.

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Short Title: Maternal risk factors for infant maltreatment

Conflict of Interest: The authors have no conflicts of interest relevant to this article to disclose.

Funding/Support: This study was supported by ICES, which is funded by an annual grant from the Ontario Ministry of Health (MOH) and the Ministry of Long-Term Care (MLTC). Parts of this material are based on data and information compiled and provided by: MOH, MLTC, Canadian Institute for Health Information (CIHI), and Immigration, Refugees Citizenship Canada (IRCC). The analyses, conclusions, opinions and statements expressed herein are solely those of the authors and do not reflect those of the funding or data sources; no endorsement is intended or should be inferred. Parts of this report are also based on Ontario Registrar General (ORG) information on deaths, the original source of which is ServiceOntario. The views expressed therein are those of the author and do not necessarily reflect those of ORG or Ministry of Government Services. Dr. Harron is supported by funding from the National Institute of Health Research (NIHR 17/99/19). This research was supported in part by the NIHR Great Ormond Street Hospital Biomedical Research Centre and the Health Data Research UK (grant No. LOND1), which is funded by the UK Medical Research Council and eight other funders. Dr. Guttmann is funded by a Tier 1 Canada Research Chair in child health services and policy. The other authors received no additional funding.

Abbreviations: CI, confidence intervals; OR, odds ratio; Q, quintile; SES, socioeconomic status; IPV, intimate partner violence

Article Summary: We used population-level data to evaluate the association between maternal risk factors typically used for targeting home visiting programmes, and infant maltreatment in Ontario.

What's Known on This Subject: A number of risk factors experienced by some mothers prior to delivery have been shown to be associated with child maltreatment. Many of these risk factors are currently used as criteria for public health visiting programs.

What This Study Adds: The risk of infant maltreatment increases significantly with an increasing number of risk factors. Young maternal age is an important risk factor and should be redefined to extend beyond typical parameters of adolescence.

How this study might affect research, practice or policy: This study has implications for public health policy, as it identified that infants of young mothers had the highest risk of maltreatment, suggesting they should be a focus of public health programming.

Contributors' Statement:

Dr. Smith conceptualized and designed the study, interpreted the results, drafted the initial manuscript and revised the manuscript.

Drs Guttman, Harron, Vandermorris and Shouldice conceptualized and designed the study, interpreted the results and drafted the manuscript.

Mr. Kopp was involved in the design of the study, had access to and analyzed the data, interpreted the results and drafted the manuscript.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Abstract

Objective: We aimed to evaluate the risk of infant maltreatment associated with commonly used criteria for home visiting programs: young maternal age, maternal adversity (homelessness, substance abuse, intimate partner violence), newcomer status, and mental health concerns in Ontario, Canada.

Design: This retrospective cohort study included infants born in hospital in Ontario from April 1, 2005 to March 31, 2017 captured in linked health administrative and demographic databases. Infants were followed from newborn hospitalization until 1 year of age for child maltreatment captured in healthcare or death records. The association between type and number of maternal risk factors, and maltreatment, was analysed using multivariable logistic regression modelling, controlling for infant characteristics and material deprivation. Further modelling explored the association of each year of maternal age with maltreatment.

Results: Of 989,586 infants, 434 (0.04%) had recorded maltreatment. Maternal age <22 years conferred higher risk of infant maltreatment (adjusted odds ratio (aOR) 5.5, 95% confidence interval (CI) 4.5-6.8) compared with age \geq 22 years. Maternal mental health diagnoses (aOR 2.0, 95% CI 1.6-2.5) were also associated with maltreatment, while refugee status appeared protective (aOR 0.6, 95% CI 0.4-1.0). The odds of maltreatment increased with higher numbers of maternal risk factors. Maternal age was associated with maltreatment until age 28.

Conclusion: Infants born to young mothers are at greater risk of infant maltreatment, and this association remained until age 28 years. These findings are important for ensuring public health interventions are supporting populations experiencing structural vulnerabilities with the aim of preventing maltreatment.

Keywords: child maltreatment, maternal risk factors, vulnerabilities, child abuse

Introduction

Child maltreatment remains a significant cause of morbidity and mortality in high-income countries¹⁻³. In Canada, 32% of adults reported personal histories of child maltreatment, including physical, sexual and emotional abuse⁴. In addition to being widely prevalent, exposure to child maltreatment has long-term negative impacts on health and development, making it an important public health issue^{4,5}.

Risk factors for child maltreatment including low socioeconomic status (SES) and structural vulnerabilities⁶⁻⁹ are often present prior to birth¹⁰. The literature describes parental risk factors for infant maltreatment, including young age, mental health concerns, substance use, and a history of experiencing violence, and these are in turn linked to low SES and other important social determinants of health^{6,11-17}. Observational and population-based studies report associations between infant characteristics and risk of child maltreatment, including congenital anomalies, male sex, prematurity and low birth weight^{6,11,13,18,19}. Further research can determine the risk factors most strongly associated with child maltreatment, in order to provide targeted guidance about the populations most likely to benefit from support and intervention.

Capitalizing on population-based linked administrative and demographic data, this study explored the association of young maternal age, maternal adversity (defined as homelessness, substance abuse or intimate partner violence), refugee status, and a history of mental health diagnosis with those presenting for medical care due to infant maltreatment in Ontario, Canada. Ontario has public health home visiting programming with universal

screening designed to mitigate risk factors for maltreatment yet limited information on program outcomes. While this study was not an evaluation of existing public health programs, it sought to explore the relationship between risk factors used for targeting of public health programs and maltreatment in mother-infant dyads.

Methods

Study Design and Setting

This was a population-based retrospective cohort study of all live births captured in hospital data in Ontario, Canada between April 1, 2005 and March 31, 2017 and available at ICES (formerly known as the Institute for Clinical Evaluative Sciences). ICES is an independent, non-profit research institute whose legal status under Ontario's health information privacy law allows it to collect and analyze health care and demographic data, without consent, for health system evaluation and improvement. The end date was determined by the availability of immigration data which was one of the important variables studied.

Data Sources

Study data were extracted from linked population-based administrative and demographic databases using encoded identifiers. The National Ambulatory Care Reporting System (NACRS) identifies Emergency Department visits according to discharge diagnosis (*International Classification of Diseases [ICD] 10th Revision* codes)²⁰ and the Canadian Institute for Health Information Discharge Abstract Database (CIHI-DAD) contains information regarding patients discharged from hospitals²¹. These identified infant baseline characteristics, child maltreatment outcomes, and some maternal risk factors. The CIHI-

DAD data are also used to create the MOMBABY dataset which contains linked maternal and newborn health records. The Ontario Mental Health Reporting System (OMHRS) and Ontario Health Insurance Plan (OHIP) codes were utilized to identify those mothers with a history of mental health disorders. The Ontario portion of the federally maintained Immigration, Refugees and Citizenship Canada's (IRCC) Permanent Resident Database characterized immigrant and refugee status, these data are available from 1985 to May 2017. The Ontario Registered Persons Database (RPDB) and The Office of the Registrar General – Deaths (ORGD) are demographic databases that provided infant death outcomes²². Census data were used to describe neighbourhood level material deprivation, one component of the Ontario Marginalization index²³.

Study population

We included live births in Ontario between April 1, 2005 and March 31, 2017. We randomly selected one child per mother in the study period to avoid clustering of outcomes in families. We excluded mother-baby dyads who were not Ontario residents or were not linked to the Registered Persons Database (RPDB). We also excluded infants not exposed to their mother beyond the birth hospitalization (infants who died during newborn hospitalization or were discharged to the care of child protective services (CPS) from newborn hospitalisation).

Exposures

We defined a number of maternal exposure variables (see Appendix A for diagnostic codes), based on key socio-demographic referral criteria for the public health home visiting program in Ontario, Healthy Babies Healthy Children (HBHC)²⁴. We used a lookback period of three

years prior to delivery, as this period prior to birth could have impacts on the outcomes. These included history of mental health disorders (inpatient or outpatient assessment), or adversity (any emergency visit or admission where substance abuse, intimate partner violence (IPV), or homelessness was recorded). Newcomer status was categorised as recent newcomer (immigrant and refugee newcomer, <3 years in residence as defined by HBHC), less recent refugees; less recent non-refugee immigrants were combined with Canadian-born or other long-term residents of Ontario. Young maternal age was initially defined as mothers <22 years at time of delivery, in line with HBHC screening criteria used by some public health units. *Post hoc* analyses then explored maternal age by year until the age of 30 years.

Covariates

Prematurity, congenital anomalies (Appendix B) and infant sex were included as covariates as these variables have previously been shown to be associated with child maltreatment^{6,11,16,19}. The major congenital anomaly categories were described using the previously created classification system using ICD-10 codes²⁵. Neighbourhood quintiles of material deprivation were also included, based on a number of census variables including proportion of lone-parent families, educational attainment, need for social assistance, unemployment, and low-income households²³.

Outcomes

Infants were followed from time of discharge from newborn hospitalization until the earliest of either their first birthday or death. Our primary outcome was a measure of infant maltreatment, defined as death or presentation to hospital with diagnoses of child

maltreatment or assault before age 1 identified by ICD-10 codes from existing international work by Gilbert, et al (Appendix C)².

Analysis

The association between infant maltreatment and maternal risk factors was analysed using multivariable logistic regression. The model included infant characteristics (infant sex, gestational age, congenital anomalies). Birth weight was not included in the final model to avoid collinearity with gestational age. A separate model was created to explore the association between the number of maternal risk factors (1, 2, or ≥ 3) and outcomes.

To further explore the association between young maternal age and infant outcomes, the risk of infant maltreatment was explored by single year of maternal age between 22 and 29 years (compared to a reference group of mothers aged 30-34 years). Due to the small numbers of outcomes, the maternal age category <22 years was not divided further to maintain stability of the regression models.

Ethical Considerations

This study was approved by the Research Ethics Board at The Hospital for Sick Children, Toronto (REB 1000056239) and The London School of Hygiene and Tropical Medicine (ref 12206).

Results

1,607,687 mother-baby dyads were examined for eligibility (Figure 1). Following exclusions and random selection of one infant per mother, 989,586 mother-baby dyads born were included.

Table 1 describes maternal and infant baseline characteristics by type of maternal risk factor. Maternal and infant baseline characteristics by number of maternal risk factors can be found in the supplementary material.

Overall, 0.04% (n=434) of infants were recorded with fatal (n=13) or non-fatal (n=421) maltreatment or assault (Table 2). The number and percent of infants with maltreatment increased with the number of maternal risk factors (0.02% in mothers with no risk factors, 0.09% in mothers with 1 risk factor, 0.21% in those with 2, and 0.28% in those with three or more).

Association between exposure and outcome

In the adjusted model, the odds of maltreatment were 5.5 times higher (95% CI 4.5-6.8) in infants born to mothers aged <22 years than ≥ 22 (Table 3) and having a history of a mental health diagnosis had an OR of 2.0 (95% CI 1.6-2.5). Adversity had an unadjusted OR of 6.2 (95% 3.9-9.8) but adjusting for other factors reduced this to 1.5 (95% CI 0.9-2.4). Recent refugee status appeared protective with an adjusted OR of 0.6 (95% CI 0.4-1.0). The risk of maltreatment increased significantly with increasing numbers of maternal risk factors (Table 3).

Exploring young maternal age by year demonstrated a significant risk of maltreatment that continued to the age of 28 years (Figure 2) while controlling for other risk factors. Infants experiencing maltreatment were 11.1 times (95% CI 8.3-14.7) more likely to have mothers

≤ 22 years than mothers who were 30-34 years. Risk of maltreatment remained elevated until age 28 years, as infants were 2.0 times (95% CI 1.2-3.2) more likely to experience maltreatment than infants born to mothers aged 30-34 years.

Discussion

Our study used population-level data for Ontario to determine the prevalence of infant maltreatment presenting for healthcare and showed that 0.04% of infants presented with a fatal or non-fatal maltreatment diagnosis between 2005 and 2018. Structural vulnerabilities were explored and infants born to mothers aged <22 years were 5.5 times more likely to experience maltreatment than those born to mothers aged ≥ 22 , after adjusting for covariates and other maternal factors. The risk of infant maltreatment was greatest for mothers with multiple risk factors. Refugee status did not appear to be associated with increased risk of infant maltreatment, which is in keeping with a study exploring maltreatment rates in immigrants²⁶; however, this requires further dedicated analysis given the possible trauma experienced by those claiming refugee status.

Our study confirms findings from previous studies showing that younger maternal age is associated with maltreatment^{12,16,27,28}. It has been suggested that this may reflect other risk factors associated with young maternal age, such as lower SES, substance abuse, and mental health conditions^{27,29,30}. However, the increased risk remained while controlling for these risk factors in our study. This suggests that young maternal age has inherent risks or that there are other unmeasured confounding factors, such as low maternal educational attainment, a lack of social supports, suboptimal living arrangements, or intergenerational trauma. Importantly, a maternal history of trauma has been associated with both early pregnancy,^{27,31-33} and maltreatment of infants^{17,28,34,35}. Data from the Canadian Incidence Study of Reported Child Abuse and Neglect found that young mothers are more likely to have lived in foster care or a group home²⁷. A study examining maltreatment in infants of

adolescent mothers found a maternal history of maltreatment to be the greatest predictive factor of infant maltreatment, demonstrating the importance of intergenerational trauma as a risk factor for subsequent child maltreatment³⁶. A meta-analysis examining adolescent pregnancy and abuse history found that adolescents who had experienced physical or sexual assault were at increased risk of pregnancy³². This suggests that enhanced supports and a focus on decreasing structural vulnerabilities for people experiencing intergenerational trauma could lead to positive outcomes for parents and children.

Young maternal age has traditionally been categorized as adolescent (10-19 years of age) females. However, our study found that maternal age remained a significant risk factor until 28 years. This is supported by evidence in other settings: a population-based study in California found that young maternal age <25 was significantly associated with maltreatment fatalities¹². Analysis of CPS reports in Alaska found increased maltreatment reports in mothers <26 years³⁷. Similar findings have been observed for other adverse infant outcomes including unplanned hospital contacts and mortality³⁸. While social risk factors and structural vulnerabilities likely explain much of the effect of young age, another theory is that at a neurobiological level, full maturation of the brain (particularly the prefrontal cortex) is not attained until mid-20s. Though this association has not been directly studied, relative neurodevelopmental immaturity may be a contributing factor through, for example, decreased impulse control^{30,39,40}. Furthermore, in 2016, the average age of first-time mothers in Ontario was 30 years, compared to the early 1970s when the average age was about 24 years, which likely reflects a shift in the social context with women pursuing further education and careers⁴⁰⁻⁴². Our evidence highlights that considering young maternal age to be

<20 (or 22, for HBHC) excludes young mothers who could also benefit from increased support of services and social policies.

The risk of maltreatment increased significantly with increasing numbers of maternal risk factors. Although there has been limited research regarding the effect of multiple risk factors on the risk of maltreatment, an Australian population-based cohort study spanning 27 years demonstrated similar findings⁴³. In our study, infants born to mothers with 3 or more risk factors had 9 times the risk of infant maltreatment. This suggests a need for extended supports that decrease vulnerabilities in families with multiple risk factors, such as through employment and education opportunities, adequate housing, access to mental health services and social inclusion. Increased support before, during and after pregnancy for vulnerable mothers could impact maltreatment, given these risk factors are also associated with preterm birth, and mortality and unplanned infant hospital admissions¹⁰.

Limitations

While the population-based nature of the study data sources is an asset, administrative data confer a number of limitations. ICD coding is known to be challenging, particularly in the field of maltreatment⁴⁴. Additionally, many children who experience maltreatment do not present to healthcare with injuries. Previous studies examining maltreatment outcomes utilized similar ICD-10 codes^{2,45,46}. Limited validation studies currently exist for child maltreatment research using ICD-10 codes; however, a study by Garza, et al demonstrated that while specificity was higher (79%), sensitivity was 56% using ICD-10 maltreatment and assault codes to identify maltreatment for inpatients⁴⁶. This raises the possibility of under-ascertainment of maltreatment outcomes. Conversely, those with apparent risk factors, such

as young age, may be more readily diagnosed with maltreatment resulting in potential over-representation.

Furthermore, diagnosed infant maltreatment is relatively rare, limiting the analysis of more granular maternal risk factors, for instance, type of mental health diagnosis. Risk factors such as IPV, substance use and homelessness are underreported and frequently not identified in healthcare settings; prevalence is expected to be higher than represented in the healthcare data and these factors may be more significant than shown in our analysis. In particular, studies have demonstrated IPV in the home increases the risk of maltreatment, including occult physical injuries⁴⁷. Using administrative data, the analysis is restricted to previously collected variables and some factors such as maternal education and intergenerational trauma could not be examined. Lastly, information on types of support accessed, such as public health home visiting programs, was unavailable.

Future directions

This study has implications for public health policy. It identifies important groups that would benefit from increased support, including young mothers up to age 28, those with mental health concerns, those experiencing adversity and those with multiple risk factors. This may indicate a need for a graded intensity of support. Infants of young mothers had the highest risk of maltreatment and comprised the largest group, suggesting they should be a focus of public health programming. This could include interventions enhancing early adolescents' educational engagement, perceptions of economic and vocational opportunities, and awareness of sexual health options⁴⁸. While it is helpful to understand risk factors at a

population level, the next step is to understand whether public health programs aimed to support this group improve outcomes. Recent reviews of the effect of public health programs aimed at mitigating risk factors demonstrate variable outcomes⁴⁹⁻⁵². Accessing observational public health program data to understand outcomes of those engaged with the program is critical in delineating the impact. Effective public health programming that improves outcomes for children and families could decrease the future risk of maltreatment and mortality and from the societal perspective, promote the health, productivity and cohesion of the population as a whole.

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Table 1. Baseline characteristics of mothers and infants born between April 1, 2005 and March 31, 2017 by maternal risk factor.

Table 2. Infant maltreatment outcomes by maternal risk factor and number of risk factors.

Table 3. Unadjusted and Adjusted Odds ratios for infant maltreatment outcomes by maternal risk factor and infant characteristics.

Figure 1. Creation of the study cohort.

Figure 2. Adjusted odds ratios for infant maltreatment outcomes by maternal age compared to maternal age 30-34 years.

Table 1. Baseline characteristics of mothers and infants born between April 1, 2005 and March 31, 2017 by maternal risk factor.

	Maternal Mental Health 3 years prior to delivery		Maternal Age		Immigration Status			Maternal History of Adversity 3 years prior to delivery			Total
	Known mental health diagnosis	No mental health diagnosis	<22 years	≥22 years	Recent Refugee	Recent immigrant (Non-refugee)	Canadian-born or long-term resident	Substance Abuse	Violence	Homelessness	
No. (%)*											
Total	133,117 (13.5%)	856,469 (86.6%)	66,441 (6.7%)	923,145 (93.3%)	7,520 (0.8%)	68,930 (7.0%)	913,136 (92.3%)	1,443 (0.1%)	6,572 (0.7%)	480 (0.05%)	989,586
Material Deprivation (quintile)											
Q1 (Least Deprived)	22,804 (17.1%)	159,768 (18.7%)	4,928 (7.4%)	177,644 (19.2%)	369 (4.9%)	8,558 (12.4%)	173,645 (19.0%)	134 (9.3%)	625 (9.5%)	43 (9.0%)	182,572 (18.4%)
Q2	20,467 (15.4%)	137,714 (16.1%)	7,494 (11.3%)	150,687 (16.3%)	437 (5.8%)	8,344 (12.1%)	149,400 (16.4%)	152 (10.5%)	743 (11.3%)	39 (8.1%)	158,181 (16.0%)
Q3	21,688 (16.3%)	140,220 (16.4%)	9,944 (15.0%)	151,964 (16.5%)	907 (12.1%)	10,607 (15.4%)	150,394 (16.5%)	204 (14.1%)	946 (14.4%)	71 (14.8%)	161,908 (16.4%)
Q4	23,103 (17.4%)	141,997 (16.6%)	13,458 (20.3%)	151,642 (16.4%)	1,455 (19.3%)	13,474 (19.5%)	150,171 (16.4%)	269 (18.6%)	1,279 (19.5%)	70 (14.6%)	165,100 (16.7%)
Q5 (Most Deprived)	31,704 (23.8%)	170,496 (19.9%)	24,615 (37.0%)	177,585 (19.2%)	3,745 (49.8%)	18,239 (26.5%)	180,216 (19.7%)	516 (35.8%)	2,158 (32.8%)	218 (45.4%)	202,200 (20.4%)
Unknown	13,324 (10.0%)	106,301 (12.4%)	6,002 (9.0%)	113,623 (12.3%)	607 (8.1%)	9,708 (14.1%)	109,310 (12.0%)	168 (11.6%)	821 (12.5%)	39 (8.1%)	119,625 (12.1%)
Infant Characteristics											
Congenital Anomalies	7872 (5.9%)	45,942 (5.4%)	3,736 (5.6%)	50,078 (5.4%)	377 (5.0%)	3,379 (4.9%)	50,058 (5.5%)	99 (6.9%)	434 (6.6%)	42 (8.8%)	53,814 (5.4%)
Birth weight (g)											

<1500	1,381 (1.0%)	6,766 (0.8%)	537 (0.8%)	7,610 (0.8%)	71 (0.9%)	502 (0.7%)	7574 (0.8%)	19 (1.3%)	73 (1.1%)	6 (1.3%)	8,147 (0.8%)
1500-2499	8258 (6.2%)	42,752 (5.0%)	3,754 (5.7%)	47,256 (5.1%)	325 (4.3%)	3,869 (5.6%)	46,816 (5.1%)	171 (11.9%)	515 (7.8%)	57 (11.9%)	51,010 (5.2%)
2500-3999	109,446 (82.2%)	715,380 (83.5%)	55,637 (83.7%)	769,189 (83.3%)	6,422 (85.4%)	60,410 (87.6%)	757,994 (83.0%)	1,125 (78.0%)	5,371 (81.7%)	386 (80.4%)	824,826 (83.4%)
≥4000	14,000 (10.5%)	91,579 (10.7%)	6,511 (9.8%)	99,068 (10.7%)	702 (9.3%)	4,146 (6.0%)	100,731 (11.0%)	128 (8.9%)	613 (9.3%)	31 (6.5%)	105,579 (10.7%)
Gestational age (weeks)											
≤28	485 (0.4%)	2,317 (0.3%)	183 (0.3%)	2,619 (0.3%)	26 (0.3%)	157 (0.2%)	2,619 (0.3%)	6 (0.4%)	25 (0.4%)	≤5	2,802 (0.3%)
29-32	1,679 (1.3%)	8,238 (1.0%)	704 (1.1%)	9,213 (1.0%)	67 (0.9%)	541 (0.8%)	9,309 (1.0%)	31 (2.1%)	102 (1.6%)	12-16 (2.5-3.3%)	9,917 (1.0%)
33-36	10,484 (7.9%)	50,340 (5.9%)	3,960 (6.0%)	56,864 (6.2%)	371 (4.9%)	3,440 (5.0%)	57,013 (6.2%)	159 (11.0%)	528 (8.0%)	50 (10.4%)	60,824 (6.1%)
≥37	120,387 (90.4%)	795,320 (92.9%)	61,519 (92.6%)	854,188 (92.5%)	7,054 (93.8%)	64,782 (94.0%)	843,871 (92.4%)	1,245 (86.3%)	5,908 (89.9%)	412 (85.8%)	915,707 (92.5%)

*In accordance with the ICES Protection of ICES Data Policy cell sizes of less than or equal to five are not reported and some cells are then reported in ranges to reduce the risk of re-identification.

Table 2. Infant maltreatment outcomes by maternal risk factor and number of risk factors.

	Total	Infants with maltreatment outcome(s)
	No.*	
Total	989,586	434 (0.04%)**
History of Mental Health Diagnosis 3 years prior to delivery		
Yes	133,090	129 (0.10%)
No	856,496	305 (0.04%)
Maternal age		
<22	66,441	147 (0.22%)
≥22	923,145	287 (0.03%)
Immigration Status		
Recent refugee	7,520	≤5
Recent immigrant (non-refugee)	68,930	10-16 (0.02%)
Canadian-born or long-term resident	913,136	417 (0.05%)
Maternal History of Adversity 3 years prior to delivery		
Yes	8,495	21 (0.25%)
No	981,091	413 (0.04%)
Number of Maternal Risk Factors		
0	733,290	183 (0.02%)
1	231,942	198 (0.09%)
2	20,815	43 (0.21%)
≥3	3,539	10 (0.28%)

*In accordance with the ICES Protection of ICES Data Policy cell sizes of less than or equal to five are not reported and some cells are then reported in ranges to reduce the risk of re-identification.

**Row percentages are reported

Table 3. Unadjusted and Adjusted Odds ratios for infant maltreatment outcomes by maternal risk factor and infant characteristics.

	Odds Ratio			Adjusted Odds Ratio		
	OR	95% CI	p-value	aOR	95% CI	p-value
Type of maternal risk factor						
No risk factor	1 (ref)			1 (ref)		
Age < 22	7.2	5.9 – 8.8	<0.001	5.5	4.5 – 6.8	<0.001
Mental health diagnosis*	2.7	2.2 – 3.3	<0.001	2.0	1.6 – 2.5	<0.001
Recent Refugee	0.5	0.3 – 0.8	0.005	0.6	0.4 – 1.0	0.045
Adversity*	6.2	3.9 – 9.8	<0.001	1.5	0.9 – 2.4	0.128
Number of maternal risk factors						
0	1 (ref)			1 (ref)		
1	3.4	2.8 – 4.2	<0.001	3.1	2.5 – 3.8	<0.001
2	8.5	6.1 – 11.9	<0.001	7.2	5.1 – 10.1	<0.001
≥3	10.8	5.5 – 21.1	<0.001	9.1	4.7 – 17.9	<0.001
Congenital** anomaly	1.4	1.0 – 2.0	0.061	1.2	0.8 – 1.7	0.368
Male sex**	1.3	1.1 – 1.6	0.006	1.3	1.1 – 1.6	0.008
Gestational age (weeks)**						
≤28	3.4	1.3 – 9.4	0.013	2.9	1.1 – 8.1	0.040
29-32	2.2	1.1 – 4.3	0.019	2.0	1.0 – 3.8	0.049
33-36	1.4	1.0 – 2.0	0.059	1.3	0.9 – 1.9	0.116
≥37	1 (ref)			1 (ref)		
Material deprivation (quintile)**						
Q1 (least deprived)	0.6	0.4 – 0.9	0.017	0.7	0.5 – 1.1	0.096
Q2	0.7	0.5 – 1.0	0.077	0.7	0.5 – 1.1	0.134
Q3	1 (ref)			1 (ref)		
Q4	1.4	1.0 – 2.0	0.029	1.3	1.0 – 1.9	0.084
Q5 (most deprived)	2.1	1.5 – 2.8	<0.001	1.7	1.2 – 2.3	0.001

*Within 3 years prior to delivery

**From type of maternal risk factor model