

# **Infants and toddlers at risk: Injuries, abuse and behavioural problems**

Thesis for the degree of PhD

by

Mia Cathrine Myhre, MD

Norwegian Centre for Violence and Traumatic Stress Studies

Department of Paediatrics, Oslo University Hospital

Faculty of Medicine, University of Oslo

2014

Nasjonalt kunnskapssenter

om vold og traumatisk stress

© Mia Cathrine Myhre, 2014

*Series of dissertations submitted to the  
Faculty of Medicine, University of Oslo  
No. 1699*

ISBN 978-82-8264-775-5

All rights reserved. No part of this publication may be reproduced or transmitted, in any form or by any means, without permission.

Cover: Inger Sandved Anfinsen.  
Printed in Norway: AIT Oslo AS.

Produced in co-operation with Akademika Publishing.  
The thesis is produced by Akademika Publishing merely in connection with the thesis defence. Kindly direct all inquiries regarding the thesis to the copyright holder or the unit which grants the doctorate.

**Table of Contents**

**Acknowledgements**..... 5

**Abbreviations** ..... 7

**List of papers** ..... 8

**SUMMARY** ..... 9

**1 INTRODUCTION**..... 11

**1.1 What this dissertation is about**..... 11

**1.2 Background - The child in the family and society** ..... 12

**1.3 Injuries in young children** ..... 13

**1.4 Child abuse**..... 15

*1.4.1 Background and history* ..... 15

*1.4.2 Definitions* ..... 18

*1.4.3 Prevalence of childhood abuse* ..... 18

**1.5 Traumatic head injury in infants and toddlers** ..... 20

**1.6 Long-term consequences of abuse** ..... 23

**1.7 Intergenerational transmission** ..... 24

**1.8 Maternal childhood abuse and consequences for the offspring**..... 26

**2 AIMS OF THE STUDY** ..... 28

**3 METHODS** ..... 29

**3.1 Design** ..... 29

**3.2 Sample and procedure paper I** ..... 29

**3.3 Variables and measurements paper I** ..... 31

*3.3.1 Type of injury* ..... 31

*3.3.2 Recorded mechanism of injury* ..... 31

*3.3.3 Cause of injury*..... 32

*3.3.4 Other variables* ..... 33

**3.4 Sample and procedure paper II & III**..... 33

**3.5 Variables and measurements paper II & III** ..... 34

*3.5.1 Sociodemographic information (paper II & III)*..... 34

*3.5.2 Maternal mental health (paper II & III)* ..... 34

*3.5.3 Injuries (paper II)* ..... 35

*3.5.4 Child development (paper II)*..... 35

3.5.5 <i>Child temperament (paper II)</i> .....	36
3.5.6 <i>Child externalising behaviour (paper II &amp; III)</i> .....	36
3.5.7 <i>Maternal abuse (paper III)</i> .....	37
<b>3.6 Statistics</b> .....	<b>39</b>
<b>3.7 Ethical considerations</b> .....	<b>41</b>
<b>4 RESULTS</b> .....	<b>43</b>
<b>4.1 Paper I</b> .....	<b>43</b>
<b>4.2 Paper II</b> .....	<b>44</b>
<b>4.3 Paper III</b> .....	<b>44</b>
<b>5 DISCUSSION</b> .....	<b>46</b>
<b>5.1 Discussion of the main findings</b> .....	<b>46</b>
<b>5.2 Consideration of methodology</b> .....	<b>52</b>
5.2.1 <i>Main limitations and strengths in paper I</i> .....	52
5.2.2 <i>Main limitations and strengths in paper II &amp; III</i> .....	53
5.2.2.1 <i>Selection bias in MoBa and implications for our study</i> .....	53
5.2.2.2 <i>Information bias in the measurement of child injury</i> .....	54
5.2.2.3 <i>Information bias in the measurement of childhood abuse</i> .....	55
5.2.2.4 <i>Single-informant bias</i> .....	55
5.2.2.5 <i>Reliability and validity</i> .....	56
<b>5.3 Implications and suggestions for future research</b> .....	<b>57</b>
<b>5.4 Conclusions</b> .....	<b>59</b>
<b>References</b> .....	<b>61</b>
<b>Errata</b> .....	<b>75</b>
<b>Paper I - III</b>	
<b>Appendix I</b>	

## **Acknowledgements**

This study started in 2005 when I was working at the children's department at Oslo University Hospital (OUS) as a collaborative project with the Norwegian Centre for Violence and Traumatic Stress Studies (NKVTS). From 2006 and throughout the study period, I have continued to work part-time at the Pediatric Intensive Care Unit at OUS-ULlevål, while the study has been conducted at NKVTS, where I also have been employed part-time. I am most grateful to NKVTS for giving me this opportunity and for funding my thesis. NKVTS has been a very inspiring place to work. I want to thank the staff and administration for their helpful assistance, and fellow researchers and colleagues from many professions who have generously shared their vast knowledge in the field of violence and traumatic stress.

A number of people have provided indispensable contributions. First of all, this study would never have been realized, nor finalized, without the continuous support from my main supervisor, Dr.med. Grete Dyb. She has shown confidence in me from the start, ensured my employment at NKVTS and allowed me to pursue my ideas. She has been patient and supportive throughout the process, and I owe her my greatest thanks. Her thoroughness and persistence during the writing of the articles and the thesis has kept the project on track and been of enormous help.

I am also much in debt to my co-supervisor Dr.med. Jens Grøgaard, who introduced me to the field of child abuse, guided me into scientific work, and granted me a position at OUS that made it possible to combine research and clinical work. His extensive clinical experience and enthusiasm have served as a continuous inspiration. Our discussions have always been fruitful and of great value for this thesis.

My sincere gratitude also to my co-supervisor Dr.psychol. Siri Thoresen. Her constructive critique, probing questions, and insightful comments followed by inventive suggestions and solutions, have been invaluable for this thesis.

Many thanks to my co-authors on paper I, Marianne Nordhov and Leif Sandvik, who were of great help in the first phase of the project. Special thanks goes to Tore Wenzel-Larsen for his generous and patient help with the analysis, and presentation of the results of paper II and III. His advice and ability to find solutions for statistical and methodological issues have been of great value.

Many thanks to my colleagues at the children's department OUS, for their support. Special thanks to Thore Henrichsen, who taught me pediatric intensive care and got me interested in traumatic head injuries.

I also want to thank The Norwegian Institute of Public Health for giving me access to data from the Norwegian Mother and Child Cohort Study, and the staff at the Norwegian Medical Birth Registry for providing the data files and for always being service-minded. Furthermore, thanks to all the participating families in this ongoing cohort study who have shared their time and made this kind of research possible.

Finally, I want to thank my family for their support and patience during this process. My children Amalie and Andreas have brought joy through the ups and downs of this project, and my beloved husband Jan Harald who has been standing firmly by my side.

## **Acronyms and abbreviations**

ASQ	Age and Stage Questionnaire
CBCL	Child Behaviour Checklist
CT-scan	Computerised Tomography scanning
EAS	The Emotionality, Activity, Shyness, and Sociability Temperament Survey
HPA-axis	Hypothalamic-pituitary-adrenal axis
ICD-9	International Classification of Diseases, 9 <sup>th</sup> revision (WHO)
ICD-10	International Classification of Diseases, 10 <sup>th</sup> revision (WHO)
ICP	Intracranial pressure
LOS	Length of Stay
MBRN	Medical Birth Registry Norway
MRI	Magnetic Resonance Imaging
MoBa	The Norwegian Mother and Child Cohort Study
NOVA	Norwegian Social Research
OUS	Oslo University Hospital former UUS Ullevål University Hospital
SCL-8	Hopkins Symptom Check List including 8 items
Q1- Q6	Questionnaire 1 – 6 in the MoBa study

## **List of papers**

This thesis builds on the following papers, henceforth referred to by their Roman numerals:

### **Paper I**

Myhre MC, Grøgaard JB, Dyb GA, Sandvik L, Nordhov M

Traumatic Head Injury in Infants and Toddlers

*Acta Paediatrica* 2007 Aug; 96(8):1159-1163

### **Paper II**

Myhre MC, Thoresen S, Grøgaard JB, Dyb G

Familial factors and child characteristics as predictors of injuries in toddlers: a prospective cohort study. *BMJ Open* 2012 Mar 8; 2(2):e000740

### **Paper III**

Myhre MC, Dyb G, Wentzel-Larsen T, Grøgaard JB, Thoresen S

Maternal childhood abuse predicts externalising behaviour in toddlers: a prospective cohort study.

Submitted



## **SUMMARY**

This thesis involves both a clinical and a public health approach to studying injuries in young children. In addition, the possible long-term consequences of childhood abuse in mothers are explored. Two study samples were chosen to explore these perspectives. The clinical study is a retrospective study reviewing the medical records of 91 children younger than 36 months of age admitted to a university hospital with a traumatic head injury. The aims were to describe the types of injuries, presenting characteristics and hospital course in young children with traumatic head injuries, and to identify the characteristics of inflicted injuries. Data from the Norwegian Mother and Child Cohort study conducted by the Norwegian Institute of Public Health were used to explore the public health perspective in the next two papers. This sample comprised 27,000 mother and child dyads in the general population and had a longitudinal design. The aim of the second paper was to identify the child characteristics and familial factors for predicting injuries in toddlers. The aim of the third paper was to assess intergenerational perspectives on child abuse. We investigated the relationship between maternal childhood abuse and behaviour in their toddlers, and the potential mediation of maternal mental distress for this pathway.

In paper I, 17 cases met the criteria for inflicted injury (19%), 35 cases met the criteria for accident (39%), and the remaining 39 cases (43%) were regarded as indeterminate. Inflicted and accidental head injuries differed in injury type and presenting characteristics. Nearly two-thirds of the subdural haemorrhages (SDH) were classified as inflicted, but none of the epidural haemorrhages (EDH) or skull fractures were classified as inflicted. Seizures and SDH without skull fractures occurred more frequently in the inflicted group. Compared with the accident group, the children in the inflicted group were significantly more likely to have been hospitalised earlier despite being considerably younger. The largest group was classified as indeterminate. This group was characterised by low morbidity, and most of their

injuries were caused by domestic falls. The indeterminate group shared some characteristics with the inflicted injury group. This overlap may indicate that some children in the indeterminate group have been abused or neglected.

In paper II, we discussed both child characteristics and familial factors as predictors of injuries in toddlers. Younger maternal age, financial problems, maternal mental distress, having older siblings, increased gestational age at birth, male gender, impaired fine motor development and attention problems were all risk factors for hospital-attended injuries. Shyness and impaired gross motor development were protective factors. The paper demonstrated how difficult it can be to separate relevant risk factors, which perhaps reflects a complex reality where risk factors are truly entangled.

In paper III, we found that mothers having experienced abuse in childhood reported more externalising behaviour in their children at three years of age compared with mothers without such experiences. Maternal mental health problems constituted a partial mediator of the relationship. Maternal childhood emotional abuse was as strong a predictor of behavioural problems in the children as physical and/or sexual abuse. This study suggested that even in low-risk populations, an intergenerational transmission of adverse effects of childhood abuse may occur.

This thesis demonstrates that child abuse and neglect must be considered when infants and toddlers suffer from severe head injuries, and thorough evaluations should be implemented for these children in hospitals. In the general Norwegian population the risk of being injured as a toddler depended on both child characteristics and familial factors. Maternal childhood abuse predicted externalising behaviour in the offspring, and this thesis suggests that childhood abuse may influence the subsequent generation.

# **1 INTRODUCTION**

## **1.1 What this dissertation is about**

Soon after I started my career at the paediatric intensive care unit, three children with severe inflicted head injuries were admitted. These children made a lasting impression and inspired me to learn more. My research career started with an intention to review cases with recognised inflicted head injuries. However, early in this process, I became aware of the challenges clinicians face in recognising inflicted injuries and differentiating inflicted from non-inflicted injuries. Consequently, all cases of young children with traumatic head injuries had to be included in the review. In collaboration with Oslo University Hospital and the Norwegian Center for Violence and Traumatic Stress Studies, I was given the opportunity to study the hospital files of all cases of young children with traumatic head injuries admitted in the last ten years. Reviewing the cases, our impression was that many of the children were injured because they were insufficiently protected or secured, and we realised that maltreatment in the form of child neglect was also a common cause of head injuries. Furthermore, sociodemographic adverse factors were often described in the files. The observation of the complex interaction between child maltreatment and injuries in children motivated me to explore risk factors for injuries in young children with an epidemiological approach. The Norwegian Mother and Child Cohort Study (MoBa) offered an opportunity to assess some of the main risk factors for injuries in infants and toddlers in a large-scale, population-based study.

The more I learning about child maltreatment, I realised that no matter how devastating the neurodevelopmental consequences following inflicted brain injuries might be, the psychological effects constitute the major public burden from child maltreatment. The long-term consequences may also affect parenthood and subsequently the children of abuse victims. The large number of mother-child dyads in the MoBa study offered an opportunity to

explore a possible intergenerational transmission of problems and thereby obtain a broader picture of the risk factors for young children.

## **1.2 Background**

The common view of children and childhood has changed dramatically in the Western world during the last centuries. The United Nations Convention on the Rights of the Child from 1989 is perhaps the most important sign of this transition. This legally binding international instrument incorporates the full range of human rights for children and states that children deserve special considerations to ensure their wellbeing and development (1). New knowledge on what is potentially harmful and threatening to the wellbeing of children has evolved, and child maltreatment is now defined as a serious threat to children's health and development. In addition, the long-term negative consequences for mental health as well as social functioning have been documented (2-5). As some negative consequences may affect parenthood, maltreatment also has the potential to negatively affect subsequent generations (6-9).

Up until the 1960s, physical discipline was an important part of parenting, and corporal punishment was often an integrated and accepted part of the upbringing of children. However, research has documented that corporal punishment is a risk factor for developing psychological problems in children (10-12). This knowledge, together with the improved social status of children, led to legislation against child maltreatment. In Norway, all corporal punishment has been banned since 1987 (13). Just as important as the legislation was a shift in the common opinion, and research from Sweden indicates that the majority now find corporal punishment unacceptable (14).

Although our modern welfare state has established rights for children and extensive research has documented the importance of protection against injuries and maltreatment,

children are still largely dependent upon the family environment to be safe, to develop and to thrive. Parents do not always manage to act in the best interest of their children and often attempt to conceal disadvantageous factors because of shame and social taboos. The family is a private arena in society, and such social taboos may also prevent physicians and other professionals from asking about family problems and abuse; thus, maltreatment often remains undetected. To promote disclosure and aid for children at risk of injuries, abuse and behaviour problems, more knowledge facilitating the identification of early warning signs is needed. Earlier intervention may also break a potential vicious circle with the transmission to future generations. This thesis will contribute to new knowledge by investigating the risk factors for injuries in children from both a clinical and epidemiological perspective as well as by investigating the intergenerational effects of childhood abuse.

### **1.3 Injuries in young children**

An injury is defined as the physical damage that results when a human body is suddenly subjected to energy in amounts that exceed the threshold of physiological tolerance – or as the result of a lack of one or more vital elements, such as oxygen (15, 16). When the burden of infectious diseases declined after the Second World War, injuries construed an increasing share of morbidity and mortality (16). Studies followed, and as a result patterns of incidence and prevalence were recognised. The view of injuries changed from being regarded as accidental and a result of misfortune and something that happens randomly into injuries being considered aetiologically. William Haddon wrote a ground-breaking article in 1968 in which he conceptualised the etiological aspect of injuries and introduced a matrix model for analysing the aetiology of injuries (17). Even if injuries are often still referred to as accidents, the events that result in injuries are no longer regarded as random and unpredictable. The events often form a pattern, have defined risk factors and are preventable.

A range of risk factors has been identified. The early literature focused on demographic factors such as age and sex, and it was recognised that the risk of injuries was high in early childhood and in adolescence and was a leading threat to children's life and health. It is now well established that young children have a high rate of injuries and that the incidence of injury, mechanism of trauma and type of injury vary with the child's age and developmental stage (18-20). In addition, a steep socioeconomic gradient was soon also identified, where children from the least advantaged families, neighbourhoods and countries were observed to be at greater risk (16, 21). Such a gradient has also been demonstrated in the wealthy Scandinavian countries (20, 22, 23). Among the best established risk factors for injuries in children are low parental education, young maternal age, single motherhood, large family size, unemployment and substance abuse (22-24).

Unintentional injuries in young children may result from inadequate supervision and failure by caregivers to protect the child from potential hazards. Parental supervision has been a recurrent theme in the discussion of how to protect children from injuries (25). However, researchers have only recently included the role of adequate supervision systematically in studies (26-28). Failing to meet the standards of adequate supervision and exposing a child to avoidable harm may also be regarded as neglect. Supervision is the responsibility of the parents, and parental characteristics may thus represent risk factors of injuries in their children. Parents' ability and capacity to protect their children may depend on a combination of living conditions and personal factors (29). Parental mental health, personality, temperament and parenting style have been linked to injuries in children. (30, 31)

Injuries may be preceded by a series of psychologically motivated decisions and behaviours, and since the late 1960s, behavioural scientists have made progress in identifying child-based risk factors for injuries (32). Sensation seeking, activity level, impulsivity and poor inhibitory control are traits that contribute to children's tendencies to place themselves in

potentially dangerous situations (33). Furthermore, behaviour problems and psychopathology that encompass such traits have also been identified as risk factors for childhood injuries (34-36). Attention problems may affect children's ability to recognise potential hazards and to comply with their supervisors' instructions and rules. Aggression and high levels of oppositional behaviour may challenge supervisors in controlling children and keeping them safe from harm (33, 37). Motor development is rapid in toddlers with a considerable individual variation. Young children's motor development precedes their ability to understand the consequences of their actions, and cognitive capacity and motor development may play a central role in children's safety. This relationship is, however, not well established, as the few studies that have been conducted reported conflicting results (32, 38, 39).

Theorists who assert that the material and social environments are the major determinants of accidents have challenged the concept that the personal characteristics of individuals are important components of the accident process. Child-based risk factors associated with injuries coexist with environmental and social factors that have also been established as risk factors for injuries (25, 40), and a focus on individual characteristics may be perceived as "blaming the victim" (41). These relationships and interactions are not fully understood but are likely to vary with child age and different social settings, and documentation is scarce in regard to injuries in the youngest children. To learn more about the risk factors for injuries in toddlers, this thesis will focus on child-factors and family factors together.

## **1.4 Child abuse**

### *1.4.1 Background and history*

Children have been maltreated throughout history, and stories of neglected and abused children are found in myths and fairytales as well as in classical literature. The first medical or

scientific description of the injuries associated with child abuse is attributed to the French pathologist Auguste Ambroise Tardieu. He described the classical features of almost all forms of child abuse and neglect, and he was the first physician to recognise the prevalence of children being mistreated at the hands of their parents (42). Tardieu also recognised that sex crimes against children were alarmingly common (42). Nonetheless, Tardieu's research was either sharply criticised or ignored by legal authorities and other clinicians, partly because his conclusions and evidence, especially on sexual abuse, contradicted the prevailing beliefs and violated taboos. John Caffey reintroduced research on abusive injuries in children in 1946 when he described 6 infants with chronic subdural hematomas in whom he identified long bone fractures from an “obscure” traumatic origin (43). Later, Fredrick Silverman, a junior associate of Caffey's, collaborated with Henry Kempe and colleagues in 1962 to frame “The Battered Child Syndrome”(44). They observed that injuries historically noted to be from “unrecognised trauma” were in reality from “serious physical abuse”. In Norway, the first report “Vanrøktssyndromet” [“The battered child syndrome”] was published in Tidsskrift for Den Norske Lægeforening in 1964 (45) and was followed by public and professional engagement (46), with the social worker Kari Killén as perhaps the foremost pioneer (47, 48), together with the children's department at Ullevål University Hospital lead by professor Sverre Halvorsen. Sexual abuse of children came to the public and the professionals' attention later than physical abuse (49), and public concern did not rise before the late 1970s, with the dedication from parts of the feminist movement playing a major role. Cases of sexual abuse of children were increasingly investigated by the police and prosecuted in the court system. Medical research focusing on physical findings and forensic evidence evolved as a result (50). At the same time, psychological and psychiatric research ascertained potential severe mental health consequences. Among mental health professionals, emotional abuse was also recognised as a type of maltreatment. Emotional abuse was first believed to be less harmful,



but in the late 1980s, reports recognised severe mental health consequences from emotional abuse, even in the absence of physical maltreatment (51, 52). Exposure to domestic violence may also be regarded as a form of child maltreatment. It has been debated whether exposure to domestic violence should be included under emotional abuse or neglect or whether it should be described separately (2, 53).

Along with clinical studies, epidemiological research revealed that the different forms of abuse commonly co-occurred and that poly-victimisation was common (54, 55). In addition, the phenomena overlap conceptually. Aspects of emotional abuse are present in almost all cases of physical and sexual abuse, and neglect overlaps with abuse, at least in the form of failure to protect against harm (56).

From these early investigators, the body of medical literature on child abuse continues to evolve (57). The modern definitions of child maltreatment reflect the present knowledge and its consequences in the context of the view of the society on appropriate child rearing and the rights of children.

## 1.4.2 Definitions

Child maltreatment is the abuse and neglect that occurs to children under 18 years of age.

*Child maltreatment* includes all types of physical and/or emotional ill-treatment, sexual abuse, neglect, negligence and commercial or other exploitation, which results in actual or potential harm to the child's health, survival, development or dignity in the context of a relationship of responsibility, trust or power (2).

WHO Consultation on Child Abuse Prevention distinguishes four types of child maltreatment:

*Physical abuse* is the intentional use of physical force against a child that results in – or has a high likelihood of resulting in – harm for the child's health, survival, development or dignity. This includes hitting, beating, kicking, shaking, biting, strangling, scalding, burning, poisoning and suffocating (4).

*Sexual abuse* is the involvement of a child in sexual activity that he or she does not fully comprehend, is unable to give informed consent to, or for which the child is not developmentally prepared, or else that violates the laws or social taboos of society. Children can be sexually abused by both adults and other children who are – by virtue of their age or stage of development – in a position of responsibility, trust or power over the victim (4).

*Emotional abuse* involves both isolated incidents, as well as a pattern of failure over time on the part of a parent or caregiver to provide a developmentally appropriate and supportive environment. Acts in this category may have a high probability of damaging the child's physical or mental health, or its physical, mental, spiritual, moral or social development. Abuse of this type includes the restriction of movement, patterns of belittling, blaming, threatening, frightening, discriminating against or ridiculing and other non-physical forms of rejection or hostile treatment (4).

*Neglect* includes both isolated incidents, as well as a pattern of failure over time on the part of a parent or other family member to provide for the development and well-being of the child – where the parent is in a position to do so – in one or more of the following areas: health, education, emotional development, nutrition, shelter and safe living conditions (4).

## 1.4.3 Prevalence and incidence of childhood abuse

Population-based studies of child maltreatment have revealed a wide gap between the low rates of maltreatment recognised by child-protection agencies and the ten-fold higher rates reported in surveys (58, 59). The prevalence of child abuse differs between countries and parts of the world, with the highest figures in developing countries (4, 16). However, to

provide a foundation for discussion in this thesis, we have focused on results from countries in the Western world, and included with Norwegian and other Scandinavian figures when available. Internationally, a recent comprehensive review of the burden of child maltreatment estimated the prevalence of the different forms of child maltreatment in the US and developed European countries. The estimated prevalence of physical abuse during childhood ranged from 5% to 35%, and approximately 5% of cases had been reported to child protection agencies (5, 60, 61). In Sweden and Norway, the prevalence of physical child abuse was found to be in the lower range of these estimates. In Sweden, two surveys of schoolchildren concluded that approximately 15% had been hit by a caretaker at least once in their life, whereas 3-6% experienced being hit by a caretaker repeatedly (14, 62). In Norway, a survey conducted by Norwegian Social Research (NOVA) of 18 – 19-year-old adolescents found the lifetime prevalence of violence to be higher for mild physical violence at least once (25%) but was at comparable levels for severe violence (7%) and frequent violence (2%) (55). Only six persons reported that they had received medical care because of an abusive injury. In another Norwegian survey of 15 -16-year-old schoolchildren, a total of 4.6% of girls and 3.3% of boys reported violence from an adult in the last 12 months (63).

In the international review, the prevalence of any type of sexual abuse was estimated to 15–30% for girls and 5–15% for boys. Penetrative sexual abuse was estimated to be 5–10% for girls and 1–5% for boys (5, 60). In the NOVA study of adolescents, 22% of girls and 8 % of boys reported having experienced less severe forms of sexual abuse, and 15 % of the girls and 7 % of the boys reported suffering more severe sexual offences (55). In the study of 15 -16-year-old schoolchildren, 6.1% of the girls and 1.6% of the boys reported experiencing some form of sexual abuse in the last 12 months (63).

Emotional abuse may be difficult to measure as there may be more room for interpretation depending on how the questions are asked. International estimates for children

experiencing emotional abuse range from 4 – 9% (5, 60, 64-66). In Norway, Schou et al. found that 11.0% of children surveyed answered affirmative to that one or both of their parents often having told them how stupid or useless they were during the last 12 months (63). Witnessing violence in the home may also be regarded as abuse, and in the NOVA survey, 10% of the participants had witnessed at least one incident of violence against one of their parents (55). A total of 16 % reported at least one severe offence (severe sexual abuse, severe direct violence from parents, or severe indirect violence), and within this group, multi-victimisation was common.

The discrepancy between self-reported offences and contact with child protection services is also evident in Norway. According to the NOVA study of adolescents, only 20-25% of the youth who reported severe offences had been in contact with Child Protection services, Child Psychiatry, or Pedagogical and Psychological services within the school system. Moreover, emotional abuse was reported as a reason for intervention by child protection services in 218 cases, physical abuse in 507 cases and sexual abuse in 116 cases in Norway in 2011 (67).

### **1.5 Traumatic head injury in children**

Traumatic head injury is defined as any physical damage to the brain or skull caused by an external force. Traumatic head injury is a common cause of mortality and acquired neurological impairment in children (68). Several studies have reported that children younger than 3 years of age have the highest incidence of head injury in the child and adolescent population, and head injury is the most common type of injury presenting to health care in this age group (69-73). In Stockholm, Falk et al. found the highest incidence among children younger than 18 months of age (24 per 1,000 children per year), followed by 17 per 1,000

children in the 18 months to three years of age group (71). These figures are comparable with international estimates of approximately 20 per 1,000 children (69, 70).

In clinical samples, several studies have established that many head injuries in young children may be inflicted (19% to 33%) and that the highest proportion is observed in infants (74-76). Information on inflicted injuries can rarely be extracted from large health registries, partly because of missing and inconsistent registration of the intentional cause of injury but also because abuse may not be recognised at all or not confirmed. Official statistics from child protection and police registries can be valuable, but these statistics most likely represent only a small portion of the total number of cases and may be incomplete regarding medical information. The most thorough population-based study of inflicted traumatic brain injury in young children was conducted in North Carolina, USA. The incidence of inflicted traumatic brain injury in the first 2 years of life was 17.0 per 100,000 person-years. Infants had a higher incidence than children in the second year of life (29.7 vs. 3.8 per 100,000 person-years) (77).

The literature on inflicted vs. accidental traumatic brain injuries demonstrates the progress made as well as the challenges that still remain in the medical assessment of child abuse. The radiologist John Caffey published two seminal papers in 1972 and 1974, attributing severe head injuries in infants to shaking (78, 79). Since then, the term "Shaken Baby Syndrome" has been widely used for this type of injury. The violent shaking of a child causes the head to fling back and forth, generating powerful acceleration-deceleration forces within the head. Infants have a relative large and heavy head, weak neck muscles, and less myelinisation of the brain and are therefore physically vulnerable to shaking. However, the causal mechanism is rarely confirmed. Terminology that neither implies mechanism nor intention has therefore been recommended. At present, leading professionals are moving towards a consensus to use the term "abusive head trauma" (80, 81). However, in this thesis, "inflicted head injury" is used in accordance with paper I.

The most frequent finding associated with severe inflicted injury is subdural haemorrhage (SDH) due to the rupture of bridging veins caused by the acceleration-deceleration motion of the brain within the skull. The presence of SDH of varying density/attenuation on computed tomography (CT) and magnetic resonance imaging (MRI) may represent injuries of different dates, indicating abuse with recurrent traumas. Children can also sustain parenchymal brain injuries, particularly secondary hypoxic – ischemic encephalopathy appears to be related to abuse (82). Trauma to the infant brain may result in respiratory compromise with apnoea, and young children tend to develop cerebral oedema and poor blood perfusion to the brain after a head trauma (83). In addition, abused children are often presented late for treatment, and secondary injuries may have more time to develop. Inflicted brain injury has been proven to be associated with worse outcomes than non-inflicted (84), and there is increasing evidence of greater vulnerability after brain injuries in the youngest children (84, 85).

From the early 70s, retinal haemorrhages were noted in children with inflicted head injuries, and a strong association has been confirmed through many studies since then (79, 86). Although no findings are pathognomonic for inflicted head injury, the triad of SDH, hypoxic-ischemic encephalopathy and retinal haemorrhages in a previously healthy child without a history of a major trauma may indicate an inflicted injury (87, 88). Such an injury pattern has repeatedly been found in children where abuse is documented, and other causes of this combination are not known (87, 89). The presence of other injuries associated with abuse, such as rib fractures, metaphyseal fractures and bruises, in addition to head injuries, will increase the probability of an injury being inflicted (90).

The identification of injury characteristics associated with abuse demonstrates the progress made in this field. However, challenges still remain. Unknown medical conditions may predispose children to SDH after low-energy traumas. Furthermore, many cases remain

unsolved both clinically and in the legal system, and additional knowledge of injury mechanisms and the forces involved in head injuries in children is needed. To obtain additional knowledge, we studied children less than three years of age who had been admitted to our hospital unit with a head injury. Of particular interest were characteristics that may indicate that a head trauma was inflicted.

### **1.6 Long-term consequences of abuse**

Although many physical injuries from abuse heal over time, children may suffer from severe neurological sequelae after brain injuries, scars from burns and pain conditions. The psychological consequences may also be long lasting and constitute the major burden of abuse. Although different types of abuse may have specific consequences, this thesis focuses on consequences that all types of abuse have in common.

Researchers and professionals now increasingly recognise that childhood abuse and emotional trauma have profound and enduring effects on the developing brain. The immediate emotional effects of abuse, such as fear, anger and sadness, can translate into lifelong disturbances in emotion regulation and self-esteem as well as stress activation and post-traumatic stress symptoms. Furthermore, child maltreatment may disrupt the normal parent-child attachment dynamic and influence social relationships throughout life. Over the last decades, a large body of research has concluded that there are long-term negative consequences of childhood adversities for a range of social problems, along with negative somatic and mental health outcomes (91-94). Large prospective studies have repeatedly indicated that experiencing abuse in childhood predicts common psychiatric disorders, such as depression, anxiety, post-traumatic stress disorder and self-harm later in life (5, 95-98). Furthermore, children who are exposed to maltreatment have an increased risk of re-

experiencing abuse as well as being exposed to more than one type of maltreatment. Such re- and poly-victimisation has been associated with more adverse outcomes (94, 99, 100).

The broad range of negative consequences reported in clinical and epidemiological studies is underpinned by research demonstrating genetic, neuroendocrine, immunological and structural neurobiological changes associated with childhood abuse (92, 101-103). For instance, neuroendocrine studies have revealed an association between early adversity and atypical development of the hypothalamic-pituitary-adrenal (HPA) axis stress response, which may predispose sufferers to psychiatric vulnerability in adulthood (104, 105). Neuroimaging research in children and adults has reported changes in the corpus callosum, cerebellum and prefrontal cortex, with the most consistent evidence for reduced corpus callosum volume in children and adults who have experienced maltreatment (106) and decreased prefrontal cortex volume among adults with childhood histories of maltreatment (107, 108). Functional differences have been reported in the regions involved in emotional and behavioural regulation, such as the amygdala and anterior cingulate cortex (109, 110). In addition, animal studies have found evidence of later health effects of early life adversity (111). Such changes at the neurobiological level may represent adaptations to early life stress, but may nevertheless, result in lifelong susceptibility to disease, including psychopathology.

### **1.7 Intergenerational transmission**

The convergence of evidence from neurobiology in humans and animals and epidemiological studies leave little doubt that profound negative consequences of child abuse can last into adulthood and manifest in many ways that may affect parenthood (112). The impact on the next generation is likely through multiple pathways, but parental mental health is likely to be an important mediator; being well established both as a consequence of exposure to abuse and as a risk factor for problems in offspring.



Mental health problems include various disorders in which a person's thoughts, emotions, or behaviours cause suffering to themselves or other people. The most common problems include anxiety, depression, posttraumatic stress disorder and addictive behaviours (113). In addition, there is psychological distress, which is experienced as troubling but does not qualify for a psychiatric diagnosis. All mental disorders affect interactions with others. Parenting, which is a complex process of promoting and supporting the physical, emotional, social, and intellectual development of a child, is likely to be affected. Mental health problems may reduce the ability to meet children's needs and may also influence the awareness of children's safety as well as reduce parents' attention to external cues of potential hazards. Furthermore, mental health problems are entangled with social problems and problematic adult relationships, including domestic violence. Lower social support and higher social isolation adds toll to the burden and increases the risk of victimisation of children (114). Children of abused mothers might therefore be at risk of growing up in a harsh and stressful environment. From the early 1960s, it has been hypothesised that abusive parents were themselves abused as children (115), and more recent studies have confirmed that abused parents may fail in their own parenting role (6, 7, 116, 117). Consequently, childhood abuse may be associated with a later harsh or abusive parenting style, which may contribute to the intergenerational transfer of difficulties due to abuse (8, 116-118). This alleged causal relationship has been criticised by theorists and reviews that stressed the key roles of social determinants and environmental factors (119, 120).

Genetic factors and neuroendocrine changes in the children may further enhance their vulnerability (9, 121). Heritable individual variations imply that victims with the most symptoms may be genetically vulnerable to psychological traumas and that this vulnerability can be inherited by their offspring (122, 123). Neuroendocrine changes in the mother, especially changes related to the HPA-axis, may, during pregnancy, have a direct impact on

the development of the foetal brain and may induce epigenetic changes (124) with long-lasting changes related to stress responses in the child (125). Such relationships are also underpinned by animal studies describing epigenetic changes related to stressful versus normal rearing practice in rodents and primates (126, 127).

Moreover, the factors involved in the intergenerational transmission of problems due to adverse childhood experiences are not only entangled but are also likely to interact. Although understanding of the biological fundamentals of the intergenerational transmission has progressed, more knowledge is also needed on how these complex pathways affect the population in general. To contribute to such an understanding, we investigated the potential impacts of maternal childhood abuse on toddlers' behaviour in a population-based sample and assessed the potential mediation of maternal mental distress.

### **1.8 Maternal childhood abuse and consequences for the offspring**

The maternal mental health problems, parenting difficulties, social disadvantages and biological changes discussed above are likely to affect the development of children. Outcomes may differ due to individual susceptibility and predispositions as well as other circumstances involved, and a broad spectrum of possible consequences has been identified (128-132).

Previous studies have also documented an impact of maternal childhood abuse on offspring adjustment (116, 133). In the youngest children, maladjustment is perhaps most easily observed as behavioural problems. Externalising behaviours in early childhood are the most common complaint regarding behaviour in young children, and may also be associated with maternal childhood abuse (8). The construct of externalising behaviour problems refers to a grouping of behaviour problems that are manifested in children's outward behaviour and reflect the child negatively acting on the external environment (134). Three key behaviour problems similarly make up this construct: aggression, delinquency, and hyperactivity.

Hyperactivity includes two types of problems; the first type is an excess of motor activity or restlessness, and the second type involves attention deficits (134). Externalising behaviours encompass a tendency to end in potentially dangerous situations and are risk factors for both non-intentional and intentional injuries. Although a number of studies have indicated that externalising problems tend to decrease from the age of 2 years onward (135, 136), such behavioural problems cause concern because, for some of the children, they predict persistent problems and psychiatric disorders (137-139). Follow-up studies of preschool children identified as having behaviour problems at ages 3 or 4 years generally report a high probability (approximately 50%) that the children will continue to display difficulties throughout the elementary school years (137). For some children, the problems will continue through adolescent years and into adulthood and may affect parenthood thus closing the circle of intergenerational transmission of problems. However, it may be difficult at an early age to separate transitory from persistent problems, and further research on the relevant trajectories is needed (140). High levels of problems, negative parenting, familial stress and other social risk factors have been observed to predict persistent and more severe problems (140, 141). To address this issue further, the aim of this study was to investigate the impact of maternal childhood abuse on toddlers' behaviour in a population-based sample.

## **2 AIMS OF THE STUDY**

Although there have been substantial achievements in research on injuries in children and child abuse in recent decades, the knowledge is in many ways fragmented. The overall aim of this thesis was to contribute to more integration of the knowledge of injuries and abuse in infants and toddlers. To achieve this goal, we studied the risk factors for injuries in children from both a clinical and epidemiological perspective and we investigated the intergenerational effects of childhood abuse.

The aim of the first paper was to describe the presenting characteristics, type of injury and hospital course in young children with traumatic head injuries and to identify characteristics indicating that the trauma was inflicted.

The aim of the second paper was to assess child characteristics and familial factors as predictors for injuries in toddlers.

The aim of the third paper was to assess intergenerational perspectives by investigating the impact of maternal childhood abuse on toddlers' behaviour and to assess the potential mediation of maternal mental distress for this pathway.

### **3 MATERIAL AND METHODS**

#### **3.1 Design**

Two samples were used in this thesis. The first paper was based on a retrospective medical record review with an observational design of 91 children younger than 36 months of age with a traumatic head injury. The next two papers were based on a longitudinal prospective pregnancy cohort study, the Norwegian Mother and Child Cohort study. The study sample comprises 27,000 mother and child dyads.

#### **3.2 Sample and procedure paper I**

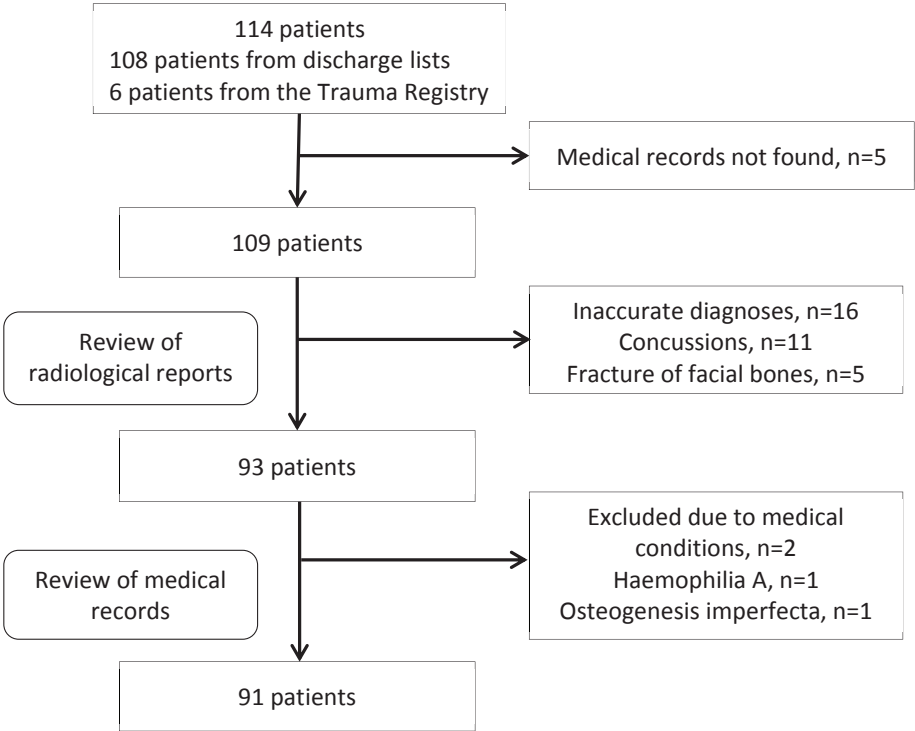
Children younger than 36 months of age with a traumatic head injury admitted to Oslo University Hospital (OUS) from January 1, 1995 through December 31, 2005, were identified by diagnostic codes in administrative discharge lists by the first author. One hundred eight patients were identified. The following diagnoses were included in this study (ICD-9 was in use before 1999 and ICD-10 from 1999):

- Fracture(s) of the skull and fracture of the base of the skull, excluding fracture of the facial bones (ICD-10: S02.00 - .99, ICD-9: 800.00 - .99, 801.00 - .99, 803.00 - .99, 804.00 - .99)
- Traumatic intracranial haemorrhage (ICD-10: S06.4 -.6, ICD-9: 852.00 - .99)
- Intracerebral haemorrhage and cerebral parenchymal injuries (ICD-10: S06.1 - .3 S06.8 S06.9, ICD-9: 851.00 - .99, 853.00 - .99, 854.00 - .99, 959.01)

We also searched the Trauma Registry at Ullevål University Hospital. This is a hospital-based trauma registry implemented August 1, 2000, including all patients were there had been trauma alarm activation. Six additional patients were identified and included the study. Five were not found in the discharge list because the codes were incomplete, and one patient died in the emergency room. After an extensive search throughout the hospital, the complete

records for all but five patients were found. The radiological reports and medical records were reviewed for eligibility. In total, 18 patients were excluded. The registered ICD code was inaccurate in 16 cases (11 cases were concussion, and five cases had fracture of facial bone and not the skull), and two cases were excluded due to medical conditions that could have impact upon the findings, e.g., bleeding disorders and bone disorders. The final study sample comprised 91 children.

Figure 1. Flow-chart for inclusion of cases in Traumatic Head Injuries in Infants and Toddlers study



The injuries were classified as falling into one of three “Causes of injury”, “Inflicted injury”, “Accident” or “Indeterminate”, based on the criteria for inflicted injuries and accidents (Box 1). The cases were classified by the first author and second author together. Information on the age of the patient, anamnestic information regarding the cause of the head injury and copies of the radiological reports were sent to an external collaborator for additional “Cause of injury” classification. Interrater evaluation was performed.

### **3.3 Variables and measurements paper I**

#### *3.3.1 Type of injury*

The cases were categorised into four groups according to the most profound type of head injury described in the radiological reports: isolated skull fractures, epidural haemorrhage (EDH), subdural haemorrhage (SDH) and parenchymal brain injury, including intracerebral haemorrhage. All patients had a CT scan of the head. In addition, MRI was performed in 21 patients. When two or more neuroexaminations were performed, the findings were added together.

#### *3.3.2 Recorded mechanism of injury*

The injury mechanism recorded in the medical records was evaluated and classified as unknown, fall < 0.8 m; fall 0.8–1.2 m; fall > 1.2 m; fall down stair; motor vehicle accident; and unique accident (Appendix table 2). The limits were chosen primarily to ensure that potential low and high impact falls were separated (< 0.8 m vs. > 1.2 m), secondly to comply with literature from other countries where both 3 feet (approx. 90 cm) and 4 feet (approx. 1.2 m) are used as limits for low vs. high impact falls, and finally to frame the actual descriptions in the records as accurately as possible, e.g., in many records the height of falls were estimated to be approximately one meter or a fall from a high bench or changing table were

described (approx. 90 cm high). Such common descriptions could, with reasonable certainty, be classified as between 0.8–1.2 m.

### 3.3.3 Cause of injury

#### **Criteria for classification as inflicted injury (74):**

1. Documented presumptive abuse in the medical record and referral to child protective services.
2. Injuries where the medical history could not explain the injury (142).
  - No history of trauma
  - A low-impact insult (height of fall < 1.0 m)
  - Changes in the history given by the caregivers
  - History incompatible with the child's developmental level
3. Injuries where additional findings indicate child abuse.
  - Retinal haemorrhages
  - Additional injuries which were incompatible with the given mechanism of the injury
  - Older injuries without explanation

#### Criteria for classification as accident (75):

1. Motor vehicle accident
2. Witnessed accident by people other than the caretaker(s)
3. Isolated or unique injury mechanism with consistent and detailed description evaluated as accidental in the medical record.

For cases with skull fracture(s) and EDH, the interrater agreement was low (kappa 0.13).

Therefore, these cases had to meet the first or third criteria above to be classified as inflicted.

For cases with SDH or parenchymal brain injuries, the interrater agreement was good (kappa 0.85). These cases were classified as inflicted if agreement between the raters was found and one of the above criteria was present (Table 3). All cases were classified as an accident if they met one of the above criteria for accidents. The remaining cases were classified as indeterminate.



### *3.3.4 Other variables*

Information regarding age (months), gender, mother age (years), father age (years), prior hospitalisation, estimated hours before call for medical assistance, seizures, decreased level of consciousness, apnoea or hypoventilation, increased intracranial pressure, length of stay, admittance to the intensive care unit, neurosequelae, and death were also retrieved from the medical records.

### **3.4 Sample and procedure paper II & III**

Paper II and III used data from the Norwegian Mother and Child Cohort Study (MoBa), conducted by the Norwegian Institute of Public Health. MoBa is a prospective pregnancy cohort study with a target population of all pregnant women in Norway and their children. Participants were recruited from all over Norway from 1999 – 2008 through postal invitations prior to routine ultrasound examinations at their local hospitals at approximately week 17 of gestation, and 38.5% of invited women consented to participate. The cohort now includes 108,000 children, 90,700 mothers and 71,500 fathers. The details of the MoBa study's sampling, design, questionnaires, informed consent processes, and data collection strategies have been reported elsewhere ([www.fhi.no/morogbarn](http://www.fhi.no/morogbarn)) (143, 144).

Although recruitment to the MoBa cohort is completed, data collection remains an on-going process. The current study was based on version IV of the quality-assured data files released for research on February 2009. This file comprises the first 27,227 mother and child dyads (N = 25,488 mothers) with completed questionnaires when the children were 36 months of age (children born 2001 – 2005). For paper II, cases with missing data on hospital-attended injuries in the children were excluded (N = 1,140), and the study sample comprised 26,087 children and mothers. The sample used for paper III comprised the first 25,452

children and their mothers who had completed the questionnaires when their children were 18 and 36 months of age.

### **3.5 Variables and measurements paper II & III**

Questionnaire data collected at gestational weeks 17 (Q1) and 30 (Q3) and at child ages 6 (Q4), 18 (Q5), and 36 months (Q6) were available for the current studies. The mother reported both for herself and the child. The response rates were 95% for Q1, 92% for Q3, 87% for Q4, 77% for Q5 and 62% for Q6. Information from the Medical Birth Registry of Norway (MBRN), which contains data on all births in Norway, was also available ([www.fhi.no/mfr](http://www.fhi.no/mfr)).

#### *3.5.1 Sociodemographic information (paper II & III)*

Demographic information regarding maternal age and education (paper II and III), older siblings and maternal occupational status (paper II) was reported at inclusion, Q1. Information regarding sex and gestational age of the child (paper II) was retrieved from the MBRN. The mother's civil status and current financial problems (paper II) were reported at child's age 18 months, Q5. 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%).

#### *3.5.2 Maternal mental health (paper II & III)*

The mother's mental health was assessed with the Symptom Checklist – 8 (SCL-8), which is an 8-item short version of the Hopkins Symptom Checklist (145-147), when the child was 18 months of age. The SCL-8 is designed to measure psychological distress, particularly anxiety and depression, in population surveys. Short versions of the SCL have shown good

psychometric properties (145, 146). The internal consistency in this sample was good and comparable to other studies (Cronbach's  $\alpha = 0.84$ ).

### *3.5.3 Injuries (paper II)*

Hospital attended-injuries between the age of 18 and 36 months were the selected outcome in paper II. 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".

### *3.5.4 Child development (paper II)*

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 (148) and has been validated in a Norwegian sample (149). When the child was 18 months of age, 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".

### 3.5.5 Child temperament (Paper II)

The Emotionality, Activity, Shyness, and Sociability Temperament Survey for Children (EAS) (150) 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 five-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.

### 3.5.6 Child externalising behaviour (paper II & III)

Child behaviour in both MoBa studies was assessed by items from the Child Behaviour Checklist (CBCL) for ages 1.5 to 5 years (134). The instrument is designed to identify a broad array of problem behaviours and should be completed by caregivers or others who observe the child in familiar settings. The externalising grouping of syndromes comprises problems that mainly involve conflicts with other people and with their expectations for the child and is divided into two syndromes: attention problems and aggressive behaviour. As with other large scale multidisciplinary studies, item selection was necessary because of restricted questionnaire space. Items selection in the MoBa study aimed at representing each subscale with items that were both clinically and theoretically relevant and based on a consensus among specialists in clinical and developmental psychology. All items were, according to the CBCL procedure, rated “not true” = 0, “somewhat or sometimes true” = 1, and “very true or often true” = 2.

*Paper II:* Child externalising behaviour was assessed when the child reached 18 months of age. 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. "Somewhat or sometimes true" and "very true or often true" were categorised together to indicate problem behaviours. The number of problems were summarised and then categorised as "no problems"; one, two or three problems for the attention subscale; and one, two or three or more problems for the aggressiveness subscale.

*Paper III:* Child externalising behaviour was assessed when the child reached 36 months of age using seven items measuring aggressiveness and four items measuring attention problems. Cronbach's  $\alpha$  was 0.74. Ratings from all items were summarised into a total score.

#### 3.5.4 Maternal abuse (paper III)

Maternal abuse exposure was assessed in late pregnancy with four items: 1) degradation or humiliation: "Someone has over a long period of time systematically tried to subdue, degrade or humiliate you"; 2) threats, "Someone has threatened to hurt you or someone close to you"; 3) physical abuse, "You have been subjected to physical abuse" and 4) sexual abuse: "You have been forced to perform sexual acts".<sup>1</sup> The choice of response was "no, never", "yes, as a child (under 18 years of age)" and/or "yes, as an adult (over 18 years of age)". The questions were based on the Norvold Abuse Questionnaire (NorAq) (151). Degradation or humiliation and threats (items 1 and 2) were classified together as emotional abuse, and physical and sexual abuse (items 3 and 4) were classified together. Emotional abuse in combination with physical and/or sexual abuse, was categorised as physical and/or sexual abuse, due to the

---

<sup>1</sup> Footnote

In the official English version of the 30th week of gestation questionnaire, the question about sexual abuse experience is "Have you been forced to have sexual intercourse?"

In this paper, we apply the wording "Have you been forced to sexual acts?", which we believe is a more correct translation of the question from Norwegian (Har du blitt presset til seksuelle handlinger?).

likelihood of elements of emotional abuse being present together with physical or sexual abuse. The following categories for childhood abuse experience, “no childhood abuse”, “childhood emotional abuse alone” and “childhood physical and/or sexual abuse”, were formed.

The mothers’ exposure to abuse as adults (after age 18) was categorised in the same manner as childhood abuse, creating the categories “no adult abuse”, “adult emotional abuse alone” and “adult physical and/or sexual abuse”.

Figure 2. Prevalence of maternal exposure to childhood abuse

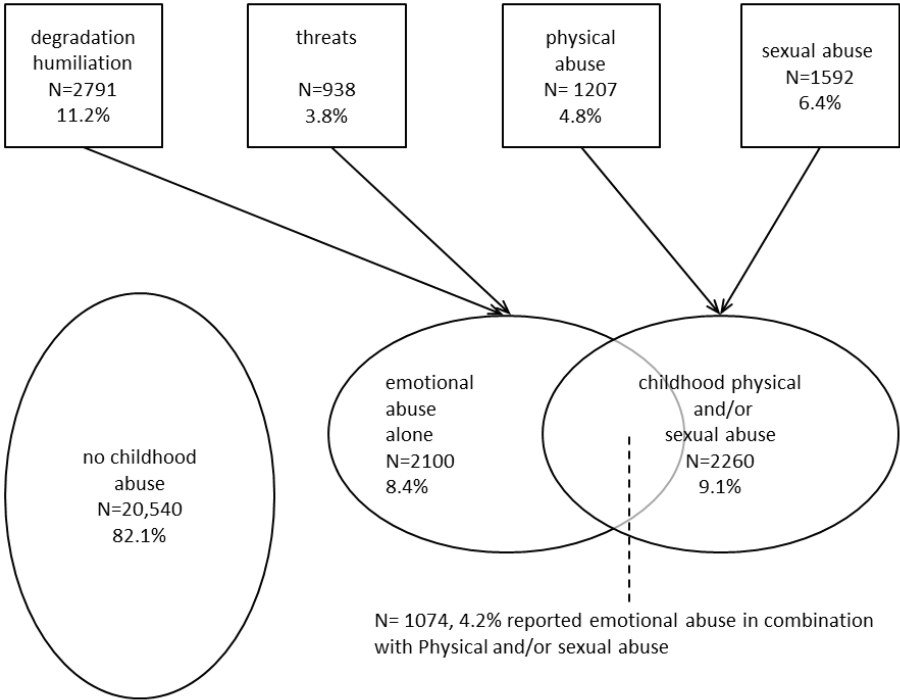


Table 1. Overview of the variables in paper II & III

	Q1	Q3	MBRN	Q5	Q6
	17-20 week of pregnancy	30 week of pregnancy	Birth	Child age 18 months	Child age 36 months
	Exposure			Outcome	
Paper II	Maternal age		Gender	Mother and child not living with the father	Hospital attended injuries
	Older sibling(s)		Gestational age at birth	Financial problems	
	Maternal education			Maternal mental health problems	
	Mother unemployed or disabled			<i>Child development</i> Gross motor Fine motor Communication Social	
				<i>Child temperament</i> Activity Emotionality Shyness	
				<i>Child externalising behaviour</i> Attention Aggression	
Paper III	Maternal age	Childhood abuse	Gender	Maternal mental health problems	Child externalising behaviour
	Maternal education	Adult Abuse		Civil status	

### 3.6 Statistics

In paper I, continuous data were presented as the mean with 95% confidence interval (CI), except when the distribution was far from normal. In such cases, the median and interquartile

range (IQR) were used. When comparing continuous variables, t-tests were used if the distribution of the variable was sufficiently close to the normal distribution. Otherwise, Mann-Whitney tests were used. Chi-square tests were used when comparing categorical data. Pearson's correlation coefficient was used to measure associations between two continuous variables. SPSS 12.01 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis.

In paper II, the predictors of hospital-attended injuries in children were analysed using logistic regression. Associations were presented as crude odds ratios (cORs) and adjusted odds ratios (aORs) with 95% confidence intervals [95% CI]. The corresponding tests for significance were performed using the Wald-test statistic. The summed scores of independent continuous measures were standardised, and the presented odds ratios represent the difference in risk for an increase of one standard deviation. Measures with internal consistency of Cronbach's  $\alpha < 0.60$  were categorised.

In paper III, chi-square tests were used for comparison between groups of categorical variables and one-way Analysis of variance (ANOVA) was used for continuous variables. For pairwise comparisons, post-hoc tests with Holm correction were used for chi-squared tests and Scheffé correction for ANOVAs. Maternal childhood abuse was investigated as a predictor for externalising behaviour in children using hierarchical linear regression. The potential mediation of maternal mental distress was tested using the four steps suggested by Baron and Kenny (152).

In paper II and III, a Generalised Estimating Equation (GEE) approach was used both for logistic and linear regression to account for clustering due to the inclusion of siblings in the study sample. Multicollinearity among the predictors was assessed by variance inflation factors and did not suggest any problems in either of the studies. The model in paper II was cross-validated in two randomly selected subsamples. Stratification by child gender produced only minor differences in effect estimates for all models. The rate of missing information on



single items ranged from 0% to 11.9% in paper II and 0% to 3.0% in paper III, and modelling was based on 20 multiply imputed datasets. Multivariate Imputation by Chained Equations (MICE) was used for imputations. All analyses were performed using R (The R Foundation for Statistical Computing, Vienna, Austria) with the R packages gee for GEE analysis and mice for multiple imputation.

### **3.7 Ethical considerations**

The traumatic head injury part of this thesis was conducted as a quality assurance and evaluation project. In accordance with the requirements for such retrospective research on hospital patients, personal consent was not obtained from the included patients. This approach was approved by the Data Protection Official at Ullevål University Hospital, and the study was approved by the Regional Committee for Medical Research Ethics for Eastern Norway. The study included already collected information from medical records and did not affect the treatment or follow-up for the patients. Nevertheless, the study includes information of very sensitive character and precautions were taken to keep the patients and carers anonymous. Retrospective research in this field in the largest trauma hospital in Norway is likely to be of value for further quality assurance and improvement and justifies the inclusion of information from vulnerable patients.

Participation in the Norwegian Mother and Child Cohort Study with repeated extensive questionnaires may be burdensome. The study is based on informed written consent and participants may at any time withdraw from the study without any negative consequence. Children are included with consent from the mother. Children will be informed personally about the study when they are 15 years of age. When the child reaches 18 years of age, informed consent from the child is needed for further storage of data. The Regional Committee for Medical Research Ethics and the Norwegian Data Inspectorate approved the

study. Our project has the same overall intention as the main study: identification of causal factors of disease and health problems, and is thus embedded by the original consent given, and no additional approval from the Regional Ethical Committee was required. The privacy of the participant is secured as we only have access to de-identified data, and the number of participants is so large that recognition of individuals is considered impossible.

The current study used only data that was already collected and therefore represents no additional burden to the participants. Our study, like other sub-studies, ensures that more knowledge can be generated from previously collected data and increases the utility of large population studies. Sub-studies that use existing data are cost effective and contribute to efficient use of public funds and research resources. Epidemiological research on victims of abuse might unintentionally contribute to stigmatism, a feeling of humiliation and self-blame among victims. The linkage to another unwanted attribute such as externalising behaviour in their children might further enhance such feelings. "Increased risk of injuries in children" is also a negatively charged term, which also has the potential of inducing regret and self-blame in parents. Therefore, we thought carefully about the wording and statements before the results were presented to avoid such effects.

## 4 RESULTS

### 4.1 Paper I

#### **Traumatic head injuries in infants and toddlers**

Ninety-one children with a traumatic head injury were included in the study. The cases were classified according to four types of injuries: isolated skull fractures (N = 39), EDH (N = 12), SDH (27) and parenchymal brain injury (N = 13)<sup>2</sup>. Domestic falls were the most common reported cause of isolated skull fractures. EDH followed the pattern of skull fractures in regards to mechanism of injury. Two-thirds of the SDH were reported from fall heights < 0.8 m, and there were no history of trauma in 26%. In total, 63% were classified as inflicted. No fall < 1 m was reported as a cause of parenchymal brain injury, and the largest proportion of motor vehicle accidents was found in this category.

Seventeen cases met the criteria for inflicted injury (19%), 35 cases met the criteria for accident (39%), and the remaining 39 cases (43%) were regarded as indeterminate. Compared to the accident group, the children in the inflicted group were significantly more likely to have been hospitalised earlier despite being considerably younger. Seizures and SDH without skull fractures occurred more frequently in the inflicted group.

The indeterminate group was characterised by low morbidity, and most of the injuries (46%) were caused by domestic falls from heights 0.8 to 1.2 m. The indeterminate group shared some characteristics with the inflicted injury group. The children were young, several had previously been hospitalised, and there were cases with no history of trauma, changing history or a low-impact fall described.

---

<sup>2</sup> The tables in paper I were published as supporting information online (<http://onlinelibrary.wiley.com/doi/10.1111/j.1651-2227.2007.00356.x/full>), and are here presented in appendix I.

## **4.2 Paper II**

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

In this study, we investigated characteristics that place toddlers at risk of injury. Both child-related factors (male gender, increased gestational age at birth, motor development, shyness, and attention) and familial factors (having older siblings, younger maternal age, financial difficulties and maternal mental health problems) were associated with hospital attended injuries.

In the multivariable analysis, younger maternal age, financial problems, maternal mental distress, having older siblings, increased gestational age at birth and male gender were risk factors for hospital-attended injuries. Children with impaired gross motor development had a decreased risk of injury, whereas those with impaired fine motor development had an increased risk. Of the temperamental traits, shyness was a protective factor after adjustment, whereas activity was no longer significant. Children with three reported attention problems had a slightly increased risk of injuries; otherwise, externalising behaviour was not a significant risk factor. This longitudinal population-based study confirmed that a wide-variety of factors interact as predictors of injuries in toddlers.

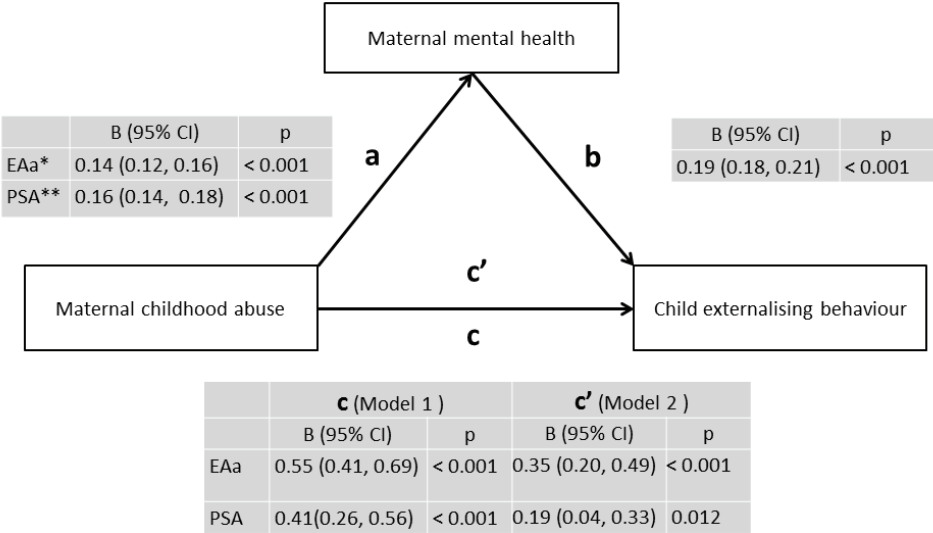
## **4.3 Paper III**

### **Maternal childhood abuse predicts externalising behaviour in toddlers – A prospective cohort study**

In this study, we investigated the impacts of maternal childhood abuse on toddlers' behaviour in a population-based sample. Maternal mental distress was assessed as a mediator for this pathway. Childhood emotional abuse alone was reported by 8.3% of the mothers and physical

and/or sexual abuse was reported by 8.9%. Mothers with childhood abuse experiences were younger, less educated, at a greater risk for adult abuse and mental distress, and fewer were married or lived with a partner compared with women not reporting childhood abuse. Children of mothers with childhood abuse experiences displayed significantly more externalising behaviour, even after adjusting for maternal age, education, single motherhood, gender and adult abuse experiences. When maternal mental health was entered into the model, the associations remained significant but were substantially attenuated.

Figure 3. Maternal mental health as mediator of the relationship between maternal childhood abuse and externalising behaviour in the offspring



Adjusted for maternal age, maternal education, maternal marital status and child's gender  
 \*Emotional Abuse alone (EAa), \*\*Physical and/or Sexual Abuse

## **5 DISCUSSION**

### **5.1 Discussion of the main findings**

In many ways, our first paper illustrates both the progress made and the problems that remain in the field of traumatic head injuries in young children. For SDHs, the existing knowledge made it possible to recognise inflicted injuries, and in many of these cases, there was strong evidence of abuse. For skull fractures and EDHs, our study demonstrated how difficult it is to be conclusive regarding “cause of injury” if there were no other signs of child maltreatment. Nearly two-thirds of the SDHs were classified as inflicted, but none of the EDHs or skull fractures were classified as inflicted. This proportion is consistent with other studies (76, 153). The children in the inflicted group were young, which is also consistent with the literature. This well-established relationship between age and inflicted head injuries is first of all due to infants being vulnerable to shaking. Babies are often taken care of by the perpetrator from birth, and situations such as extensive crying that may trigger abuse often arise early. It may also be easier to question parents’ explanations of injuries in babies compared with older children, as babies have limited opportunity to harm themselves. Despite being considerably younger, the children in the inflicted group were significantly more likely to have been hospitalised earlier. This result indicates that the parents may have had some concerns, although the underlying situation was not disclosed. We detected no clear pattern in the causes of hospitalisation. The fact that parents sought medical help underlines the importance of a thorough history and examination when young children present to health care. Otherwise, an opportunity to recognise abuse could be lost. It also underscores the importance of documenting the medical history when children present with injuries. Inflicted injuries were associated with seizure, and this finding has been confirmed by several studies (154-156). Seizures are likely to be a consequence of the injury type in combination with young age. It may also be a factor that seizures are so frightening for the carers that they bring the child to

health care in a situation where they otherwise would be reluctant to do so. Contrary to many other studies, few sociodemographic differences were found between the groups (157, 158), except for younger paternal than maternal age in the inflicted group. This is, however, an uncertain finding because the numbers were small. The few socioeconomic differences observed may be due to social risk factors being present in all three groups. Reviewing the material, our impression was that such risk factors were common in the whole sample, but comparison with the general population was not possible.

The largest group was classified as indeterminate. Injuries due to abuse and neglect may be indistinguishable from unintentional injuries with the present knowledge. The indeterminate group was characterised by skull fractures with low morbidity, and most of the injuries were caused by domestic falls. Even in a prospective study with diagnostic procedures according to best practise for all cases, there is likely to be indeterminate cases. Nevertheless, a more detailed and systematic history may reduce the proportion. The indeterminate group shared some characteristics with the inflicted injury group. They were young, more of them than expected had previously been hospitalised, and there were cases with no history of trauma, changing explanations or a low-impact mechanism as explanation. This could indicate that more children were abused or neglected and demonstrates that follow-up after unclear injuries in young children is necessary. It also exemplified that more knowledge is needed.

It is important to keep in mind that documented presumptive abuse in the medical record and referral to child protective services was one of the criteria for classification as inflicted injury. Hence, many of the established features associated with abuse, such as SDH and retinal haemorrhages, were already taken into account in the primary evaluation, and we had to be careful to avoid circular reasoning where the premise included the conclusion when we interpreted our results. The issue of circular reasoning is one of the main concerns when

comparing factors indicative of abuse vs. not abuse and makes research on inflicted injuries challenging. However, a comparative design is useful to identify new or not well-established features, in addition to evaluate features blinded in the classification. When our study was performed, seizures, prior hospitalisation and paternal age were not well-established features of inflicted injuries and were not likely to have been considered either in the primary evaluation or in the study classification. Age, time elapsed before accessing medical assistance and the absence of skull fracture when an intracranial injury was present may, on the other hand, have been considered in the primary evaluation. Since the publication of this study, systematic review articles of abusive head injuries have been published (87, 90, 156, 159), also including the present study (156). This review by Piteau et al. also compared the result when only studies with multidisciplinary assessment were included with the results when all studies otherwise available were included. Interestingly, few differences were found (156). This suggests that some medical features of inflicted injuries are so well-established as indicators of abuse that further multidisciplinary evaluation provides little additional information.

In the second paper, we investigated risk factors for hospital-attended injuries in toddlers with an epidemiological design. This study confirmed that a wide variety of factors are in play as predictors. One of the most robust risk factors was maternal mental distress. Other recent studies have also found that maternal depression constituted a risk factor for injuries in children (30, 31). Parents' mental health conditions should be addressed in further studies, preferably including both parents and providing more extensive information of mental health problems. Maternal mental health may be a factor one should be more aware of when assessing injury risk in children. Contrary to other studies, socioeconomic factors were not prominent risk factors in our study. This lack of association may be due to the low-risk profile of the sample. In addition, young age may also be an explanation for this result, as other



studies have found that socioeconomic factors are less important in the youngest children (160). Financial problems, which were significantly associated with injuries, 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, which may contribute to familial stress (22, 23).

In contrast to other studies, we did not identify temperamental and behavioural characteristics as robust risk factors for injury in children (33, 34, 37, 161). This disparity may be due to the younger age in this study, and assessment of child characteristics may be difficult at this early age. In our study, the associations between temperament, behaviour, and injury were substantially attenuated in adjusted models, perhaps indicating that other factors may be more robust predictors of injuries in young children. Child development withstood adjustment better. Children with impaired gross motor development had a decreased risk of injury, whereas those with impaired fine motor development had an increased risk. The different directionalities suggest that these areas should be assessed separately in future studies and illustrates the usefulness of assessing the developmental areas separately.

Our finding that preterm birth was associated with a decreased risk of injuries was unanticipated. Many studies have identified behavioural problems that are also linked to injury proneness in children born preterm (162, 163). On the other hand, studies of adolescents have suggested that children born with extremely low birth weights are more cautious, shy and risk averse than children born at term (164), and our finding might be explained by such attributes. Along the same line, shyness was a protective factor against injury. Shyness is considered to represent an inhibition to the unfamiliar and is associated with inhibitory control (165, 166). The finding of decreased injury risk in children born prematurely may have limited implication for injury prevention but may, nevertheless, contribute to insight regarding the consequences of premature birth.

A hospital-attended injury between 18 and 36 months of age was reported for 4.6% of the children, which is lower than most international estimates. A report from six European countries showed a wide variation in attendance rates ranging from 50 – 180 per 1,000 population for all children per year admission (167). Injury prevalence is often graphically represented as a pyramid, with fatalities on top, hospitalised patients in the middle and non-hospitalised patients at the base. Naturally, the prevalence varies greatly depending on which injuries are included but may also be influenced of access to health care and the organisation of health care. The low rate in our study may be due to many injuries being taken care of in primary care, as well as the low risk profile of the sample. Brudvik found an annual incidence of 9% (90 per 1,000) for medically attended injuries in preschool children below six years of age in Bergen in 2000 (73), and as expected, the rate was lower for hospital-attended injuries than for medically attended injuries.

In the third paper, we investigated potential behaviour problems in children of childhood abuse victims. This study found that mothers who had experienced abuse in childhood reported more externalising behaviour in their children at three years of age compared with mothers without such experiences. Adjustment for sociodemographic variables and abuse experiences later in life had little impact. Maternal mental health problems were a partial mediator of the relationship, but the associations remained significant in the final model. Consequently, other mechanisms not assessed in our study are in play. Important factors not assessed in our study may include genetic factors, parenting style or paternal factors. However, the robustness of the effect of childhood experience emphasises how childhood adversities may have intergenerational consequences. To our surprise, childhood emotional abuse was as strong a predictor of behavioural problems in the children as physical and /or sexual abuse. Both parental verbal aggression and other forms of emotional abuse have been proven to be a potent form of maltreatment in other studies (93,

168). One comparable study also suggested an association between childhood emotional abuse and behaviour problems in the offspring (133). Emotional abuse may be more chronic exposure, whereas more single or time-limited events may have been included in physical and /or sexual abuse. Repeated exposure to abuse has been found to result in worse outcomes than single events (94, 169). Nevertheless, our study suggests that childhood emotional abuse may affect parenthood.

The prevalence of physical abuse (4.7 %) and sexual abuse (6.3 %) were lower than most international and national estimates for these types of abuse in general (5, 55), and this may be due to the low risk profile of this sample. The prevalence was closer to what has been reported for more severe offences in Norway, and the reported abuse may then perhaps represent more severe offences (55). The use of a single labelled question for each of the abuse types may have contributed to underreporting of less severe offences (170). On the other hand, the prevalence of emotional abuse (12.5%) was higher than the international estimates of 4 - 9% (5). This may depend upon the use of two descriptive- and behaviour-specific questions used in the assessment of emotional abuse (170). Uses of such questions have been demonstrated to reduce underreporting (171).

Maternal mental health was an important predictor both for injuries in children and behavioural problems. Mental distress may reduce a parent's attention to external cues and may negatively impact the parent-child relationship. These relationships indicate that the wellbeing of mothers is important for child safety and development. Together, these studies indicated that maternal childhood abuse may also be a risk factor for injuries in their children. Maternal childhood abuse predicted an increase in child externalising behaviour, and externalising behaviour may be a risk factor for injuries even though a robust relationship could not be established in our study.

## **5.2 Methodological considerations**

The clinical and the epidemiological approaches used in this thesis represent different research strategies and designs and hence different limitations and strengths. Paper I is based on a retrospective review of medical records of a highly selected hospital sample, whereas paper II and III is based on data from a large prospective cohort survey of the general population with a wide aim. These different designs have different implications in regard to hypothesis testing. In paper I, the likelihood for type II errors was most prominent. The small sample and the non-systematic information available in the files may have resulted in no significant differences between the groups on characteristics which in reality were different. In paper II and III, the large sample and the large number of available variables may have given false positive relationships, and type I errors may be considered.

### *5.2.1 Main limitations and strengths in paper I*

In paper I, the information available was restricted to the content of the medical records, including radiologic reports and laboratory reports. Standardised measures were not regularly used, and the available information varied. Generally, more information was available for severe cases with a long hospital stay and the most recent cases. Moreover, the medical assessment was dependent of the injury type. For instance, skeletal survey and fundoscopy were only performed if abuse was suspected. This limitation put restrictions on choice of variables, classification and analyses. However, the comparison groups are likely to be representative with regards to inflicted vs. accidental injuries. This was ensured by a conservative approach where cases were classified as indeterminate when pre-set criteria for inflicted injury or accident were not clearly met. Likewise, a variable was left missing if there was any doubt of its value. Furthermore, interrater reliability was assessed. Interrater reliability was good for the more severe injuries, and they could be classified according to the

pre-set criteria. For less severe injuries, the interrater reliability was low. Consequently, the classification criteria were set more stringent for these injuries. The strength of this study was the proximity to the clinic, and the authors' clinical experience in the hospital which made it possible to extract much of the available information retrospectively.

### *5.2.2 Main limitations and strengths in paper II and III*

#### 5.2.2.1 Selection bias in MoBa and implications for our studies

Selection bias is a systematic error in a study that stems from the procedure used to select subjects and from factors that influence study participation (172). A response rate of 38.5% in the MoBa-study and a further attrition where the response rates were 95% for Q1, 92% for Q3, 87% for Q4, 77% for Q5 and 62% for Q6 suggest a potential selection bias, which gives rise to concern to what extent the results of MoBa are valid for the total pregnant population. A comparison of educational information using national data indicated that women with the highest education level were overrepresented in the cohort (national: 31%; cohort: 56%) (143), and comparisons with data from MBRN indicate that the youngest women (<25 years), those living alone, mothers with >2 previous births and with previous stillbirth were strongly underrepresented (143, 173). Attrition analysis indicated the same tendency with regard to demographic and family risk variables (132). Furthermore, the sample predominantly comprised ethnic Norwegian participants and did not allow us to investigate the influence of ethnicity or culture. Our study samples may be regarded as representing a low-risk population, and the prevalence of risk factors and adversities, such as childhood abuse, are likely to be underestimated. However, few significant differences in exposure-outcome associations have been found in studies where this cohort has been compared data from the MBRN, which comprises the entire Norwegian pregnancy population (173). The implication is that although

participants may differ from non-participants on key characteristics, the associations observed in our studies are most likely to be underestimated.

#### 5.2.2.2 Information bias in the measurement of child injury

Information bias occurs because erroneous information from or about participants leads to systematic misclassification. Self-reported medically attended or hospital-attended injuries are common measures in the injury literature and for children parental report are often used.

However, concerns about the sensitivity and validity of self-reported injury data have been raised and may also have biased our risk estimates (174). Parental injury recall has been shown to decrease with time and tends to be more accurate for major injuries (175, 176). The expected over-representation of more recent injuries and more severe injuries are, however, not likely affect the association measures substantially.

Our study did not include measures of injury type or injury mechanism. Not knowing the injury type was not a concern because we wanted to study the risk factors common to all types of injuries. The lack of information about the injury mechanism may have reduced the probability of identifying child-based risk factors because injuries with little child control were included (e.g., car occupant accidents). Similarly, the inclusion of injuries occurring without parental control, e.g., in day-care, may have reduced the likelihood of identifying familial factors. Not knowing the injury mechanism also made it impossible to recognise injuries caused by neglect and abuse.

A concern in our study was that there may be some overlap between the comparison groups of children with and without hospital-attended injuries regarding injury severity, which may have reduced effect sizes. Although the specification “admitted to or examined in a hospital” ensured a minimal injury severity, there are differences in referral routines and organisation of the health care system throughout Norway. Differences in hospital attendance

can be expected with more severe injuries treated in out-patient clinics in rural areas, as well as in the large inner city Emergency Medical Agency in Oslo. On the other hand, the large sample size made it less likely that important risk factors were overlooked. Notably, patients require a referral from a GP for an examination at a hospital in Norway. The impact of parental differences in seeking health care was thereby reduced for hospital-attended injuries. Moreover, financial difficulties should not contribute to differences as all medical care for children in Norway is free.

#### 5.2.2.3 Information bias in the measurement of childhood abuse

Retrospective reports of adverse childhood experiences are likely to involve measurement errors, but are nevertheless regarded to have a worthwhile place in research (177, 178). Forgetfulness, denial, misunderstanding, and embarrassment may result in false negative reports (5, 179). On the other hand, studies indicate that few individuals report a false history of abuse (170), and the assumed problems are more likely to lead to the under-reporting rather than over-reporting of abuse of children and then perhaps diminished strength of associations (177, 180).

Maternal childhood abuse was assessed in late pregnancy with four questions. The first two questions were descriptive and behaviour specific. Both described constructs are defined as emotional abuse, and thus they were categorised together. Physical and sexual abuse were both assessed by single, broad labelling questions. Such labelling has been demonstrated to result in lower positive responses, compared with descriptive questions, and may have contributed to false negative reports (171, 181).

#### 5.2.2.4 Single-informant bias

Reliance on the mother as single informant may have affected the response accuracy.

Parents have been observed to report more externalising behaviour in their children than teachers and other professionals. Regardless, parental reports of externalising behaviour have been demonstrated to be equally predictive of later problem behaviour as professional reports (182, 183).

In our studies, the mother was the informant of both her own symptoms and the child's characteristics. Current maternal mental distress has been observed to result in reporting of more behaviour problems in the child by the mother, thereby raising questions about the validity of reports of child behaviour by persons who are currently distressed (184).

Depressed or anxious mothers may also remember adverse events such as injuries to their children better than mothers in general. To our knowledge, no such effects are described in the literature, but they cannot be excluded, and may have resulted in an overestimation of the relationship between maternal mental health and injury in their children. The potential over-report of child behaviour problems by distressed mothers may have resulted in an over-estimation of the relationship between maternal childhood abuse and behavioural problems in children in the models that did not include mental health (185). In the final model, the adjustment for maternal mental health compensated for this effect. The mediation effect of maternal mental health may, on the other hand, be overestimated. However, even though the depression–distortion question is worth considering, it may not explain the full effect (186).

#### 5.2.2.5 Reliability and validity

Shortened scales lessen the burden on the respondents and allow more variables to be included in questionnaires with limited space. However, the use of abbreviated scales may have threatened the reliability as well as the validity of otherwise psychometrically well-documented instruments. A major concern in our study was the low internal reliability for some of the measures. These measures were analysed as categorical variables, which may



have reduced their sensitivity and lessened the opportunity to identify significant and robust child characteristic as risk factors.

The MoBa study used items from instruments that have been extensively validated (134, 148, 150). Items for the abbreviated scales were selected by consensus among specialists in clinical and developmental psychology with an aim towards maintaining content validity. However, the scale abbreviations may represent the original construct less accurately (187). Both the instruments used to assess behaviour and development were constructed to identify children in need of further follow-up. As expected, these measures were heavily skewed toward low scores in this normal population. Instruments that had captured the normal variation better might have provided additional knowledge.

### **5.3 Implications and suggestions for future research**

The traumatic head injury study may have had implications for clinical practice in Norway. The study was the first on inflicted injuries in Norway and brought focus to the topic, which may have contributed to more cases being identified as well as better documentation and more systematic assessment regarding injury mechanism of head injuries in young children (188). To develop this field further, a prospective study with systematic gathering of information is needed. Long-term follow-up would be valuable, not only to assess neurological sequelae, but also to follow social and legal issues. However, in the future, research on inflicted vs. non-inflicted injuries must avoid circular reasoning, which may limit the identification of new aspects as well as confirm established knowledge without a critical view. Research with other approaches, such as studies of biomechanics of the infant skull and brain and a combination of biomechanical measurements and reconstruction of witnessed events, may prove useful. Attempts to develop tests and methodology to date bruises, bleedings, brain injury and fractures more accurately have been made (189, 190), but more knowledge is needed before

such strategies are applicable for clinical and forensic use. Many professions are involved in regard to injuries in children and child abuse and neglect, and the clinical knowledge as well as research is in many ways fragmented. Research cooperation between paediatricians and forensic pathologists with knowledge of child abuse, surgeons who treat injuries and epidemiologists with knowledge of how and why children of different age, size and developmental stage become injured may provide valuable new insight. Finally, long-term consequences of childhood abuse have been established for both somatic and mental health, but there is little integrated research on the more acute aspects.

A variety of relevant predictors were associated with injuries in toddlers. Our study demonstrates that it can be difficult to separate relevant risk factors and perhaps reflect that the risk factors were truly entangled. However, some of the limitations in our study is possible to overcome. Injury variables that better capture the continuous nature of many aspects of injuries, such as frequency and severity may better identify injury prone children. To achieve this, a more accurate injury surveillance system or population-based studies especially designed for this purpose are needed. A combination of such register data and survey data are likely to provide even more valuable results. The forthcoming national injury surveillance system through the Norwegian Patient Registry will hopefully provide new research opportunities on children's injury risk in Norway. Furthermore, monitoring of injury incidence with changes over time and evaluation of preventions strategies will be possible. New possibilities would also arise if such registries included information identifying inflicted injuries.

The large sample size made it possible to recognise small group differences that may not be directly recognisable in clinical practice. However, the direction of the associations may provide clues to what to look for, and the risk factors may also be clinically evident in

the upper end of the constructs. The identification of specific child-based risk factors may also reveal interesting information on child developmental psychology.

In addition to neurobiological research to understand the underlying biological changes, integrated research that focuses on the family context is required to obtain further knowledge of the processes involved in intergenerational transmission of adversity. Studies that use both biological and psychological methods may also give rise to new interesting perspectives. Our study describes three indicators of families at risk: maternal childhood abuse, maternal mental health problems and child behaviour. First and foremost, this calls for cooperation between child and adult psychology/psychiatry. The mother's history, the mother's present mental health and child problems should be studied simultaneously. Up until now, studies with an intergeneration perspective have mainly focused on mother and child dyads, whereas fathers have received less attention, and the inclusion of fathers in future studies may provide valuable new insight.

In the MoBa papers, the low risk profile of the sample may have led to underestimation of the relationships, and sampling strategies that ensure a better representation of the general population, including the immigrant population and high-risk groups, would be valuable in future epidemiological research on adversities in childhood. Preferably, further studies should also include both parents.

#### **5.4 Conclusions**

A considerable number of the children admitted to hospital with a head injury were not adequately assessed for trauma history and possible abuse. This thesis demonstrates that a thorough evaluation is necessary when a young child presents with a head injury otherwise severe abuse could be missed. Inadequate supervision may also have caused the injury. Assessments of and actions towards potential neglect and abuse are thereby also needed to

safeguard the children against future injuries. Our study confirms that a wide-variety of factors are in play as predictors of injuries. Both child characteristics and familial factors increase injury risk in toddlers. Professionals should be especially aware of maternal mental health and delayed fine motor development as risk factors. Furthermore, maternal childhood abuse predicted increased externalising behaviour in the offspring. The longitudinal design of the study supports a parent-to-child directionality, and this thesis suggests that childhood abuse may influence the subsequent generation. Multiple pathways are possible, but maternal mental health was identified as a significant mediator. Systematic assessment of predictors may help to identify children at risk of abuse, injuries and behavioural problems at an early stage. A family perspective and involvement of both somatic and mental health professionals may increase the quality of evaluations and the level of care.

## References

- (1) Convention on the Rights of the Child. United Nations Treaty Collection. London: 1989.
- (2) Krug EG, Dahlberg LL, Mercy JA, Zwi AB, Lozano R. World report on violence and health. Geneva: World Health Organization, 2002.
- (3) Pinheiro PS. World report on violence against children. Geneva: The United Nations, 2006.
- (4) Butchart A, Harvey AP, Mian M, Furniss T. *Preventing child maltreatment: A guide to taking action and generating evidence*. Geneva: World Health Organization and International Society for Prevention of Child Abuse and Neglect, 2006.
- (5) Gilbert R, Widom CS, Browne K, Fergusson D, Webb E, Janson S. Burden and consequences of child maltreatment in high-income countries. *Lancet*. 2009;373(9657):68-81.
- (6) DiLillo D, Damashek A. Parenting characteristics of women reporting a history of childhood sexual abuse. *Child Maltreat*. 2003;8(4):319-33.
- (7) Egeland B, Jacobvitz D, Sroufe LA. Breaking the cycle of abuse. *Child Dev*. 1988;59(4):1080-8.
- (8) Dubowitz H, Black MM, Kerr MA, Hussey JM, Morrel TM, Everson MD, et al. Type and timing of mothers' victimization: effects on mothers and children. *Pediatrics*. 2001;107(4):728-35.
- (9) Neigh GN, Gillespie CF, Nemeroff CB. The neurobiological toll of child abuse and neglect. *Trauma Violence Abuse*. 2009;10(4):389-410.
- (10) Straus MA. Spanking and the making of a violent society. *Pediatrics*. 1996;98(4 Pt 2):837-42.
- (11) Guidance for effective discipline. American Academy of Pediatrics. Committee on Psychosocial Aspects of Child and Family Health. *Pediatrics*. 1998;101(4 Pt 1):723-8.
- (12) Gershoff ET. Corporal punishment by parents and associated child behaviors and experiences: a meta-analytic and theoretical review. *Psychol Bull*. 2002;128(4):539-79.
- (13) Lov om barn og foreldre. [The children act]. Sect. 5. § 30 (1981).
- (14) Janson S, Jernbro C, Långberg B. Kroppslig bestraffning ock annan krankning av barn i Sverige [Corporal punishment and other humiliating behavior towards children in Sweden - a national study]. Stiftelsen Allmänna Barnhuset og Karlstad Universitet, 2011.
- (15) Baker SP, O'Neill B, Karpf RS. *The injury fact book*. Lexington, MA: Lexington Books; 1984.

- (16) Peden M, Oyegbite K, Ozanne-Smith J, Hyder AA, Branche C, Rahman AF, et al. World Report on Child Injury Prevention. Geneva, Switzerland: World Health Organization, 2008.
- (17) Haddon W. 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):1431-8.
- (18) Agran PF, Anderson C, Winn D, Trent R, Walton-Haynes L, Thayer S. Rates of pediatric injuries by 3-month intervals for children 0 to 3 years of age. *Pediatrics*. 2003;111(6 Pt 1):92.
- (19) Flavin MP, Dostaler SM, Simpson K, Brison RJ, Pickett W. Stages of development and injury patterns in the early years: a population-based analysis. *BMC public health*. 2006;6:187.
- (20) Janson S. Så skadar sig barn [How children get injured]. Kristinestad: Forlagshuset Gothia; 2005.
- (21) Faelker T, Pickett W, Brison RJ. Socioeconomic differences in childhood injury: a population based epidemiologic study in Ontario, Canada. *Injury Prevention*. 2000;6(3):203-8.
- (22) Hjern A, Ringback-Weitof G, Andersson R. Socio-demographic risk factors for home-type injuries in Swedish infants and toddlers. *Acta Paediatrica*. 2001;90(1):61-8.
- (23) Laursen B, Nielsen JW. Influence of sociodemographic factors on the risk of unintentional childhood home injuries. *Eur J Public Health*. 2008;18(4):366-70.
- (24) Bijur PE, Golding J, Kurzon M. Childhood accidents, family size and birth order. *Soc Sci Med*. 1988;26(8):839-43.
- (25) Garbarino J. Preventing childhood injury: developmental and mental health issues. *Am J Orthopsychiatry*. 1988;58(1):25-45.
- (26) Petrass L, Blitvich JD, Finch CF. Parent/Caregiver supervision and child injury: a systematic review of critical dimensions for understanding this relationship. *Fam Community Health*. 2009;32(2):123-35.
- (27) Morrongiello BA, Ondejko L, Littlejohn A. Understanding toddlers' in-home injuries: I. Context, correlates, and determinants. *J Pediatr Psychol*. 2004;29(6):415-31.
- (28) Morrongiello BA, Ondejko L, Littlejohn A. Understanding toddlers' in-home injuries: II. Examining parental strategies, and their efficacy, for managing child injury risk. *J Pediatr Psychol*. 2004;29(6):433-46.
- (29) Peden M, McGee K, Krug E. Injury: A leading cause of the global burden of disease 2000. Geneva: World Health Organization, 2002.
- (30) Phelan K, Khoury J, Atherton H, Kahn RS. Maternal depression, child behavior, and injury. *Inj Prev*. 2007;13(6):403-8.

- (31) Schwebel DC, Brezaussek CM. Chronic maternal depression and children's injury risk. *J Pediatr Psychol.* 2008;33(10):1108-16.
- (32) Manheimer DI, Mellinger GD. Personality characteristics of the child accident repeater. *Child Dev.* 1967;38(2):491-513.
- (33) Schwebel DC, Gaines J. Pediatric unintentional injury: behavioral risk factors and implications for prevention. *J Dev Behav Pediatr.* 2007;28(3):245-54.
- (34) Byrne JM, Bawden HN, Beattie T, DeWolfe NA. Risk for injury in preschoolers: relationship to attention deficit hyperactivity disorder. *Child Neuropsychol.* 2003;9(2):142-51.
- (35) Brehaut JC, Miller A, Raina P, McGrail KM. Childhood behavior disorders and injuries among children and youth: a population-based study. *Pediatrics.* 2003;111(2):262-9.
- (36) Rowe R, Maughan B, Goodman R. Childhood psychiatric disorder and unintentional injury: findings from a national cohort study. *J Pediatr Psychol.* 2004;29(2):119-30.
- (37) Bijur PE, Stewart-Brown S, Butler N. Child behavior and accidental injury in 11,966 preschool children. *Am J Dis Child.* 1986;140(5):487-92.
- (38) Angle CR. Locomotor skills and school accidents. *Pediatrics.* 1975;56(5):819-22.
- (39) Schwebel DC, Binder SC, Sales JM, Plumert JM. Is there a link between children's motor abilities and unintentional injuries? *J Safety Res.* 2003;34(2):135-41.
- (40) Peterson L, Brown D. Integrating child injury and abuse-neglect research: common histories, etiologies, and solutions. *Psychol Bull.* 1994;116(2):293-315.
- (41) Sass R, Crook G. Accident proneness: science or non-science? *Int J Health Serv.* 1981;11(2):175-90.
- (42) Labbe J. Ambroise Tardieu: the man and his work on child maltreatment a century before Kempe. *Child Abuse Negl.* 2005;29(4):311-24.
- (43) Caffey J. Multiple fractures in the long bones of infants suffering from chronic subdural hematoma. *Am J Roentgenol Radium Ther.* 1946;56(2):163-73.
- (44) Kempe CH, Silverman FN, Steele BF, Droegemueller W, Silver HK. The battered-child syndrome. *JAMA.* 1962;181:17-24.
- (45) Gjerdrum K. "Vanrøktssyndromet" ["The Battered child syndrome"]. *Tidsskr Nor Legeforen.* 1964;84:1609-12.
- (46) Hågå P. Barnemishandling - "The Battered Child Syndrome" [Child abuse - "The Battered Child Syndrome"]. *Tidsskrift for Den Norske Lægeforening.* 1975;95(12):752-5.

- (47) Heap KK. Omsorgssvikt - en kassstudie og etterundersøkelse av barn i omsorgssviktsituasjoner [Doktoravhandling] [Neglect]  
Oslo: Univerity of Oslo; 1987.
- (48) Killén K. Sveket I [Betrayed I]. 4 ed. Oslo: Kommuneforlaget; 2009.
- (49) Kempe CH. Sexual abuse, another hidden pediatric problem: the 1977 C. Anderson Aldrich lecture. *Pediatrics*. 1978;62(3):382-9.
- (50) Heger AH. Twenty years in the evaluation of the sexually abused child: has medicine helped or hurt the child and the family? *Child Abuse Negl*. 1996;20(10):893-7.
- (51) Hart SN, Brassard MR. A major threat to children's mental health. Psychological maltreatment. *Am Psychol*. 1987;42(2):160-5.
- (52) Kairys SW, Johnson CF. The psychological maltreatment of children--technical report. *Pediatrics*. 2002;109(4):e68.
- (53) Øverlien C. Vold i hjemmet - barns strategier. [Domestic violence - Children's strategies] Oslo: Universitetsforlaget; 2012.
- (54) Finkelhor D, Turner H, Ormrod R, Hamby SL. Violence, abuse, and crime exposure in a national sample of children and youth. *Pediatrics*. 2009;124(5):1411-23.
- (55) Stefansen K. Vold og overgrep mot barn og unge. *En selvrappporteringsstudie blant avgangselever i videregående skole*. [Violence and sexual abuse against children and young people in Norway: A questionnaire study among students in their last year of secondary school]. In: Mossige S, Stefansen K, editors. NOVA Rapport. 20/07. Oslo: Norsk institutt for forskning om oppvekst, velferd og aldring NOVA; 2007. p. s. 48-75
- (56) Claussen AH, Crittenden PM. Physical and psychological maltreatment: relations among types of maltreatment. *Child Abuse Negl*. 1991;15(1-2):5-18.
- (57) Greeley CS. The evolution of the child maltreatment literature. *Pediatrics*. 2012;130(2):347-8.
- (58) MacMillan HL, Jamieson E, Walsh CA. Reported contact with child protection services among those reporting child physical and sexual abuse: results from a community survey. *Child Abuse Negl*. 2003;27(12):1397-408.
- (59) Finkelhor D. Childhood victimization, Violence, Crime and Abuse in the Lives of Young People. Renzetti C, Edleson JL, editors. New York: Oxford University Press 2008.
- (60) Finkelhor D, Turner H, Ormrod R, Hamby SL. Trends in childhood violence and abuse exposure: evidence from 2 national surveys. *Arch Pediatr Adolesc Med*. 2010;164(3):238-42.



- (61) Sidebotham P, Heron J, Golding J. Child maltreatment in the "Children of the Nineties:" deprivation, class, and social networks in a UK sample. *Child Abuse Negl.* 2002;26(12):1243-59.
- (62) Annerback EM, Wingren G, Svedin CG, Gustafsson PA. Prevalence and characteristics of child physical abuse in Sweden - findings from a population-based youth survey. *Acta Paediatr.* 2010;99(8):1229-36.
- (63) Schou L, Dyb G, Graff-Iversen S. Voldsutsatt ungdom i Norge - resultater fra helseundersøkelser i seks fylker [Youth exposed to violence in Norway]. Oslo: Nasjonalt folkehelseinstitutt og Nasjonalt kunnskapscenter om vold og traumatisk stress, 2007.
- (64) Edwards VJ, Holden GW, Felitti VJ, Anda RF. Relationship between multiple forms of childhood maltreatment and adult mental health in community respondents: results from the adverse childhood experiences study. *Am J Psychiatry.* 2003;160(8):1453-60.
- (65) May-Chahal C, Cawson P. Measuring child maltreatment in the United Kingdom: a study of the prevalence of child abuse and neglect. *Child Abuse Negl.* 2005;29(9):969-84.
- (66) Långberg B, Bodil S, Janson S. Våld mot barn 2006 - 2007 [Violence against children 2006 - 2007]. Stockholm: Allmanna Barnhuset and Karlstad University, 2007.
- (67) Undersøkingssaker starta av barnevernet, etter innhald i meldinga, kven som melde saka og alder: 2011. [New cases of children with measures from the Child Welfare Services during the year, by age and reason for measure: 2011]: Statistics Norway; 2012 [updated 10. Juni; cited 2013 10. Juni ]. Available from: <https://www.ssb.no/statistikkbanken/selectvarval/saveselections.asp>.
- (68) Parslow RC, Morris KP, Tasker RC, Forsyth RJ, Hawley CA. Epidemiology of traumatic brain injury in children receiving intensive care in the UK. *Arch Dis Child.* 2005;90(11):1182-7.
- (69) Bayreuther J, Wagener S, Woodford M, Edwards A, Lecky F, Bouamra O, et al. Paediatric trauma: injury pattern and mortality in the UK. *Arch Dis Child Educ Pract Ed.* 2009;94(2):37-41.
- (70) Crowe L, Babl F, Anderson V, Catroppa C. The epidemiology of paediatric head injuries: data from a referral centre in Victoria, Australia. *Journal of paediatrics and child health.* 2009;45(6):346-50.
- (71) Falk AC, Klang B, Paavonen EJ, von Wendt L. Current incidence and management of children with traumatic head injuries: the Stockholm experience. *Dev Neurorehabil.* 2007;10(1):49-55.
- (72) Spady DW, Saunders DL, Schopflocher DP, Svenson LW. Patterns of injury in children: a population-based approach. *Pediatrics.* 2004;113(3 Pt 1):522-9.
- (73) Brudvik C. Child injuries in Bergen, Norway. *Injury.* 2000;31(10):761-7.

- (74) Duhaime AC, Alario AJ, Lewander WJ, Schut L, Sutton LN, Seidl TS, et al. Head injury in very young children: mechanisms, injury types, and ophthalmologic findings in 100 hospitalized patients younger than 2 years of age. *Pediatrics*. 1992;90(2 Pt 1):179-85.
- (75) Reece RM, Sege R. Childhood head injuries: accidental or inflicted? *Arch Pediatr Adolesc Med*. 2000;154(1):11-5.
- (76) Ettaro L, Berger RP, Songer T. Abusive head trauma in young children: characteristics and medical charges in a hospitalized population. *Child Abuse Negl*. 2004;28(10):1099-111.
- (77) Keenan HT, Runyan DK, Marshall SW, Nocera MA, Merten DF, Sinal SH. A population-based study of inflicted traumatic brain injury in young children. *JAMA*. 2003;290(5):621-6.
- (78) Caffey J. On the theory and practice of shaking infants. Its potential residual effects of permanent brain damage and mental retardation. *Am J Dis Child*. 1972;124(2):161-9.
- (79) Caffey J. The whiplash shaken infant syndrome: manual shaking by the extremities with whiplash-induced intracranial and intraocular bleedings, linked with residual permanent brain damage and mental retardation. *Pediatrics*. 1974;54(4):396-403.
- (80) Christian CW, Block R. Abusive head trauma in infants and children. *Pediatrics*. 2009;123(5):1409-11.
- (81) Kemp AM. Abusive head trauma: recognition and the essential investigation. *Arch Dis Child Educ Pract Ed*. 2011;96(6):202-8.
- (82) Hymel KP, Makoroff KL, Laskey AL, Conaway MR, Blackman JA. Mechanisms, clinical presentations, injuries, and outcomes from inflicted versus noninflicted head trauma during infancy: results of a prospective, multicentered, comparative study. *Pediatrics*. 2007;119(5):922-9.
- (83) Sookplung P, Vavilala MS. What is new in pediatric traumatic brain injury? *Curr Opin Anaesthesiol*. 2009;22(5):572-8.
- (84) Keenan HT, Hooper SR, Wetherington CE, Nocera M, Runyan DK. Neurodevelopmental consequences of early traumatic brain injury in 3-year-old children. *Pediatrics*. 2007;119(3):23.
- (85) Anderson V, Spencer-Smith M, Wood A. Do children really recover better? Neurobehavioural plasticity after early brain insult. *Brain*. 2011;134(Pt 8):2197-221.
- (86) Bhardwaj G, Chowdhury V, Jacobs MB, Moran KT, Martin FJ, Coroneo MT. A systematic review of the diagnostic accuracy of ocular signs in pediatric abusive head trauma. *Ophthalmology*. 2010;117(5):983-92.
- (87) Maguire S, Pickerd N, Farewell D, Mann M, Tempest V, Kemp AM. Which clinical features distinguish inflicted from non-inflicted brain injury? A systematic review. *Arch Dis Child*. 2009;94(11):860-7.

- (88) When to suspect child maltreatment London: National Collaborating Centre for Women's and Children's Health; 2009. Available from: <http://guidance.nice.org.uk/CG89>.
- (89) Vinchon M, de Foort-Dhellemmes S, Desurmont M, Delestret I. Confessed abuse versus witnessed accidents in infants: comparison of clinical, radiological, and ophthalmological data in corroborated cases. *Childs Nervous System*. 2010;26(5):637-45.
- (90) Maguire SA, Kemp AM, Lumb RC, Farewell DM. Estimating the probability of abusive head trauma: a pooled analysis. *Pediatrics*. 2011;128(3):e550-64.
- (91) Felitti VJ, Anda RF, Nordenberg D, Williamson DF, Spitz AM, Edwards V, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The Adverse Childhood Experiences (ACE) Study. *Am J Prev Med*. 1998;14(4):245-58.
- (92) Danese A, Pariante CM, Caspi A, Taylor A, Poulton R. Childhood maltreatment predicts adult inflammation in a life-course study. *Proc Natl Acad Sci U S A*. 2007;104(4):1319-24.
- (93) Norman RE, Byambaa M, De R, Butchart A, Scott J, Vos T. The long-term health consequences of child physical abuse, emotional abuse, and neglect: a systematic review and meta-analysis. *PLoS Med*. 2012;9(11):e1001349.
- (94) Annerback EM, Sahlqvist L, Svedin CG, Wingren G, Gustafsson PA. Child physical abuse and concurrence of other types of child abuse in Sweden-Associations with health and risk behaviors. *Child Abuse Negl*. 2012;36(7-8):585-95.
- (95) Chapman DP, Whitfield CL, Felitti VJ, Dube SR, Edwards VJ, Anda RF. Adverse childhood experiences and the risk of depressive disorders in adulthood. *J Affect Disord*. 2004;82(2):217-25.
- (96) Fergusson DM, Boden JM, Horwood LJ. Exposure to childhood sexual and physical abuse and adjustment in early adulthood. *Child Abuse Negl*. 2008;32(6):607-19.
- (97) Kessler RC, McLaughlin KA, Green JG, Gruber MJ, Sampson NA, Zaslavsky AM, et al. Childhood adversities and adult psychopathology in the WHO World Mental Health Surveys. *Br J Psychiatry*. 2010;197(5):378-85.
- (98) Weich S, Patterson J, Shaw R, Stewart-Brown S. Family relationships in childhood and common psychiatric disorders in later life: systematic review of prospective studies. *Br J Psychiatry*. 2009;194(5):392-8.
- (99) Finkelhor D, Ormrod R, Turner H, Holt M. Pathways to poly-victimization. *Child Maltreat*. 2009;14(4):316-29.
- (100) Turner HA, Finkelhor D, Ormrod R. Poly-victimization in a national sample of children and youth. *Am J Prev Med*. 2010;38(3):323-30.

- (101) McCrory E, De Brito SA, Viding E. Research review: the neurobiology and genetics of maltreatment and adversity. *J Child Psychol Psychiatry*. 2010;51(10):1079-95.
- (102) Grassi-Oliveira R, Ashy M, Stein LM. Psychobiology of childhood maltreatment: effects of allostatic load? *Rev Bras Psiquiatr*. 2008;30(1):60-8.
- (103) Teicher MH, Tomoda A, Andersen SL. Neurobiological consequences of early stress and childhood maltreatment: are results from human and animal studies comparable? *Ann N Y Acad Sci*. 2006;1071:313-23.
- (104) Tarullo AR, Gunnar MR. Child maltreatment and the developing HPA axis. *Horm Behav*. 2006;50(4):632-9.
- (105) Miller GE, Chen E, Zhou ES. If it goes up, must it come down? Chronic stress and the hypothalamic-pituitary-adrenocortical axis in humans. *Psychol Bull*. 2007;133(1):25-45.
- (106) Teicher MH, Dumont NL, Ito Y, Vaituzis C, Giedd JN, Andersen SL. Childhood neglect is associated with reduced corpus callosum area. *Biol Psychiatry*. 2004;56(2):80-5.
- (107) Tomoda A, Suzuki H, Rabi K, Sheu YS, Polcari A, Teicher MH. Reduced prefrontal cortical gray matter volume in young adults exposed to harsh corporal punishment. *Neuroimage*. 2009;47 Suppl 2:T66-71.
- (108) Tottenham N, Sheridan MA. A review of adversity, the amygdala and the hippocampus: a consideration of developmental timing. *Front Hum Neurosci*. 2009;3:68.
- (109) Grant MM, Cannistraci C, Hollon SD, Gore J, Shelton R. Childhood trauma history differentiates amygdala response to sad faces within MDD. *J Psychiatr Res*. 2011;45(7):886-95.
- (110) Tottenham N, Hare TA, Millner A, Gilhooly T, Zevin JD, Casey BJ. Elevated amygdala response to faces following early deprivation. *Dev Sci*. 2011;14(2):190-204.
- (111) Conti G, Hansman C, Heckman JJ, Novak MF, Ruggiero A, Suomi SJ. Primate evidence on the late health effects of early-life adversity. *Proc Natl Acad Sci U S A*. 2012;109(23):8866-71.
- (112) Anda RF, Felitti VJ, Bremner JD, Walker JD, Whitfield C, Perry BD, et al. The enduring effects of abuse and related adverse experiences in childhood. A convergence of evidence from neurobiology and epidemiology. *Eur Arch Psychiatry Clin Neurosci*. 2006;256(3):174-86.
- (113) Mykletun A, Knudsen AK, Mathiesen KS. Psykiske lidelser i Norge: et folkehelseperspektiv [Mental disorders in Norway: A public health perspective]. Oslo: Nasjonalt folkehelseinstitutt, 2009.
- (114) Berlin LJ, Appleyard K, Dodge KA. Intergenerational continuity in child maltreatment: mediating mechanisms and implications for prevention. *Child Dev*. 2011;82(1):162-76.

- (115) Curtis GC. Violence Breeds Violence - Perhaps? *Am J Psychiatry*. 1963;120:386-7.
- (116) Roberts R, O'Connor T, Dunn J, Golding J. The effects of child sexual abuse in later family life; mental health, parenting and adjustment of offspring. *Child Abuse Negl*. 2004;28(5):525-45.
- (117) Bailey HN, DeOliveira CA, Wolfe VV, Evans EM, Hartwick C. The impact of childhood maltreatment history on parenting: a comparison of maltreatment types and assessment methods. *Child Abuse Negl*. 2012;36(3):236-46.
- (118) Thompson R. Mothers' violence victimization and child behavior problems: examining the link. *Am J Orthopsychiatry*. 2007;77(2):306-15.
- (119) Bronfenbrenner U. *The Ecology of Human Development - Experiments of nature and design*. USA: Harvard University Press; 1979.
- (120) Garbarino J. *Children and Families in the Social Environment*. USA: Aldine Transaction; 1992.
- (121) Gillespie CF, Phifer J, Bradley B, Ressler KJ. Risk and resilience: genetic and environmental influences on development of the stress response. *Depress Anxiety*. 2009;26(11):984-92.
- (122) Sullivan PF, Neale MC, Kendler KS. Genetic epidemiology of major depression: review and meta-analysis. *Am J Psychiatry*. 2000;157(10):1552-62.
- (123) Koenen KC, Nugent NR, Amstadter AB. Gene-environment interaction in posttraumatic stress disorder: review, strategy and new directions for future research. *Eur Arch Psychiatry Clin Neurosci*. 2008;258(2):82-96.
- (124) Heim C, Newport DJ, Heit S, Graham YP, Wilcox M, Bonsall R, et al. Pituitary-adrenal and autonomic responses to stress in women after sexual and physical abuse in childhood. *JAMA*. 2000;284(5):592-7.
- (125) Brand SR, Brennan PA, Newport DJ, Smith AK, Weiss T, Stowe ZN. The impact of maternal childhood abuse on maternal and infant HPA axis function in the postpartum period. *Psychoneuroendocrinology*. 2010;35(5):686-93.
- (126) Weaver IC, Cervoni N, Champagne FA, D'Alessio AC, Sharma S, Seckl JR, et al. Epigenetic programming by maternal behavior. *Nat Neurosci*. 2004;7(8):847-54.
- (127) Provencal N, Suderman MJ, Guillemin C, Massart R, Ruggiero A, Wang D, et al. The signature of maternal rearing in the methylome in rhesus macaque prefrontal cortex and T cells. *J Neurosci*. 2012;32(44):15626-42.
- (128) Brennan PA, Hammen C, Andersen MJ, Bor W, Najman JM, Williams GM. Chronicity, severity, and timing of maternal depressive symptoms: relationships with child outcomes at age 5. *Dev Psychol*. 2000;36(6):759-66.
- (129) Slade EP, Wissow LS. Spanking in early childhood and later behavior problems: a prospective study of infants and young toddlers. *Pediatrics*. 2004;113(5):1321-30.

- (130) Whitaker RC, Orzol SM, Kahn RS. Maternal mental health, substance use, and domestic violence in the year after delivery and subsequent behavior problems in children at age 3 years. *Arch Gen Psychiatry*. 2006;63(5):551-60.
- (131) Ashman SB, Dawson G, Panagiotides H. Trajectories of maternal depression over 7 years: relations with child psychophysiology and behavior and role of contextual risks. *Dev Psychopathol*. 2008;20(1):55-77.
- (132) Bekkhus M, Rutter M, Barker ED, Borge AI. The role of pre- and postnatal timing of family risk factors on child behavior at 36 months. *J Abnorm Child Psychol*. 2011;39(4):611-21.
- (133) Collishaw S, Dunn J, O'Connor TG, Golding J. Maternal childhood abuse and offspring adjustment over time. *Dev Psychopathol*. 2007;19(2):367-83.
- (134) Achenbach TM, Rescorla LA. *Manuale for the ASEBA Preschoole Forms and Profiles*: Burlington, VT: University of Vermont, Research Center for Children, Youth and Families.; 2000.
- (135) Achenbach TM, Howell CT, Quay HC, Conners CK. National survey of problems and competencies among four- to sixteen-year-olds: parents' reports for normative and clinical samples. *Monogr Soc Res Child Dev*. 1991;56(3):1-131.
- (136) Gilliom M, Shaw DS. Codevelopment of externalizing and internalizing problems in early childhood. *Dev Psychopathol*. 2004;16(2):313-33.
- (137) Campbell SB, Shaw DS, Gilliom M. Early externalizing behavior problems: toddlers and preschoolers at risk for later maladjustment. *Dev Psychopathol*. 2000;12(3):467-88.
- (138) Caspi A, Moffitt TE, Newman DL, Silva PA. Behavioral observations at age 3 years predict adult psychiatric disorders. Longitudinal evidence from a birth cohort. *Arch Gen Psychiatry*. 1996;53(11):1033-9.
- (139) Mathiesen KS, Sanson A. Dimensions of early childhood behavior problems: stability and predictors of change from 18 to 30 months. *J Abnorm Child Psychol*. 2000;28(1):15-31.
- (140) Mathiesen KS, Sanson A, Stoolmiller M, Karevold E. The nature and predictors of undercontrolled and internalizing problem trajectories across early childhood. *J Abnorm Child Psychol*. 2009;37(2):209-22.
- (141) Tremblay RE, Nagin DS, Seguin JR, Zoccolillo M, Zelazo PD, Boivin M, et al. Physical aggression during early childhood: trajectories and predictors. *Pediatrics*. 2004;114(1):e43-50.
- (142) Hettler J, Greenes DS. Can the initial history predict whether a child with a head injury has been abused? *Pediatrics*. 2003;111(3):602-7.

- (143) Magnus P, Irgens LM, Haug K, Nystad W, Skjaerven R, Stoltenberg C. Cohort profile: the Norwegian Mother and Child Cohort Study (MoBa). *Int J Epidemiol*. 2006;35(5):1146-50.
- (144) End of inclusion Protocol II The Norwegian Mother and Child Cohort Study (MoBa) <http://www.fhi.no/dokumenter/346045b550.pdf>. Norwegian Institute of Public Health; 2010.
- (145) Tambs K, Moum T. How well can a few questionnaire items indicate anxiety and depression? *Acta Psychiatr Scand*. 1993;87(5):364-7.
- (146) Strand BH, Dalgard OS, Tambs K, Rognerud M. Measuring the mental health status of the Norwegian population: a comparison of the instruments SCL-25, SCL-10, SCL-5 and MHI-5 (SF-36). *Nord J Psychiatry*. 2003;57(2):113-8.
- (147) Sandanger I, Moum T, Ingebrigtsen G, Dalgard OS, Sorensen T, Bruusgaard D. Concordance between symptom screening and diagnostic procedure: the Hopkins Symptom Checklist-25 and the Composite International Diagnostic Interview I. *Soc Psychiatry Psychiatr Epidemiol*. 1998;33(7):345-54.
- (148) Squires J, Potter L, Bricker D. *The ASQ User's Guide for the Ages and Stages Questionnaires: A Parent- Completed, Child Monitoring System*. Baltimore, MD: Paul H. Brookes.; 1999.
- (149) Richter J, Janson H. A validation study of the Norwegian version of the Ages and Stages Questionnaires. *Acta Paediatr*. 2007;96(5):748-52.
- (150) Mathiesen KS, Tambs K. The EAS temperament questionnaire--factor structure, age trends, reliability, and stability in a Norwegian sample. *J Child Psychol Psychiatry*. 1999;40(3):431-9.
- (151) Swahnberg IM, Wijma B. The NorVold Abuse Questionnaire (NorAQ): validation of new measures of emotional, physical, and sexual abuse, and abuse in the health care system among women. *European Journal of Public Health*. 2003;13(4):361-6.
- (152) Baron RM, Kenny DA. The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations. *J Pers Soc Psychol*. 1986;51(6):1173-82.
- (153) Ewing-Cobbs L, Prasad M, Kramer L, Louis PT, Baumgartner J, Fletcher JM, et al. Acute neuroradiologic findings in young children with inflicted or noninflicted traumatic brain injury. *Childs Nerv Syst*. 2000;16(1):25-33; discussion 4.
- (154) Bechtel K, Stoessel K, Leventhal JM, Ogle E, Teague B, Lavietes S, et al. Characteristics that distinguish accidental from abusive injury in hospitalized young children with head trauma. *Pediatrics*. 2004;114(1):165-8.
- (155) Vinchon M, Defoort-Dhellemmes S, Desurmont M, Dhellemmes P. Accidental and nonaccidental head injuries in infants: a prospective study. *J Neurosurg*. 2005;102(4 Suppl):380-4.

- (156) Piteau SJ, Ward MG, Barrowman NJ, Plint AC. Clinical and radiographic characteristics associated with abusive and nonabusive head trauma: a systematic review. *Pediatrics*. 2012;130(2):315-23.
- (157) Keenan HT, Runyan DK, Marshall SW, Nocera MA, Merten DF. A population-based comparison of clinical and outcome characteristics of young children with serious inflicted and noninflicted traumatic brain injury. *Pediatrics*. 2004;114(3):633-9.
- (158) Minns RA, Jones PA, Mok JY. Incidence and demography of non-accidental head injury in southeast Scotland from a national database. *Am J Prev Med*. 2008;34(4 Suppl):S126-33.
- (159) Kemp AM, Jaspan T, Griffiths J, Stoodley N, Mann MK, Tempest V, et al. Neuroimaging: what neuroradiological features distinguish abusive from non-abusive head trauma? A systematic review. *Arch Dis Child*. 2011.
- (160) Engstrom K, Diderichsen F, Laflamme L. Socioeconomic differences in injury risks in childhood and adolescence: a nation-wide study of intentional and unintentional injuries in Sweden. *Inj Prev*. 2002;8(2):137-42.
- (161) Wazana A. Are there injury-prone children? A critical review of the literature. *Can J Psychiatry*. 1997;42(6):602-10.
- (162) Aarnoudse-Moens CS, Weisglas-Kuperus N, van Goudoever JB, Oosterlaan J. Meta-analysis of neurobehavioral outcomes in very preterm and/or very low birth weight children. *Pediatrics*. 2009;124(2):717-28.
- (163) Indredavik MS, Vik T, Evensen KA, Skranes J, Taraldsen G, Brubakk AM. Perinatal risk and psychiatric outcome in adolescents born preterm with very low birth weight or term small for gestational age. *J Dev Behav Pediatr*. 2010;31(4):286-94.
- (164) Schmidt LA, Miskovic V, Boyle MH, Saigal S. Shyness and timidity in young adults who were born at extremely low birth weight. *Pediatrics*. 2008;122(1):e181-7.
- (165) Pfeifer M, Goldsmith HH, Davidson RJ, Rickman M. Continuity and change in inhibited and uninhibited children. *Child Dev*. 2002;73(5):1474-85.
- (166) Schwebel DC, Plumert JM. Longitudinal and concurrent relations among temperament, ability estimation, and injury proneness. *Child Dev*. 1999;70(3):700-12.
- (167) Sengoelge M, Bauer R, Laflamme L. Unintentional child home injury incidence and patterns in six countries in Europe. *Int J Inj Contr Saf Promot*. 2008;15(3):129-39.
- (168) Teicher MH, Samson JA, Polcari A, McGreenery CE. Sticks, stones, and hurtful words: relative effects of various forms of childhood maltreatment. *Am J Psychiatry*. 2006;163(6):993-1000.
- (169) Finkelhor D, Ormrod RK, Turner HA. Lifetime assessment of poly-victimization in a national sample of children and youth. *Child Abuse Negl*. 2009;33(7):403-11.



- (170) McKinney CM, Harris TR, Caetano R. Reliability of self-reported childhood physical abuse by adults and factors predictive of inconsistent reporting. *Violence Vict.* 2009;24(5):653-68.
- (171) Fisher BS, Cullen FT. *Measuring the Sexual Victimization of Women: Evolution, Current Controversies and Future Research.* Washington, DC: U.S. Department of Justice, National Institute of Justice, 2000.
- (172) Rotman KJ. Biases in Study Design. *Epidemiology: An Introduction.* New York: Oxford University Press; 2002. p. 94-112.
- (173) Nilsen RM, Vollset SE, Gjessing HK, Skjaerven R, Melve KK, Schreuder P, et al. Self-selection and bias in a large prospective pregnancy cohort in Norway. *Paediatr Perinat Epidemiol.* 2009;23(6):597-608.
- (174) White HL, Macpherson AK. Capturing paediatric injury in Ontario: differences in injury incidence using self-reported survey and health service utilisation data. *Inj Prev.* 2012;18(1):33-7.
- (175) Pless CE, Pless IB. How well they remember. The accuracy of parent reports. *Arch Pediatr Adolesc Med.* 1995;149(5):553-8.
- (176) Cummings P, Rivara FP, Thompson RS, Reid RJ. Ability of parents to recall the injuries of their young children. *Inj Prev.* 2005;11(1):43-7.
- (177) Hardt J, Rutter M. Validity of adult retrospective reports of adverse childhood experiences: review of the evidence. *J Child Psychol Psychiatry.* 2004;45(2):260-73.
- (178) Kendall-Tackett K, Becker-Blease K. The importance of retrospective findings in child maltreatment research. *Child Abuse Negl.* 2004;28(7):723-7.
- (179) Melchert TP, Parker RL. Different forms of childhood abuse and memory. *Child Abuse Negl.* 1997;21(2):125-35.
- (180) Fergusson DM, Horwood LJ, Woodward LJ. The stability of child abuse reports: a longitudinal study of the reporting behaviour of young adults. *Psychol Med.* 2000;30(3):529-44.
- (181) Thombs BD, Bernstein DP, Ziegelstein RC, Scher CD, Forde DR, Walker EA, et al. An evaluation of screening questions for childhood abuse in 2 community samples: implications for clinical practice. *Arch Intern Med.* 2006;166(18):2020-6.
- (182) Leblanc N, Boivin M, Dionne G, Brendgen M, Vitaro F, Tremblay RE, et al. The development of hyperactive-impulsive behaviors during the preschool years: the predictive validity of parental assessments. *J Abnorm Child Psychol.* 2008;36(7):977-87.
- (183) Miller-Lewis LR, Baghurst PA, Sawyer MG, Prior MR, Clark JJ, Arney FM, et al. Early childhood externalising behaviour problems: child, parenting, and family-related predictors over time. *J Abnorm Child Psychol.* 2006;34(6):891-906.

- (184) Najman JM, Williams GM, Nikles J, Spence S, Bor W, O'Callaghan M, et al. Mothers' mental illness and child behavior problems: cause-effect association or observation bias? *J Am Acad Child Adolesc Psychiatry*. 2000;39(5):592-602.
- (185) Min MO, Singer LT, Minnes S, Kim H, Short E. Mediating links between maternal childhood trauma and preadolescent behavioral adjustment. *J Interpers Violence*. 2013;28(4):831-51.
- (186) Richters JE. Depressed mothers as informants about their children: a critical review of the evidence for distortion. *Psychol Bull*. 1992;112(3):485-99.
- (187) Messick S. Validity of Psychological Assessment, Validation of Inferences From Persons' Responses and Performances as Scientific Inquiry Into Score Meaning. *Am Psychol*. 1995;Vol. 50.( No.9. ):741-9.
- (188) Håndbok for helsepersonell ved mistanke om fysisk barnemishandling [Physical child abuse - Guidelines for health professionals] Oslo: Norwegian Centre for Violence and Traumatic Stress Studies; 2013. Available from: <http://www.nkvts.no/sites/Barnemishandling/Pages/index.aspx>.
- (189) Randeberg LL, Haugen OA, Haaverstad R, Svaasand LO. A novel approach to age determination of traumatic injuries by reflectance spectroscopy. *Lasers Surg Med*. 2006;38(4):277-89.
- (190) Berger RP, Adelson PD, Richichi R, Kochanek PM. Serum biomarkers after traumatic and hypoxemic brain injuries: insight into the biochemical response of the pediatric brain to inflicted brain injury. *Dev Neurosci*. 2006;28(4-5):327-35.

## **Errata**

### 4.3 Results Paper III (page 44-45)

Childhood emotional abuse alone was reported by 8.3% of the mothers and physical and/or sexual abuse was reported by 8.9% *should read* Childhood emotional abuse alone was reported by 8.4% of the mothers and physical and/or sexual abuse was reported by 9.1%.

### Paper III abstract

Childhood emotional abuse alone was reported by 8.3% of the mothers and physical and/or sexual abuse was reported by 8.9% *should read* Childhood emotional abuse alone was reported by 8.4% of the mothers and physical and/or sexual abuse was reported by 9.1%.













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

Mia Cathrine Myhre,<sup>1,2</sup> Siri Thoresen,<sup>1</sup> Jens Bernard Grøgaard,<sup>2</sup> Grete Dyb<sup>1,3</sup>

**To cite:** Myhre MC, Thoresen S, Grøgaard JB, *et al*. Familial factors and child characteristics as predictors of injuries in toddlers: a prospective cohort study. *BMJ Open* 2012;**2**:e000740. doi:10.1136/bmjopen-2011-000740

► Prepublication history for this paper is available online. To view these files please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2011-000740>).

Received 14 December 2011  
Accepted 21 February 2012

This final article is available for use under the terms of the Creative Commons Attribution Non-Commercial 2.0 Licence; see <http://bmjopen.bmj.com>

<sup>1</sup>Norwegian Centre for Violence and Traumatic Stress Studies, Oslo, Norway  
<sup>2</sup>Department of Pediatrics, Oslo University Hospital, Ullevål, Oslo, Norway  
<sup>3</sup>Institute of Clinical Medicine, University of Oslo, Oslo, Norway

**Correspondence to**  
Dr Mia Cathrine Myhre; m.c.myhre@nkvts.unirand.no

## 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), 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.<sup>1</sup> The incidence of injury, mechanisms of trauma and type of injury vary with children's ages and developmental

## ARTICLE SUMMARY

### 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 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.
- Children with impaired gross motor development had a decreased risk of injury, whereas those with impaired fine motor development had an increased risk; and the timing of preventive measures against injuries should be based on motor development in young children and not on age.

### 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 have affected the response accuracy, and there may be information biases.
- The use of abbreviated scales might have threatened the validity of measures.

stages.<sup>2,3</sup> Before adolescence, the highest rate of injury occurs in toddlers aged 15–17 months.<sup>2</sup> Falls are consistently the leading cause of non-fatal injuries in toddlers, followed by poisoning and transportation-related

## Predictors of injuries in toddlers: a prospective cohort study

injuries.<sup>2 3</sup> Wounds and head injuries are the most common types of injury.<sup>3</sup>

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.<sup>4</sup> 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<sup>5-7</sup> 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.<sup>6-8</sup> More recently, researchers have found associations between the mother's mental health and an increased risk of injury in toddlers.<sup>9 10</sup> Adequate adult supervision is essential for toddlers to stay free from harm,<sup>11-13</sup> 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.<sup>14</sup> 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.<sup>15-17</sup> 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.<sup>14</sup> 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.<sup>14 18</sup> 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.<sup>14 18-20</sup>

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%.<sup>21</sup> 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>).<sup>21</sup>

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

## Predictors of injuries in toddlers: a prospective cohort study

of 18 months, whether the mother and child lived with the child's father was assessed with the following question: 'Do you and your child live with your child's father?' Current financial problems were assessed with the following questions: 'Have you had financial problems 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.<sup>22 23</sup> The SCL-8 is designed to measure psychological distress, particularly anxiety and depression, in population surveys. Each item has four response categories, ranging from 'not at all'=1 to 'severe'=4.<sup>24</sup> 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.<sup>25</sup> 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 Children<sup>26</sup> 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 years<sup>27</sup> 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 indicate 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 or 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 significance were performed using the Wald test statistic and a significance level of  $p<0.05$ . The sum scores of independent 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 53% 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

## Predictors of injuries in toddlers: a prospective cohort study

mothers. A hospital-attended injury between 18 and 36 months of age was reported for 4.6% (N=1247) of the children.

Table 1 displays univariable and multivariable comparisons between children with and without hospital-attended injuries. 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 behaviour 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,<sup>8</sup> 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 association. 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.<sup>28</sup>

Education and socioeconomic status are closely intertwined, and most prior studies have found that low

maternal education is a risk factor for injuries in children. 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 problems, 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.<sup>6 7</sup>

In line with previous research, maternal mental health problems constituted a risk factor for injuries in children.<sup>9 10</sup> 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 predictors. 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 unanticipated. Many studies have identified later behavioural problems, including attention deficit and hyperactivity in children who are born preterm,<sup>29</sup> 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 counterparts,<sup>30</sup> 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 environment. 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 directionalities of the associations between gross and fine motor development and injury risk imply that these areas should be assessed separately in future studies.

## Predictors of injuries in toddlers: a prospective cohort study

**Table 1** Descriptive comparison between children with and without hospital-attended injuries and univariable and multivariable logistic regression analysis of potential risk factors (N=26087)

	Overall (N = 26 087) % (N)/mean (SD)	Without injuries % (N)/mean (SD)	With injuries % (N)/mean (SD)	OR (95% CI)	aOR (95% CI)
<b>Family factors</b>					
Older sibling(s)	53.3 (13 902)	53.1 (13 197)	56.5 (705)	1.15 (1.02 to 1.29)*	1.22 (1.08 to 1.39)**
Maternal age	29.7 (4.43)	29.7 (4.44)	29.5 (4.44)	0.95 (0.89 to 1.02)	0.93 (0.86 to 1.00)*
Maternal education ≤12 years	37.6 (9534)	37.6 (9078)	37.6 (456)	0.99 (0.88 to 1.12)	0.90 (0.80 to 1.02)
Mother unemployed or disabled	4.1 (1069)	4.1 (1017)	4.2 (52)	1.01 (0.76 to 1.36)	0.95 (0.71 to 1.26)
Mother and child not living with the father	3.4 (819)	3.4 (778)	3.6 (41)	1.06 (0.77 to 1.46)	0.96 (0.69 to 1.33)
Financial problems	18.6 (4379)	18.4 (4129)	22.4 (250)	1.27 (1.09 to 1.48)**	1.18 (1.01 to 1.39)*
Maternal mental health problems (8-32)	10.2 (2 824)	10.1 (2 82)	10.5 (3 06)	1.12 (1.06 to 1.18)**	1.09 (1.03 to 1.16)**
<b>Child factors</b>					
Male	50.8 (13 250)	50.5 (12 540)	56.9 (710)	1.30 (1.16 to 1.45)**	1.26 (1.11 to 1.42)**
Gestational age	39.4 (1.94)	39.4 (1.96)	39.5 (1.79)	1.04 (1.01 to 1.07)*	1.04 (1.00 to 1.07)*
Gross motor development					
All skills achieved	82.2 (19 742)	82.1 (18 794)	83.8 (948)	Reference	Reference
One skill not achieved	14.5 (3481)	14.5 (3322)	14.1 (159)	0.94 (0.80 to 1.12)	0.94 (0.79 to 1.12)
Two or three skills not achieved	3.4 (800)	3.4 (776)	2.1 (24)	0.65 (0.43 to 0.98)*	0.65 (0.42 to 0.99)*
Fine motor development					
All skills achieved	73.8 (17 569)	73.9 (16 754)	72.3 (815)	Reference	Reference
One skill not achieved	21.0 (5004)	21.0 (4774)	20.4 (230)	1.01 (0.87 to 1.18)	1.03 (0.89 to 1.19)
Two or three skills not achieved	5.2 (1236)	5.1 (1154)	7.3 (82)	1.45 (1.15 to 1.83)**	1.55 (1.22 to 1.97)**
Communication development					
All skills achieved	46.6 (11 117)	46.8 (10 631)	43.1 (486)	Reference	Reference
One skill not achieved	26.5 (6313)	26.4 (5989)	28.7 (324)	1.16 (1.00 to 1.34)*	1.11 (0.95 to 1.28)
Two or three skills not achieved	26.9 (6413)	18.3 (6095)	19.3 (318)	1.13 (0.98 to 1.31)	1.04 (0.89 to 1.22)
Social development					
All skills achieved	71.3 (17 094)	71.4 (16 302)	70.3 (792)	Reference	Reference
One skill not achieved	19.6 (4688)	19.5 (4451)	21.0 (237)	1.09 (0.94 to 1.27)	1.04 (0.90 to 1.21)
Two or more skill not achieved	6.6 (1582)	6.6 (1510)	6.4 (72)	0.99 (0.77 to 1.26)	0.92 (0.73 to 1.15)
Temperament					
Activity (3–15)	12.1 (1.96)	12.1 (1.96)	12.2 (1.97)	1.09 (1.02 to 1.16)**	1.02 (0.95 to 1.09)
Emotionality (3–15)	8.2 (2.27)	8.2 (2.26)	8.3 (2.37)	1.06 (0.99 to 1.12)	1.02 (0.96 to 1.09)
Shyness (3–15)	6.1 (1.93)	6.1 (1.93)	6.0 (1.95)	0.92 (0.87 to 0.98)**	0.92 (0.86 to 0.98)*
Externalising behaviour					
Attention					
No attention problem	10.7 (2464)	10.8 (2371)	8.7 (93)	Reference	Reference
One attention problem	41.9 (9653)	42.1 (9231)	39.3 (422)	1.15 (0.91 to 1.44)	1.13 (0.89 to 1.43)
Two attention problems	28.7 (6611)	28.7 (6288)	30.0 (323)	1.26 (1.00 to 1.60)	1.19 (0.93 to 1.53)
Three attention problems	18.7 (4294)	18.5 (4057)	22.0 (237)	1.47 (1.16 to 1.86)**	1.33 (1.02 to 1.72)*

Continued

## Predictors of injuries in toddlers: a prospective cohort study

Table 1 Continued

	Overall (N = 26 087) % (N)/mean (SD)	Without injuries % (N)/mean (SD)	With injuries % (N)/mean (SD)	OR (95% CI)	aOR (95% CI)
Aggression					
No aggression problem	14.6 (3278)	14.6 (3151)	12.1 (127)	Reference	Reference
One aggression problem	22.8 (5953)	26.3 (5685)	25.5 (268)	1.13 (0.92 to 1.38)	1.07 (0.87 to 1.31)
Two aggression problems	24.3 (6332)	27.9 (6018)	29.8 (314)	1.21 (0.99 to 1.47)	1.09 (0.89 to 1.34)
Three or more aggression problems	27.2 (7091)	31.2 (6747)	32.7 (344)	1.21 (1.00 to 1.47)	1.01 (0.82 to 1.25)

\*p&lt;0.05, \*\*p&lt;0.01, \*\*\*p&lt;0.001 from Wald test statistic.

aOR, adjusted OR.

Shyness was a consistent protective factor against injury. Shyness is considered to be an inhibition to the unfamiliar and is associated with inhibitory control.<sup>31 32</sup> 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.<sup>14 18–20</sup> 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,<sup>21 33</sup> 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,<sup>33</sup> 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.<sup>34 35</sup> 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.

## Predictors of injuries in toddlers: a prospective cohort study

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.

**Acknowledgements** We are grateful to all the participating families in Norway who take part in this ongoing cohort study.

**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.

**Funding** The Norwegian Mother and Child Cohort Study is supported by the Norwegian Ministry of Health and the Ministry of Education and Research, NIH/NIEHS (contract no NO-ES-75558), NIH/NINDS (grant no.1 U01 NS 047537-01) and the Norwegian Research Council/FUGE (grant no. 151918/S10). The current study did not receive any specific funding but was conducted as part of the authors' employment at the Norwegian Centre for Violence and Traumatic Stress Studies.

**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 according to defined rules, submitting the appropriate application form together with licences and approval as needed. All applications should be sent to [dataaccess@fhi.no](mailto:dataaccess@fhi.no)

## REFERENCES

- Dowd MD, Keenan HT, Bratton SL. Epidemiology and prevention of childhood injuries. *Crit Care Med* 2002;30(11 Suppl):S385–92.
- Agran PF, Anderson C, Winn D, et al. Rates of pediatric injuries by 3-month intervals for children 0 to 3 years of age. *Pediatrics* 2003;111:92.
- Flavin MP, Dostaler SM, Simpson K, et al. Stages of development and injury patterns in the early years: a population-based analysis. *BMC public health* 2006;6:187.
- Haddon W. The changing approach to the epidemiology, prevention, and amelioration of trauma: the transition to approaches etiologically rather than descriptively based. *Am J Public Health Nation's Health* 1968;58:1431–8.
- Faelker T, Pickett W, Brison RJ. Socioeconomic differences in childhood injury: a population based epidemiologic study in Ontario, Canada. *Inj Prev* 2000;6:203–8.
- Hjern A, Ringback-Weitof G, Andersson R. Socio-demographic risk factors for home-type injuries in Swedish infants and toddlers. *Acta Paediatr* 2001;90:61–8.
- Laursen B, Nielsen JW. Influence of sociodemographic factors on the risk of unintentional childhood home injuries. *Eur J Public Health* 2008;18:366–70.
- Bijur PE, Golding J, Kurzon M. Childhood accidents, family size and birth order. *Soc Sci Med* 1988;26:839–43.
- Phelan K, Khoury J, Atherton H, et al. Maternal depression, child behavior, and injury. *Inj Prev* 2007;13:403–8.
- Schwebel DC, Brezausek CM. Chronic maternal depression and children's injury risk. *J Pediatr Psychol* 2008;33:1108–16.
- Morrongiello BA, Corbett M, Brison RJ. Identifying predictors of medically-attended injuries to young children: do child or parent behavioural attributes matter? *Inj Prev* 2009;15:220–5.
- Schwebel DC, Brezausek CM, Ramey SL, et al. Interactions between child behavior patterns and parenting: implications for children's unintentional injury risk. *J Pediatr Psychol* 2004;29:93–104.
- Morrongiello BA, Klemencic N, Corbett M. Interactions between child behavior patterns and parent supervision: implications for children's risk of unintentional injury. *Child Dev* 2008;79:627–38.
- Schwebel DC, Gaines J. Pediatric unintentional injury: behavioral risk factors and implications for prevention. *J Dev Behav Pediatr* 2007;28:245–54.
- Manheimer DL, Mellinger GD. Personality characteristics of the child accident repeater. *Child Dev* 1967;38:491–513.
- Angle CR. Locomotor skills and school accidents. *Pediatrics* 1975;56:819–22.
- Schwebel DC, Binder SC, Sales JM, et al. Is there a link between children's motor abilities and unintentional injuries? *J Saf Res* 2003;34:135–41.
- Wazana A. Are there injury-prone children? A critical review of the literature. *Can J Psychiatry* 1997;42:602–10.
- Bijur PE, Stewart-Brown S, Butler N. Child behavior and accidental injury in 11,966 preschool children. *Am J Dis Child* 1986;140:487–92.
- Byrne JM, Bawden HN, Beattie T, et al. Risk for injury in preschoolers: relationship to attention deficit hyperactivity disorder. *Child Neuropsychol* 2003;9:142–51.
- Magnus P, Irgens LM, Haug K, et al. Cohort profile: the Norwegian mother and child cohort study (MoBa). *Int J Epidemiol* 2006;35:1146–50.
- Tambo K, Moum T. How well can a few questionnaire items indicate anxiety and depression? *Acta Psychiatrica Scand* 1993;87:364–7.
- Strand BH, Dalgard OS, Tambo K, et al. Measuring the mental health status of the Norwegian population: a comparison of the instruments SCL-25, SCL-10, SCL-5 and MHI-5 (SF-36). *Nordic J Psychiatry* 2003;57:113–18.
- Sandanger I, Moum T, Ingebrigtsen G, et al. Concordance between symptom screening and diagnostic procedure: the Hopkins symptom checklist-25 and the composite international diagnostic interview I. *Soc Psychiatry Psychiatr Epidemiol* 1998;33:345–54.
- Squires JPL, Bricker D. *The ASQ User's Guide for the Ages and Stages Questionnaires: a Parent-Completed, Child Monitoring System*. Baltimore, MD: Paul H. Brookes, 1999.
- Mathiesen KS, Tambo K. The EAS temperament questionnaire—factor structure, age trends, reliability, and stability in a Norwegian sample. *J Child Psychol Psychiatry* 1999;40:431–9.
- Aschenbach TM, Rescorla LA. *Manual for the ASEBA Preschool Forms and Profiles*. Burlington, VT: University of Vermont, Research Center for Children, Youth and Families, 2000.
- Morrongiello BA, Schell SL, Schmidt S. "Please keep an eye on your younger sister": sibling supervision and young children's risk of unintentional injury. *Inj Prev* 2010;16:398–402.
- Aarnoudse-Moens CS, Weisglas-Kuperus N, van Goudoever JB, et al. Meta-analysis of neurobehavioral outcomes in very preterm and/or very low birth weight children. *Pediatrics* 2009;124:717–28.
- Schmidt LA, Miskovic V, Boyle MH, et al. Shyness and timidity in young adults who were born at extremely low birth weight. *Pediatrics* 2008;122:e181–7.
- Pfeifer M, Goldsmith HH, Davidson RJ, et al. Continuity and change in inhibited and uninhibited children. *Child Dev* 2002;73:1474–85.
- Schwebel DC, Plumert JM. Longitudinal and concurrent relations among temperament, ability estimation, and injury proneness. *Child Development* 1999;70:700–12.
- Nilsen RM, Vollset SE, Gjessing HK, et al. Self-selection and bias in a large prospective pregnancy cohort in Norway. *Paediatric Perinatal Epidemiol* 2009;23:597–608.
- Pless CE, Pless IB. How well they remember. The accuracy of parent reports. *Arch Pediatrics Adolesc Med* 1995;149:553–8.
- Cummings P, Rivara FP, Thompson RS, et al. Ability of parents to recall the injuries of their young children. *Inj prevention* 2005;11:43–7.









**Maternal childhood abuse predicts externalizing behaviour in toddlers:  
a prospective cohort study**

Mia C Myhre<sup>1,2</sup>, MD

Grete A Dyb<sup>1,3</sup>, MD, PhD.

Tore Wentzel-Larsen<sup>1,4</sup>, MSc.

Jens B Grøgaard<sup>2</sup>, MD, PhD.

Siri Thoresen<sup>1</sup>, PhD.

<sup>1</sup> Norwegian Centre for Violence and Traumatic Stress Studies, Oslo, Norway

<sup>2</sup> Department of Paediatrics, Oslo University Hospital, Oslo, Norway

<sup>3</sup> Institute of Clinical Medicine, University of Oslo, Oslo, Norway

<sup>4</sup> Centre for Child and Adolescent Mental Health, Eastern and Southern Norway

Corresponding author:

Mia C Myhre, Postbox 181 Nydalen, N-0409 OSLO, Norway.

Phone: +47 22 59 55 00, Fax: +47 22 59 55 01

Email: [m.c.myhre@nkvtst.unirand.no](mailto:m.c.myhre@nkvtst.unirand.no)

## **Abstract**

**Aims:** To investigate the impact of maternal childhood abuse on toddlers' behaviour and assess the potential mediation of maternal mental distress for this pathway.

**Methods:** This study was based on the Norwegian Mother and Child Cohort Study, conducted by the Norwegian Institute of Public Health. The study sample consisted of 25,452 children and their mothers. Maternal childhood abuse was investigated as a potential predictor for child externalizing behaviour at 36 months of age. Maternal mental distress at child age 18 months was assessed as a potential mediator. Hierarchical linear regressions were used for analyses.

**Results:** Childhood emotional abuse alone was reported by 8.3% of the mothers and physical and/or sexual abuse by 8.9%. Mothers with childhood abuse experiences were younger, less educated, more at risk for adult abuse and mental distress, and fewer were married or lived with a partner compared with women not reporting childhood abuse. Children of mothers with childhood abuse experiences showed significantly more externalizing behaviour even after adjusting for maternal age, education, single motherhood, gender and adult abuse experiences. When maternal mental health was entered into the model, the associations remained statistically significant, but were substantially attenuated.

**Conclusions:** Maternal childhood abuse consistently predicted increased externalizing behaviour in the offspring, and this study suggests that childhood abuse impacts subsequent generations. Multiple pathways are possible, but this study identified maternal mental health as a significant mediator.

## **Key words**

Childhood abuse, mental health, psychological distress, child behaviour, the Norwegian Mother and Child Cohort Study

## **Introduction**

Child abuse is a widespread problem in society. Prevalence estimates vary between studies and populations, but even the lowest estimates describe child abuse as a major public problem with a large number of victims [1, 2]. Three forms of abuse are recognized: emotional or psychological abuse, physical abuse and sexual abuse [2]. Studies have shown that the various forms of abuse are interrelated and that exposure to more than one type is common [3-5].

A large body of research supports that all types of abuse experiences in childhood are linked with negative mental health outcomes [1, 4, 6], and several studies have demonstrated an association between maternal mental health problems and emotional and behavioural difficulties in their children [7-9]. The life-long consequences of childhood abuse are therefore likely to affect the children, and intergenerational transmission of problems has been described where children of mothers exposed to childhood abuse seem to be at an increased risk of adjustment problems [10-12]. In a previous study both maternal childhood sexual and physical abuse was found to be associated with increased internalizing and externalizing behaviours in a high risk sample [10], and in one population based study maternal childhood emotional abuse as well as sexual and physical abuse was found to be associated with poorer behavioural trajectories [11]. In the youngest children, externalizing behaviours are among the most common complaint regarding adjustment [13], and may also be related to maternal childhood abuse [10]. Less is known about the mechanisms involved, but maternal mental health problems with subsequent parenting difficulties are likely to be of importance [7, 10-12, 14]. Furthermore, several studies have demonstrated that children of abused mothers have an increased risk of growing up in harsh and stressful environments, including an increased risk of being exposed to domestic violence and abusive parenting [15].

In summary, previous research suggests a link between maternal childhood abuse and behavioural difficulties in their offspring. Mothers' mental health may be an important factor

in this relationship as mental health is a well-established consequence of exposure to abuse and a risk factor for problems in offspring. Most of the previous studies who have investigated these relationships are from clinical or high risk samples. However, the large number of childhood abuse victims and the common long-term consequences point to a public health problem, and emphasize the importance of understanding the mechanisms involved. To address this issue further, the aim of this study was to investigate the impact of maternal childhood abuse on toddlers' behaviour in a population-based sample. In addition, we investigated if maternal mental health was a mediator in this relationship. The Norwegian Mother and Child Cohort study (MoBa), with its comprehensive data collection on mother-child dyads over several waves, offered a valuable opportunity to assess this relationship longitudinally.

## **Material and methods**

This study used data from the Norwegian Mother and Child Cohort Study (MoBa). MoBa is a prospective population-based pregnancy cohort study conducted by the Norwegian Institute of Public Health [16]. The main aim of the MoBa study is to detect early signs of childhood diseases including rare conditions for which a very large sample size was needed. Participants were recruited from all over Norway from 1999 – 2008, through postal invitations prior to routine ultrasound examinations at their local hospitals at approximately week 17 of gestation and 38.5% of invited women consented to participate. The cohort now includes 108,000 children, 90,700 mothers and 71,500 fathers. Blood samples were obtained from both parents during pregnancy and from mothers and children (umbilical cord) at birth. Follow-up is conducted by questionnaires over several waves and by linkage to national health registries. Several sub-studies are conducting additional collections of data and biological materials. Informed consent was obtained from each participant upon recruitment. The Regional

Committee for Medical Research Ethics in South-Eastern Norway and the Norwegian Data Inspectorate approved the study. Details of the MoBa study sampling, design, questionnaires, informed consent processes, and data collection strategies have been reported elsewhere ([www.fhi.no/morogbarn](http://www.fhi.no/morogbarn)) [16].

Although recruitment to the study is complete, data collection is an on-going process. The current study is based on version IV of the quality-assured data files released for research in February 2009. Information from the Medical Birth Registry of Norway, MBRN, was also available ([www.fhi.no/mfr](http://www.fhi.no/mfr)). The current sample comprises the first 25,452 mother and child dyads (including 23,805 unique mothers) with children born 2001- 2005.

### *Measures*

We used data from four separate waves of the MoBa study, collected at gestational weeks 17 and 30, and at child ages 18 and 36 months.

*Child behaviour.* Child externalizing behaviour was assessed when the child reached 36 months of age using 11 items from the Child Behaviour Checklist (CBCL) for ages 1.5 to 5 years [17]. Seven items measured aggressiveness, and four items measured attention problems. All items were rated “not true” = 0, “somewhat or sometimes true” = 1, and “very true or often true” = 2. Cronbach’s  $\alpha$  was 0.74.

*Maternal abuse.* Maternal experiences of abuse were assessed in late pregnancy with four items: 1) degradation or humiliation: “Someone has over a long period of time systematically tried to subdue, degrade or humiliate you”, 2) threats: “Someone has threatened to hurt you or someone close to you”, 3) physical abuse: “You have been subjected to physical abuse” and 4) sexual abuse: “You have been forced to perform sexual acts”. The choice of response was “no,

never”, “yes, as a child (under 18 years of age)” and/or “yes, as an adult (over 18 years of age)”. The questions were based on the Norvold Abuse Questionnaire (NorAq) [18]. An affirmative answer to item 1 and/or 2 but not 3 or 4 was classified as “Emotional abuse alone”. An affirmative answer to item 3 and/or 4 was classified as “Physical and/or sexual abuse”, including also those with additional emotional abuse due to the likelihood of elements of emotional abuse being present together with physical or sexual abuse. Separate categories were created for childhood (<18 years) and adult experiences.

*Maternal mental health.* The mother’s mental health was assessed with the Symptom Checklist SCL-8, which is an 8-item short version of the Hopkins Symptom Checklist [19] when the child was 18 months of age. The SCL-8 is designed to measure psychological distress, particularly anxiety and depression, in population surveys. Each item has four response categories, ranging from “not at all”=1 to “severe”=4. Cronbach’s  $\alpha$  was 0.84.

*Sociodemographic information.* Demographic information regarding maternal age and education was reported at inclusion. The mother’s marital status at child age 18 months was applied. Information regarding the child’s sex was retrieved from the MBRN. 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%) [16].

#### *Statistical Analyses*

For comparison between groups, chi-squared tests were used for categorical variables and one-way ANOVA was used for continuous variables. For pairwise comparisons, post hoc tests with Holm correction were used for chi-squared tests and Scheffé correction was used for ANOVA.



Maternal childhood abuse was investigated as a predictor for externalizing behaviour in children using hierarchical linear regression with a Generalized Estimating Equation (GEE) approach to account for clustering due to the inclusion of siblings in the study sample. The potential mediation of maternal mental distress was tested using the four steps suggested by Baron and Kenny [20]: Step 1: The relationship between maternal childhood abuse and child behaviour was assessed without the suggested mediator (maternal mental health) in the model; Step 2: The relationship between maternal childhood abuse and mental health was assessed; Step 3 and 4: The relationship between maternal childhood abuse and child behaviour was assessed with the suggested mediator in the model. The mediation effect was then tested with the Sobel test.

In all analyses, we used two-sided tests and a significance level of  $p < 0.05$ . Multicollinearity among the predictors was assessed by variance inflation factors and did not suggest any problem. Stratification by child gender produced only minor differences in effect estimates. The rate of missing information on single items ranged from 0% to 3.0%. Modelling was based on 20 multiply imputed datasets. Multivariate Imputation by Chained Equations (MICE) was used for imputations. All analyses were performed using R (The R Foundation for Statistical Computing, Vienna, Austria) with the R packages *gee* for GEE analyses and *mice* for multiple imputation.

## **Results**

Maternal age ranged from 14 to 47 years, with a mean of 29.7 years (SD = 4.4). Only 0.9% (N = 252) of the sample were teenage mothers. The majority of mothers (60.5%) had completed more than 12 years of education, 4% of mothers were unemployed or disabled and 3.2% (N=801) were not living with a partner. The study sample comprised 50.7% boys.

A total of 17.5% (N=4,360) of the mothers responded affirmatively to at least one out of the four childhood abuse questions. Childhood emotional abuse alone was reported by 8.4% (N = 2,100), and childhood physical and/or sexual abuse by 9.1% (N = 2,260); of the latter, 1074 mothers (41.3%) reported emotional abuse in addition to the physical and/or sexual abuse (Table I).

Mothers, who reported childhood abuse experiences were younger, less educated and fewer were married or lived with a partner compared with women not reporting childhood abuse (Table II). Childhood abuse was associated with abuse in adult life and mothers with childhood abuse experiences reported more mental distress themselves, as well as more externalizing behaviour in their children at three years of age compared with mothers without such experiences. Comparing the two abuse categories those exposed to physical and/or sexual abuse in childhood were more at risk for adult abuse and mental distress than those who had experienced emotional abuse alone (Table II, b vs. c). However, there was no significant difference in child externalizing behaviour between the two abuse categories.

The association between maternal childhood abuse and child externalizing behaviour withstood adjustment for maternal age, education, single motherhood, gender and adult abuse experiences (Model 1, Table III). To test if maternal mental health was a mediator between maternal childhood abuse and externalizing behaviour in the offspring, maternal mental health was added in Model 2. The relationship remained statistically significant (Model 2, Table III), but was substantially attenuated, as confirmed by the Sobel test (test statistics for emotional abuse alone 11.8, SE 0.017,  $p < 0.001$  and physical and/or sexual abuse 12.7, SE 0.017,  $p = p < 0.001$ ). Externalizing behaviour did not differ significantly between the two exposure groups (Table III). An increase in the regression coefficient of 0.5 – 0.6 in the crude analyses and 0.2 – 0.4 in the adjusted model for a 0 – 22 point scale may not be of clear clinical

significance, but the results showed a consistent positive prediction towards more behavioural difficulties in children of exposed mothers.

In addition to childhood abuse, adult abuse experiences were also associated with externalizing behaviour in the offspring. Emotional abuse alone did not remain significant after adjustment for maternal mental health, and adult physical/sexual abuse was only marginally significant (Model 2, Table 3), indicating a near fully mediation of mental health for these relationships.

## **Discussion**

The current population-based study of mother-child dyads found that mothers who had experienced abuse in childhood reported more externalizing behaviour in their children at three years of age compared with mothers without such experiences. This finding indicates that childhood abuse have consequences also for the next generation. Our findings confirm and expand on the limited previous population based research, which has suggested an association between maternal childhood abuse and offspring adjustment [11, 12]. In addition, the longitudinal design of the current study made it possible to investigate potential mediation, and our results suggests that maternal mental health may be a partial mediator of the relationship. To our knowledge this has not been demonstrated in other population based studies. However, the association between maternal childhood abuse and child behaviour remained significant also after the adjustment for mental health, indicating that there must be other pathways as well. Important factors not assessed in our study include biological factors, parenting style and paternal factors. On the other hand, the relationship between maternal adult abuse and child externalizing behaviour was almost completely mediated by mental health. This suggests that established mechanisms between maternal mental distress and behaviour in offspring predominantly accounted for the relationship [9].

In line with previous literature describing long-term consequences of childhood abuse on social functioning, mental health and later victimization [1, 4-6, 12], we found that childhood abuse experiences were associated with lower levels of education, single motherhood, maternal mental distress and later exposure to abuse. However, adjustment for these factors only slightly attenuated the relationship between maternal childhood experiences and increased externalizing behaviour in the children in the children. The stable relationship of childhood experience emphasizes how early adversities may have long-term and intergenerational consequences.

To our surprise, our study showed that maternal childhood emotional abuse alone was as strong a predictor of behavioural problems in the children as physical and /or sexual abuse. Several studies confirm a strong independent association between childhood emotional abuse and mental health problems later in life [21, 22], and one comparable study also found a significant association between childhood emotional abuse and adjustment of offspring [11]. Our study suggests that childhood emotional abuse may affect parenthood, but further research is needed to confirm this association. Nevertheless, the result highlights that it is important to assess also emotional abuse in future studies of the consequence of childhood abuse.

There are some important limitations to this study. A response rate of 38.5% suggests a selection bias, and comparisons with national registry data have shown that women with the highest education level were overrepresented and that the youngest women (<25 years), those living alone, mothers with >2 previous births and with previous stillbirth were strongly underrepresented [16, 23]. The study sample may then be regarded as representing a low-risk population and the prevalence of risk factors and adversities, such as childhood abuse, are likely to be underestimated. However, few significant differences in exposure-outcome associations have been identified in studies of this cohort [23]. Furthermore, the sample

comprised predominantly ethnic Norwegian participants, and did not allow us to investigate the influence of ethnicity or culture. Sampling strategies that ensure a better representation of the general population, including the immigrant population and high-risk groups, would be valuable in future epidemiological research on adversities in childhood. Preferably, further studies should also include both parents.

Retrospective reports of adverse childhood experiences are likely to involve measurement errors, but are nevertheless regarded to have a worthwhile place in research [24]. Forgetfulness, denial, misunderstanding, and embarrassment may result in false negative reports [1, 25]. On the other hand, studies indicate that few individuals report a false history of abuse [26]. Maternal childhood abuse was assessed in late pregnancy with four questions. The two questions assessing emotional abuse were descriptive and behaviour specific. Physical and sexual abuse was assessed by single, broad labelling questions. Such labelling has been demonstrated to result in lower positive responses, compared with descriptive questions, and may have contributed to false negative reports [27].

Reliance on the mother as single informant may have affected the response accuracy. Parents have been found to report more externalizing behaviour in their children than teachers and other professionals [28]. However, parental report of externalizing behaviour has been shown to be predictive of later problem behaviour [28]. Behaviour at three years of age may not be a stable construct, and further research on trajectories is needed to identify children with persistent problems more accurately [13]. Maternal mental health may influence the perception of child behaviour, and the result could be influenced by shared method variance, and hence an over-estimation of the associations is possible [29].

As in other large population studies, abbreviated scales were used. Items from the CBCL were selected by consensus among specialists in clinical and developmental psychology with an aim towards maintaining content validity. However, the scale

abbreviation may represent the original construct less accurately. The strengths of this study included its large sample size and prospective design with assessment of many potentially important variables several times making it possible to assess mediation.

The large sample size may have led to the detection of statistically significant effects that are not necessarily clinically relevant per se. Nevertheless, this study indicated a trend towards more behavioural difficulties in children of mothers exposed to childhood abuse, and the longitudinal design of the study supports a parent-to-child directionality. The low risk profile of the sample and the identification of this association in a Scandinavian welfare state add support to the robustness of the observation. Intergenerational transmission of adversity is a major challenge to public health and effort to break this cycle may profit from a focus on all three aspects discussed in this paper; Childhood abuse, maternal mental health and child behaviour.

### **Acknowledgements**

We are grateful to all the participating families in Norway who take part in this on-going cohort study.

### **Funding**

The Norwegian Mother and Child Cohort Study is supported by the Norwegian Ministry of Health and the Ministry of Education and Research, NIH/NIEHS(contract no NO-ES-75558), NIH/NINDS (grant no.1 UO1 NS 047537-01), and the Norwegian Research Council/FUGE (grant no. 151918/S10). The current study did not receive any specific funding, but was conducted as part of the authors' employment at the Norwegian Centre for Violence and Traumatic Stress Studies.

### **Conflict of interest**

None declared

## References

- [1] Gilbert R, Widom CS, Browne K, et al. Burden and consequences of child maltreatment in high-income countries. *Lancet*. Jan 3 2009;373(9657):68-81.
- [2] Butchart A, Harvey AP, Mian M, et al. *Preventing child maltreatment: A guide to taking action and generating evidence*. Geneva: World Health Organization and International Society for Prevention of Child Abuse and Neglect; 2006.
- [3] Dong M, Anda RF, Felitti VJ, et al. The interrelatedness of multiple forms of childhood abuse, neglect, and household dysfunction. *Child Abuse Negl*. Jul 2004;28(7):771-784.
- [4] Kessler RC, McLaughlin KA, Green JG, et al. Childhood adversities and adult psychopathology in the WHO World Mental Health Surveys. *Br J Psychiatry*. Nov 2010;197(5):378-385.
- [5] Finkelhor D. *Childhood victimization, Violence, Crime and Abuse in the Lives of Young People*. New York: Oxford University Press 2008.
- [6] Weich S, Patterson J, Shaw R, et al. Family relationships in childhood and common psychiatric disorders in later life: systematic review of prospective studies. *Br J Psychiatry*. May 2009;194(5):392-398.
- [7] Bayer JK, Ukoumunne OC, Lucas N, et al. Risk factors for childhood mental health symptoms: national longitudinal study of Australian children. *Pediatrics*. Oct 2011;128(4):e865-879.
- [8] Civic D, Holt VL. Maternal depressive symptoms and child behavior problems in a nationally representative normal birthweight sample. *Matern Child Health J*. Dec 2000;4(4):215-221.
- [9] Goodman SH, Rouse MH, Connell AM, et al. Maternal depression and child psychopathology: a meta-analytic review. *Clinical child and family psychology review*. Mar 2011;14(1):1-27.
- [10] Dubowitz H, Black MM, Kerr MA, et al. Type and timing of mothers' victimization: effects on mothers and children. *Pediatrics*. Apr 2001;107(4):728-735.
- [11] Collishaw S, Dunn J, O'Connor TG, et al. Maternal childhood abuse and offspring adjustment over time. *Dev Psychopathol*. Spring 2007;19(2):367-383.
- [12] Roberts R, O'Connor T, Dunn J, et al. The effects of child sexual abuse in later family life; mental health, parenting and adjustment of offspring. *Child Abuse Negl*. May 2004;28(5):525-545.
- [13] Mathiesen KS, Sanson A, Stoolmiller M, et al. The nature and predictors of undercontrolled and internalizing problem trajectories across early childhood. *J Abnorm Child Psychol*. Feb 2009;37(2):209-222.
- [14] Bailey HN, DeOliveira CA, Wolfe VV, et al. The impact of childhood maltreatment history on parenting: a comparison of maltreatment types and assessment methods. *Child Abuse Negl*. Mar 2012;36(3):236-246.
- [15] Berlin LJ, Appleyard K, Dodge KA. Intergenerational continuity in child maltreatment: mediating mechanisms and implications for prevention. *Child Dev*. Jan-Feb 2011;82(1):162-176.
- [16] Magnus P, Irgens LM, Haug K, et al. Cohort profile: the Norwegian Mother and Child Cohort Study (MoBa). *Int J Epidemiol*. Oct 2006;35(5):1146-1150.
- [17] Achenbach TM, Rescorla LA. *Manuale for the ASEBA Preschoole Forms and Profiles*: Burlington, VT: University of Vermont, Research Center for Children, Youth and Families.; 2000.
- [18] Swahnberg IM, Wijma B. The NorVold Abuse Questionnaire (NorAQ): validation of new measures of emotional, physical, and sexual abuse, and abuse in the health care system among women. *European Journal of Public Health*. Dec 2003;13(4):361-366.
- [19] Tambs K, Moum T. How well can a few questionnaire items indicate anxiety and depression? *Acta Psychiatr Scand*. May 1993;87(5):364-367.
- [20] Baron RM, Kenny DA. The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations. *J Pers Soc Psychol*. Dec 1986;51(6):1173-1182.
- [21] Teicher MH, Samson JA, Polcari A, et al. Sticks, stones, and hurtful words: relative effects of various forms of childhood maltreatment. *Am J Psychiatry*. Jun 2006;163(6):993-1000.
- [22] Norman RE, Byambaa M, De R, et al. The long-term health consequences of child physical abuse, emotional abuse, and neglect: a systematic review and meta-analysis. *PLoS medicine*. 2012;9(11):e1001349.
- [23] Nilsen RM, Vollset SE, Gjessing HK, et al. Self-selection and bias in a large prospective pregnancy cohort in Norway. *Paediatr Perinat Epidemiol*. Nov 2009;23(6):597-608.
- [24] Hardt J, Rutter M. Validity of adult retrospective reports of adverse childhood experiences: review of the evidence. *J Child Psychol Psychiatry*. Feb 2004;45(2):260-273.
- [25] Melchert TP, Parker RL. Different forms of childhood abuse and memory. *Child Abuse Negl*. Feb 1997;21(2):125-135.

- [26] McKinney CM, Harris TR, Caetano R. Reliability of self-reported childhood physical abuse by adults and factors predictive of inconsistent reporting. *Violence Vict.* 2009;24(5):653-668.
- [27] Thombs BD, Bernstein DP, Ziegelstein RC, et al. An evaluation of screening questions for childhood abuse in 2 community samples: implications for clinical practice. *Archives of internal medicine.* Oct 9 2006;166(18):2020-2026.
- [28] Leblanc N, Boivin M, Dionne G, et al. The development of hyperactive-impulsive behaviors during the preschool years: the predictive validity of parental assessments. *J Abnorm Child Psychol.* Oct 2008;36(7):977-987.
- [29] Najman JM, Williams GM, Nikles J, et al. Mothers' mental illness and child behavior problems: cause-effect association or observation bias? *J Am Acad Child Adolesc Psychiatry.* May 2000;39(5):592-602.



Table I. Prevalence of maternal childhood abuse in the Norwegian Mother and Child Cohort Study

Childhood abuse categories	Questionnaire items responses (N = 24,900) <sup>a</sup>				
	Degradation or humiliation	Threats	Physical abuse	Sexual abuse	Total
	% (n)	% (n)	% (n)	% (n)	% (n)
Emotional abuse alone	7.5% (1,874)	1.6% (397)	—	—	8.4% (2,100)
Sexual and/or physical abuse	3.7% (917)	2.2% (541)	4.8% (1,207)	6.4% (1,592)	9.1% (2,260)
Total	11.2% (2,791)	3.8% (938)	4.8% (1,207)	6.4% (1,592)	17.1% (4,360)

<sup>a</sup> Missing rate 2.2%

Table II. Sociodemographic characteristics, maternal mental health and child behaviour at three years of age for the different categories of maternal childhood abuse, and comparisons between the categories

Characteristics	Maternal childhood abuse n=24,900		Comparison between the categories of childhood abuse <sup>a,b</sup>		
	No, never	Emotional abuse alone	Physical and/or sexual abuse	Overall test	a vs. b a vs. c b vs. c
	(a)	(b)	(c)	statistics	
	82.5%	8.4%	9.1%		
	(20,540)	(2,100)	(2,260)		
	%(n) / mean (SD)				
Maternal age	29.9 (4.3)	29.0 (4.6)	29.3 (5.0)	< 0.001	< 0.001 < 0.001 < 0.001
Maternal education ≤ 12 years	35.3% (7,046)	40.9% (829)	50.1% (1,088)	< 0.001	< 0.001 < 0.001 < 0.001
Not living with a partner	2.6% (530)	4.7% (97)	6.3% (140)	< 0.001	< 0.001 < 0.001 < 0.022
Maternal adult abuse				< 0.001	< 0.001 < 0.001 < 0.001
No, never (N = 20,423)	84.6% (17,377)	70.9% (1,477)	65.0% (1,442)		
Emotional abuse alone (N = 2,602)	9.0% (1,840)	16.9% (352)	17.5% (388)		
Physical and/or sexual abuse (N = 1,990)	6.4% (1,323)	12.2% (254)	17.6% (390)		
Maternal mental distress (mean 1 - 4)	1.24 (0.32)	1.40 (0.45)	1.43 (0.48)	< 0.001	< 0.001 < 0.001 < 0.025
Child externalizing behaviour (0 - 22)	5.40 (3.07)	6.03 (3.26)	5.94 (3.34)	< 0.001	< 0.001 < 0.001 < 0.62

<sup>a</sup> Chi-square tests were used for comparison between categorical variables and one-way ANOVA between continuous variables

<sup>b</sup> Post hoc p values for pairwise comparisons using Scheffé correction for ANOVA and Holm correction for chi-square tests

Table III. Hierarchical regression with maternal childhood abuse as predictor of externalizing behavior in the offspring (N = 25,452) <sup>a</sup>

	Univariate		Model 1 <sup>c</sup>		Model 2 <sup>c</sup>	
	B (95% CI) <sup>b</sup>	p	B (95% CI) <sup>b</sup>	p	B (95% CI) <sup>b</sup>	p
<b>Maternal childhood abuse</b>						
Emotional abuse alone vs. no, never	0.64 (0.49, 0.79)	< 0.001	0.55 (0.41, 0.69)	< 0.001	0.35 (0.20, 0.49)	< 0.001
Physical and/or sexual abuse vs. no, never	0.56 (0.41, 0.71)	< 0.001	0.41(0.26, 0.56)	< 0.001	0.19 (0.04, 0.33)	0.012
Physical and/or sexual abuse vs.						
Emotional abuse alone	0.08 (-0.12, 0.28)	0.428	0.14(-0.006, 0.34)	0.164	0.16 (-0.03, 0.34)	0.105
<b>Maternal adult abuse</b>						
Emotional abuse alone vs. no, never	0.34 (0.21, 0.475)	< 0.001	0.25 (0.12, 0.39)	< 0.001	0.11 ( -0.022, 0.24)	0.10
Physical and/or sexual abuse vs. no, never	0.43 (0.28, 0.58)	< 0.001	0.32 (0.17, 0.47)	< 0.001	0.15 (0.005, 0.30)	0.043
Maternal mental health	0.19 (0.18, 0.21)	< 0.001			0.18 (0.16, 0.19)	< 0.001

<sup>a</sup> Modelling based on 20 multiply imputed datasets

<sup>b</sup> B = unstandardized regressions coefficient

<sup>c</sup> Adjusted for maternal age, maternal education, maternal marital status and child's gender



**APPENDIX I**



Table S1 (Paper I) Type of injury, evaluated by radiological reports.

	Skull fracture(s) n=39 (43%)	Epidural haemorrhage n=12 (13%)	Subdural haemorrhage n=27 (30%)	Parenchymal brain injury n=13 (14%)
Type of skull fracture				
Simple	29	10	9	3
Impression	5	1	1	3
Base of skull	2	0	0	0
Complex or multiple	3	1	7	6
None	-	0	10	1
Parenchymal injury	-	1	15	13
Edema	-	0	11	7
Increased ICP	-	5	10	3
Spine injury	0	0	0	0
Visceral injuries	0	0	1	1
Extremity fracture(s)	2	0	4	0
Costa fracture(s)	0	0	2	0

Table S2 (Paper I) Reported cause of injury in relation to type of injury.

Reported cause of injury	Skull fractures <i>n</i> =39	Epidural haemorrhage <i>n</i> =12	Subdural haemorrhage <i>n</i> =27	Parenchymal brain injury <i>n</i> =13
Unknown	5 (13%)	0	7 (26%)	0
Fall < 0.8m	7 (18%)	1 (8%)	8 (30%)	0
Fall 0.8–1.2m	10 (26%)	7 (58%)	1 (4%)	3 (23%)
Fall > 1.2 m	8 (21%)	3 (25%)	3 (11%)	4 (31%)
Fall down stairs	1 (3%)	0	2 (7%)	1 (8%)
Motor vehicle accident	4 (10%)	0	5 (19%)	4 (31%)
Unique accident	4 (10%)	1 (8%)	1 (4%)	1 (8%)



Table S3 (Paper I) Classification criteria for the cases in the inflicted injury group.

Age (months) n=17	Type of injury	Classification criteria
2	SDH	1, 2b, 4
13	SF, SDH, PBI	1, 2b, 3a, 4
17	SF, SDH, PBI	1, 2a, 3a, 3b, 4
3	SF, SDH, PBI	1, 2a, 3b, 4
1	SF, SDH, PBI	1, 2b, 3a, 4
12	SF, SDH, PBI	1, 2b, 2c, 3a, 4
2	SDH, PBI	2b, 4
2	SF, SDH, PBI	1, 2a, 3a
3	SDH	1, 2a, 3b
2	SDH	1, 2a, 3a, 4
0	SF, SDH	2b
4	SF, SDH	2b
3	SDH	2b, 4
4	SDH	2b
1	SF, SDH	2b, 2c
14	SDH, PBI	1, 2a, 3a, 4
12	SDH, PBI	2a

Skull fracture SF, Subdural haemorrhage SDH, Parenchymal brain injury PBI

- 1) Documented presumptive abuse in the medical record, and referral to child protective services.
- 2) Injuries where the medical history could not explain the injury [18].
  - a) No history of trauma
  - b) A low impact insult (height of fall < 1.0m)
  - c) Changes in the history given by the caregivers
  - d) History incompatible with the child's developmental level
- 3) Injuries where additional findings indicate child abuse.
  - a) Retinal haemorrhages
  - b) Additional injuries which were incompatible with the given mechanism of the injury
- 4) Older injuries without explanation

Table S4. (Paper I) Comparison between the inflicted and the accident group.

	Inflicted <i>n</i> =17	Accident <i>n</i> = 35	OR (95% CI)	<i>p</i> value
Age (months), median (IQR)	3 (2.0-12.0)	20 (13-28)	–	<0.001
Gender, male	12 (71%)	19 (54%)	2.0 (0.6-7.0)	0.26
Mother age (years), mean (SD)	31.4 (5.2)	32.2 (4.2)	–	0.63
Father age (years), mean (SD)	29.6 (4.7)	34.3 (4.2)	–	0.018
Prior hospitalization	5 (30%)	2 (6%)	6.9 (1.2-40.3)	0.031
Estimated hours before call for medical assistance, median (IQR)	6 (0-24)	0 (0-0)	–	<0.001
Seizures	8 (47%)	3 (9%)	9.5 (2.1-43.3)	0.003
Decreased level of consciousness	15 (88%)	26 (74%)	2.3 (0.5-13.6)	0.30
Apnoea or hypoventilation	10 (59%)	12 (34%)	2.7 (0.8-9.0)	0.14
Skull fracture	9 (53%)	31 (89%)	6.9 (1.7-28.2)	0.011
Edema	7 (41%)	11 (31%)	1.5 (0.5-5.1)	0.54
Increased ICP	8 (47%)	6 (17%)	4.3 (1.2-15.7)	0.043
LOS (days), median (IQR)	9 (4-15)	4 (2-11)	–	0.12
Admittance to the PICU	14 (82%)	23 (66%)	2.4 (0.6-10.2)	0.33
Neurosequele	10 (58%)	6 (19%)	6.2 (1.7-23.0)	0.009
Death	0	3 (9%)	1.5 (1.2-1.9)	0.54

Table S5 (Paper I) Characteristics of the indeterminate cases.

Characteristics of the indeterminate cases	n (%) /median (IQR)	Comparison with	Comparison with
		the inflicted group	the accident group
		<i>p</i> value	<i>p</i> value
Age (months)	7.0 (5 – 11)	0.023	< 0.001
Gender, male	20 (51%)	0.24	0.82
Prior hospitalization	10 (26%)	0.76	0.027
Estimated hours before call for medical assistance	1 (0.48)	0.83	< 0.001
Seizures	1 (3%)	0.001	0.34
Decreased level of consciousness	16 (41%)	0.001	0.001
Apnoea or hypoventilation	2 (5%)	0.001	0.002
Skull fracture	38 (97%)	0.001	0.18
Increased ICP	5 (13%)	0.013	0.75
LOS (days)	2 (1 - 3)	0.001	0.001
Admittance to the PICU	8 (21%)	0.001	0.001
Neurosequele	2 (5%)	0.001	0.13
Death	0	-	0.10

