Familial factors and child characteristics as predictors of injuries in toddlers: a prospective cohort study

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ABSTRACT

Objective: To identify family and child characteristics that put toddlers at risk of injuries.

Design: A prospective cohort study.

Setting: This study was based on the Norwegian Mother and Child Cohort Study, conducted by the Norwegian Institute of Public Health.

Participants: The study sample consisted of 26 087 children and their mothers.

Outcome measures: Family and child characteristics measured before or at 18 months of age were investigated as potential predictors of hospital-attended injuries that occurred between 18 and 36 months of age.

Results: In the multivariable analysis, younger maternal age (OR 0.93, 95% CI 0.86 to 1.00), financial problems (OR 1.18, 95% CI 1.01 to 1.39), maternal mental distress (OR 1.09, 95% CI 1.03 to 1.16), having older siblings (OR 1.22, 95% CI 1.08 to 1.39), and increased gestational age at birth (OR 1.04, 95% CI 1.00 to 1.07) and male gender (OR 1.26, 95% CI 1.11 to 1.42) were risk factors for hospital-attended injuries. Children with impaired gross motor development had a decreased risk of injury (OR 0.65, 95% CI 0.42 to 0.99), whereas those with impaired fine motor development had an increased risk (OR 1.55, 95% CI 1.22 to 1.97). Shyness was a protective factor (OR 0.92, 95% CI 0.86 to 0.98). Children with three reported attention problems had a slightly increased risk of hospital-attended injuries (OR 1.33, 95% CI 1.02 to 1.72; p=0.035); otherwise, behaviour was not a significant risk factor.

Conclusions: This study demonstrated that a wide variety of factors were in play as predictors of injuries in young children. Both child-related factors (gender, gestational age at birth, child motor development, shyness and attention) and familial factors (having older siblings, maternal age, financial difficulties and maternal mental health problems) were associated with injuries in toddlers.

INTRODUCTION

Injuries are a major cause of morbidity and mortality in toddlers.1 The incidence of injury, mechanisms of trauma and type of injury vary with children’s ages and developmental stages.2 3 Before adolescence, the highest rate of injury occurs in toddlers aged 15–17 months.4 Falls are consistently the leading cause of non-fatal injuries in toddlers, followed by poisoning and transportation-related injuries.5 6 7

ARTICLE SUMMARY

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Article focus

To identify characteristics that put toddlers at risk of injuries in a large prospective cohort study.

Several risk factors related to both the child's family situation and individual characteristics of the child have been identified, and in this study assessed both important child factors and familial factors together.

Key messages

This longitudinal population-based study of toddlers confirmed that a wide variety of factors are in play as predictors of injuries.

Both child-related factors (gender, gestational age at birth, child motor development, shyness and attention) and familial factors (having older siblings, maternal age, financial difficulties and maternal mental health problems) were associated with injuries in toddlers.

Strengths and limitations of this study

The strengths of this study included its prospective design, large sample size and the inclusion of a large number of potentially important variables.

A response rate of 42.7% suggests a selection bias, and comparisons with registry data have shown a positive selection into this cohort.

This study's reliance on self-reported data may be information biases.

The use of abbreviated scales might have threatened the validity of measures.
Injuries. \(^2\) Wounds and head injuries are the most common types of injury. \(^3\)

Until the 1960s, injuries were considered accidental in the sense of being random acts of misfortune. Although they are still referred to as ‘accidents’, events that result in injuries are no longer regarded as unpredictable; rather, they are thought to have a causal sequence with identifiable risk factors. \(^3\) Several studies have since reported that risk factors related to both the child’s family situation and individual characteristics of the child are associated with injuries in children.

Low familial socioeconomic status \(^5\)–\(^7\) and related aspects, including low parental education, young maternal age, single motherhood, large family size, unemployment and substance abuse, are established risk factors for injuries in children. \(^6\)–\(^8\) More recently, researchers have found associations between the mother’s mental health and an increased risk of injury in toddlers. \(^9\)–\(^10\) Adequate adult supervision is essential for toddlers to stay free from harm. \(^11\)–\(^13\) and mothers mental distress may reduce the ability to meet children’s needs and may impact awareness of children’s safety. Many unintentional injuries among young children are the results of inadequate supervision. Supervision exists on a spectrum from keeping a child overly protected and thereby denied opportunities to develop towards inadequate supervision and boundary setting exposing a child to avoidable harm.

Male sex is probably the best established risk factor for injury, and gender-specific behaviours such as rough play and taking risks are believed to contribute to this association in children. \(^14\) Potentially important predictors that have received less attention in the literature include preterm birth and psychomotor development. Many studies have identified cognitive and behavioural consequences of preterm birth; however, few have examined these consequences in relation to the risk of later injury. Similarly, the relationship between psychomotor development and the risk of injury is not well established, as the few studies that have been conducted show conflicting results. \(^15\)–\(^17\) However, there is considerable individual variation in toddlers’ motor development, and their physical development precedes their ability to understand the consequences of their actions. Motor ability may therefore be of specific importance as a risk factor for injuries in this age group.

Temperamental attributes in children have been associated with proneness to injury, including a high activity level, impulsiveness, sensation seeking and poor inhibitory control. \(^14\) Each of these traits contributes to children’s tendencies to place themselves in potentially dangerous situations. Externalising behaviours may also be challenging in toddlers and can affect child safety. \(^14\) Attention problems may affect a child’s ability to recognise potential environmental hazards and to comply with their supervisor’s instructions and rules. Aggression and related high levels of oppositional behaviour make it difficult for parents to control their children and keep them safe from harm. \(^14\) \(^18\)–\(^20\)

The aim of this study was to assess important child factors and familial factors for injuries requiring hospital admission in toddlers. Research, mainly on older children, has identified a range of characteristics of children and several familial factors as risk factors for injuries in childhood, but few have assessed them together in young children. The Norwegian Mother and Child Cohort Study (MoBa), with its comprehensive data collection over several waves, offered a unique opportunity to assess these relationships prospectively in a large-scale population-based study.

**METHODS**

**Design and participants**

This study used data from the MoBa, conducted by the Norwegian Institute of Public Health. MoBa is a prospective, population-based pregnancy cohort study with a target population of all pregnant women in Norway and their children. The women were recruited to the study at approximately week 17 of gestation through postal invitations prior to routine ultrasound examinations at their local hospitals. The study included 108 000 pregnancies; recruitment began in 1999 and was completed in 2008. The response rate was 42.7\%. \(^21\) Questionnaire data were collected at gestational weeks 17 and 30 and at an age of 6, 18 and 36 months of the child. Information from the Medical Birth Registry of Norway (MBRN) was also available (http://www.fhi.no/mfr). Informed consent was obtained from each participant upon recruitment. The Regional Committee for Medical Research Ethics and the Norwegian Data Inspectorate approved the study. Details of the MoBa study’s sampling, design, questionnaires, informed consent processes and data collection strategies have been reported elsewhere (http://www.fhi.no/morogbarn). \(^21\)

Although recruitment to the study is complete, data collection is an ongoing process. The current study is based on data files released for research on February 2009. This file comprised the first 27 227 children and their mothers who had completed the questionnaires when their children were aged 36 months. Cases with missing data on hospital-attended injuries in the children were excluded \((N=1140)\), and the study sample comprised 26 087 children and mothers.

**Injuries**

At 36 months of age, injuries in toddlers were assessed using the following questions: ‘Has your child suffered any injury or accident since the age of 18 months?’ and ‘If yes, has the child been admitted to or examined in hospital?’ The response categories to both items were ‘yes’ or ‘no’. The outcome variable in our study was an affirmative answer for hospital-attended injuries.

**Familial factors**

Demographic information regarding older siblings, maternal age, maternal education and occupational status was reported at gestational week 17. At child’s age...
of 18 months, whether the mother and child lived with
the child’s father was assessed with the following ques-
tion: ‘Do you and your child live with your child’s
father?’ Current financial problems were assessed with
the following questions: ‘Have you had financial prob-
lems since the previous questionnaire?’ The response
categories were ‘yes’ or ‘no’. Data on ethnicity were
not available at the individual level in this study;
however, the MoBa cohort comprised predominantly
ethnic Norwegian and Scandinavian families (95%).

Maternal mental health
The mother’s mental health was assessed with the
Symptom Checklist SCL-8 when the child was aged
18 months.22 23 The SCL-8 is designed to measure
psychological distress, particularly anxiety and depres-
sion, in population surveys. Each item has four response
categories, ranging from ‘not at all’=1 to ‘severe’=4.24
Cronbach’s $\alpha$ was 0.84.

Child factors
Information regarding the child’s sex, birth weight and
gestational age was retrieved from the MBRN. Births
before gestational age of 37 weeks were classified as
preterm births.

Child development
Development was assessed using items derived from the
Norwegian version of the Ages and Stages Questionnaire
(ASQ). The ASQ was designed for first-level screening
and to monitor developmental delay in children.25
When the child was aged 18 months, development was
assessed using three items from the gross motor area
(Cronbach’s $\alpha$=0.63), three items from the fine motor
area (Cronbach’s $\alpha$=0.30), three items from the
communication area (Cronbach’s $\alpha$=0.59) and four
items from the personal–social area (Cronbach’s
$\alpha$=0.50) of the ASQ 18 months form. Due to poor
internal consistency, these measures were analysed as
categorical variables. The choice of responses was ‘not
yet’, ‘sometimes’ or ‘yes’. Responses of ‘not yet’ and
‘sometimes’ are indicative of delayed development and
were categorised jointly as ‘not yet’. The number of
developmental skills that were not achieved was
summarised, and the following three categories were
formed: ‘all skills achieved’, ‘one skill not achieved’ and
two or more skills not achieved’.

Child temperament
The Emotionality, Activity, Shyness and Sociability
Temperament Survey for Children26 was used to assess
temperament at 18 months of age. Three items from
each of the emotionality, activity and shyness subscales
were included. ‘Emotionality’ refers to the tendency to
become easily and intensely aroused or upset. ‘Activity’
refers to the preferred level of activity and speed of
action. ‘Shyness’ refers to the tendency to be inhibited
and awkward in new social situations. Each item was
rated using a 5-point scale, ranging from ‘not typical’=1

to ‘very typical’=5. Cronbach’s $\alpha$ was 0.64 for emotionality,
0.64 for activity and 0.65 for shyness.

Child behaviour
Child externalising behaviour was assessed using items
from the Child Behaviour Checklist for ages
1.5–5 years27 when the child was aged 18 months. Five
items assessing aggressiveness and three items assessing
attention problems were available. Cronbach’s $\alpha$ was 0.44
for the aggressive subscale and 0.59 for the attention
subscale. Due to poor internal consistency, these
measures were analysed as categorical variables. All items
were rated ‘not true’, ‘somewhat or sometimes true’ and
‘very true or often true’. ‘Somewhat or sometimes true’
and ‘very true or often true’ were categorised together to
describe problem behaviours. The number of problems
was summarised and then categorised as ‘no problems’,
one, two or three problems for the attention subscale
and one, two or three more problems for the aggressiveness
subscale.

Statistical analysis
Predictors of hospital-attended injuries in children were
analysed using logistic regression with a Generalised
Estimating Equation approach to account for correlation
due to the inclusion of siblings in the study sample.
Associations are presented as crude ORs and adjusted
ORs with 95% CIs. The corresponding tests for signifi-
cance were performed using the Wald test statistic and
a significance level of $p<0.05$. The sum scores of inde-
pendent continuous measures were standardised, and
the presented ORs represent the difference in risk for an
increase of 1SD. Measures with internal consistency of
Cronbach’s $\alpha$<0.60 were categorised. Variance inflation
factors were computed to assess multicollinearity. The
model was cross-validated in two randomly selected
subsamples. Stratification by gender produced only
minor differences in effect estimates of potential risk
factors. The rate of missing information ranged from 0%
to 11.9%. Modelling was based on 20 multiply imputed
data sets. Multivariate Imputation by Chained Equations
was used for imputations.

All analyses were performed using R (The R Foundation
for Statistical Computing, Vienna, Austria), with the
R packages gee for logistic regression using Generalised
Estimating Equation and Multivariate Imputation by
Chained Equations for multiple imputation.

RESULTS
The study sample comprised 50.7% males, with 55% of
the children having older siblings. The mean gestational
age at birth was 39.4 weeks (SD=2.0). Maternal age
ranged from 14 to 47 years, with a mean of 29.7 years
(SD=4.4). The majority of mothers (60.5%) had more
than 12 years of education. Only 0.9% of the subjects
(N=252) were teenage mothers, and 3.4% (N=853)
reported not living with the father of their child. Four
per cent of mothers were unemployed or disabled.
Current financial problems were reported by 18.5% of
Injuries in toddlers are multifaceted phenomena with
disorders related to injury. In unadjusted analyses,
a range of factors were significantly associated with
injuries, including maternal mental distress, financial
problems, gender, gestational age at birth, development,
temperament and behaviour. Children born preterm
had a decreased risk of injury (OR=0.74, 95% CI 0.56 to
0.96; p=0.024).

Similarly, several potential predictors were significantly
associated with hospital-attended injuries in toddlers in
the multivariable analyses.

**Familial factors**

In the adjusted model, financial problems, maternal
mental distress and having older siblings were risk
factors for hospital-attended injuries in toddlers. Older
maternal age was a protective factor. Maternal education,
occupational status and not living with the child’s father
were not associated with hospital-attended injuries.

**Child factors**

Male gender and increased gestational age at birth were
risk factors for hospital-attended injuries in the toddlers.
Children with impaired gross motor development were
less prone to injury, whereas children with less fine
motor skills were more at risk. Social development was
not significantly associated with hospital-attended
injuries. Impaired communication, the temperamental
traits of emotionality and activity and aggressive behav-
our did not achieve statistical significance in the
adjusted analysis. Following adjustment, shyness
remained a protective factor and children with at least
three reported attention problems had a modestly
increased risk for hospital-attended injuries (p=0.035).

**DISCUSSION**

Injuries in toddlers are multifaceted phenomena with
a wide variety of relevant risk factors in play. The current
population-based study of toddlers found that both
familial factors and developmental factors in children
were associated with injury risk. Consistent with previous
studies and our clinical experience, children admitted to
hospitals with injuries are not randomly selected.

Similar to earlier studies, having older siblings was
a risk factor for hospital-attended injuries. Differences in
parental supervision or the possibility that older siblings
sometimes act as supervisors may explain this associa-
tion. Older siblings may also act as models of risky
behaviour. Research has shown that children are allowed
to engage in more risky behaviour and show poor
compliance when supervised by their older siblings
rather than by their mothers.

Education and socioeconomic status are closely inter-
twined, and most prior studies have found that low
maternal education is a risk factor for injuries in chil-
dren. In this study, maternal education, unemployment
and single parenthood were not associated with injury.
This lack of association may be due to the generally high
educational level, well-developed social security system
and high standard of living in Norway. Financial prob-
lems, which were significantly associated with injury,
were reported by a rather large proportion of the
mothers in this study and are not likely to represent
poverty, but perhaps problems to adapt to a life situation
with a growing family. As in other studies, older maternal
age was a protective factor.

In line with previous research, maternal mental health
problems constituted a risk factor for injuries in chil-
dren. Mental distress may reduce a parent’s attention
to external cues and may negatively impact the parent–
child relationship. Maternal mental distress withstood
adjustment for other familial and child-related predic-
tors. This observation calls for further investigation of
the mechanisms involved.

Behavioural and temperamental differences between
boys and girls have been proposed as explanations for
the well-established relationship between gender and
injury risk. In this study, adjustment for development,
temperament and behaviour did barely attenuate this
relationship. Perhaps other differences, for example,
gender-specific socialisation, supervision and guidance,
games and encouraged activities, might explain this
disparity.

Our finding that the risk of injury was increased
with increasing gestational age at birth and that preterm
birth was associated with a decreased risk was unantici-
pated. Many studies have identified later behavioural
problems, including attention deficit and hyperactivity
in children who are born preterm, attributes that are
also linked to injury proneness. On the other hand,
studies of adolescents have suggested that children born
at extremely low birth weight are more cautious, shy and
risk averse than their normal birth weight counter-
parts, and our finding might be explained by such
attributes. More research is needed to confirm and
explain this finding.

Novel findings in this study were that children with
impaired gross motor development had a decreased risk
for injury, whereas those with impaired fine motor
development had an increased risk. Toddlers’ physical
development often precedes their ability to understand
the consequences of their actions, and early physical
mobility may put children at greater risk of injury,
regardless of their temperament, behaviour or environ-
ment. Impaired fine motor development may be linked
to clumsiness, which subsequently leads to injury
proneness. Alternatively, early fine motor development
may reflect a preference for calmer activities. The
different directionality of the associations between
gross and fine motor development and injury risk imply
that these areas should be assessed separately in future
studies.
## Table 1: Descriptive comparison between children with and without hospital-attended injuries and univariable and multivariable logistic regression analysis of potential risk factors (N=26,087)

<table>
<thead>
<tr>
<th>Family factors</th>
<th>Overall (N=26,087)</th>
<th>Without injuries (N=22,998)</th>
<th>With injuries (N=3,089)</th>
<th>OR (95% CI)</th>
<th>aOR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% (N)/mean (SD)</td>
<td>% (N)/mean (SD)</td>
<td>% (N)/mean (SD)</td>
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<tr>
<td>Family factors</td>
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</tr>
<tr>
<td>Older sibling(s)</td>
<td>53.3 (13,902)</td>
<td>53.1 (13,197)</td>
<td>56.5 (705)</td>
<td>1.15 (1.02 to 1.29)*</td>
<td>1.22 (1.08 to 1.39)**</td>
</tr>
<tr>
<td>Maternal age</td>
<td>29.7 (4.43)</td>
<td>29.7 (4.44)</td>
<td>29.5 (4.44)</td>
<td>0.95 (0.89 to 1.02)</td>
<td>0.93 (0.86 to 1.00)*</td>
</tr>
<tr>
<td>Maternal education ≤12 years</td>
<td>37.6 (9534)</td>
<td>37.6 (9078)</td>
<td>37.6 (456)</td>
<td>0.99 (0.88 to 1.12)</td>
<td>0.90 (0.80 to 1.02)</td>
</tr>
<tr>
<td>Mother unemployed or disabled</td>
<td>4.1 (1069)</td>
<td>4.1 (1017)</td>
<td>4.2 (52)</td>
<td>1.01 (0.76 to 1.36)</td>
<td>0.95 (0.71 to 1.26)</td>
</tr>
<tr>
<td>Mother and child not living with the father</td>
<td>3.4 (819)</td>
<td>3.4 (778)</td>
<td>3.6 (41)</td>
<td>1.06 (0.77 to 1.46)</td>
<td>0.96 (0.69 to 1.33)</td>
</tr>
<tr>
<td>Financial problems</td>
<td>18.6 (4379)</td>
<td>18.4 (4129)</td>
<td>22.4 (250)</td>
<td>1.27 (1.09 to 1.48)**</td>
<td>1.18 (1.01 to 1.39)*</td>
</tr>
<tr>
<td>Maternal mental health problems (8-32)</td>
<td>10.2 (2.84)</td>
<td>10.1 (2.82)</td>
<td>10.5 (3.06)</td>
<td>1.12 (1.06 to 1.18)**</td>
<td>1.09 (1.03 to 1.16)**</td>
</tr>
<tr>
<td>Child factors</td>
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</tr>
<tr>
<td>Male</td>
<td>50.8 (13,250)</td>
<td>50.5 (12,540)</td>
<td>56.9 (710)</td>
<td>1.30 (1.16 to 1.45)**</td>
<td>1.26 (1.11 to 1.42)**</td>
</tr>
<tr>
<td>Gestational age</td>
<td>39.4 (1.94)</td>
<td>39.4 (1.96)</td>
<td>39.5 (1.79)</td>
<td>1.04 (1.01 to 1.07)*</td>
<td>1.04 (1.00 to 1.07)*</td>
</tr>
<tr>
<td>Gross motor development</td>
<td></td>
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</tr>
<tr>
<td>All skills achieved</td>
<td>82.2 (17,742)</td>
<td>82.1 (18,794)</td>
<td>83.8 (948)</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>One skill not achieved</td>
<td>14.5 (3,481)</td>
<td>14.5 (3,322)</td>
<td>14.1 (159)</td>
<td>0.94 (0.80 to 1.12)</td>
<td>0.94 (0.79 to 1.12)</td>
</tr>
<tr>
<td>Two or three skills not achieved</td>
<td>3.4 (800)</td>
<td>3.4 (776)</td>
<td>2.1 (24)</td>
<td>0.65 (0.43 to 0.98)*</td>
<td>0.65 (0.42 to 0.99)*</td>
</tr>
<tr>
<td>Fine motor development</td>
<td></td>
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<tr>
<td>All skills achieved</td>
<td>73.8 (17,569)</td>
<td>73.9 (16,754)</td>
<td>72.3 (815)</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>One skill not achieved</td>
<td>21.0 (5,004)</td>
<td>21.0 (4,774)</td>
<td>20.4 (230)</td>
<td>1.01 (0.87 to 1.18)</td>
<td>1.03 (0.89 to 1.19)</td>
</tr>
<tr>
<td>Two or three skills not achieved</td>
<td>5.2 (1,236)</td>
<td>5.1 (1,154)</td>
<td>7.3 (82)</td>
<td>1.45 (1.15 to 1.83)**</td>
<td>1.55 (1.22 to 1.97)**</td>
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<tr>
<td>Communication development</td>
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<tr>
<td>All skills achieved</td>
<td>46.6 (11,117)</td>
<td>46.8 (10,631)</td>
<td>43.1 (486)</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>One skill not achieved</td>
<td>26.5 (6313)</td>
<td>26.4 (5989)</td>
<td>28.7 (324)</td>
<td>1.16 (1.00 to 1.34)*</td>
<td>1.11 (0.95 to 1.28)</td>
</tr>
<tr>
<td>Two or three skills not achieved</td>
<td>26.9 (6413)</td>
<td>18.3 (6095)</td>
<td>19.3 (318)</td>
<td>1.13 (0.98 to 1.31)</td>
<td>1.04 (0.89 to 1.22)</td>
</tr>
<tr>
<td>Social development</td>
<td></td>
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<tr>
<td>All skills achieved</td>
<td>71.3 (17,094)</td>
<td>71.4 (16,302)</td>
<td>70.3 (792)</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>One skill not achieved</td>
<td>19.6 (4,688)</td>
<td>19.5 (4,451)</td>
<td>21.0 (237)</td>
<td>1.09 (0.94 to 1.27)</td>
<td>1.04 (0.90 to 1.21)</td>
</tr>
<tr>
<td>Two or more skill not achieved</td>
<td>6.6 (1,582)</td>
<td>6.6 (1,510)</td>
<td>6.4 (72)</td>
<td>0.99 (0.77 to 1.26)</td>
<td>0.92 (0.73 to 1.15)</td>
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<tr>
<td>Temperament</td>
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<tr>
<td>Activity (3–15)</td>
<td>12.1 (1.96)</td>
<td>12.1 (1.96)</td>
<td>12.2 (1.97)</td>
<td>1.09 (1.02 to 1.16)**</td>
<td>1.02 (0.95 to 1.09)</td>
</tr>
<tr>
<td>Emotionality (3–15)</td>
<td>8.2 (2.27)</td>
<td>8.2 (2.26)</td>
<td>8.3 (2.37)</td>
<td>1.06 (0.99 to 1.12)</td>
<td>1.02 (0.96 to 1.09)</td>
</tr>
<tr>
<td>Shyness (3–15)</td>
<td>6.1 (1.93)</td>
<td>6.1 (1.93)</td>
<td>6.0 (1.95)</td>
<td>0.92 (0.87 to 0.98)**</td>
<td>0.92 (0.86 to 0.98)*</td>
</tr>
<tr>
<td>Externalising behaviour</td>
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<tr>
<td>Attention</td>
<td></td>
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<tr>
<td>No attention problem</td>
<td>10.7 (2,464)</td>
<td>10.8 (2,371)</td>
<td>8.7 (93)</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>One attention problem</td>
<td>41.9 (9,653)</td>
<td>42.1 (9,231)</td>
<td>39.3 (422)</td>
<td>1.15 (0.91 to 1.44)</td>
<td>1.13 (0.89 to 1.43)</td>
</tr>
<tr>
<td>Two attention problems</td>
<td>28.7 (6,611)</td>
<td>28.7 (6,288)</td>
<td>30.0 (323)</td>
<td>1.26 (1.00 to 1.60)</td>
<td>1.19 (0.93 to 1.53)</td>
</tr>
<tr>
<td>Three attention problems</td>
<td>18.7 (4,294)</td>
<td>18.5 (4,057)</td>
<td>22.0 (237)</td>
<td>1.47 (1.16 to 1.86)**</td>
<td>1.33 (1.02 to 1.72)**</td>
</tr>
</tbody>
</table>

Continued
Shyness was a consistent protective factor against injury. Shyness is considered to be an inhibition to the unfamiliar and is associated with inhibitory control. The protective effect of shyness observed in this study indicates that inhibitory control may also be a protective factor against injury in young children. Attention problems was borderline significant after adjustment and may be a risk factor for injuries in toddlers. Aggression was not significant. These findings are different from the many studies of older children concluding with behaviour as a predictor for injuries. This disparity may be due to measurement difficulties at this early age or lack of stability in aggressive behaviour in the developmental period in this study (18 and 36 months). In our study, the associations between temperament and behaviour, and injury were substantially attenuated following adjustment, perhaps indicating that other factors may be more robust predictors of injuries in young children.

There are some important limitations of this study. A response rate of 42.7% suggests a selection bias, and comparisons with data from MBRN have shown a positive selection into this cohort, and the study sample can be regarded as a low-risk population; this fact may have resulted in an underestimation of the true effect sizes. However, few significant differences in exposure–outcome associations have been identified in studies of this cohort, and the positive associations found in this study is likely to be generalisable.

This study’s reliance on self-reported data may have affected the response accuracy. Self-reported medically attended or hospital-attended injuries are common measures in the injury literature. However, injury recall has been shown to decrease with time and tends to be more accurate for major injuries. The expected over-representation of more recent injuries and more severe injuries will, however, not affect the association measures. The division into children with and without hospital-attended injuries leaves children with injuries treated in outpatient clinics in the comparison group and may have led to an underestimation of effects. There may also be selection biases regarding injury severity and type of injuries, which are treated in outpatient clinics. Especially, regional differences with more severe injuries treated in outpatient clinics in rural areas are expected. Our study did not include systematic measures of injury severity, injury mechanism or injury type. Another omitted variable in this study was adult supervision, which is an important factor in preventing injuries in preschool children. This study was also unable to discriminate injuries that resulted from abuse.

The sample predominantly comprised ethnic Norwegian participants and did not allow us to investigate the influence of ethnicity or culture. As in other large population studies, there was extensive use of abbreviated scales that might threaten the validity of measures. The strengths of this study included its prospective design, large sample size and the inclusion of a large number of potentially important variables.
An injury brings the family in contact with healthcare and gives professionals an opportunity to identify potential risk factors. In addition, the fact that injuries may also be caused by poor supervision and, sometimes, neglect or abuse emphasise that a thorough assessment of the circumstances surrounding injuries in young children is important to identify families where children are at risk of further injury.

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Contributors MCM cleaned and analysed the data and drafted and revised the paper. ST, JBG and GD contributed to the interpretation of the data and critical revisions of the manuscript. All authors have studied the manuscript in the form submitted and have accepted the order of authorship.

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Competing interests None.

Patient consent This study was based on data from the Norwegian Mother and Child Cohort Study, conducted by the Norwegian Institute of Public Health. The current study did not use a separate consent form.

Ethics approval The Norwegian Data Inspectorate (ref nr 01/4325) and the Regional Committee for Medical Research Ethics (ref nr S-97045 and S-95113). The current study used only anonymous data and did not require separate approval.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement This study was based on the Norwegian Mother and Child Cohort Study, conducted by the Norwegian Institute of Public Health (NIPH). Researchers who want to access data or other biological material from health registers, biobanks and projects administered by the NIPH must apply to NIPH. Researchers who want to access data or other biological material from the Child Neuropsychol. 2009;15:220.


