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Children at risk of medicinal and non-medicinal poisoning:

a population-based case-control study in general practice

Abstract

Background
Preschool children have a high risk of poisoning. While medicines prescribed by primary care are potential poisoning agents, the risk factors for poisoning from medication are not well described.

Aim
To identify risk factors for medicinal and non-medicinal poisoning in preschool children.

Design and setting
Population-based nested case-control study using The Health Improvement Network primary care database 1988–2004.

Method
Conditional logistic regression was used to identify child, maternal, and social risk factors for medicinal (1316 cases) and non-medicinal poisoning (503 cases), using 17 709 controls matched on general practice.

Results
Poisoning by medicines was independently associated with deprivation (test for trend $P<0.001$), maternal age ($P<0.001$), birth order ($P<0.001$), maternal alcohol misuse (odds ratio [OR] = 5.44, 95% confidence interval [CI] = 1.99 to 14.91), and perinatal depression (OR = 1.54, 95% CI = 1.26 to 1.88). Living in a household with two or more adults lowered the odds of injury compared to single-parent households (OR = 0.85, 95% CI = 0.74 to 0.96) and the odds varied by age, being highest in 2 year olds (OR = 9.61, 95% CI = 7.73 to 11.95). Non-medicinal poisoning was associated with deprivation ($P = 0.001$), maternal age ($P<0.001$), and birth order ($P<0.001$). The odds were raised in 1 year olds (OR = 5.44, 95% CI = 4.07 to 7.26) and 2 year olds (OR = 5.07, 95% CI = 3.73 to 6.90) compared to those aged <1 year.

Conclusion
Primary care data can be used to target interventions to children at risk of poisoning. This is pertinent when prescribing for children/family members, as prescribed medications may become poisoning agents. Prompt identification of maternal depression and alcohol misuse, and delivery of poisoning-prevention interventions at this stage may help prevent poisonings.

Keywords
child; general practice; poisoning; primary health care; risk factors.

INTRODUCTION

Poisonings are an important child health problem; they result in considerable distress for the child and family and may even be fatal. There are approximately 16 000 hospital admissions for poisoning per year in England in those aged <15 years,[1] and preschool children in particular are at risk, with more than 26 000 emergency department (ED) attendances each year in the UK.[2] The cost to the NHS, based on 2011/2012 tariffs for poisoning admissions, is over £8 million per year,[3] and clinical commissioning groups (CCGs) will bear the brunt of these costs.

Recent commissioning guidance on urgent and emergency care highlighted that 'prevention is as important as service provision to address acute avoidable episodes',[4] but contained little detail on how primary care or CCGs may achieve this. The National Institute for Health and Clinical Excellence (NICE) has, however, issued guidance on injury prevention and recommends that primary care practitioners provide safety advice and refer families at greatest risk of injury for home safety assessments and for safety equipment provision.[5] But how can the primary care team establish which children are at greatest risk? The data collected routinely by primary care do include information on known risk factors for childhood poisoning injury, including child age,[6–10] sex,[6,7,11] birth order,[12] maternal age,[8,13] depression,[13] socioeconomic disadvantage,[12,14–16] and single parenthood,[13] but these data are not currently used to identify families with the greatest potential to benefit from poisoning-prevention interventions. Given that primary care clinicians have specific responsibilities for poison prevention when they are prescribing or advising parents to purchase over-the-counter medications that are potential poisoning agents, this study has been undertaken to determine if children at risk of poisoning, and more specifically poisoning by medicines and non-medicines, can be identified using primary care data. This information could be used to enable primary care clinicians to target interventions appropriately, as set out by NICE guidelines.[5]

METHOD

Participants and setting

This study used prospectively collected longitudinal data extracted from The Health Improvement Network (THIN), a computerised database of 3.9 million general practice patient records (at the time of generating the dataset) from across the UK.

Study populations were drawn from an open cohort of all children in THIN born between January 1988 and November 2004 who were linked to their mothers' general practice records, as previously described.[17] All children were registered with their general practice within 60 days of birth, to

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How this fits in

Preschool children are known to have a high risk of poisoning injury, and while advice from GPs about safer storage of medicines and cleaning products is effective, previous research suggests that the number of GPs providing such advice may be small. Given the frequent contacts that primary care has with preschool children, this study explored whether GP clinical information systems could be used to easily identify those children most at risk of poisoning and whether there are different risk factors for medicinal and non-medicinal poisoning cases. The study shows that children at high risk of medicinal and non-medicinal poisoning injury can be identified using information from clinical systems alone. This information can be used to target effective safety interventions as recommended by the NICE and to advise parents that medicines and household products should be put away immediately after purchase/use and not to take medicines in front of children because children often imitate adult behaviour.

ensure identification of the first occurrence of a poisoning episode and risk factors from birth onwards. One child was then selected at random from each household, to avoid clustering of common risk factors for multiple children in the same household. Other household members were identified using a household code within THIN.

Case definition

Cases were children with a recorded poisoning event before 5 years of age. Poisoning events were identified by Read Codes entered by the general practice into the patient's electronic record. For any child with more than one poisoning event under the age of 5 years, only the first chronological event was used. The poisoning substances involved were categorised as medicinal or non-medicinal, according to the World Health Organization (WHO) International Classification of Diseases version 10 (ICD-10). Cases where the type of poisoning substance was not identified as medicinal or non-medicinal using the Read Code were excluded from the analysis. To minimise the number of excluded cases, additional injury Read Code entries within 3 months after the first poisoning event were inspected manually, to identify any codes that specified whether the poisoning was medicinal or non-medicinal.

Control definition

Each case had up to 10 controls selected at random that had been matched on the case's general practice. Controls were registered in THIN and aged <5 years on the date of the case's poisoning injury (which was applied as their proxy poisoning date) but did not have a poisoning Read Code recorded in their medical records by this date.

Sample size calculation

The statistical power of the analyses was estimated using the prevalence of maternal depression during pregnancy or within the 6 months after delivery. This is an important issue commonly seen in general practice and is one of the least common risk factors in the controls. To obtain 80% power to detect an odds ratio (OR) of 1.65 at the 5% significance level, assuming a correlation for exposures between cases and controls of 0.2 to allow for matching on general practice, 448 cases and 10 matched controls were required for each study. For most other exposures, there was much greater statistical power.

Risk factor variables

Potential risk factors identified from the literature and available in THIN data included child age, sex, birth order, maternal age at the birth of the child, most recently recorded maternal smoking status before the birth of the child, maternal alcohol misuse prior to the poisoning event (defined as Read Codes indicating problematic drinking, frequent high levels of alcohol intake, adverse health outcomes due to alcohol, or specific treatment for alcohol addiction), perinatal depression (defined as a Read Codes recorded in the maternal record indicating a diagnosis of or treatment for depression during pregnancy or within 6 months of birth), Townsend index (in quintiles), and the number of adults aged >16 years registered at the same general practice living in the household at the time of the poisoning. The Townsend score is a measure of household-level material deprivation, based on unemployment, non-car ownership, non-home ownership, and overcrowding,[18] and is assigned to each patient record, based on their postcode, before release for research use.

Statistical analysis

The data were analysed using StataSE (version 11). Conditional logistic regression was used for univariate and multivariable analyses for medicinal and non-medicinal poisonings separately. Multivariable models

Table 1. Characteristics of cases and controls and univariate associations between risk factors and medicinal poisoning

Characteristic	Cases (%), *n* = 1316	Controls (%), *n* = 12 836	Unadjusted odds ratio (95% CI)
Child characteristics			
Sex of child			
Female	627 (48)	6284 (49)	1.00
Male	689 (52)	6552 (51)	1.05 (0.94 to 1.18)
Age when poisoning occurred, months			
0–12	108 (8)	4272 (33)	1.00
13–24	430 (33)	2799 (22)	6.22 (5.01 to 7.74)
25–36	516 (39)	2308 (18)	9.24 (7.44 to 11.47)
≥37	262 (20)	3457 (27)	3.15 (2.49 to 3.97)
Birth order of child			
1st	853 (65)	9093 (71)	1.00
2nd	390 (30)	3192 (25)	1.34 (1.17 to 1.53)
3rd or more	73 (5)	551 (4)	1.48 (1.14 to 1.92
Maternal characteristics			
Maternal age at birth of child, years			
<20	111 (8)	733 (6)	1.00
20–29	724 (55)	6308 (49)	0.75 (0.60 to 0.93)
30–39	448 (34)	5481 (43)	0.53 (0.42 to 0.66)
≥40	33 (3)	314 (2)	0.67 (0.44 to 1.02)
Maternal diagnosis of depression			
No	1177 (89)	11 938 (93)	1.00
Yes	139 (11)	898 (7)	1.58 (1.31 to 1.92)
Maternal smoking			
Never smoked	586 (44)	6414 (50)	1.00
Ex-smoker	63 (5)	556 (4)	1.26 (0.95 to 1.66)
Current smoker	343 (26)	2809 (22)	1.35 (1.17 to 1.56)
Missing	324 (25)	3057 (24)	1.17 (0.99 to 1.37)
Maternal alcohol misuse			
Never	1299 (98.71)	12 774 (99.52)	1.00
≤1 year before poisoning	7 (0.53)	12 (0.09)	5.54 (2.17 to 14.15)
>1 year before poisoning	10 (0.76)	50 (0.39)	1.99 (1.00 to 3.93)
Social characteristics			
Townsend index quintile			
1 (least deprived)	260 (20)	2843 (22)	1.00
2	200 (15)	2370 (18)	0.93 (0.76 to 1.13)
3	252 (19)	2439 (19)	1.17 (0.96 to 1.41)
4	266 (20)	2300 (18)	1.35 (1.12 to 1.65)
5 (most deprived)	242 (19)	1876 (15)	1.57 (1.28 to 1.93)
Missing	96 (7)	1008 (8)	0.94 (0.63 to 1.39)
Single parenthood			
Single adult	581 (44)	4906 (38)	1.00
Two adults	646 (49)	6817 (53)	0.78 (0.69 to 0.89)
Other	89 (7)	1113 (9)	0.66 (0.52 to 0.84)

were built using the procedure described by Collett and assessing significance using likelihood ratio tests.[19] Potential interactions were identified a priori, based on theoretical plausibility, then tested by adding interaction terms to the models, using a *P*-value of <0.01 (in view of the large sample size) as indicating statistical significance. Models were assessed for multicollinearity.

RESULTS

Using a comprehensive list of poisoning Read Codes, a total of 2193 cases of first poisoning were identified. Of these, 1316 could be identified as poisonings by medicines and 503 as poisonings by other substances. The cases included 29 children whose poisoning injury was classified based on an additional code entered into the medical record within 48 hours of the first poisoning code. The cause of poisoning could not be established in 374 cases and these were excluded from the analysis. On comparison, the characteristics of included and excluded cases were very similar (data not shown). The characteristics of children identified as having medicinal and non-medicinal poisonings, and their controls, are shown in Tables 1 and 2.

Table 3 shows the risk factors independently associated with each type of poisoning. Child sex was not significantly associated with either type of poisoning. There was an 'n'-shaped relationship between age and medicinal poisoning, with the highest odds in the 25–36 months age group (OR = 9.61, 95% confidence interval [CI] = 7.73 to 11.95) but with significantly raised odds for all age groups compared to the <1 year age group. The odds of a non-medicinal poisoning were significantly raised only between the ages of 13 and 36 months and were similar for the 13–24 months (OR = 5.44, 95% CI = 4.07 to 7.26) and 25–36 months (OR = 5.07, 95% CI = 3.73 to 6.90) age groups. Higher birth order, when compared with the lowest, was associated with increasing odds of both types of poisoning (test for trend *P*<0.001 for both types of poisoning), and increasing maternal age when compared with the youngest, was associated with decreasing odds of both types of poisoning (test for trend *P*<0.001 for both types of poisoning). Children living in more disadvantaged areas had higher odds of both types of poisoning than those in more affluent areas (test for trend *P*<0.001 for medicinal and *P* = 0.001 for non-medicinal poisoning). Perinatal depression, maternal alcohol misuse, and household composition were only significantly associated with medicinal poisonings on multivariable analyses, but had similar ORs on univariable analyses for both types of poisoning. Perinatal depression increased the odds by 54% (OR = 1.54, 95% CI = 1.26 to 1.88), maternal alcohol misuse within the previous year increased the odds by more than five times (OR = 5.44, 95% CI = 1.99 to 14.91), and living in a household with two adults (OR = 0.85, 95% CI = 0.74 to 0.96) or more than two adults (OR = 0.71,

Table 2. Characteristics of cases and controls and univariate associations between risk factors and non-medicinal poisoning

Characteristic	Cases (%), *n* = 503	Controls (%), *n* = 4873	Unadjusted odds ratio (95% CI)
Child characteristics			
Sex of child			
Female	240 (48)	2372 (49)	1.00
Male	263 (52)	2501 (51)	1.04 (0.86 to 1.25)
Age when poisoning occurred, months			
0–12	67 (13)	1697 (35)	1.00
13–24	226 (45)	1116 (23)	5.40 (4.05 to 7.20)
25–36	159 (32)	875 (18)	4.86 (3.58 to 6.60)
≥37	51 (10)	1185 (24)	1.06 (0.73 to 1.56)
Birth order of child			
1st	338 (68)	3607 (74)	1.00
2nd	130 (26)	1094 (22)	1.35 (1.08 to 1.68)
3rd or more	35 (7)	172 (4)	2.42 (1.62 to 3.63)
Maternal characteristics			
Maternal age at birth of child, years			
<20	44 (9)	249 (5)	1.00
20–29	293 (58)	2531 (52)	0.66 (0.47 to 0.93)
30–39	161 (32)	1987 (41)	0.46 (0.32 to 0.66)
≥40	5 (1)	106 (2)	0.26 (0.10 to 0.68)
Maternal diagnosis of depression			
No	454 (90)	4538 (93)	1.00
Yes	49 (10)	335 (7)	1.46 (1.06 to 2.01)
Maternal smoking			
Never smoked	201 (40)	2279 (47)	1.00
Ex-smoker	25 (5)	198 (4)	1.39 (0.90 to 2.17)
Current smoker	137 (27)	1065 (22)	1.45 (1.15 to 1.83)
Missing	140 (28)	1331 (27)	1.18 (0.91 to 1.52)
Maternal alcohol misuse			
Never	497 (98.81)	4847 (99.47)	1.00
≤1 year before poisoning	2 (0.40)	3 (0.06)	6.07 (1.01 to 36.47)
>1 year before poisoning	4 (0.80)	23 (0.47)	1.68 (0.58 to 4.86)
Social characteristics			
Townsend index quintile			
1 (least deprived)	89 (18)	1057 (22)	1.00
2	73 (15)	895 (18)	1.00 (0.71 to 1.39)
3	102 (20)	928 (19)	1.40 (1.02 to 1.92)
4	108 (21)	920 (19)	1.53 (1.11 to 2.11)
5 (most deprived)	102 (20)	750 (15)	1.87 (1.33 to 2.62)
Missing	29 (6)	323 (7)	0.96 (0.49 to 1.90)
Single parenthood			
Single adult	226 (45)	1964 (40)	1.00
Two adults	241 (48)	2531 (52)	0.82 (0.67 to 1.00)
Other	36 (7)	378 (8)	0.83 (0.56 to 1.21)

95% CI = 0.56 to 0.92) reduced the odds of medicinal poisoning compared to a single-parent household.

DISCUSSION

Summary

This study found very similar risk factors for medicinal and non-medicinal poisoning. Increasing deprivation, teenage pregnancy, and being a younger child in a larger family were associated with significantly increased odds for both types of poisoning, but maternal alcohol misuse, maternal depression, and single-adult households were significant risk factors only for medicinal poisoning in multivariable models. The odds of poisoning by age showed an 'n'-shaped relationship for both types of poisoning, but the pattern was much steeper for poisoning by medicines; compared to children aged <1 year, children aged 2–3 years were nearly 10 times more likely to have medicinal poisoning and were five times more likely to have a non-medicinal poisoning.

Strengths and limitations

Practices that contribute to THIN are broadly representative of UK general practices with regard to geographical distribution, the age and sex of patients, practice size, and data quality,[20] making these findings generalisable to the UK population. Furthermore, data are entered into the database prospectively in a clinical setting, minimising recall, response, or social desirability biases associated with questionnaire-based studies. The proportion of cases with medicinal and non-medicinal poisonings in this study was similar to previous studies, which have found 65–70% of all poisonings result from medicines.[9,11,16]

The study did not look at the risk factors for repeat poisoning injuries or multiple poisonings occurring within the same household, and risk factor profiles in these situations may differ from those described here. Furthermore, it cannot be ruled out that some poisoning events were not Read Coded in the patient records, resulting in under-ascertainment of cases. Assuming such under-recording is not related to child or family risk factors, the effect of this would be to shift the results towards the null hypothesis, making the estimates of risk underestimates of the 'true' risk. Likewise, alcohol misuse is likely to be both under-reported and under-recorded, especially among those with less severe problems.[21] For this reason, the definition of alcohol misuse used included only problematic drinking, frequent high levels of alcohol intake, and adverse health outcomes due to alcohol, or specific treatment for alcohol addiction. Associations may exist between less severe alcohol-related problems and childhood poisoning but these cannot be explored in large primary care database studies until the recording of alcohol intake is substantially improved. Nevertheless, the study found that maternal alcohol misuse is

Table 3. Mutually adjusted multivariable associations between risk factors for medicinal and non-medicinal poisoning

Risk factors	Medicinal poisoning, adjusted odds ratios (95% CI)	Non-medicinal poisoning, adjusted odds ratios (95% CI)
Child characteristics		
Sex of child		
Female	1.00	1.00
Male	1.04 (0.93 to 1.17)	1.04 (0.85 to 1.25)
Age of child, months		
0–12	1.00	1.00
13–24	6.34 (5.09 to 7.90)	5.44 (4.07 to 7.26)
25–36	9.61 (7.73 to 11.95)	5.07 (3.73 to 6.90)
≥37	3.35 (2.65 to 4.23)	1.14 (0.78 to 1.66)
Birth order of child		
1st	1.00	1.00
2nd	1.45 (1.26 to 1.66)	1.34 (1.06 to 1.69)
3rd	1.67 (1.27 to 2.20)	2.64 (1.71 to 4.08)
	Test for trend $P<0.001$	Test for trend $P<0.001$
Maternal characteristics		
Maternal age at child's birth, years		
<20	1.00	1.00
20–29	0.72 (0.57 to 0.91)	0.62 (0.42 to 0.90)
30–39	0.53 (0.41 to 0.67)	0.44 (0.29 to 0.65)
≥40	0.70 (0.45 to 1.08)	0.23 (0.09 to 0.62)
	Test for trend $P<0.001$	Test for trend $P<0.001$
Perinatal depression		
No	1.00	–
Yes	1.54 (1.26 to 1.88)	–
Maternal alcohol misuse		
Never	1.00	–
≤1 year before injury	5.44 (1.99 to 14.91)	–
≥1 year before injury	1.60 (0.77 to 3.32)	–
Social characteristics		
Townsend index (quintiles)		
1 (least deprived)	1.00	1.00
2	0.93 (0.76 to 1.13)	0.96 (0.68 to 1.35)
3	1.18 (0.96 to 1.43)	1.23 (0.89 to 1.71)
4	1.24 (1.01 to 1.52)	1.36 (0.97 to 1.90)
5 (most deprived	1.40 (1.13 to 1.74)	1.60 (1.12 to 2.29)
Missing	0.89 (0.59 to 1.34)	0.95 (0.48 to 1.89)
	Test for trend $P<0.001$	Test for trend $P = 0.001$
Family composition		
Single adult	1.00	–
Two adults	0.85 (0.74 to 0.96)	–
Other	0.71 (0.56 to 0.92)	–

a risk factor for medicinal poisoning but not non-medicinal poisoning. While this may be a true difference, it must be acknowledged that, based on the sample size calculation, this may be because of the smaller number of non-medicinal cases resulting in a lack of statistical power to detect an increased risk in this group.

The measure of household composition used in this study was based on adults registered with the same GP living in the child–mother household. Given the high proportion of single-parent families in this sample compared with recent national statistics showing 24% of children live in single-parent households,[22] it is plausible that some fathers were registered with a different GP, resulting in a misclassification of households as 'single-parent'. Such misclassification, if similar for both cases and controls, would tend to underestimate the protective effect of living in households with two or more adults.

Comparison with existing literature

The study findings regarding the age at which children are at the greatest risk of each type of poisoning are consistent with previous studies,[8,9,13] and are possibly explained by the development of dexterity,[10] mobility, exploratory, and mouthing behaviour.[7,9,23] Child development, however, cannot explain age differentials between medicinal and non-medicinal products. A potential difference may be in where these products are stored and the access that children have to them. For example, a study of safety practices by parents of young children showed that medicines are more commonly stored at or above adult eye level and cleaning products below adult eye level, with a substantial proportion stored in unlocked locations.[24] Thus non-medicinal products stored at low levels are likely to be accessible to children at an earlier age, while medicines stored at higher levels will become accessible as children are able to stand well enough to reach and climb.[25] In addition, children may observe parents or older siblings taking medicines, and the development of imitation behaviour around the age of 18–24 months may partly explain the higher risk of medicinal than non-medicinal poisoning in children aged over 2 years,[26] and there is some evidence that increased risks of poisonings from medications may be directly related to prescribed medications for depression.[27,28]

The protective effect of two-adult households is consistent with findings from previous work,[13] and may be explained by support with childcare, supervisory practices, and parental psychological wellbeing.[8,13,29] The present findings with respect to birth order, maternal age, household composition, and deprivation are also consistent with those of other studies.[8,13,16] Interestingly, it was found that child sex was not associated with either medicinal or non-medicinal poisoning, which is contrary to some previous work,[7,11,30] although Beautris *et al* did record a similar finding,[13] and, in addition, the poisoning incidence statistics reported by

WHO showed only a small (0.1/100 000) difference between male and female children in poisoning rates in Europe.[31]

Implications for practice

This study has shown that routinely collected primary care data can be used to identify children at greatest risk of poisoning by medicinal and non-medicinal agents. Primary care clinicians have access to this information during routine consultations and should use it to target effective safety interventions. This is particularly pertinent when prescribing for children and other family members, as all prescribed medications can become poisoning agents and previous studies have shown that home safety education, including that provided by GPs, is effective in increasing safer storage of medicines and cleaning products.[32,33] Despite this, other studies have shown that the number of GPs providing such advice may be small,[34] and that injury prevention, while considered important in primary care, may be a low priority.[35]

Advice should include storing medicines and household products at or above adult eye level, preferably in locked cupboards or drawers, and putting them away after use, since most poisonings occur when substances have been left out or are in a different location following use or recent purchase.[11,13] Parents should also be advised not to take medicines in front of children, because children often imitate adult behaviour. In addition, pharmacists are in a position to give advice about safe storage of medicines when they are dispensed.

This study has shown a strong association between poisoning injury and maternal alcohol misuse or depression. Prompt identification of these conditions, and early advice about safe storage and use of medicines may also reduce poisonings.

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This study was unfunded.

Ethical approval

The Health Improvement Network (THIN) primary care data was used for this research. The company that owns THIN (Cegedim Strategic Data Medical Research) has received ethical approval for studies using only precollected, anonymised data to undergo only a scientific review. This applies to this study and the authors have complied fully with this procedure. A research protocol was submitted to the scientific review committee and the protocol was approved in October 2009. Patient informed consent is not required under this agreement, nor is additional ethics approval from either the NHS ethics committees or from The University of Nottingham.

Provenance

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Competing interests

The authors have declared no competing interests.

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