The Benefits and Harms Associated with the Practice of Bed sharing: A Systematic Review

Prepared for:
CITY OF TORONTO
Toronto Public Health
175 Memorial Park Avenue
Toronto, ON M4J 4Y6

Prepared by:
The Chalmers Research Group at the
Chidren's Hospital of Eastern Ontario (CHEO) Research Institute
Ottawa, Ontario
Canada

Investigators:

Tanya Armour[1,2] PhD
Tammy Clifford[2,6,7] PhD
Nick Barrowman[1], PhD
Sue Bennett[2,3], MB, ChB, FRCP
Fatemeh Yazdi[1], MSc
Margaret Sampson[1]
David Moher[1,6], PhD
Orvie Dingwall[4], BA
Howard M Schachter[2], PhD
Raymond Daniel[1], BA
Aurore Cote[5], MD

[1] The Chalmers Research Group, CHEO Research Institute - Ottawa Canada
[2] Department of Pediatrics, University of Ottawa and the Children's Hospital of Eastern Ontario - Ottawa, Canada.
[3] University of Ottawa Departments of Psychiatry - University of Ottawa
[4] Canadian Patient Safety Institute - Edmonton, Canada
[5] McGill University, Respiratory Medicine Division at the Montreal Children's Hospital – Montreal, Canada
[6] Department of Epidemiology and Community Medicine - University of Ottawa
[7] Canadian Coordinating Office Health Technology Assessment - Ottawa, Canada

November 2005

Acknowledgments

We thankfully acknowledge the Provincial Coroner's Offices for contributing to our review and completing our surveys.

Thank you to Charlotte MacDonald and Chantelle Garritty for preparing the initial documents and contracts for this report.

Funding Sources

Financial contribution from the City of Toronto is acknowledged.

The views expressed therein do not necessarily represent the views of the City of Toronto or the Ministry of Children and Youth Services.

Executive Summary

Introduction

Bed sharing, the practice of adults sleeping on the same surface as a child, is a controversial practice about which health care professionals are often asked to advise parents. There is a need to clarify the harms and benefits of this practice, including strategies that could eliminate or reduce the harms for children, in order to develop guidance in this area. There is a growing body of research literature on the possible benefits of bed sharing but also on the possible harms, namely the association between bed sharing and sudden deaths in infants. This systematic review was undertaken to provide health professionals with the best empirical evidence on the harms and benefits of bed sharing.

Objectives

The primary objectives of this systematic review were:

1. To determine how many child-related deaths and injuries are associated with bed sharing in Canada and other comparable jurisdictions.
2. To determine what child-related harms and benefits are associated with bed sharing
3. To determine what factors related to bed sharing are associated with child-related outcomes (i.e. harms, benefits)
4. To determine what strategies are effective for reducing child-related harms associated with bed sharing

Section I. Infant Mortality and Injury Statistics

Two types of bed sharing deaths are examined in this section: (1) accidental deaths while bed sharing in an adult bed and (2) unexplained deaths in bed sharing situations. Unintentional deaths while bed sharing in an adult bed occur as a result of asphyxia, which can occur in two ways. Firstly, infants can be found entrapped between elements (e.g. mattress and the wall) of the bed or between the mattress and other adjacent pieces of furniture. These deaths are unrelated to bed sharing per se and result from the fact that adult beds are not constructed with infant safety in mind.

Secondly, infants can be found underneath a sleeping adult with their airway or their entire body compressed. Unexplained deaths in bed sharing situations refers to deaths of infants that have occurred in adult beds but where it is not possible to determine whether bed sharing was instrumental in the cause of death. Unintentional injuries while bed sharing in an adult bed were also examined.

Methods

To determine the number of bed sharing deaths and injuries, mortality and injury statistics for children 0-2 years of age were sought directly from available national and provincial databases or from publications and reports, Since all deaths and injuries are classified according to the International Classification of Disease (ICD), the first step was to determine which ICD code(s) appropriately described bed sharing deaths or injuries. The closest ICD code (10^{th} revision) is W75 which describes "accidental suffocation in bed". While this code includes suffocation of the child by the mother's body (implying the same sleeping surface), it also includes suffocation by pillow or bed linen, which does not necessarily mean that bed sharing had occurred.

Given this, it was clear that searching Canadian provincial, territorial or national databases would not yield specific data on bed sharing deaths or injuries. Nevertheless, it was felt that the data retrieved under code W75 would be useful in providing an estimate of the number of bed sharing deaths (even if the numbers are an overestimation, because they include deaths in cribs). We extracted data from Statistics Canada's socio-economic database (Canadian Socio-economic Information Management: CANSIM) and from the Canadian Hospital Injury Reporting and Prevention Program (CHIRPP).

In addition to reviewing infant mortality and injury statistics, the issue of the process of data collection regarding bed sharing deaths was also explored. As coroners and medical examiners are in charge of investigating unexpected deaths and accidents, all provincial and territorial coroner's offices and/or medical examiner's offices were contacted and requested to complete a questionnaire related to data collection on bed sharing deaths. The intent of the questionnaire was to determine if

data specific to bed sharing deaths was collected, how this data was coded, and in what forms it was available.

Results

Canadian infant mortality and injury data

Our searches for Canadian child mortality and injury data directly related to the practice of bed sharing revealed that data is not available specifically on the location of death (adult bed, crib, other type of beds). As well, the mortality and injury data summarized from national databases are grouped for 0-1 year olds and 1-4 year olds but not for 0-2 year olds which precluded any analysis for this specific age grouping.. . Presented below are (1) unintentional suffocation resulting in deaths and injuries and (2) unexplained sudden infant deaths.

Data on unintentional (accidental) suffocation

Infant Mortality

Data on deaths by unintentional suffocation were extracted from Statistics Canada's socio-economic database (Canadian Socio-economic Information Management: CANSIM), published reports, and an unpublished study in Quebec. For children 0-1 year of age in Canada, the numbers of deaths from unintentional suffocation increased from 3 during 1990-1992 to 11 during 2002. For children 0-1 year of age in Quebec, over a ten-year period, there were 7 unintentional deaths in adult beds. 3 occurred in a bed sharing situation while 4 occurred during solitary sleep in an adult bed. Bed sharing deaths represented 25% of the total number of unintentional deaths by asphyxia in beds over this time frame. The province of Quebec dataset was important to examine because, to date, it is the first time that patient-level data (full review of each case) has been examined and coded according to the types of bed (e.g. adult bed or crib) in which deaths occurred.

We also reviewed data from publications using the Consumer Product Safety Commission (CPSC) databases (United States). Two publications reported data on unintentional suffocation and other accidents occurring in beds and the years examined were in the mid-nineties (1990 to 1997 and 1995 to 1998). Overall, 23.5% and 17 % of the deaths had occurred in a bed sharing situation, numbers that are very close to that of the province of Quebec at 25%.

In summary then, child-related deaths directly linked with the practice of bed sharing are not frequent occurrences in Canada. Limited data from other comparable jurisdictions showed similar prevalence rates. The number of injuries was slightly higher.

Data on unexplained bed sharing deaths but for which it was not possible to determine whether bed sharing was instrumental in the manner of death.

Unexplained bed sharing deaths were reviewed for Ontario and Quebec using data available through the coroner's office. Comparisons between the provinces revealed that the number of sudden unexpected deaths where bed sharing was a factor was much greater in Ontario than in Quebec for the years studied. The reasons for this difference are unknown.

Unexplained bed sharing deaths were reviewed for Ontario and Quebec using data available through the coroner's office. The proportions of bed sharing deaths were quite different between the two provinces, averaging 15% in Quebec and 60% in Ontario for the year's studies. The reasons for this difference are unknown.

Coroner's office questionnaire

Analysis of the returned questionnaires from coroners' offices and medical examiners' offices from across Canada revealed differences in data collection with regard to what was collected, how it was collected and collated, and how it was presented. Few offices reported using a formalized database for maintaining data and no offices reported using ICD coding systems. In Canada, assigning causes of death is the responsibility of the local coroner or medical examiner in charge of investigating deaths. Their report is often the basis of reporting for coroners' offices. The

provincial/territorial vital registrar's offices collect and code this data and then submit it to Statistics Canada. Standardization of data collection techniques, and the type of data collected by coroner's offices and medical examiner's offices would make determination of bed sharing related deaths in infants more accurate.

Section II. Systematic Review

Research Design and Methods

Search Strategy

MEDLINE, CINAHL, Healthstar, PsycINFO, The Cochrane Library, TRIP, SocAbs, and AMED databases were searched for English-language records published between 1993 - January 2005. Published and unpublished reports of any study design were included for our systematic review. In particular, those with a comparison group along with pre versus post, prospective cohort, and case series designs were considered. We included studies that were published in journal format. Conference proceedings, letters to the editor, dissertation abstracts, and conference abstracts were excluded from our review. Bed sharing was defined as 'the practice of sharing a sleep surface between adults and young children'. Any study investigating the practice of bed sharing and associated harms and benefits, in children 0-2 years of age was included in our review.

Study Selection

Following a calibration exercise that involved screening records for inclusion or exclusion using questions developed specifically for this review, records were uploaded into the University of Ottawa, Evidence-based Practice Center review management system. This is an internet-based, secured, software program. All records retrieved through searches were initially screened (Level 1) by two authors using titles, and abstracts, where available, and standardized screening questions. All records that were tagged by reviewers at this level as a review article, report, or statement were screened for relevance for our review. Studies identified as potentially relevant at Level I were

retrieved in full-text format, and screened independently for inclusion by two reviewers (Level II). At this level, consensus was required so when disagreements occurred, consensus was achieved through discussion.

Data Extraction

Once studies were identified as relevant in Level II, relevant data on study design, population demographics, study characteristics, exposure variables, risk factors, methodological quality, and outcomes were extracted and summarized. Data were also thoroughly extracted for the exposure (description of the bed sharing environment). Outcomes were summarized using a qualitative data synthesis for each study, and presented using narrative descriptions.

For this systematic review, 'complete' data extraction and any potential meta-analytical pooling was limited to prospective cohort and case control studies. Studies that were identified as relevant for our review, but that did not have a contemporaneous comparator (e.g. case series, retrospective cohort, 'other', etc.) were excluded from any analysis. Because we were dealing mostly with case control and prospective cohorts, the Newcastle-Ottawa scale (NOS) was used for quality assessment. Quality assessment was determined solely by what was reported in each study. No attempt was made to contact authors for missing information.

Statistical Analysis

Quantitative estimates of the association between bed sharing and harms were extracted by a statistician using a standardized extraction form. Odds ratios (ORs) and 95% confidence intervals (CIs) for bed sharing as a risk factor were extracted. Adjusted ORs were chosen in preference to unadjusted ORs because of concerns about confounding in case-control studies.

It was evident early on in the systematic review process that no attempt would be made to pool estimates of the association between bed sharing and harms/benefits across studies, for various reasons. First, reporting of interactions was inconsistent

between studies. Secondly, when an individual study did not find an interaction to be statistically significant, further detail on the interaction was typically not provided. From the perspective of potential pooling, this selective reporting poses a problem akin to publication bias, in which statistically non-significant results may not be available. Pooling only the available results may lead to bias. Finally, varying definitions of exposure and overlapping data sets make pooling problematic. Nevertheless, the consistency across studies of associations between bed sharing and harms/benefits was examined.

Results

Literature Search

Our initial searches identified a total of 1218 records from bibliographic sources. After excluding the duplicate publications, we then screened the titles and abstracts and excluded non relevant and non-English publications. A total of 323 articles were retrieved for full-text relevance screening (performed in duplicate). Our searches yielded 83 studies, which met topic-specific inclusion criteria. We further excluded 43 studies from formal synthesis on the basis of their level of evidence (i.e. study design). In total, 40 studies (30 case-control studies, 10 prospective cohort studies) met our final inclusion criteria and make up the body of this evidence review.

Studies were original articles investigating child-related harms (sudden unexplained deaths –SIDS) or benefits (bonding, sleep patterns, breastfeeding), or strategies to reduce harms associated with the practice of bed sharing.

Quality assessment

Seventeen case control studies and eight prospective cohort studies were quality assessed using the Newcastle-Ottawa Scale (NOS). This scale assesses the following aspects of the studies: selection, comparability and exposure. Only primary publications were assessed; companion papers were not.

Selection was rated quite well for the case-controls studies in our review. Comparability was much more heterogeneous within in these studies. Only 11/17 studies met all criteria for maximum scoring at this level while the remaining studies received only one point. This means that these studies did not plan *a priori* to match their cases with their controls on certain variables of interest nor did they adjust for these variables in their statistical analysis. The exposure assessment was generally the lowest rated section of this scoring system.

Unlike the case-control studies, the prospective cohort studies did most poorly within the 'selection' category. This raises concerns that if the populations being examined are inadequately selected or are subject to bias, it is difficult to be confident that the outcomes reported are true representations of the cohorts examined. These results suggest there may be some bias in the results of these studies, if selection of subjects, comparability and exposure were not of high quality or methodology.

It should be noted that although these studies were rated for the most part well, the study designs are low on the study hierarchy scale and are limited by their nature of design. Even the highest rated case-control study cannot provide answers regarding causality because of the difficulty that arises when trying to verify temporality; that is, demonstrating that the exposure preceded the outcome. Prospective cohort studies, while higher in the hierarchy of evidence than case-control studies, cannot be as definitive as controlled trials vis-à-vis their ability to prove a causal relationship between exposure and outcome.

Harms and Risk Factors Associated with Bed sharing

The studies we reviewed were mostly aimed at identifying the prevalence of known or potential risk factors for SIDS. None were specifically aimed, when designed, at determining whether bed sharing was a risk factor for SIDS and whether bed sharing interacted with other risk factors. Thirty publications were retained concerning 17 different datasets. The studies were carried out between 1987 and 2001 in 10 countries (England, Germany, Ireland, Japan, New Zealand, Norway, Russia, Scotland, The Netherlands, and the United States). In addition, one study grouped data from 20

regions of Europe and included data from other included publications. Most of the studies included infants aged up to one year of age. The majority of populations included in these studies were Caucasian. One study reported data collected solely on Indigenous people in the USA; and one other study examined a predominantly African American population. The New Zealand datasets were collected to reflect adequate representation for Maoris and Pacific Islanders.

Definitions for sleeping location (bed sharing or non-bed sharing) were heterogeneous. Nevertheless, the studies can be classified broadly into two subgroups: those reporting *routine* sleep locations and those reporting bed sharing *on a particular night* (last sleep for the cases and reference sleep for the controls -- the time of day or night corresponding to the time of the index cases' last sleep). Six studies reported data on both routine bed sharing and bed sharing on a particular night. For two studies, the definition of sleep location was not clearly reported.

Seven publications were more specifically aimed at investigating bed sharing and SIDS. Two publications had incomplete results and noted a follow-up publication is expected. One publication reported data solely for the cases. Finally, one publication reported only the prevalence of bed sharing in cases and controls without any further analysis.

In summary, there was quite a variation in what was studied and how the data were analysed. As well, data from four of the 17 studies were not extractable. Overall, there were 11 original studies reporting from different datasets for which ORs (and 95% confidence intervals) were provided for bed sharing data. The results can be grouped as follows

- Five studies reported a non-significant OR for bed sharing in multivariate analysis, four of these five studies used *routine practice* as their definition of bed sharing. One study reported a non significant odds ratio when parents were bed sharing (last sleep) but a significant one for any bed sharing (with anyone including siblings).

- Five studies reported a significant OR for bed sharing (2 reported only OR for univariate analysis and 3 for multivariate analysis); four of the five studies used bed sharing during last sleep/reference sleep as their definition of bed sharing.

There are a number of cautions associated with interpretation of the above summary. First, as the reviewed data are from observational studies, the problem of residual confounding due to other unknown or unaccounted-for differences between the bed sharing and non-bed sharing populations cannot be discounted. Second, when a significant interaction exists between a factor (i.e. smoking) and bed sharing, simply looking at an association between bed sharing and SIDS (as summarized above) might not be meaningful. We therefore examined the literature for factors that had been investigated for their interactions with bed sharing as a risk factor for SIDS

Interactions

While the investigation of interactions is one of the objectives of the present work, reports of interactions frequently lacked sufficient detail for our purposes. It was often unclear from reports exactly which interactions had been considered, whether statistical tests of these interactions had been performed, and what other combinations of variables were included in the model. Unless an interaction was of specific interest to the authors of a report, the information provided was often sparse. When interactions were reported, it was not always clear if they were statistically significant. When interactions were not found to be statistically significant, further information such as a p-value was often not reported.

Smoking exposure

The most frequently investigated interaction with bed sharing was smoking (most commonly by the mother either during pregnancy or postpartum). A total of 10 studies (in 11 reports) provided data on interactions for smoking. Due to varying definitions of exposure (e.g. maternal smoking during pregnancy or postpartum), a total of 15 investigations of this interaction are summarized in the report.

Reported interaction ratios are all greater than 1 (range 1.6 to 29.23). Of 13 reported interaction ratios, 6 were statistically significant, 6 were not statistically significant. Interaction ratios are not available for a number of studies (primarily those where the interaction was reported to be statistically non-significant) and might be substantially lower in these cases.

On the basis of these results, it appears there may be an association between bed sharing and SIDS among smokers (particularly the mother; however smoking is defined), but among non-smokers no clear relationship between bed sharing and SIDS has been identified. This does not mean that no relationship exists between bed sharing and SIDS among non-smokers, but simply that the limited existing evidence does not convincingly establish such a relationship. More research is required.

Other interactions

There were 25 other interactions reported. Of these, only 6 were statistically significant. Of these 6 estimated interactions that were statistically significant, 3 of them were for age of infant, and were all in the same direction, namely suggesting that bed sharing may be more strongly associated with SIDS for younger infants.

Definitive conclusions about these other interactions cannot be drawn given the differences in study designs and data and reporting limitations, and perhaps most importantly the limited attention paid to the control of confounders in the included studies.

Critiques of the studies reviewed

Although there are many data pertaining to the risk factors and harms associated with the practice of bed sharing, the results of the systematic review were difficult to interpret for a number of reasons: First, the quality of the studies was not always good and some studies were unusable in the final report either because no data were reported for controls, no analysis of bed sharing data was performed or the study was not completed and as such, the authors were forced to rely on a preliminary publication that incompletely reported on the relevant outcomes. Second, the definition of risk

exposure (bed sharing and smoking) varied considerably between studies. The definitions of bed sharing included ‘bed sharing on a specific night’ (night of death or night before the interview), ‘bed sharing as a routine practice’, and ‘bed sharing in the past two weeks’. The duration of bed sharing (whether it was for routine or specific night practice) varied as well. The definition used to describe the exposure to smoking was heterogeneous across studies as well; it varied from ‘maternal smoking during pregnancy’, ‘mother smoked in previous 2 weeks’, ‘any parents smoking’. Attempts to compare results across these studies are therefore extremely difficult.

Studies were also, for the most part, derived from population-based case-control studies undertaken in the mid 1990s. Most of those studies were not undertaken to evaluate the risks and/or harm of bed sharing, but rather to study a variety of potential risk factors for SIDS. More specifically, much of the data analyses were often exploratory in nature, with bed sharing being one of many variables examined as possible risk factors. It is extremely difficult to make any conclusions from these reports as they were, more often that not, intended to generate rather than test hypotheses by exploring a multitude of potential risk factors and by performing multiple tests of statistical significance.

Benefits of bed sharing

Through an iterative process with our technical expert panel, clinical content experts, and Toronto Public Health we chose to examine three child related benefits of bed sharing (breast feeding, sleep-related issues, and parent-child bonding).

Breast feeding

Our searches identified a total of 3 studies (in 4 publications) that examined the impact of bed sharing on the practice of breastfeeding. All were prospective cohort in design and were published between1999 – 2004. The studies had diverse representation from England, USA, and New Zealand and were also heterogeneous in terms of follow-up time interval with a range from 3 months, 6 months, 12 months, and

the longest interval being 18 years. The ethnicity of the study populations were similar with Caucasians being the predominant representation while one included African-Americans, Hispanic and Asian participants.

There is evidence for an association between bed sharing and breastfeeding, but the data cannot clarify the issue of causality (e.g. whether bed sharing promotes breastfeeding or whether breast feeding promotes bed sharing). The results of our systematic review suggest that they are in a positive direction of effect (i.e. increase duration of breastfeeding). However, it is possible that these data reflect the propensity for women who are most likely to practice prolonged breast feeding to also prefer to bed share.

Bonding

No studies examining the impact of bed sharing in relation to bonding, which included a contemporaneous comparator, were identified by our searches. The association between attachment and bed sharing has not been systematically studied.

Bed sharing and sleep related issues

Our searches identified 5 studies that examined bed sharing and sleep-related issues. Four studies examined infant sleep/wake patterns, two studies examined infant sleep problems and two examined infant sleep physiology. All studies examining infant sleep/wake patterns have shown that bed sharing infants have an increased number of awakenings when compared to solitary sleeping infants.

Critiques of the studies reviewed

Searches for studies related to the benefits of bed sharing did not yield many studies. Many of the studies were of low quality, and heterogeneous. The studies were different in their definitions of bed sharing (i.e. previous night sleep, slept within previous week etc.) and the reporting of outcomes (i.e. night wakings, sleep patterns, etc.) There were few studies similar enough to combine to drawn meaningful conclusions. However,

there is evidence for an association between bed sharing and breastfeeding, but the data cannot clarify the issue of causality (e.g. whether bed sharing promotes breastfeeding or whether breastfeeding promotes bed sharing). The results of our systematic review suggest that they are in a positive direction of effect (i.e. increase duration of breastfeeding) but definitive conclusions cannot be drawn due to the study limitations noted above. It is possible that these data reflect the propensity for women who are most likely to practice prolonged breastfeeding to also prefer to bed share. The evidence also suggests that there may be a relationship between bed sharing infants and the bed sharing adult whereby they have an increased number of awakenings during the evening when compared to solitary sleeping infants. Few conclusions about this particular finding can be drawn as to the clinical relevance. There were no studies directly examining the impact of bed sharing on bonding, which included a contemporaneous comparator, identified by our review

Strategies to Reduce Harms

No primary studies examining strategies to reduce child-related harms associated with bed sharing were identified through the literature search.

Strengths and limitations of the review

Our systematic review has many strengths, which included a structured and thorough search of electronic databases, web-based organizations, coroner's offices, reference lists, and content-specific journals to retrieve an extensive body of literature. To the best of our knowledge this is the first and largest, rigorous systematic review examining benefits and harms of bed sharing in the literature. This is an important statement in that most recommendations and guidelines for bed sharing are based on non-systematic samples of evidence.

There are also limitations within our review. Our review was limited to English-language literature. Although this is not an atypical practice for systematic reviews it should be noted that there may be published, non-English reports available which were

not identified in our report. Secondly, our reporting and assessment of each study was limited to published data because no attempts were made to contact authors for additional information or missing data.

An additional limitation to this review stems from the potential for publication bias whereby studies that demonstrate an association are more likely to be published. In the case of bed sharing, an additional facet of publication bias exists whereby studies that reflect potential harms of bed sharing are more apt to be in the public domain than are studies that reflect bed sharing potential benefits.

Position Statements on Bed Sharing

In addition to conducting a systematic review on the benefits and harms of bed sharing, a number of statements on the practice of bed sharing were examined. Concerns regarding infant and child injuries and mortality due to entrapment and compression in adult beds have led health authorities in Canada and other countries, to issue statements about not using adult beds for infants and children. A number of countries have also released statements related to the issue of bed sharing

New Zealand was the first country to issue recommendations against bed sharing in 1992 following the publication of results from the New Zealand Cot Death Study. The recommendations specifically addressed the safety (or lack thereof) of bed sharing for smoking families and also when awareness is impaired by alcohol, marijuana or other drugs. In a follow-up case-control study (risk of SIDS), the prevalence of bed sharing among control infants was shown to be 11.6% as compared to 10.5% prior to the campaign. No data are available specific to the rates of bed sharing among smoking mothers/parents and as such, this precludes any determination of whether the New Zealand recommendations against bed sharing by smoking mothers/parents were followed.

In the USA, the Consumer Product Safety Commission (CPSC), The American Academy of Pediatrics (AAP) and the National Institutes of Health (NIH) have all taken

positions on the issue of bed sharing. The CPSC, following the publication of a case series identifying infant deaths in an adult bed, stated that the only safe place for babies to sleep is in a crib that meets current safety standards. The CPSC also warned against placing babies in adult beds (solitary sleep on adult beds). In addition, there was a statement in 2000 by a Task Force of the American Academy of Pediatrics. In this statement, bed sharing was not explicitly discouraged, except among infants whose mothers who smoke. The authors listed a series of conditions associated with hazards while bed sharing. These included situations where arousal is impaired by substances like alcohol or drugs. The NIH also made similar recommendations. Without explicitly discouraging bed sharing; they stated that 'for mothers who choose to bring their baby to bed for breastfeeding, it is safest to return the baby to his or her crib for sleep'. There has been no evaluation of these strategies to reduce the harms potentially associated with infant sleep on adult beds or more specifically bed sharing between infants and adults.

In the United Kingdom, a statement was published by the Department of Health in early 2004. The recommendations were more explicit than those of other countries and were derived mostly from the results of the "European concerted action on SIDS" study published earlier in The Lancet. The Department of Health recommended that parents should *never* bed share with their baby if he or she is less than eight weeks old, if they are a smoker, if they have been consuming alcohol, if they are taking medications that make them drowsy, or if they are extremely tired. The recommendations also included not falling asleep with the baby while sitting or lying on a sofa. Additionally, it should be noted that they recommended, for the first six months, that the safest place for a baby to sleep is in a crib, in the parents' room. There has been no evaluation of the impact of these recommendations in the UK.

In Canada, the Canadian Paediatric Society published a statement in November 2004 recommending that the best place for an infant to sleep is in his/her own bed, in the parents' bedroom for the first six months of life. There is acknowledgement that some parents will still elect to bed share with their infants, and as such,

recommendations are made for safe bed sharing (similarly to recommendations from the USA and other countries): they recommend against using quilts, comforters, pillows and other pillow-like items. As well, waterbeds, makeshift beds and sofas are discouraged as sleeping surfaces. In addition, room sharing is recommended as is the avoidance of smoking exposure. It is obviously too early to measure the impact of these recommendations.

At the present time, there are a number of other Canadian entities working to produce statements around this controversial topic. The Canadian Foundation for the Study of Infants Deaths (the SIDS Foundation in Canada) has not yet issued a statement on bed sharing; however, evidence in this area has been reviewed. As well, Health Canada is currently in the process of reviewing documents pertaining to SIDS with the intention of expanding the section on bed sharing following a workshop held in Edmonton, Alberta in July 2004 during the 8th SIDS International Conference.

Recommendations

Public Health recommendations

Our review of the case-control studies on potential harms of bed sharing highlighted the difficulties with some of the studies. These included the heterogeneity in the definition of bed sharing across studies as well as problems with some of the studies (e.g. the lack of data presented on bed sharing, no control groups, missing data, or no formal analysis). Given these study limitations, a *general* recommendation for or against bed sharing cannot be made.

Our review has shown, however, that the evidence suggests that there may be an association between bed sharing and SIDS among smokers (however smoking status is defined). Therefore, evidence supports a recommendation against the practice of bed sharing among smokers (however smoking status is defined), particularly in mothers (exposure to smoke before and/or after birth). Among non-smokers, such an association was not found. However, this does not mean that no relationship exists

between bed sharing and SIDS among non-smokers but simply that the limited existing evidence does not convincingly establish such a relationship. More research is required.

In addition, the evidence summarized in this review also suggests there is a beneficial effect on the practice of breastfeeding (both with respect to the rate of breastfeeding as well as its duration) among bed sharing mother-infant dyads. However, definitive conclusions cannot be drawn due to the relatively small number of observational studies and the heterogeneity between studies. As well, it is possible that these data reflect the propensity for women who are most likely to practice prolonged breast feeding to also prefer to bed share.

Recommendations for future studies

There has been no study in Canada on the prevalence of bed sharing in the general population of infants. As long as the prevalence of the practice of bed sharing is not known for a given population, the rate of deaths or injuries cannot determined because it is being related to an inappropriate denominator. In addition, there has been no Canadian study that specifically addresses the potential harms or benefits of bed sharing. Therefore, because of the absence of a high quality case-control study --in Canada or elsewhere-- designed *a priori* to test the hypothesis that bed sharing is a risk factor for sudden death, it would be next to impossible to gauge the impact of a strategy to reduce harms.

There is also a lack of data on infant mortality and injuries directly related to bed sharing in Canada, as well as for other countries. National statistics do not provide specific enough information, and better codification of these events might be needed. To that end, there has been an international protocol agreed upon in the field of sudden infant death for the purpose of the death scene investigation. This protocol should be adhered to by all provinces (and all countries as well). That being said, better codification alone, for bed sharing deaths, will not solve the problem entirely. It is also necessary to collect and examine data on the contribution of various risk factors to bed sharing deaths.

The issue of bed sharing and sudden death demands re-evaluation, in Canada and in those countries where national studies have already been undertaken to identify risk factors for sudden unexplained deaths in infants (SIDS or SUD). Indeed, most of the studies were undertaken in the early 1990s, more than a decade ago. The prevalence of bed sharing, particularly following some of the previously outlined national statements and recommendations, may have changed. It is also important that examinations include data pertaining to low socio-economic families because this group now represents the majority of SIDS victims. There may be a social, as well as physiological phenomenon, occurring. Without these data it is impossible to determine primary risk factors associated with harms. The exact sleep environment of those families, as well as other potential confounders remains unknown.

Table of Contents

Figures and Tables

Introduction

Co-sleeping, in the general sense, refers to sleeping with another person. Co-sleeping, in the context of a family, could refer to the practice of sharing a sleep surface (e.g., a bed, a couch, etc.) between adults and their young children, or to simply sharing the same room without sharing the same sleep surface. To avoid confusion, especially discussing possible harms or benefits of co-sleeping, many authors refer to *bed sharing* when parents and children share the same sleeping surface because this usually occurs in a bed. Authors refer to room sharing, without bed sharing, when co-sleeping does not occur on the same sleep surface. As such, throughout this document, we will use the term 'bed sharing' to refer to the practice of adults sleeping on the same surface as a child.

Bed sharing involving parents and young infants appears to be an increasingly common practice in our society, even though there are few robust data regarding its prevalence. This is despite the absence of any endorsement of the practice by national medical societies. On the other hand, certain ethnic populations have been observed to routinely bed share. Against this backdrop, there is a growing body of research literature on the possible benefits of bed sharing; as well as the purported association between bed sharing and sudden death in infants.

Bed sharing is a practice about which health care professionals are often asked to advise parents. From a policy maker or health care practitioners' perspective, this continues to be difficult. There is a need to clarify the harms and benefits of this practice, including strategies that could eliminate or reduce the harms for children, in order to develop appropriate guidance in this area. This systematic review was undertaken to

provide health professionals with the best empirical evidence for benefits and harms of bed sharing. To the best of our knowledge this is the first systematic review examining benefits and harms associated with the practice of bed sharing.

Context of bed sharing

Prevalence

Sleeping arrangements in different cultures are quite diverse with the expectation in some societies that infants and their mothers are one unit who naturally sleep together.[1-3] Often, this practice continues for months or years, with the baby or toddler only moving to another bed with the birth of a new baby.[4] Several narrative reviews on sleep practices have highlighted the non-industrialized countries' practice of routine bed sharing as opposed to the industrialized countries' practice of solitary sleep for infants.[3,5,6]

Bed sharing practices, past and present

Bed sharing prevalence in non-industrialized societies

Two major documents report the prevalence of bed sharing in over 200 societies/cultures within non-industrialized societies across five continents;[7,8] data are derived from meticulously collected ethnographic information over several centuries. Bed sharing as a routine practice is reported in 69% of the societies for which data are available in the publication of Barry and Paxton [7] and for 47% of the societies reported in the work of Nelson et al.[8] The prevalence of room sharing without bed sharing is reported in 100% of the societies.

Bed sharing prevalence in industrialized societies

Only scarce information is found concerning bed sharing with infants from the last part of the 20th century through to the 1990s. Hanks and Rebelsky (USA, Boston) in the 1970s[9] for instance, reported that 23% of mothers in their study had bed shared with their infant in the first year of life. In the early 1980s Elias et al.[10] (USA, Boston), reported a bed sharing prevalence of 38% at two months of age for breast fed infants. In contrast, within Japanese society, bed sharing seems to have been less frequent whereas room sharing (child sleeping in the room, not on a shared sleep surface) was the rule. Indeed, in the 1960s, Caudill and Plath[11] reported a prevalence of bed sharing with infants at only 10% but room sharing was 90% (data from cities of Tokyo, Kyoto, and Matsumoto). A very similar prevalence has recently been reported for 2001-2002 (city of Tokyo).[12]

Great interest in (re-) examining the prevalence of bed sharing started in the 1990s after a publication from New Zealand[13] linking bed sharing and sudden infant death syndrome (SIDS). Many publications on the prevalence of bed sharing are now available. We will concentrate on publications from the United States and the United Kingdom and New Zealand, because these are countries for which more than one study is available for comparison. The data are summarized in (Table 1)

Table 1- Prevalence of bed sharing in 2 to 4 month old infants

Author	Years	N	Routine Bed sharing	Bed sharing the night before the interview
US				
Caucasians				
Klonoff-Cohen [14]	1989-92	196	14.7%	
McCoy et al [15]	1995-1998	8006		Most of the night: 8%
Willinger et al.[16]	1993-2000	7278	Most of the time: 7.2% Any bed sharing: 40.4%	
African Americans				
Klonoff-Cohen [14]	1989-92	196	55%	
McCoy et al[15]	1995-1998	8006		Most of the night: 42%
Willinger et al.[16]	1993-2000	7278	Most of the time: 27.9% Any bed sharing: 76.2%	
Indigenous people				
Iyasu et al. [17]	1992-1996	66	55.4%	
UK				
Clements et al.[18]	1990-1991	488	Last two weeks: 44.3%	
Blair et al. [19]	1993-1996	1299	Most of the night: 5.9%	Part of the night: 24.1% All night: 4.2%
Hooker et al.[20]	1995-1996	40	42.5%	
Blair and Ball [21]	1998-2000	261	Occasionally: 7% Often: 15% All the time: 8%	Part of sleep: 4% All of sleep: 12%
New Zealand				
Caucasians				
Scragg et al. [13]	1987-1990	1592	Last 2 weeks: 44.5%	10.4%
Mitchell et al. [22]	1991-1993	922		Mother fell asleep with baby: 11.6%
Tuohy et al.[23]	1990-1991	2687		6.8%
Tuohy et al.[24]	1995-1996	1653		5.9%
Ford et al.[25]	1997	274		20.3%
Maoris				
Tuohy et al.[23]	1990-1991	511		21.1%
Tuohy et al.[24]	1995-1996	618		25.7%
Pacific Islanders				
Tuohy et al.[23]	1990-1991	242		42.2%
Tuohy et al.[24]	1995-1996	422		64.7%

* Year of data collection

** When no information is given, the authors stated they enquired about the routine or last sleeping arrangements but no additional details were provided.

In reviewing the studies on the prevalence of bed sharing, it becomes increasingly clear that definitions of 'bed sharing' are heterogeneous (dissimilar). It is important to keep this heterogeneity in mind when reviewing reports of bed sharing. Many recent studies have modeled data collection in a fashion similar to the seminal case-control studies investigating bed sharing as a risk factor for SIDS (infant victim found bed sharing). Therefore, the questions put to parents/caregivers that relate to bed sharing have been concerned primarily with data pertaining to the night before the interview. Few studies have investigated both the routine practice of bed sharing and bed sharing the night before the interview. Some investigators propose a range for the routine prevalence in their questionnaires (e.g., routinely, half the time, less than half the time etc.) and others do not. As for the prevalence on a specific night of bed sharing, some add quantifiers (e.g. any time, more than 2 hours, more than 5 hours etc.) while others, again, do not. This makes combining of data difficult because they are often not homogenous in their reporting, and thus difficult to combine conceptually.

Despite limitations in the available studies, some general comments can be made. First, within the same population (ethnic group), the variation in the prevalence of bed sharing seems to relate to the definition of bed sharing more than to true variations in prevalence. Overall, for the Caucasian population of the United States, United Kingdom and New Zealand, it would appear that 40% of the infant's bed share 'at some point during the night' on a routine basis. Second, when the practice of the Caucasian population of a country is compared to that of other ethnic groups (e.g. African Americans in the United States, or Indigenous people in New Zealand), bed sharing is less common in the Caucasian population.

It should be noted that currently, there is no published data available to describe the prevalence of bed sharing in Canada.

Possible Harms Associated With Bed sharing

The practice of bed sharing has been investigated to determine its possible association with the sudden deaths of infants. Death, within this context, can occur in different situations which can be classified as follows:

1) Unintentional death while bed sharing in an adult bed
2) Unintentional death in other bed sharing environments (e.g., sofa, makeshift beds, etc.)
3) Unexplained death in bed sharing situations

Unintentional death while bed sharing in adult beds

Unintentional death(s) by injury while bed sharing in an adult bed, are by asphyxia, which can occur in two distinct manners. Firstly, infants can be found entrapped between elements (e.g., the mattress and the wall) of the bed or between the mattress and other adjacent pieces of furniture. These deaths are unrelated to the practice of bed sharing *per se* and usually result from the fact that adults' beds are not constructed with infant safety in mind[1]. Secondly, infants can be found underneath a sleeping adult with their airway, their thorax, or their whole body compressed.

[1] In Canada, as in many other countries, infant bed and crib safety was regulated by federal standards: Cribs and Cradles Regulations. Ottawa: Health Canada 2004. canadagazette.gc.ca/partI/20040501/html/regle2-e.html[26,27]

Unintentional death in other bed sharing environments

Unintentional death by asphyxia can also occur when parents bed share on makeshift beds (e.g., sofa, mattress on the floor against a wall, cushions and pillows on the floor). Recent studies have reported that babies have been found trapped in various ways in these makeshift beds.[28-30] The usual characteristic of these sleeping environments is the restricted space available for the infant.

Unexplained deaths in bed sharing situations

Sudden infant death syndrome

Since ancient times, sudden infant deaths have been attributed to overlying during bed sharing.[31-33] In these cases, the cause of death was not investigated and these infants may have died of a variety of diseases including infection, congenital heart disease or inherited diseases of metabolism, to mention only a few[34] It is believed that the use of separate beds for infants might have evolved, over centuries, from the fear of overlying.[8]

Starting in the 1960s, with an increased frequency of investigations and autopsies, it was realized that a large proportion of infant deaths were sudden, unexpected, and unexplained after autopsy.[35,36] The name S*udden Infant Death Syndrome* (SIDS) was agreed upon for this condition with unknown cause.[36] These deaths generally occurred in the infants' cribs. A precise definition for SIDS evolved focusing on the requirement for an investigation to confirm the diagnosis. Sudden infant death syndrome was thus defined as: "The sudden death of an infant under one year of age which remains unexplained after a thorough case investigation, including the

performance of a complete autopsy, examination of the death scene, and review of the clinical history."[37]

SIDS has yet to be explained; it is a condition that continues to elude scientists because, despite intensive research since the 1960s, no single explanation has been found despite the testing of various hypotheses. The designs of studies (mostly case control and prospective cohort) investigating risk factors are limited in their ability to confirm or refute causality, and since there are no criteria by which SIDS can be identified with certainty, SIDS is still a diagnostic of exclusion and risk factors are numerous.

Bed sharing and SIDS

In the mid-1980s, certain child care practices began to be systematically scrutinized in relation to SIDS. This led to the identification of the prone sleeping position (a child sleeping on his/her stomach) as one of the major risk factors for the condition.[38] Following national campaigns to encourage parents to position their infants on their back to sleep, there was a remarkable decrease in the number of SIDS deaths in many countries including Canada.[34] In some case control studies that led to the identification of sleeping on the stomach as a risk factor for SIDS, data were available on bed sharing and bed sharing started to be studied as a potential risk factor for SIDS

Identification of the cause of bed sharing infant deaths

It could seem obvious that if a death is caused by asphyxia resulting from compression by the body of a parent sharing a sleep surface with an infant, the diagnosis would be confirmed by the post–mortem examination. That is however, not

the case. The examination of internal structures and organs will not reveal that the cause of death was asphyxia or compression of the airways.[39,40] Therefore, in the absence of external marks of compression to the infants body or in absence of an observer to witness that an infant was trapped underneath an adult with obstruction of the airway or thoracic compression, the diagnosis retained after the investigation is very much dependant on the investigator (coroner, medical examiner, or pathologist). Some investigators will attribute the unexplained death of an infant, in the context of bed sharing, to asphyxia/suffocation even in the absence of any external sign of compression or of a witness; it seems to be the belief that bed sharing between an adult and a young baby is unsafe that guides their decision. Others, faced with the exact same circumstances, will attribute the death to sudden infant death syndrome because the circumstances fit the definition (no cause of death is found at the autopsy). Still others will use the diagnosis of sudden unexplained death (SUD) or that of sudden unexplained death in infancy (SUDI) as an alternative to SIDS; they feel that SIDS should be used only when there is no existing doubt that anything might have contributed to the death.

This situation renders the diagnosis of SIDS, in the context of bed sharing, open to subjective criteria resulting in variations in incidence of diagnosis which exist depending on the beliefs and experience of different coroners, medical examiners, and other investigators.[41] This variation decreases our confidence in the rates and event data previously published.[42] There is evidence of an increased number of deaths attributed to SUD or SUDI in recent years in many jurisdictions, including Canada,

whereas the total number of deaths in the post-neonatal age range did not increase and the SIDS rate decreased.[43-45]

Infant Mortality and Injury Statistics

Introduction

One of the primary questions of this report was to answer:

> How many child-related deaths and injuries have been directly linked with the practice of bed sharing in Canada and other comparable jurisdictions?

Through an iterative process with our clinical experts and Toronto Public Health a decision was made to examine mortality and injury statistics both preliminarily through national statistics, coroner's offices, and targeted web-based searching as well as part of a systematic review of published literature. This decision was made because it was thought that much of this data would not be located through traditional electronic searches of literature. Our objective was to determine what sources are available to answer the above mentioned question. Thus, we begin this report with the methodology and results of published national data sets, targeted web-based searches, and contacts of the Provincial coroner's offices.

Methods

Classification of causes of death or injury

We obtained a copy of the 10th revision of the International Classification of Disease (ICD) from the World Health Organisation web site: http://www3.who.int/icd/vol1htm2003/fr-icd.htm

We reviewed all of the diagnostic categories of the 10th revision to identify the ICD codes that might correspond to bed sharing deaths. Those listed in Table 2, are the closest to the possible manner of death or injury described previously as “potential harms associated with bed sharing” section of the introduction’.

Table 2 - Other accidental threats to breathing (ICD 10: W75-W84)

	Description
W75	**Accidental suffocation and strangulation in bed** **Includes:** suffocation and strangulation due to: bed linen mother's body pillow
W78	**Inhalation of gastric contents**[2] **Includes:** asphyxia by, choked on, and suffocation by vomitus [regurgitated food]aspiration and inhalation of vomitus (into respiratory tract) not otherwise specified (NOS)
W83	**Other specified threats to breathing**
W84	**Unspecified threat to breathing** **Includes:** asphyxiation NOS aspiration NOS suffocation NOS

To be able to extract precise data on bed sharing injury or fatalities from national or provincial databases, the ICD codes have to describe appropriately the situation of bed sharing deaths or injuries. A review of the codes listed in Table 2 revealed that none of them are sufficiently specific to allow us, without a review of each individual case of death, to determine with precision the number of injuries or deaths of children in bed sharing situations. The closest ICD code is W75 which corresponds with "accidental suffocation in bed". The code includes suffocation of the child by mother's body, which implies the same sleeping surface, but also suffocation by pillow or linen,

[2] One of the authors of this report (AC) has noted in the conduct of a past research studies that investigators (mostly coroners) use that classification (inhalation of gastric content) for some cases of unexplained sudden infant deaths when the body is discovered with vomitus, on any type of sleeping surface[19,46-48]

which does not necessarily, confirm bed sharing. It would be impossible to separate these cases for analysis, without a thorough review of each case.

It is therefore evident that the search through databases of provincial, territorial or national statistics will not yield specific data on bed sharing deaths. We nevertheless felt that the information retrieved under the code W75 would be useful, especially if the numbers of deaths are low indicating a low incidence (even if the numbers are an overestimation because they include deaths in cribs).

National database searching

Our next approach for determining what information is available regarding mortality statistics related to bed sharing in infants was to actually search national statistics websites. We examined the statistics using Statistics Canada's socio-economic database (Canadian Socio-economic Information Management: CANSIM http://cansim2.statcan.ca/). Data from 2000 to 2002 were available through this route.

Coroners' office survey

We also attempted to obtain data from provincial coroners' and medical examiners' offices. The only way to obtain exact data on bed sharing deaths would be comprised of many steps. The database of each provincial coroner or medical examiner office would have to be reviewed. If the location of death was registered, all cases of infants that died in an adult bed could be extracted for review of individual dossiers to determine whether there was an adult bed sharing with the infant. If there is no entry for the location of death with specification for bed sharing, each individual dossier for all infant deaths would have to be reviewed for collection of information as to the location

of death and the description of the event leading to death. Only then would bed sharing deaths be known. The next step will be to review if the cause of death is related to bed sharing.

It was not our task to actually extract data from coroner's databases. To obtain information concerning the databases of coroners and medical examiners, we contacted the relevant offices in each province and territory. A questionnaire was developed that would be administered during each telephone contact (or mailed/fax) to maintain consistency of reporting. (Appendix 1)

Additionally, one of the authors of this report has already done a study (unpublished yet) determining precisely the number of bed sharing deaths in the province of Quebec based on information available at the provincial Coroner's Office. Because this data was available to use directly, we did not contact the Quebec coroner's office for the purpose of our survey.

Organization and web-based searching

Anticipating that there would be little published information on injuries and mortality statistics attributable to bed sharing through traditional literature searching, we attempted to locate these data through non-traditional searching methods of web-based database searches and manually through established organizations, contacts nominated by reviewers, and websites directly linked to the practice of bed sharing/bed sharing.

Health Canada, Statistics Canada, their respective libraries, and the Canadian Institute for Health Information (CIHI), were the primary contacts to establish whether infant mortality statistics, related to the practice of bed sharing were available. These

sources were able to provide further contact information for other organizations and sources they believed may record these statistics, or lead to further information. The sources provided included: the Canadian Perinatal Surveillance System, Canada Health Portal, the Canada Publications Website, the Public Health Agency of Canada, the Canadian Paediatric Society (CPS), the National Center for Health Statistics, the Ontario Chief Coroner's Office, The Canadian Foundation for the Study of Infant Deaths, and the Canadian Hospital Injury Reporting and Prevention Program (CHIRPP).

Our protocol consisted of searching organizations' websites (if available) for applicable terms such as "co-sleeping", "bed sharing", and "infant mortality". Publication lists from each organization were also thoroughly searched for reports relevant to co-sleeping/bed sharing, or infant mortality. Additionally, all organizations were contacted by email and asked specifically if they recorded, had published, or knew of sources for locating mortality statistics for co-sleeping/bed sharing.

To further confirm that this information was not available, additional organizations and websites were consulted that were linked to the websites mentioned above, or that were referenced in the co-sleeping/bed sharing literature. These included the American SIDS Institute, the American Academy of Pediatrics: Dedicated to the Health of all Children, The Foundation for the Study of Infant Deaths (FSID), SIDS and Kids Online, the American Association of SIDS Prevention Physicians, First Candle: Helping Babies Survive and Thrive, SIDS Network, the National SIDS / Infant Death Resource Center, the National SIDS & Infant Death Program Support Center, The National Center for Cultural Competence, and the National SIDS & Infant Death Project Impact.(Appendix 2)

Results

Canadian Infant Mortality and Injury Data

Injury Statistics

The process of collecting injury statistics related to the practice of bed sharing revealed that data was not readily available. For the purpose of this report it was not feasible to collect the data from the most likely source –reporting from each Canadian hospital with a pediatric emergency service. In an attempt to discern answers to this important question, we did however examine The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP, at http://www.phac-aspc.gc.ca/injury-bles/chirpp/index.html) which collects emergency department data on pediatric injuries in major Canadian Hospitals (16 pediatric and general hospitals). The number of reported injuries does not cover all of Canada but those presenting at emergency departments of the major pediatric hospitals. It is one source of information to determine the prevalence of injuries in the categories to which bed sharing injuries could be attributed. Table 3 provides the data for 1998 and 1999 in the category "suffocation or other threats to breathing (corresponding to the ICD code W75 to W84) in the age range of less than one year and 1 to 4 years of age. Unfortunately, the data was not broken down to allow us to determine the number of injuries solely for the ICD code W75.

Table 3 - Suffocation or Other Threats to Breathing in Children 0-4 Years, CHIRPP, 1998-1999 (ICD10 W75 to W84)

Event	< 1 year		1 to 4 years	
	1998	1999	1998	1999
Suffocation and other threats to breathing (ICD 10 W75 to W84)	16	2	33	6

Source: The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP), at http://www.phac-aspc.gc.ca/injury-bles/chirpp/index.html
Numbers in each cell represent the total number of injuries reported for the year.

Similarly, Health Canada published a comprehensive report on injuries in 2003 entitled *For the Safety of Canadian Children and Youth*[49] available at: http://www.phac-aspc.gc.ca/publicat/fsccy-psjc/. We extracted from chapter 10 data on hospitalizations for mechanical suffocation by age and summarized these in Table 4 (1990-1992, ICD 9 classification corresponding to the ICD 10 code W75).

Table 4 - Hospitalization for Mechanical Suffocation in Children 0-4 Years in Canada, 1990-1992 (E913.0 Equivalent to W75 in ICD10)

	< 1 year		1 to 4 years	
Event	N	Rate	N	Rate
Hospitalization for mechanical suffocation: In bed or cradle (E913.0, equivalent to W75 in ICD 10)	6	1.4	1	-

Source: Health Canada, *For The Safety of Canadian Children and Youth at:* http://www.phac-aspc.gc.ca/publicat/fsccy-psjc/
N = Mean total number of injuries reported per year
Rate = Rate per 100,000

This is the only information we were able to find relating to injuries and it dates back a few years. It does highlight, however, that injuries related to suffocation in beds (including adult beds and cribs) are not common. Clearly, these numbers do not reveal the exact number of injuries related to bed sharing, but rather serves to estimate the highest possible prevalence, if we assume that all the injuries occurred in bed sharing situation (e.g., none in cribs).

Mortality Statistics

We are presenting mortality statistics for two types of deaths. First, we obtained Canadian infant mortality statistics for deaths classified as accidental deaths in beds under the ICD code W75 (accidental suffocation and strangulation in bed). Second, we obtained data on unexplained deaths and, when possible, the proportion of those deaths that were bed sharing deaths (without any indication that bed sharing was the cause of death).

Unintentional deaths

Through CANSIM, we extracted national data concerning ICD code W75 as this is the ICD code that most closely corresponds to deaths in a bed sharing environment: We also extracted mortality data related suffocation by age from Chapter 10 of a Health Canada report entitled *For the Safety of Canadian Children*[44] available at http://www.phac-aspc.gc.ca/publicat/fsccy-psjc/ Table 5 summarizes data for all deaths of infants between 0-1 year of age concerned with ICD 10 code W75. It should be stressed again that data for the number of deaths, represent all bed sharing and non-

bed sharing deaths on adult beds, as well as deaths in cribs. Because of this, these numbers are an overestimation of the total number of bed sharing deaths.

Table 5 - Mortality for Accidental Suffocation and Strangulation in Bed for Children 0-1 Year in Canada, 1990-1992, 1997, 2000-2002, Canada (ICD 9: E913 or ICD 10: W75)

	1990-1992	1997	2000	2001	2002
Suffocation and strangulation in bed ICD 9:E913.0 ICD 10: W75	3	5	6	8	11

Data source: 1990-1992 and 1997: Source: Health Canada, *For The Safety of Canadian Children and Youth at:* http://www.phac-aspc.gc.ca/publicat/fsccy-psjc/ "2000 to 2002", CANSIM
Data expressed as number of deaths per year

Table 5 reveals that for the years that data is available, the numbers of deaths are very small. However, it should be noted that the numbers have increased from an average of 3 per year in the period 1990 to 1992, to 11 per year in 2002. The reason for this increase is unknown.

We thought it important to seek similar data in other countries. Recently published data on deaths from suffocation and strangulation in bed for children 0-1 year of age from the United States is presented in Table 6. As for Canada, the numbers increased in the most recent years.

Table 6 - Mortality for Suffocation and Strangulation in Bed for Children 0-1 Year in the United States, 1992-2001

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Suffocation in bed ICD 9:E913.0 ICD 10: W75	2.7 (110)	3.5 (138)	3.7 (145)	3.5 (137)	3.4 (132)	3.8 (149)	4.2 (165)	5.4 (214)	5.6 (227)	8.2 (329)

Source: Malloy et al, 2005; see reference[50].

The numbers represent the rate per 100,000 live births. The numbers in parentheses are the actual number of deaths each year.

In all of the mortality data presented above, there has been no distinction between deaths that occur in different types of beds (adult beds vs. cribs, for instance). Mortality data by type of bed is available from two sources. First, there have been two publications based on the data collected by the Consumer Product Safety Commission (CPSC) in the United States. Second, there is unpublished data from a review of Coroner's office records on infant deaths in Quebec.

Data from the Consumer Product Safety Commission

Data collected by the CPSC provides information on deaths in adult beds and in cribs. Deaths in adult beds have been separated further into deaths by entrapment and deaths by overlying (therefore in a bed sharing situation). The findings from two publications that report on this data are summarized here. The study by Nakamura et al., [115] reported 515 deaths from which 296 (57.5%) were due to entrapment or wedging and 121 (23.5%) were due to overlying. Of the deaths due to entrapment or wedging, 125 were due to wedging of the infant between the mattress and the wall adjoining the bed; 128 were due to wedging of the infant between the mattress and the headboard or footboard of the bed; 23 were due to strangulation when the infant's neck became trapped between the railings of the headboard or footboard; and 20 were due to entrapment between the mattress and a piece of furniture adjacent to the bed. Deaths in cribs were not reported, however, in that publication. Scheers et al [51] reported more precise which included deaths in cribs. In their review of deaths by suffocation for infants up to 11 months of age (n = 608), 46.5% of the deaths (283) were attributed to

entrapment or wedging and 17% of the deaths (103) were attributed to overlying and were therefore bed sharing deaths.

Data from Quebec

An unpublished study from Quebec reviewed all infants' deaths investigated by the coroner over a 10-year period and separated the deaths occurring in adult beds, cribs, and other locations. Table 7 presents data on, the number of bed sharing deaths on an adult bed, the number of solitary sleep deaths on an adult bed, and the number of deaths in cribs.

Table 7 - Unintentional Deaths, in Adult Beds and Cribs for Children 0-1 Year, in the Province of Québec, 1991-2000

Year(s)	Total	Bed sharing	Solitary sleep, adult bed	Crib
1991	1		1	0
1992	0	0	0	0
1993	2	0	1	1
1994	0	0	0	0
1995	2	0	1	1
1996	1	1	0	0
1997	2	1	0	1
1998	2	0	1	1
1999	0	0	0	0
2000	2	1	0	1
Total over 10 years	**12**	**3**	**4**	**5**

Source: Data extracted from the Quebec Coroner's Office (AC), unpublished yet.

The data from Quebec highlights that 1 out of 4 deaths from accidental suffocation and strangulation in bed occur in a bed sharing situation. Although the two previous publications from the USA do not report exactly the total number of bed

sharing situations (some entrapment might have occurred during bed sharing with no overlying), the reported percentage of deaths while bed sharing is in a similar range as for data of the province of Quebec. It does highlight that in the classification of suffocation in bed, approximately one out of four deaths occurred while bed sharing.

Unexplained deaths in bed sharing situation

Information on bed sharing infant deaths in Ontario is reported in the First Report of the Paediatric Death Committee (published in June 2004 by the Office of the Chief Coroner, in the Province of Ontario) and available at http://www.oacas.org/whatsnew/announcements/pediatriacdeathreview_04_june15.pdf. Data from this report are presented in Table 8. The report does not take into account whether bed sharing was instrumental in the manner of death. Similar data was extracted from the database and from a thorough chart review at the Coroner's Office in the province of Quebec and the results are presented in Table 9. For both provinces, the data from all unexplained infant deaths, whether these deaths had been classified as SIDS, or simply sudden unexplained death in infancy (SUDS) are grouped. Both tables refer to infants aged less than one year.

Table 8 - Sudden Unexpected Deaths with Bed sharing as a Factor for Children [52]

Cause of death	1995	1996	1997	1998	1999	2003
Sudden unexpected deaths with bed sharing as a factor	61	43	35	26	20	15
Total SIDS/SUDS	88	68	63	52	51	43

Cause of death	1995	1996	1997	1998	1999	2003
% bed sharing deaths as a factor	69.3	63.2	55.6	50.0	39.2	34.9

Source: http://www.oacas.org/whatsnew/announcements/pediatriacdeathreview_04_june15.pdf.

Table 9 - Quebec data obtained from review of the provincial Coroner Office data files

Cause of death	1995	1996	1997	1998	1999	2000
Sudden unexpected deaths with bed sharing as a factor	6	5	8	7	6	4
Total SUDS	41	32	29	26	36	27
% bed sharing deaths	14.6	15.6	27.6	26.9	16.7	14.8

Source: Database and from a thorough chart review at the Coroner's Office in the province of Quebec.

The comparison of data for both provinces reveals a major difference. There is a much higher proportion of bed sharing deaths in Ontario than in Quebec. Before 1999, the percentage of bed sharing deaths in Ontario was 50% or higher whereas in Quebec it ranged between 15%-28%. We cannot find an explanation for this difference. It is not known whether the prevalence of bed sharing in the general population is higher in Ontario than in Quebec because this data is not available. Examination of similar available data from other countries reveals numbers much closer to the Quebec data: Germany: 15.3% [27]; Ireland: 31% [47]; Norway 34% [53]; UK: 25.5% [19]; and combined European data: 19% [54]

Additional information on the Quebec data

The collected data in the province of Quebec span the period between January 1991 to December 2000. The total number of deaths, from all causes, in infants aged between 7 days and 365 days was N=1968. Of those, 555 were sudden unexpected deaths that were investigated by a coroner. For 88 of the 555 cases, a natural cause of death (a disease) was eventually identified; the remaining were either unexplained after the investigation (432 cases-of which 49 occurred during bed sharing) or they were unintentional deaths or due child abuse (35 cases). Of the unintentional deaths, 12 were asphyxial deaths in adult beds or cribs and 2 were in other sleeping devices (play pens). The data on the 12 unintentional deaths were presented in the previous section and compared to the Canadian and US data (see Table 7).

Unintentional deaths by asphyxia during bed sharing

The total number of cases classified as suffocation in bed (adult beds, other beds and cribs) which would correspond to ICD 10 code W75 is therefore 12 during the 10 year period. It is important to note again that, of these 12 unintentional deaths, only 3 deaths (one out of four) were bed sharing deaths.

The three cases of asphyxial death in a bed sharing situation were described as:

1. Infant found in a hide-a-bed, face down in a depression of the mattress
2. Infant bed sharing with father on sofa, found with the leg of the father on the thorax (infant aged 64 days).
3. Infant bed sharing with father on sofa, found underneath the father, very small infant aged 33 days but born at 32 weeks of gestation.

Unexplained deaths in a bed sharing situation

Of the 432 unexplained deaths, 49 (11.3%) occurred during bed sharing. The details of the sleeping surface for those deaths in bed sharing situations are given in Table 10. A number of case-control studies have identified specific aspects of bed sharing environments that carry an increased risk for sudden unexpected death. These include: lack of experience with the stomach (prone) sleeping position, sofa sharing, alcohol consumption, and use of pillows. We are therefore presenting, in Table 11, data pertaining to these aspects of bed sharing environment.

Table 10 - Details of Unexplained Deaths in Bed Sharing Situations for Children 0-1 Year, in Quebec, 1991-2000

Type of sleep surface	N	Recognized unsafe bed sharing environment
Regular adult bed	39	Alcohol consumption: 4 cases 1st time sleeping prone: 2 cases
Sofa	6	Alcohol consumption: 3 cases 1st time sleeping prone: 1 case Only sofa sharing: 2 cases
Makeshift bed	2	1st time sleeping prone: 1 case Use of pillows: 1 case
Waterbed	1	Sleeping prone: 1 case
On mother's chest	1	
Total	**49**	**15**

Source: Research data extracted from the provincial Coroner's Office (AC), unpublished yet.

Summary

Two types of bed sharing deaths were examined in this section of the results:

1 *Data on unintentional (accidental) suffocation*.

This data was extracted from national databases and from an unpublished study in Quebec and was compared to USA data. We found a very low incidence of unintentional deaths from suffocation in bed. The Canadian data extracted from databases did not separate infant deaths while bed sharing from infant deaths during solitary sleep on an adult bed or in a crib. The Quebec data did separate infant deaths by sleep location and found that bed sharing deaths represented 25% of the total number of unintentional deaths by asphyxia in beds. Similar information was available from the CPSC in the United States with a similar proportion of unintentional deaths by asphyxia while bed sharing.

2 Data on unexplained bed sharing deaths but for which it was not possible to determine whether bed sharing was instrumental in the manner of death.

We reported data from the provinces of Ontario and Quebec. The number of deaths and the proportion of bed sharing deaths were quite different between the two provinces. Comparison with other countries was made as well. Of all sudden unexpected deaths in which bed sharing was a factor, a proportion that varies between 15% (Quebec) and 60% (Ontario) was found in the past 10 years. The significance of these numbers is uncertain, as no reports exist on the prevalence of bed sharing in those two provinces.

Coroner's office questionnaire

The results for the contact with the coroner's office survey include responses from all provinces except for Quebec (Tables 12 and 13). As stated previously, one of the primary authors (AC) had access to all Quebec data, and reports the data previously. We made an attempt to contact all other provincial coroner's offices. We were able to contact all of the offices except for Nunavut, all other offices responded in some way (either by phone, fax, email, or ground mail). The survey primarily focused on two broad concepts 1) key database information and it's availability, and 2) methodology for reporting/recording co-sleeping-related mortality in children (<2 years). These two concepts were chosen because we wanted to maintain brevity with the questionnaire and also capture the most pertinent information to help clarify the 'state' of recording and availability of this information nationally. The results of the survey are summarized in the tables below (Table 11 and 12).

Table 11 - Provincial Coroners Office Survey: Database Information (June 2005)

Province	Database Exists	Data could be extracted	Code: Cause of Death	Code: Location of Death	Code: Co-sleeping Bed Sharing	Data Available/ Accessible	Comments
Alberta	Yes	Yes	Yes (text coding)	Yes (text coding)	Yes (use SIDS check list)	Yes	Do not use ICD coding system. Use in-house coding – descriptive text words.
British Columbia	Yes	Yes	Yes	Yes	Yes (also prone positioning)	Yes (via Research Policy Manger)	Currently developing a coding system to be more accurate.[3]
Manitoba	Yes	Yes (1999 & later)	Yes (SIDS/SUDS)	No (summary box may contain this information)	No (not as an official code: sometimes as cause of death)	Yes (data has not been entered electronically at this time)	Do not use ICD coding system.
New Brunswick	Yes	No	Yes (SIDS/SUDS)	No	No	Yes Annual report	Internal numeric coding system assigned
Newfoundland and Labrador	Yes	Yes	No	No	No	Yes	Do not use ICD coding system.
Northwest Territories	Yes	Yes	Yes	Yes	Yes (especially for SIDS)	Yes (could be extracted upon request)	Do not use ICD coding system

[3] More information available at: http://pssg.gov.bc.ca/coroners/service/index.htm Where is this from?

Table 11 - Provincial Coroners Office Survey: Database Information (June 2005)

Province	Database Exists	Data could be extracted	Code: Cause of Death	Code: Location of Death	Code: Co-sleeping Bed Sharing	Data Available/ Accessible	Comments
Nova Scotia	Yes (text coding system)	Yes	No	No	No	No	Do not use ICD coding system. Manually logged descriptions of each case from physician report
Nunavut	Yes	Yes	No	No	No	Yes/No (dependant on the information requested)	Although information is not coded, it can usually be found in the narrative portion of the case report
Ontario	Yes	Yes	Yes (text coding system)	- (more broadly i.e. home/school)	Yes (involvement code)	Yes (upon agreements through the office & the ethic boards)	Do not use ICD coding system. Use descriptive text and lay terms instead of official coding system. The office also has a trauma registry.
Prince Edward Island	No	No	No	No	No	No	No system of record keeping available. In SIDS cases, the Coroners office and Attorney General would maintain a record.
Quebec[4]	-	-	-	-	-	-	-
Saskatchewan	Yes	Yes	Yes	No (free text field)	No (asphyxiation, etc)	No	Internal coding system utilized.

[4] This information was provided directly from one of the primary authors of this evidence report (AC). Quebec was therefore not contact directly.
- indicates these responses were not provided or not estimable from responses

Table 11 - Provincial Coroners Office Survey: Database Information (June 2005)

Province	Database Exists	Data could be extracted	Code: Cause of Death	Code: Location of Death	Code: Co-sleeping Bed Sharing	Data Available/ Accessible	Comments
Yukon	No	No	No	No	No	No	Do not use ICD coding system. Only record statistics, and these are limited to a particular duration (not officially recorded)

Table 12 - Provincial Coroners Office survey: Reports on Infant (< 2 years) Mortality

Province	Produced Report	Published Report in the last 5 years	Records Information for:			Report Accessible	Comment(s)
			Infant Death	Location of Death	Co- sleeping, Bed sharing At death		
Alberta	No	NA	NA	NA	NA	NA	SIDS data available on website. Pediatric death review report (2001). This information in going to be updated)
British Columbia	Yes	Yes	Yes	Yes	Yes	Yes	Annual report on child death review (BC Coroners Services)*
Manitoba	No	NA	NA	NA	NA	NA	See annual report for college of physicians and surgeons: Pediatric death review committee, annual report, 1998.
New Brunswick	No	NA	NA	NA	NA	NA	See annual report for college of physicians and surgeons: Pediatric death review committee, annual report, 1998.
Newfoundland and Labrador	No	NA	NA	NA	NA	NA	No response provided

Table 12 (continued…) - Provincial Coroners Office survey: Reports on Infant (< 2 years) Mortality

Province	Produced Report	Published Report in the last 5 years	Records Information for:			Report Accessible	Comment(s)
			Infant Death	Location of Death	Co- sleeping, Bed sharing At death		
Northwest Territories	No	NA	NA	NA	NA	NA	Unable to extract useful information from the survey. A National coroner's database is being developed to record all related information).
Nova Scotia	No	NA	NA	NA	NA	NA	Do not record infant mortality statistics. Uncertain who would have those in the province.
Nunavut	No	NA	NA	NA	NA	NA	Nunavut does not have an electronic database to extract data. Searching files for information is common.
Ontario	Yes	Yes	Yes	Yes	Yes	Yes	1st report of the pediatric death committee, June 2004, Office of the Chief Coroner, Ontario
Prince Edward Island	No	NA	NA	NA	NA	NA	No response provided

Table 12 (continued…) - Provincial Coroners Office survey: Reports on Infant (< 2 years) Mortality

Province	Produced Report	Published Report in the last 5 years	Records Information for:			Report Accessible	Comment(s)
			Infant Death	Location of Death	Co- sleeping, Bed sharing At death		
Quebec[5]	-	-	-	-	-	-	-
Saskatchewan	No	NA	NA	NA	NA	NA	Reports available on Children's Advocates Issues/annual report discusses issues of co-sleeping)
Yukon	No	NA	NA	NA	NA	NA	No report made

[5] This information was provided directly from one of the primary authors of this evidence report (AC). Quebec was therefore not contacted directly.
- indicates these responses were not provided or not estimable from responses

Of 12 coroner's offices, we received responses from all 12. (Table 11) An important finding of our survey was that no coroner's offices used an ICD coding system to track data obtained by their offices. Most offices maintain a database (e.g. excel spreadsheet, book, etc.) of data. Three offices (Alberta, New Brunswick, and Saskatchewan) did use an internal coding system to track data, however, most used only text-based descriptive synthesis to summarize and collect event data. Only four (Alberta, British Columbia, Northwest Territories, and Ontario) were able to discern bed sharing events from data collected and described the data as both 'available' or 'extractable'.

Only 2 of 12 coroner's offices (Ontario, British Columbia) produced reports of data collected by their offices and have published these within the last 5 years. Both offices collect pertinent data related to the practice of bed sharing which includes infant death, location of death, and discriminate bed sharing. (Table 12)

The method of collecting and collating data, along with what is collected and how it is prepared are heterogeneous among Coroners' offices. Few offices use a formalized database for maintaining data and no offices reported using ICD coding systems. In Canada, assigning causes of death is the responsibility of the local medical examiner. This report is often the basis of reporting for coroners' offices. The provincial/territorial vital registrar's offices collect, codes, and submit this information to Statistics Canada. Standardization of data collection techniques, and the type of data collected would make determination of co-sleeping related deaths in infants more accurate.

Systematic Review

Following an organized and targeted search for information relating to infant mortality and injury statistics, we conducted a formalized systematic review of published literature.

Research Questions

The primary research questions for this evidence report were related specifically to the outcomes associated with bed sharing. These questions were formulated through an iterative process with the Chalmers Research Group and Toronto Public Health (TPH).

Primary research questions:

1. How many child-related deaths and injuries have been directly linked with the practice of bed sharing in Canada and other comparable jurisdictions?
2. What are the child-related harms and benefits associated with bed sharing?
3. What factors related to bed sharing are associated with child-related outcomes (i.e. harms, benefits)?
4. What strategies have been shown to reduce child-related harms associated with bed sharing?

For the purpose of this systematic review 'benefits' were isolated to three primary priorities, identified by TPH, as priority areas of research and were outline as 1. Breastfeeding 2. Child-specific sleep patterns, and 3. Infant-parent bonding,

Objectives

The primary objectives of this systematic review were:

5. To determine how many child-related deaths and injuries are associated with bed sharing in Canada and other comparable jurisdictions.
6. To determine what child-related harms and benefits are associated with bed sharing
7. To determine what factors related to bed sharing are associated with child-related outcomes (i.e. harms, benefits)
8. To determine what strategies are effective for reducing child-related harms associated with bed sharing

Methodology

Study identification

The electronic search strategy to identify material was designed for high recall of published material related to bed sharing. Index terms tailored to the chosen databases were supplemented by natural language variants used to describe bed sharing. Co-bedding was evaluated as a free-text term, but appeared specific to twins and multiple births, not adults and children sharing a sleeping surface, and thus, was not included in the search strategy.

The search was broadened slightly to include studies pertaining to sudden infant death (SID) and breastfeeding, with the suggestion of adult behavior or sleeping surface being discussed, without specific mention of bed sharing. To maintain a manageable search result, only the subject headings for SIDS and breastfeeding were used.

No limits on study design were introduced, though some restrictions on publication type were introduced to remove discussion pieces. These were few in number and modeled after restrictions used in a filter developed by Shojania and Bero.[55] Year of publication was limited to 1993 or more recent.

Preliminary testing was undertaken in Medline using MeSH headings to assess the ability of the search strategy to retrieve bed sharing material relevant to some of the anticipated benefits. Results demonstrate that this strategy is capable of capturing publications relating to bed sharing and breastfeeding (n=55) and bed sharing and sleep disorders or sleep deprivation (n=26) or circadian rhythm (n=6). Coverage of bed sharing and attachment was similarly demonstrated (n=10). For testing purposes the MeSH heading OBJECT ATTACHMENT/ was used to represent the concept of attachment. The scope of this MeSH heading is "Emotional attachment to someone or something in the environment." This term is used to index publications relating to the following: bonding (psychology); emotional bonds; object relations; symbiotic relations (psychology); bonding; object relationship; psychological bonding.

Toronto Public Health reviewed the preliminary search and proposed additional terms to describe adult behaviour. The search was then finalized and further modified to accommodate other electronic databases. (Appendix 3)

Search validation

In order to validate our search strategy we took the 62 articles identified through hand searching (Archives of Pediatrics and Adolescent Medicine, Pediatrics), or nominated by Toronto Public Health that were indexed in Medline, and tested how many were retrieved by our search strategy. Our search retrieved 52 of 62 reviewer

nominated items and reasons for retrieval failure were then analyzed. Of the 10 retrieval failures, 5 were not retrieved because they were outside the year range (i.e. pre-1993). In 4 of the 5 remaining misses, the title, abstract and indexing information gave no indication that bed sharing was discussed. The fifth record appeared relevant and we tested various strategies to retrieve it, resulting in the addition of one search statement to the electronic strategy (line 4 in the search strategy).

Of the remaining 4 misses, two were excluded after screening titles and abstracts, one was excluded after screening the full text for relevance screening and the last record was included in the evidence report.

Databases

In an effort to capture both harms and benefits of bed sharing, the following databases (Table 13) were chosen to provide international coverage of the biomedical, allied health and complementary and alternative medicine literature. Some restrictions (such as excluding non-human studies and removing certain publication types) are not available in all databases.

Table 13 - Coverage dates for electronic database searching

Database	Final date of coverage
Medline	to February Week 3 2005
CINAHL	to December Week 1 2004
Healthstar	to November 2004
PsycINFO	to December Week 2 2004
Cochrane Library	Issue 4, 2004
TRIP –Turning Research into Practice	to present
Social Work Abstracts	as available
AMED - Allied and Complementary Medicine	to December 2004

Eligibility Criteria

Study design

Published and unpublished English-language reports of any study design were included for our systematic review. In particular, those with a comparison group [either contemporaneous comparison group (randomized controlled trial, controlled before and after trial); along with pre versus post, prospective cohort, and case series designs were also considered.

Publication type

We included studies that were published in journal format. Conference proceedings, letters to the editor, dissertation abstracts, and conference abstracts were excluded from our review. These publications usually do not contain sufficient evidence/data to evaluate the intervention for analysis and those which are published only in abstract form may be so for several reasons – authors found results problematic, or it was not able to be accepted for publication Dissertations were also excluded from our review. These publications are often costly to retrieve, and are traditionally more difficult to locate. It has also been shown that these publications provide very little unique information

Inclusion criteria

For the purposes of this review bed sharing was defined as 'the practice of sharing a sleep surface between adults and young children'. Any study investigating the practice of bed sharing and associated harms and benefits, in children 0-2 years of age was included in our review. Any setting in which adults and children (≤ 2yrs) were

sharing a sleep surface at the time of event were considered (i.e. couch, bed, waterbed, day bed, lounge chair etc.)

Study selection

Following a calibration exercise that involved screening records for inclusion or exclusion using questions developed specifically for this review, records were uploaded into the University of Ottawa, Evidence-based Practice Center review management system. This is an internet-based, secured, software program. This program allows for synchronized evaluation with the record and relevance assessment criteria. All records retrieved through searches were initially screened (Level 1) by two authors using titles, and abstracts, where available, and standardized screening questions.(Appendix 4) All records that were tagged by reviewers at this level as a review article, report, or statement were screened for relevance for our review. Reference lists of reviews that were thought to be relevant to bed sharing were screened for potentially relevant publications.

Studies identified as potentially relevant at Level I were retrieved in full-text format, and screened independently for inclusion by two reviewers (Level II). At this level, consensus was required so when disagreements occurred, consensus was achieved through discussion. (Appendix 4) When agreement could not be achieved, a third party was consulted to achieve consensus. Reference lists of all relevant studies were screened for potentially relevant studies as well. All studies excluded at level II were placed in an exclude database, and are listed in Appendix 5.

There are various templates for grading the strength of evidence. Almost all of these approaches rate randomized controlled trials (RCTs) at the top of the ranking

scheme. This is not surprising as RCTs have a comparator group and participants are assigned to all treatment groups through randomization. Randomization is unique in that it 'controls' for known confounders and, perhaps more importantly, unknown ones. Adequate randomization has been shown to reduce the influence of bias on the results of RCTs. Other designs, such as cohort studies and case control ones, also offer some control over the influence of bias. This is because such designs incorporate a comparator group, even though there is no randomization and can also adjust for known or suspected confounders in the statistical analysis.

What is less clear is the extent of bias in studies for which there are no controls (i.e., comparator group). Although it is feasible to provide data, analytical 'solutions' to such designs do not currently exist. There is no adequate way to assess the influence of bias. In such circumstances it is pragmatic and scientifically prudent to limit systematic reviews to primary studies that have a comparator group. All relevant studies were examined to determine study design by one reviewer and confirmed by consensus using study design screening form. (Appendix 4) For this systematic review, 'complete' data extraction and any potential meta-analytical pooling was limited to prospective cohort and case control studies. Studies that were identified as relevant for our review, but that did not have a contemporaneous comparator (e.g. case series, retrospective cohort, 'other', etc.) were excluded from any analysis but data was extracted by one reviewer and presented in Appendix 6.

Data Abstraction

Data abstraction forms were developed specifically for this review and calibrated using 3 eligible studies (Appendix 7 and 8). For all eligible studies one primary reviewer

extracted data pertaining to demographic characteristics for both the child and adult (e.g. age, sex, weight, marital status, level of education, location, etc.) and bed sharing specific characteristics (e.g. type of bed, time of day, sleeping position, presence of risk factors such as alcohol use, or passive smoking, tog value of bedding or clothing, bedding used, etc.) and were checked by another reviewer. Extraction was not blinded, because there is no evidence to suggest that blinding results in a decrease in bias of conducting systematic reviews.[56]

Quality Assessment

Randomized controlled trials, controlled trials, prospective cohorts, and case control studies were considered. Although several approaches exist to measure quality of studies, an *a priori* decision was made that for any RCTs the Jadad scale would be used, and for case control and prospective cohorts, the Newcastle-Ottawa scale (NOS) (Appendix 9) (http://www.ohri.ca/programs/clinical_epidemiology/oxford.htm). Quality assessment was determined solely by what was reported in each study. No attempt was made to contact authors for missing information.

The inter- and intra-rater reliability of the NOS has been established (http://www.ohri.ca/programs/clinical_epidemiology/oxford.htm) as well as criterion validity, through comparison with more comprehensive and complicated scale.

Qualitative Data Synthesis

Outcomes were summarized using a qualitative data synthesis for each study, and presented using narrative descriptions. A description of each study, which included information pertaining to sample size and demographics, methods of recruiting of

groups, details of matching or methods of adjustment, location descriptions, and number of events were all recorded and summarized in text and/or summary and evidence tables throughout the report. These methods were used to help generate hypotheses, detail and categorize variables and risk factors and to help portray the heterogeneity of study populations and reporting of data within the published domain.

Statistical Analysis

In situations where multiple levels of evidence are available, it is generally preferable to focus available resources on synthesis of studies that provide higher levels of evidence, for reasons outlined above. In particular, studies with control groups are much less susceptible to bias. Additionally, since such studies focus on the contrast between groups, the impact of differences between studies may be much less than is often the case with studies lacking control groups. Thus, given the absence of RCTs on the topic, restricting our primary attention to cohort and case-control studies may limit one of the most troublesome issues in meta-analysis, namely statistical heterogeneity.

Associations

Epidemiological, or observational (e.g. case control) studies may reveal *associations* between factors and outcomes (e.g. bed sharing and a benefit or harm). A classic, reported, association is that between smoking and lung cancer.[57] It is important, however, to recognize the limitations of such associations. The limitation is that an association does not imply a causal relationship. More specifically – does smoking cause lung cancer? Do people with lung cancer tend to smoke more? Or is there a genetic factor associated with both addiction to cigarette smoking and predisposition to

lung cancer? To establish causality requires careful consideration of additional components. For example, Sir Austin Bradford Hill proposed a list of 9 guidelines around establishing causality including, which include for example, biological plausibility, dose response relationship, and so forth.[58] Observational study designs do not take into account this type of information.

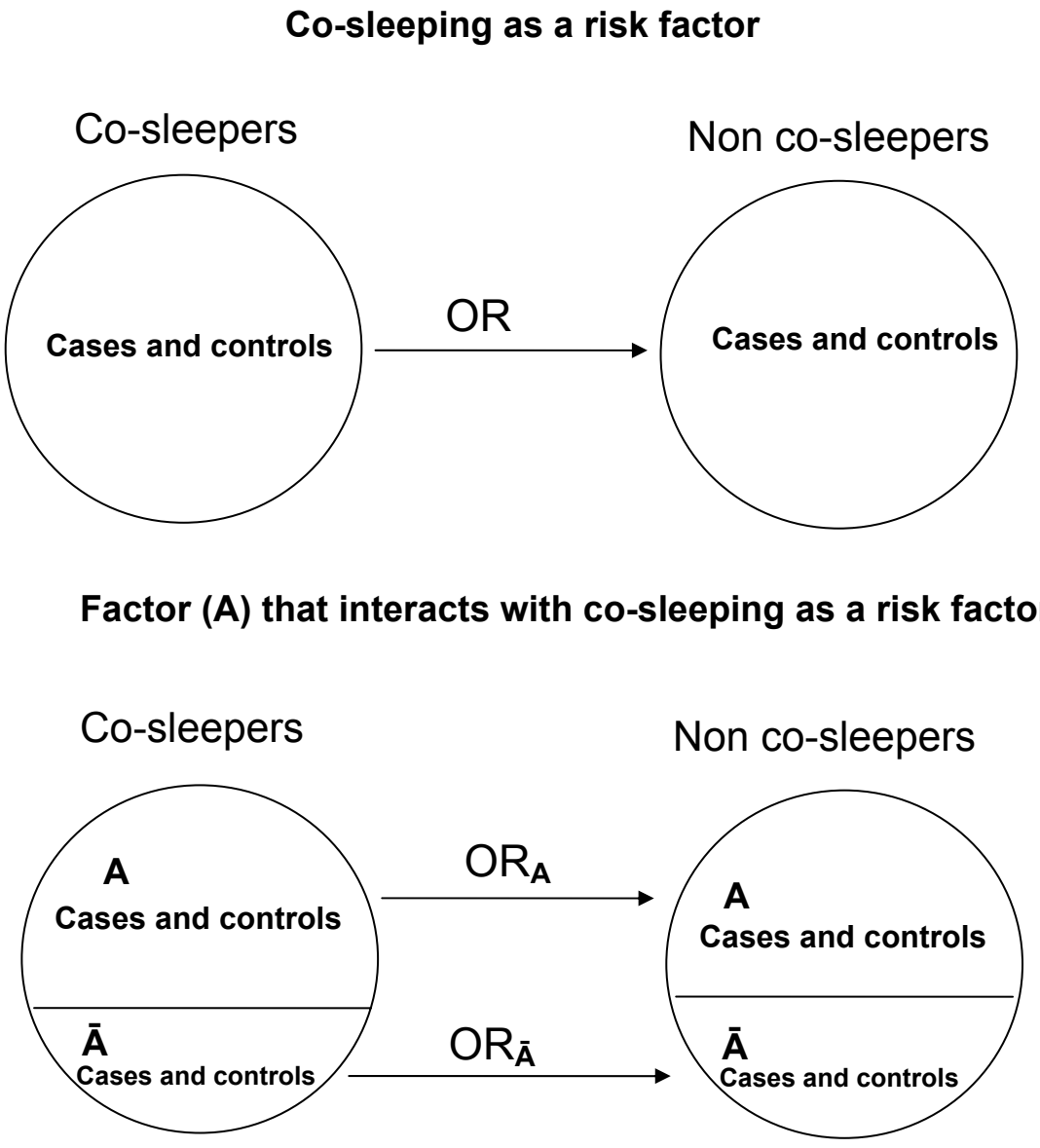
The association between bed sharing and outcomes (typically harms; however, the same framework could be used for benefits) is of fundamental importance in this review. Also of importance for our review, however, are additional factors that may modify the association between bed sharing and outcomes known as 'effect modifiers'. An 'effect modifier' is defined as a variable that influences the effect of a risk factor (i.e. age of infant) on the outcome variable. In statistical terminology, this is known as an *interaction*, but it is more familiarly referred to as a subgroup effect. These three terms (effect modifier, subgroup effect, and interaction) can be used synonymously with one another. For the purposes of this systematic review, we will use the term interaction throughout the document.

A measure of association between factors that is directly estimable in a case-control study is the *odds ratio* (OR). An odds ratio of 1 represents no association. For rare events, the OR approximates the relative risk, i.e. the ratio of the probability of an event (e.g. SIDS) in the presence of the exposure of interest (bed sharing) to the probability of an event in the absence of the exposure of interest. In this case, a large OR represents a strong association between the exposure of interest and SIDS

We shall first consider bed sharing as a risk factor; for example, the association between bed sharing and SIDS. Although estimates of this association are typically

adjusted for other risk factors, interactions between bed sharing and risk factors are not included. We shall next consider models that include such interactions, that is, factors investigated for interactions with bed sharing as a risk factor for SIDS. Figure 1 illustrates the distinction between these two concepts.

Figure 1 - Associations of bed sharing



A = Subset of population with or possessing a suspected risk factor of interest..
Ā = Subset of population without or not possessing a suspected risk factor of interest.

In statistical terminology this would represent an interaction. For the purpose of illustration, consider the outcome of SIDS and the possible interaction between bed sharing and maternal smoking. When no interactions are present, the association between bed sharing and SIDS may be summarized (typically using an odds ratio) without reference to smoking. In the presence of a statistically significant interaction with smoking, however, it is misleading to summarize the association between bed sharing and SIDS ignoring smoking. Thus, if a significant interaction exists between bed sharing and maternal smoking, then the association between bed sharing and SIDS should be summarized separately for smokers and non-smokers.

Representing interactions

Suppose ORb(smoker) is the odds ratio for the association between SIDS and bed sharing among smokers, and ORb(non-smoker) is the odds ratio for the association between SIDS and bed sharing and among non-smokers. These two odds ratios are directly interpretable estimates of the association between SIDS and bed sharing in the two groups (smokers and non-smokers). The interaction between bed sharing and smoking can be represented by the ratio ORb(smoker)/ORb(non-smoker). A test of the statistical significance of this interaction can be based on whether this ratio is significantly different from 1. An alternative representation is in terms of the following 2x2 table - Figure 2 - Logistic regression model parameters representing an interaction

Figure 2 - Logistic regression model parameters representing an interaction

		Bed sharing	
		Yes	No
Smoking	Yes	ORsb	ORs
	No	ORb	1

Note that the reference category in this table is infants who were exposed to neither bed sharing nor smoking, for whom the odds ratio is defined to be 1. The association between SIDS and bed sharing together with smoking (relative to neither bed sharing nor smoking) is ORsb, the association between SIDS and bed sharing in the absence of smoking is ORb, and the association between SIDS and smoking in the absence of bed sharing is ORs. These odds ratios are related to ORb(smoker) and ORb(non-smoker) defined above, as follows - ORb (smoker)= ORsb/ORs and ORb (non-smoker) = Orb. Thus, ORb is directly interpretable as the odds ratio for the association between SIDS and bed sharing among non-smokers, but ORsb and ORs are not directly interpretable in terms of the association between SIDS and bed sharing. Therefore the interaction ratio can be expressed as ORb (smoker)/ORb (non-smoker) = ORsb / (ORs ORb). In other words, the interaction represents the synergistic effect of smoking together with bed sharing compared to the independent effects of bed sharing and of smoking.

Reports of interactions

Studies identified by systematic review report interactions in at least 3 different ways:

1. ORb (smoker) and ORb (non-smoker) together with confidence intervals and/or p-values.
2. The interaction ratio, ORb (smoker)/ORb (non-smoker), together with a confidence interval and/or p-value.
3. ORsb, ORb, and ORs together with a confidence interval and/or p-values.

An indication of the statistical significance of the interaction may also be given. In terms of representing the association between SIDS and bed sharing in the two groups (smokers and non-smokers), case 1 is most informative. In case 2, it is not generally possible to determine ORc (smoker) and ORc (non-smoker). In case 3, it is possible to compute ORc (smoker) and ORc (non-smoker), but *not their confidence intervals*, without additional information (such as the raw data). Furthermore, in case 3 it is not possible to test the statistical significance of the interaction without further information.

Some reports provide partial information, or claim the presence of an interaction based on the statistical significance of individual odds ratios (which is not recommended statistical practice).

Data Abstraction of Interactions

Quantitative estimates of the association between bed sharing and harms were extracted by a statistician (NB) using a standardized extraction form (Appendix 10). Odds ratios (ORs) and 95% confidence intervals (CIs) for bed sharing as a risk factor were extracted. Adjusted ORs were chosen in preference to unadjusted ORs because of concerns about confounding in case-control studies.

Where several different multivariate models were presented, the model indicated by the authors to be the "final model" or the results presented in the abstract were selected. The variables adjusted for in the multivariate model were also extracted. When results were reported for more than one definition of bed sharing (e.g. bed sharing in last sleep versus usual bed sharing), an odds ratio was extracted for each definition. Since the association between harms and bed sharing may be dependent on other factors, measures of the interaction between bed sharing and other factors were also extracted where possible. Again, adjusted estimates were selected in preference to unadjusted estimates because of concerns about confounding

Summarizing the Association between Bed sharing and Harms/benefits

It was evident early on in the systematic review process that no attempt would be made to pool estimates of the association between bed sharing and harms/benefits across studies, for the following reasons. First, in some studies where interactions between bed sharing and other risk factors were found, results are only reported in terms of the interaction. A second related point is that in the presence of a statistically significant interaction, it is not meaningful to summarize the association between bed sharing and a given harm/benefit ignoring any interaction factors. Third, varying definitions of exposure make pooling problematic (e.g. habitual bed sharing or bed sharing for last sleep, smoking during pregnancy or postpartum, etc.). Fourth, when studies contain partially overlapping data sets, pooling is not appropriate.

Nevertheless, the consistency across studies of associations between bed sharing and harms/benefits was examined.

Summarizing Interactions

Similarly, no attempt was made to pool estimates of the interaction between bed sharing and other risk factors with harms/benefits across studies, for the following reasons. First, as noted previously, reporting of interactions was inconsistent between studies. Second, when an individual study did not find an interaction to be statistically significant, further detail on the interaction was typically not reported. From the perspective of potential pooling, this selective reporting poses a problem akin to publication bias, in which statistically non-significant results may not be available. Pooling only the available results may lead to bias. Finally, as noted previously, varying definitions of exposure and overlapping data sets make pooling problematic.

Nevertheless, the consistency of the directions of reported interactions was determined, and individual study estimates of interactions were examined in terms of the odds ratios for bed sharing stratified by the levels of the other risk factor (e.g. ORb(smoker) and ORb(non-smoker)), as well as the interaction ratio (e.g. ORb (smoker)/ORb (non-smoker)).

Results

Literature Search

Our initial searches identified a total of N=1218 records from bibliographic sources. Sixty-one articles were originally reviewer nominated and 192 were excluded as duplicate publications. We then screened the titles and abstracts of 1087 records. We further excluded 764 records (739 were not relevant, and 25 were non-English publications. A total of 323 articles were retrieved for full-text relevance screening which was performed in duplicate. Two-hundred and twenty-two reports did not meet our inclusion criteria, and 16 could not be retrieved. These 16 reports are summarized in the Appendix. (Appendix 11) Our searches yielded 83 studies which met topic-specific inclusion criteria. We further excluded 43 studies from formal synthesis on the basis of their level of evidence (i.e. study design). In total, 40 studies (30 case control, 10 prospective cohort) met our final inclusion criteria and make up the body of this evidence review. (Appendix 12)

For all included studies (case controls and prospective cohort design) demographic and study characteristics were summarized in evidence tables. (Appendix 13) The evidence tables include information pertaining to study identification and methodology which describe study objectives and design, inclusion and exclusion criteria, and data collection techniques. Baseline population characteristics for both adults and children are summarized describing the total population and N = for the exposure and control groups where applicable, marital status, race/ethnicity, SES, birth

weight, duration of gestation, age, and sex. Where data were not available or extractable 'NR' (not reported) was recorded.

Data were also thoroughly extracted for the exposure (description of the bed sharing environment). Exposure (bed sharing descriptive) variables were decided upon through discussion with clinical content experts. Although many variables (particularly in the SIDS publications) were reported, very few reports described the bed sharing environment in great detail. We did however, have an exhaustive list of variables for extraction and ultimately included sleep location, sleep position, adult co-sleeper (i.e. mother, father, caregiver, sister etc.), use of pacifier/soother, bedding type (i.e. duvet use, pillow use, etc.,), definition of the bed sharing routine (i.e. usual bed sharing, bed shared previous 2 weeks, daytime bed sharing, etc.,), tog value of bedding, and 'other', which was used to insert a descriptive variable related to bed sharing that was not listed on the extraction forms. There were many other variables listed on the forms, however, the data presented in the tables only reflect those of bed sharing cohorts.

Bed sharing associated factors describe those variables (outside of the baseline, descriptive bed sharing variables) that were examined as risk factors (for harms or benefits) associated with the bed sharing cohorts. These may be different responses than the descriptive variables, as authors may not have examined or reported non-significant risk factors in the bed sharing children. Finally, bed sharing related outcomes are described in the final column. The data provided here describe the intent of the paper (investigation of harms, with the outcome being SIDS, or alternatively investigation of benefits, with the outcome being sleep patterns). Also described are the risk factors examined, the completeness of data (e.g. completeness of parental

interviews, attrition, etc.,) and the reported author's conclusions. These conclusions do not necessarily represent our conclusions from the review. However, we were not inclined to support or refute the conclusion within the tables. These are presented to highlight the direction of effects of studies and highlight that often data presented do not necessarily support conclusions.

Quality Assessment

Relative to randomised trials, non-randomised studies (e.g., case-control and cohort studies) can be challenging to implement and conduct. Assessment of the quality of such studies is essential for a proper understanding of non-randomised studies. The Newcastle-Ottawa Scale (NOS) was developed to assess the quality of non-randomised studies with its design, content and ease of use directed at the task of incorporating the quality assessments in the interpretation of meta-analytic results. While the NOS assesses case-control and prospective cohort studies according to slightly different criteria, both study designs are rated according to 3 broad categories, each of which has important implications on the internal validity (and thus, the external validity) of the study: selection, comparability and exposure.

Seventeen case control studies [14,15,17,19,22,27,47,48,53,54,59-66] (in 30 publications) and 10 prospective cohorts[15,67-74,89] were quality assessed using the Newcastle-Ottawa Scale (NOS). Only primary publications were assessed; companion papers were not. (Appendix 9).

For the case-control studies, reports can be awarded a maximum of 4 points for 'selection' with one point for an affirmative response to each of the following: adequate case definition, cases representative of target population of interest, controls selected

from the same population as cases, controls' history of outcome stated. An additional 2 points are awarded for 'comparability;' that is, ensuring that cases and controls are comparable with respect to various confounders. This can take the form of matching in the design of the study and/or adjusting for such variables in the analysis. A final 3 points are available for optimal assessment of 'exposure' with ascertainment of exposure from a secure record or structured interview (whereby the interviewer is blind to case/control status) resulting in one point and an additional point being awarded if the exposure of both cases and controls were assessed in an identical manner. The final point for the 'exposure' is awarded if the non-response rate is the same for both the case and control groups.

Selection was rated quite well for the case controls in our review. In total, 16/17 studies received the maximum number of 'stars' or points for selection. One study received a total of 3.[54] Comparability was much more heterogeneous within in these studies. Only 11/17 studies met all criteria for maximum scoring at this level.[14,15,17,22,27,48,53,60,63-66] The remaining studies received only one point. [19,47,54,59,61,62] This means that the cases and controls that were studied were not necessarily sufficiently similar to reduce the likelihood of bias influencing the study results, owing to confounders. Put another way, these studies did not plan *a priori* to match their cases with their controls on certain variables of interest nor did they adjust for these variables in their statistical analysis. The exposure assessment was generally the lowest rated section of this scoring system. Only 3/17 studies met criteria for maximum scoring[17,19,22,48] and 13 studies received only one point[14,15,19,27,47,53,54,59,60,62-66]. For one study, no points were awarded.[61]

For prospective cohort studies, the same number of total points are available for each of the 3 broad categories on which the quality assessment if based; however, for the prospective cohort studies, the issues that are reviewed within each broad category differ slightly from those in the case-control studies, reflecting the inherent differences in study design and approaches to analysis More specifically, for the total of 4 points that can be awarded for 'selection' in prospective cohort studies, consideration is given to whether the exposed cohort is representative of those members in the community of interest, whether the non-exposed cohort was drawn from the same community as the exposed cohort, whether exposure status was ascertained using a secure record or structured interview and whether there was demonstration that the outcome of interest was not present at the start of the study. With respect to the 2 points that can be awarded for 'comparability,' a prospective cohort study needs to control for factors that might influence the baseline comparability of exposed and non-exposed groups; this can be accomplished through design and/or analysis. The final 3 points relate to 'outcome.' In order to score the maximum 3 points, the study needs to have assessed the outcome via independent, blind assessment or record linkage, the length of follow-up needs to be sufficiently long to have enabled the outcomes of interest to have occurred and, importantly, the follow-up of the exposed and non-exposed groups within the cohort needs to be adequate, as evidenced by a complete follow-up (i.e., all participants are accounted for) or a loss to follow-up that is sufficiently small such that such loss is unlikely to introduce bias.

Unlike the case-control studies, the prospective cohort studies did most poorly within the 'selection' category. Only 4 studies received the maximum points on the

scale.[15,69,73,89] Three studies received 3 points[67,68,71], one study received 2 points[70], and the remaining studies scored only 1 point.[72,74] This raises concerns that if the populations being examined are in adequately selected or are subject to bias, it is difficult to be confident that the outcomes reported are true representations of the cohorts examined. These results suggest there may be some bias in the results of these studies, if selection of subjects were not of high quality or methodology.

In general, comparability was scored well for most studies. Seven studies received the maximum rating of 2 for this category.[15,67,69,71-73,89] Again, unlike the case control studies, the prospective cohort studies performed best in the 'outcome' evaluation. In total, 5 studies were scored the maximum rating of 3 points.[67, 68-70, 72,74]

In summary, the studies within both of these quality scoring scales faired well. The case control studies were more likely to score well in the 'selection' category and poorly in the 'exposure' category. The opposite can be said for the prospective cohort designs. It should be noted that although these studies were rated for the most part well, these studies designs are low on the study hierarchy scale and are limited by their nature of design. Even the highest rated case-control study cannot provide answers regarding causality because of the difficulty that arises when trying to verify temporality; that is, demonstrating that the exposure preceded the outcome. Prospective cohort studies, while higher in the hierarchy of evidence than case-control studies, can not be as definitive as controlled trials vis-à-vis their ability to prove a causal relationship between exposure and outcome. This is as a result of the fact that there may be variables that are unknown, unmeasured and/or unadjusted for yet these same variables may be associated with the exposure and/or outcome; this translates to an

observed association that is not “true” (or is not as true as it could be if those additional variables had been considered). This phenomenon becomes particularly important when the baseline characteristics of the exposed and non-exposed groups differ, significantly, on that variable. Admittedly, though a randomised trial is the pinnacle of evidence, such a design is not always possible nor is such a design always ethical; for example, one cannot simply randomise certain families to breastfeed and other families to not breastfeed. The same can be said of studies examining bed sharing. A summary of both case-control and prospective cohort scores are summarized in the tables below.

Detailed description of the coding manual and rating scales for the NOS for both case-control and cohort studies can be found in Appendix 9.

Table 14 - Quality assessment of case control studies

Study ID	Selection	Comparability	Exposure
Arnestad, M (2001)[53]	* * * *	* *	*
Blair, PS (1999)[19]	* * * *	*	*
Brooke H, (1997)[63]	* * * *	* *	*
Carpenter, RG (2004)[54]	* * *	*	*
Findeisen, M (2004)[60]	* * * *	* *	*
Hauck, FR (2003)[48]	* * * *	* *	* *
Iyasu, S (2003)[17]	* * * *	* *	* *
Kelmanson, IA (1993)[66]	* * * *	* *	*

Study ID	Selection	Comparability	Exposure
Klonoff-Cohen, H (1995)[14]	* * * *	* *	*
L'Hoir, MP, (1998)[62]	* * * *	*	*
McGarvey, C (2003)[47]	* * * *	*	*
Mitchell, EA (1992)[59]	* * * *	*	*
Mitchell, EA (1997)[22]	* * * *	* *	* *
Mukai, T (1999)[61]	* * * *	*	-@
Schellscheidt, J (1997)[27]	* * * *	* *	*
Schluter, PJ (1998) [65]	* * * *	* *	*
Tappin D, (2002)[64]	* * * *	* *	*

@ - this indicates that no points could be awarded

Table 15 - Quality assessment of prospective cohort studies

Study Identification	Selection	Comparability	Exposure
Baddock, SA (2004)[67]	* * *	* *	* * *
Lozoff, B (1996)[68]	* * *	*	* * *
Mitchell, EA (1996)[69]	* * * *	* *	* * *
Mao, A (2004)[70]	* *	*	* * *
McCoy, RC (2004)[15]	* * * *	* *	*
Okami, P (2002)[71]	* * *	* *	* *

Study Identification	Selection	Comparability	Exposure
Thomas, KA (2002)[72]	*	* *	* * *
Vogel, A (1999)[73]	* * * *	* *	* *
Ball, HL (2003)[89]	* * * *	* *	* *
Richard, CA (2004)[74]	*	*	* *

Published Infant Mortality Statistics

No prospective cohort or case control studies examining mortality and/injury statistics were found by our electronic literature searches. However, there are a number of case series and other study designs which have been published to examine these phenomenons.

Harms and Risk Factors Associated with Bed sharing

All the following studies are investigating bed sharing in the context of sudden, unexpected infant deaths. The studies were mostly aimed at identifying the prevalence of known or potential risk factors for SIDS. None were specifically aimed, when designed, at determining whether bed sharing was a risk factor for SIDS and whether bed sharing interacted with other risk factors.

Thirty publications were retained concerning 17 different datasets. The distribution of dataset per country is given in Table 16. The studies were carried out between 1987 and 2001 in 10 countries (England, Germany, Ireland, Japan, New Zealand, Norway, Russia, Scotland, The Netherlands, and the United States). In

addition, one study grouped data from 20 regions of Europe [54] and included data from other included publications. Most of the studies included infants aged up to one year of age.

Table 16 - Distribution of studies per countries and number of original datasets represented

Country	Dataset 1 Reference	Dataset 2 Reference	Dataset 3 Reference	Total (n) of dataset
USA	Hauck, FR[48] (2003)	Klonoff, H[14] (1995)	Iyasu, S[17] (2002)	3
Germany	Findeisen, M[60] (2004)	Schellscheidt, J[27] (1997)		2
New Zealand	Scragg, R[13] (1993)	Mitchell, EA[22] (1997)		2
Scotland	Brooke, H[63] (1997)	Tappin, D[64] (2002)		2
England	Fleming, PJ[75] (1996) and Blair , PS[19] (1999)	Mitchell, EA[69] (1996)**		2
Ireland	McGravey, C[47] (2003)			1
Japan	Mukai, T[61] (1999)			1
Russia	Kelmanson, IA [66] (1993)			1
Netherland	L'Hoir, MP [62] (1998)			1
Norway	Arnestad, M[53] (2001)			1
ECAS	Carpenter, RG[54] (2004)			1
Total				17

** Two publications are referenced because the data in each study were complementary, although derived from the same data set

The majority of studies used questionnaires, administered face-to-face, to collect data. Questionnaires were most likely to be administered to parents/caregivers by one trained individual (investigator, nurse or research assistant). Data were collected through a mailed questionnaire in 2 instances. [53,66] For questions particularly concerned with infant sleeping environment, investigators usually referred to the last sleep of the SIDS victims and to a reference sleep for the controls; the reference sleep was chosen to represent the time of day corresponding to the time of the index cases' last sleep. The majority of populations included in these studies were Caucasian. One study reported data collected solely on Indigenous people in the USA [17]; and one other study examined a predominantly African American population.[48] The New Zealand datasets were collected to represent the ethnic distribution in the country, including adequate representation for Maoris and Pacific Islanders.

Definitions for sleeping location (bed sharing or non-bed sharing) were heterogeneous. Nevertheless, the studies can be classified broadly into two subgroups: those reporting *routine* sleep location (5 studies) [17,53,62,63,66] and those reporting bed sharing *on a particular night* (last sleep for the cases and reference sleep for the controls) 4 studies; [22,27,66,69]. Six studies[13,14,19,47,48,54] reported data on both routine bed sharing and bed sharing on a particular night. For two studies [60,60,76], the definition of sleep location was not clearly reported.

Seven publications [13,14,17,47,48,54,75] were more specifically aimed at investigating bed sharing and SIDS although the studies were not originally designed as such. Two publications [60,64] had incomplete results and noted a follow-up publication is expected. One publication [61] reported data solely for the cases. Finally, one publication [62]

reported only the prevalence of bed sharing in cases and controls without any further analysis.

Exposure to tobacco smoke was also defined in various ways. Definitions included maternal smoking during pregnancy, maternal smoking after the birth of the baby, simply parental smoking before the death of the infant, or any combination of these. An interaction between bed sharing and maternal smoking (any type) was looked for in 6 complete studies. [13,17,19,22,47,54]

In summary, there was quite a variation in what was studied and how the data were analysed. As well, data from four of the 17 studies were not extractable. [60-62,64]

In the next sub-sections, we have presented data from these studies and have grouped by country in which the studies originated. This narrative summary provides an overview of the study objectives, designs, and results related to risk factors and harms by region.

New Zealand

Thirteen reports [13,22,59,65,69,77-84] originated from New Zealand but concerned only two datasets. The first dataset was from a 3 year, national research project started in 1987 (New Zealand Cot Death Study) to identify causes for the high SIDS mortality rate in the country (highest of the industrialized world). The second dataset was collected after a campaign to decrease the prevalence of risk factors.

In the first dataset, information on infants dying from SIDS in the post neonatal age group (28 days to 365 days) in most main centres in New Zealand (covering 78% of all live births) were collected. This study was conducted before the national campaign aimed at decreasing modifiable risk factors for SIDS was initiated. Obstetric records were examined

and parental interviews were completed in 97.5% and 86.9% of cases and controls respectively. The study population was comprised of 393 cases of SIDS (81% of all cases) and 1592 controls (88.4%) that were a representative sample of all hospital births in the study region (not matched individually). Several publications have emerged from this national study; and 12 were identified by our searches.

The first publication from the first dataset and reporting an association between bed sharing and SIDS was that of *Mitchell et al*. 1992[59] The authors reported that 24% of the SIDS cases shared the parental bed vs. 10.5% of the controls (OR 2.70 [95% confidence interval, 2.02 to 3.625]). Identification of the risk of bed sharing, along with three other modifiable risk factors (sleeping on the stomach, maternal smoking, not being breast fed) were reported.

A subsequent publication by *Scragg et al,*[13] using the same dataset, also examined bed sharing. The authors investigated why bed sharing had been inconsistently noted to be a risk factor for SIDS (variation of results by ethnic subgroups, Maori vs. European) in New Zealand to determine whether maternal smoking and alcohol consumption in particular were associated risk factors for SIDS. Bed sharing was simply defined "as sleeping on the same surface as another person for some period in the two weeks prior to death for the cases or prior to the reference sleep for the controls". No attempt to be more specific about the number of days of bed sharing in the previous two weeks; the number of hours of bed sharing per night was divided as follows: < 2 hours, 2 to 5 hours, and > 5 hours. Maternal and paternal smoking was defined as any smoking in the past two weeks. No information was collected concerning mothers' smoking habits during pregnancy. The authors found that bed sharing was

associated with an increased risk of SIDS after controlling for ethnic origin (Mantel-Haenszel OR , bed sharing last two weeks: 1.64 [1.28 to 2.09, 95% confidence interval]; bed sharing last sleep: 1.74 [1.24 to 2.44]). There was an apparent dose-response relationship for the time spent bed sharing since the highest risk was noted for infants spending > 5 hours per night in the parental bed (OR 2.27 [1.59 to 3.25]). Bed sharing in combination with maternal smoking was also associated with an elevated risk for SIDS (all levels of smoking: 0 cigarettes, 1-9, 10-25, and > 25, relative risk for all smokers of 2.03 [1.45 to 2.83]). The risk for non-smoking mothers bed sharing was not statistically significant (1.19 [0.81 to 1.74]). More importantly, when non-bed sharing infants of non-smoking mothers were compared to bed sharing infants of mothers who smoked, the relative risk of SIDS were 3.94 [2.47 to 6.27] and 4.55 [2.63 to 7.88] for bed sharing in the past two weeks and bed sharing last sleep, respectively. The authors noted that when considering the attributable risk for cases exposed to both bed sharing and maternal smoking, 20% of all sudden infant deaths in New Zealand over the study period could be explained by the joint effect of the two factors. They also concluded that much of the elevated risk for SIDS in Maori infants (as compared to Caucasian infants) was attributable to the high prevalence of both bed sharing and maternal smoking in that population. The authors were cautious about recommendations against bed sharing as they perceived a need to balance the risks of SIDS against the possible benefits of bed sharing.

The second dataset from New Zealand was a follow-up to the New Zealand Cot Death Study published in 1997 by *Mitchell et al.*[22] Technically speaking, this was a case-cohort study but the results were analysed as in case-control studies. The aim of

this study was to identify the risk factors for SIDS following a national campaign to prevent SIDS that was implemented in 1991. The study spanned two 2 years (October 1, 1991 through September 30, 1993) and data were collected prospectively on all infants born in New Zealand, first shortly after birth and then at two months of age. Information on infant care practices in the previous 24 hours were recorded and included maternal and paternal smoking and whether the mother fell asleep with the infant in bed. Of the infants who later died of SIDS (those aged between 28 days and 365 days), 127 (54.6%) were included in the study (because full data were available) along with 922 controls (76.8%) chosen to be representative of all live births in New Zealand. Maternal smoking was found to be the major risk factor for SIDS. Bed sharing was also associated with an increased risk of SIDS. There was an interaction between maternal smoking and bed sharing on the risk of SIDS. Compared with infants not exposed to either bed sharing or maternal smoking, the adjusted OR for infants of mothers who smoked was 5.01 (95% CI 5 2.01, 12.46) for bed sharing at the initial contact and 5.02 (95% CI 5 1.05, 24.05) for bed sharing at 2 months. The authors concluded that almost half of the cases of SIDS could be attributed to maternal smoking. In addition, joint exposure to maternal smoking and bed sharing could be responsible for a third of the deaths. Put another way, bed sharing was a major risk factor for SIDS only for infants of smoking mothers.

In Summary, the major study on the first data set was undertaken quite a while ago (1987 to 1990) and at a time when sleeping on the stomach was still quite prevalent in that country. Bed sharing was defined as any bed sharing during the past two weeks. If we consider possible interactions, smoking was defined as any smoking in the past

two weeks. No information was collected concerning mothers' smoking habits during pregnancy. The follow-up study had a different design. The information concerning bed sharing and parental smoking were for the night before. In that study, maternal smoking was the risk factor studied and the authors look at the possible interaction with bed sharing (not the other way around). Of note for both studies, controls were not matched individually.

USA

Three studies originated from the United States.[14,17,48] One study [14] was conducted before the national campaign to decrease the prevalence of the prone sleeping position was initiated. Another [48] enrolled mostly African Americans while the third [17] enrolled American Indians.

Klonoff-Cohen et al.[14] carried-out a case-control study in Southern California with enrolment of subjects from January 1989 to December 1992. The authors determined whether routine bed sharing (parent's bed) was more common in infants who died of SIDS than in control infants. Bed sharing at time of death was the exposure of interest. Data were obtained by telephone interview. Parents were contacted six to twelve months after the death of their infants. Controls, selected from all eligible live born infants, were matched on birth hospital, date of birth, sex, and race. Data from controls were collected three to six months after the case interview. Although 600 subjects were enrolled (300 cases and 300 controls), the report concerns 200 SIDS cases and 200 controls enrolled before the height of publicity in the United States about sleep position and risks for SIDS. Racial distribution of babies in the two groups was approximately 48% Caucasians, 30% Latin American, 11% Asian and Pacific Islander, 10% African-

American and 1% North American Indian. Both routine bed sharing (daytime and night-time) and bed sharing during the last sleep were reported. Data on cigarette smoking was collected for both parents and adult caregivers. Comparisons of daytime and night-time routine bed sharing between cases and controls revealed no significant difference (50 cases and 32 controls for day time, p=0.11); and 60 cases and 52 controls for night-time, p=0.36). The overall adjusted OR (adjusted for usual sleeping position, passive smoking, breast feeding, intercom/monitor use, infant birth weight, medical conditions at birth, and maternal age and education) for routine bed sharing in the daytime was 1.38 (95% confidence interval 0.59 to 3.22). This same value was 1.21 (0.59 to 2.48) for night-time bed sharing. Forty five infants (22.4%) in the SIDS group were bed sharing at the time of death but comparable data are not reported for controls. There was no interaction between bed sharing and passive smoking or alcohol use. The authors concluded that there was no significant association between routine bed sharing and SIDS. As well, there was no interaction between bed sharing and passive smoking or alcohol use by either parent.

Hauck et al. [48] conducted a case-control study with enrolment of subjects between 1993 and 1996 in the setting of an inner city, low income, largely African American population (city of Chicago). The study's aim was to examine risk factors for SIDS with the goal of reducing SIDS mortality among blacks as it had been documented that their SIDS mortality rate was twice the rate of Caucasians. An earlier paper, published on the same dataset [85] dealt more precisely with the contribution of prone sleeping position to racial disparity in SIDS. Data were collected via face-to-face interviews of parents of 260 cases and 260 controls. The study groups were composed

of 75.0% black; 13.1% Hispanic white; and 11.9% non-Hispanic white. Controls were matched on maternal race/ethnicity, age at death/interview, and birth weight.

Data on sleep location were collected for the last sleep period in cases and a reference sleep (corresponding to the same time of the day or night) for the controls. Although not presented in the results, data were also collected on routine sleep practices in the past two weeks. Data on who was bed sharing (mother, father, mother and father, other adult or children) were specifically collected and analysed.

Bed sharing was associated with an increased risk of SIDS, with an OR of 2.7; 95% CI: 1.8, 4.2). The authors then divided the groups according to bed sharing partner. In univariate analyses, there was an increased risk for SIDS for bed sharing with one parent alone (OR: 1.9 95% CI 1.2, 3.1), and bed sharing in other combinations (OR: 5.4 95% CI: 2.8, 10.2). In the multivariate model, however, only bed sharing with a partner other than with one parent alone remained a significant risk after adjusting for maternal education, marital status, age and prenatal care. There was no analysis on associated risk factors in combination (e.g., maternal smoking and bed sharing). The authors concluded that, in order to further lower the SIDS rate among African American and other racial/ethnic groups, prone sleeping, the use of soft bedding and pillows, and some types of bed sharing should be reduced.

Iyasu et al. [17] conducted a population-based case-control study in North and South Dakota, Iowa and Nebraska. The study was designed to determine pre-natal and post-natal risk factors for SIDS among American Indians. Enrolment occurred between December 1992 and November 1996. Data collection was from parental interview. The enrolled subjects were all Plains Indians: 33 (of 37) SIDS cases and 66 controls. The

controls were matched for postnatal age and community or reservation residence. Data on smoking were collected for the mother and related to before, during, and after the pregnancy. Data on sleep location were collected on usual practice (2 weeks prior to death or reference sleep).

A similar proportion of cases and controls usually bed shared with their parents (59.4% of cases and 55.4% of controls, unadjusted OR 1.1 95% CI: 0.5, 2.6). There was no interaction between bed sharing and maternal smoking or alcohol consumption.

To summarize, the study of Klonoff-Cohen was undertaken before the campaign to decrease prone sleeping. There was a very long time interval between the event (SIDS death) and the telephone interview which could introduce a significant recall bias. Data from the controls were collected three to 6 months later, therefore at another time of the year, which could (in theory) influence the practice of bed sharing. The routine practice of bed sharing was studied, irrespective of the fact that the study infants died while bed sharing or not. The study of Hauck et al. provides interesting data on mostly inner-city, low-socio-economic background, African-American population and maternal smoking is not analysed as a factor interacting with bed sharing. The study of Iyasu et al. did not identify bed sharing as a risk factor for SIDS in the population of Indigenous people (Plain Indians).

United Kingdom

The confidential enquiry into stillbirth and sudden death in infancy (CESDI) was a single large case-control study that took place in five regions in England over three years (1993 to 1996). The study commenced a few years after the national campaign to reduce the modifiable risk factors for SIDS. Several publications were derived from

this dataset and two were retrieved with our search strategy on bed sharing. The first one published in 1996 by *Fleming et al* [75] concerned the first two years of the CESDI study. These data were also used for a later study by Carpenter et al [54] that is presented later in this text. The publication involving the whole dataset and focussing on the contribution of bed sharing was published by *Blair et al.* [19] in 1999. The results will be given in summary for the whole analysis (the full dataset –3 years).

The general objective of CESDI was to investigate the risks for SIDS. More precisely, the authors wished to identify factors in sleeping environments that may have contributed to infant deaths. Data were collected from parental interviews for both cases and controls. Four controls were matched to each SIDS case on date of birth (within two weeks) and region of residence. A total of 325 babies who died were enrolled as well as 1300 control infants. Sleeping location was studied in two ways: routine behaviour and last/reference sleep. For the last/reference sleep, the authors also differentiated the babies who bed shared for only part of the night. This is unique to this study. Smoking refers to at least one parent smoking at the time of interview.

The authors found, in the univariate analysis, that routine bed sharing increased the risk of SIDS irrespective of the socio-economic status. As for bed sharing for the last/reference sleep, the data are more complex. Relative to controls, a greater proportion of SIDS victims slept in their parents' bed or in a separate room. The authors also investigated associated risks. The risk of SIDS for bed sharing infants of parents who did not smoke was not significant. The infants who died in the parental bed were much younger (8 weeks, 4 to 14 weeks) than those who were found in their crib (15 weeks, 10 to 23 weeks); this association was significant (4.65; 2.70, 7.99). The authors

also identified sofa-sharing as a significant risk factor for SIDS using a multivariate odds ration controlling for adverse bed sharing conditions [(25.86; 6.72, 99.47) p<0.0001]. The authors concluded “there are certain circumstances when bed sharing should be avoided, particularly for infants under four months old. Parents sleeping on a sofa with infants should always be avoided. There is no evidence that bed sharing is hazardous for infants of parents who do not smoke.”

This study was quite well done and data on both routine bed sharing and bed sharing the night before the interview were collected. As well, the authors gave information on the proportion of infants bed sharing all night and those for only part of the night. A risk for bed sharing was identified for those infants *found bed sharing*. Unfortunately, the author did not provide separate analysis for the infants bed sharing all night vs. for only part of the night (the former group was, however, quite small). Unfortunately as well, data on smoking was for any of the parent smoking the day of the interview which does not give any information on the risk of maternal smoking, especially during pregnancy. Young age was identified as a risk factor interacting with bed sharing.

Comparison of UK to New Zealand

Mitchell et al’s [69] study compared risk factors for SIDS in New Zealand with those in the UK using the same methodology. The data for New Zealand are those from the New Zealand Cot Death study (already presented) whereas the UK data were collected in Southwest Thames in England. This study was a prospective cohort design. Subjects were enrolled between October 1990 and October 1991. Specific questions covered in the publication relate to position in which the infant was put to sleep, whether

or not the infant bed shared with another person and whether a pacifier was used. The prevalence of bed sharing was 10.5% for the New Zealand group and 6.8% for the UK group. The major finding of the study was that there was no significant difference in the prevalence of the four modifiable risk factors for SIDS between the two countries and that these four factors (prone sleeping, maternal smoking, bed sharing and not being breast fed) could not account for the discrepancy in SIDS rates between the UK and New Zealand.

In summary, these studies examined two cohorts of SIDS victims from different countries and were compared to determine which factors could explain the differing SIDS incidence in the two countries. As mentioned, none of the factors studied show a significant difference.

Ireland

Three publications originated from Ireland and all relate to the same dataset.[47,86,87] The study was a population based case-control study that took place between 1994 and 1998 (i.e., after the campaign aimed at reducing the risk factors for SIDS was launched). Data were collected by parental interview for each case and control. Three controls were selected for each case, matched on age, place of birth and last sleep period. A total of 203 SIDS cases and 622 control infants were studied. Data were collected on routine sleeping location as well as for the last/reference sleep. Maternal smoking data referred to smoking during pregnancy.

In 2002, *McDonnell et al* [86] published their analysis of the dataset, concentrating on the effect of cigarette smoking exposure on SIDS. The following year, *Matthews et al*

[87] reported on the influence of analytical design on the variability of published results in studies of SIDS.

This was followed by *McGarvey et al.'s* [47] 2004 publication that aimed to identify risk factors for SIDS that related to infants' sleeping environments. The authors found that bed sharing was more prevalent among cases than controls (68 cases [44%], 32 controls [5%]. In the multivariate analysis, routine bed sharing was associated with an increased risk of SIDS (adjusted OR 4.31 95% CI 1.07, 17.37) as was bed sharing during the last sleep (adjusted OR 16.47 95% CI 3.73, 72.75). The increased risk of SIDS seen with bed sharing was further increased among infants whose mothers smoked during pregnancy (OR 21.84 95% CI 2.27, 209.89). The risk of bed sharing was not significant for infants older than 20 weeks of age (OR 2.63 95% CI 0.49, 70.10). The authors also found that infant's bed sharing for part of the night had no increased risk for SIDS. The authors, thus, concluded that bed sharing should be avoided in infants who are younger than 20 weeks of age and for infants of mothers who smoked during pregnancy.

This study was quite well done and data on both routine bed sharing and bed sharing during the last sleep were collected. Bed sharing for only a part of the night was considered in the analysis and found not to be a risk factor for SIDS. Data were obtained on smoking during pregnancy but not on passive exposure to smoking after birth. This is one of the few studies looking at the effect of age and the risk of bed sharing was found for younger infants (less than 20 weeks).

Scotland

Two large nation-wide studies were conducted in Scotland.[64,88] Both studies were initiated after a documented reduction in mortality rates that followed the introduction of national campaign to decrease the risks of SIDS.

The aim of the population-based case-control study by *Brooke et al*.[63] was to investigate the relation between routine infant care practices and the sudden infant death syndrome in Scotland. The study enrolled 201 cases of sudden infant death syndrome and 276 controls between 1992 and 1996. Data were collected for both cases and controls through home interviews. Controls were matched on maternity unit (place of birth) and date of birth. Data on sleep location concerned the routine practice for both cases and controls; additional data concerning sleep location at the time of death was also collected for cases. Parental smoking in the postnatal period was also documented. In univariate analyses, routine bed sharing was a significant risk factor for SIDS (8% for cases, 2% for controls; OR 3.92 95% CI 1.35, 11.37); this did not hold true in the multivariate model (OR 2.90 95% CI 0.75, 11.26). For the SIDS group, 11 (7.5%) routinely bed shared and 48 (32.7%) were bed sharing at the time of death. Overall, the risk of SIDS with smoking increased with the number of parents smoking ($P<0.0001$), with the number of cigarettes smoked by mother or father ($p=0.0001$), and with bed sharing ($p<0.005$).

A second dataset was collected between 1 January 1996 and 31 May 2000 for 131 infants who died of SIDS and 278 controls matched on age, season of death of the index case and obstetric unit. This second study, not yet published, explores infants' sleeping location/environment in much greater details (e.g., which room, what was the

sleep surface, for how long did bed sharing occur during last sleep, where in bed - at the edge or between others, how close). Tappin et al. [64] (using the second dataset) looked at the relationship between SIDS and used mattresses. They did report some data on bed sharing with 50% of the cases and 19% of the controls bed sharing during the last/reference sleep.

In summary, not much can be concluded from the Scottish latest study. It is hoped that full publication of the data analysis concerning bed sharing will enable meaningful conclusions to be drawn.

Germany

Two distinct studies originated from Germany and both were commenced after the launching of educational campaigns to reduce risk factors for SIDS.[27,60] *Schellscheidt et al's* [27] study was based in two districts (Munster and Detmold) and collected data on SIDS deaths that occurred between January 1993 and December 1994. The objective was to assess whether epidemiological risk factors for SIDS remained significant after the 1992 regional intervention campaign against the prone sleeping position. All 59 cases identified as SIDS were included as well as 156 controls. The controls were chosen from the physicians' practice of the SIDS cases and matched for age (within 4 weeks) and sex. Data for both cases and controls were collected during a home interview. Maternal smoking was defined as smoking during pregnancy. Sleep location was defined as where the baby was found at the time of death. The authors report that 15.3% of the SIDS victims were bed sharing as opposed to 5.8% of the control infants (OR 3.3, 1.1, 9.8). No analysis of associated risk factors was done.

Findeisen et al [60]carried out the second German study in 11 federal states between 1998 and 2001. I t was a multi-centre, case control study that enrolled 455 cases of sudden and unexpected death that occurred in infants aged 8-365 days. The aim of the study was the assessment of etiological factors and risk factors for SIDS. Five control infants were recruited from local registry offices where the SIDS infant had died. As such, 2,702 "control" families were and 1118 (58.7%) agreed to participate. These infants were born 4 to 6 weeks after the index infants and were the same age, in general, as the index case. Data were collected via questionnaires administered to parents during home visits. A questionnaire was also completed by the physician who took care of the case and control infants. Interpretation of this study's findings is limited as the publication reports only some general findings in addition to the study design. Indeed, data concerning bed sharing are provided only for the sudden deaths group (SIDS and other diagnoses). with no data for the controls. A follow-up publication will need to be reviewed for more data (not yet available).

The first study provided no analysis of bed sharing data and the second study provided no data which could be synthesized.

Norway

Arnestad et al [53] published the results of a large case-control study that was set in Norway and spanned 23 years. Both cases and controls were from the southeast region of Norway (which represents 55% of Norway's population). The aim of the study was to examine changes in risk factors for SIDS before and after the campaign to reduce the modifiable risk factors for SIDS. Data were collected through a questionnaire mailed to parents (266 parents of SIDS victims and 698 parents of control infants); one

mailing was done in 1993 and one in 1998. The time between the death and the administration of the questionnaire varied between one and eight years. The final numbers were 174 SIDS infants enrolled (65.4%), dying between 1984 and 1998, and 375 controls (53.7%) matched for age, sex, and place of birth. The controls were identified from the national population register. Parents of SIDS victims were asked questions related to child care practices (including sleep location) covering from the time of birth to time of death. For controls, the period of observation was the first year of life. Three study periods we established: 1984-1989, 1990-1992, 1993-1993. During the three study periods, the number of SIDS victims found bed sharing increased significantly (from 2% to 34%, p value for interaction with period $p<0.01$) but bed sharing was not found to be a risk factor for SIDS because it increased in both the SIDS group and the control group over the years of the study. The absence of an association between bed sharing and SIDS persisted in the multivariate analysis.

The major weakness of the study is the major time delay between the event and the administration of the questionnaire (up to eight years).

The Netherlands

L'Hoir et al. [62] conducted a case control study in the Netherlands, and their results are part of the European concerted action on SIDS The study took place from March 1995 to September 1996. All sudden unexpected deaths were intended to be included in the study but after investigation, only cases of SIDS who died between 7-730 days of age were retained in the final analysis. Two controls were matched to the cases on date of birth (within one week of the cases). Data were collected through a questionnaire administered during a home visit. The median delay between the death

of the infant enrolled in the study and the interview was 34 days and it was 77 days for the matched controls. For controls, a reference sleep was chosen corresponding to the time of day when the matched case had died. The authors provide a description of the well-known risk factors for SIDS with the prevalence of these factors in both cases and controls. Bed sharing is reported to be 8% among cases and 5 % among controls. No further information on bed sharing is provided nor was bed sharing considered in any analyses. Rather, discussion centered on factors that were significantly associated with SIDS in the study and that are modifiable (e.g., passive exposure to tobacco smoke, alcohol consumption by the mother in the 24 hours before death of her baby, change in routine for the infants.)

In summary, it should be noted that there was no analysis of data. Bed sharing information is given narratively, but not analysed.

Japan

Mukai et al [61] studied 56 SIDS cases (aged less than one year) and a group of living infants at 3 months of age, both groups from the city of Okinawa. Data on the SIDS cases were collected from police records and data from the controls were collected from an interview with the parents. Data collection occurred between 1982 and 1992. No statistical comparisons were made between the two groups concerning bed sharing. It is reported that 23.2% of the SIDS victims were sharing the same sleeping surface as their parents. The authors only state that “many” control infants were sleeping with a member of their family (no actual data given). The authors nevertheless concluded that bed sharing should be taken into consideration in the investigation of SIDS.

The data cannot be reviewed for strength or weaknesses due to lack of results provided for controls.

Russia

Kelmanson's[66] study focussed on the functional aspects of children's environments in both SIDS cases and in a control group. The study was undertaken between January 1986 and October 1991 in St-Petersburg, Russia before the implementation of a campaign to reduce the risk of SIDS. Of the 127 SIDS cases that occurred in the time interval, 48 were included in the study (37.8%). Data were collected from a questionnaire that the mothers were ask to complete. A questionnaire was also mailed to the paediatrician of the cases. The control group (48 infants) was recruited from the practice of the paediatricians of the index infants; these controls were matched for sex, age, paediatrician and geographical location. Data collection on sleep location related to routine practice. The author reports that 13.3% of the SIDS cases bed shared with their parents as opposed to none in the control group (OR 15.8). In the SIDS group, 3.3% bed shared with brothers or sisters whereas none in the control group (OR 5.3). No other details are provided. The authors concluded that "there was an increased risk for unexpected death when the baby slept with his or her brother or sister or with a parent." There was no study of interaction of factors.

The design of the study is weak and the proportion of non-responder quite high.

European concerted action on SIDS --ECAS

Carpenter [54] was the lead author of a large multi-centre study which was an amalgamation of population based case-control studies that took place between

September 1992 and April 1996 all over Europe. The data originated from various large national studies already published and other ongoing studies. The main objectives were to combine data from across Europe, to review current risk factors (after the campaign to decrease the prevalence of prone sleeping), to assess whether levels of risk vary across Europe, and to investigate the extent to which risk factors interact. Data were collected by parental interview and the comprehensive questionnaire included specific items on routine sleeping location as well as sleeping location for the last/reference sleep. Two or more controls were selected for each case, matched on age and area of residence. A total of 745 SIDS cases and 2411 control infants were studied. Bed sharing was defined as all night bed sharing. Maternal smoking data referred mostly to smoking during pregnancy although additional data were collected on maternal smoking before and after pregnancy and on paternal smoking. As already mentioned, the first two years of data from the CESDI study [75] was included in the ECAS study as well as data from the Netherlands [62] Ireland.[47]

Bed sharing was a significant risk factor for SIDS (OR 2.93, CI 2.3, 3.72) in the univariate analysis. In the multivariate analysis, the risk of bed sharing was significant for both cases with mothers who smoked and those with mothers who did not smoke. The ORs for the cases with a smoking mothers was 27.0 (CI, 13.3, 54.9) at 2 weeks of age and 7.5 (4.3, 13.2) at 26 weeks. The high OR at 2 weeks was partly attributable to maternal alcohol consumption. For non-smokers, the risk was significant only at less than 8 weeks. At 2 weeks of age, the OR for bed sharing if the mother did not smoke was 2.4 (CI1.2, 4.6). After complete analysis of all factors, the authors concluded that, despite unavoidable disadvantages, most of these deaths might not have occurred had

these infants been put down supine in a cot in the parent's room with light bedding that the baby could not get over its head.

The major disadvantage of the study is that the definition of bed sharing was bed sharing for most of the night, which leads to a very low prevalence in both the control and the exposed group. The strengths of the study are many and include the number of cases enrolled --which is high enough, the fact that data was collected on both routine bed sharing and bed sharing for the last sleep and the examination of smoking (both maternal and paternal) before, during and after pregnancy. The very large dataset allowed for the study of the effect of age. This is one of the three studies reporting that young age (less than 8 weeks) contributed to the risk of bed sharing.

Overall, there were 11 original studies reporting from different dataset for which ORs (and 95% confidence intervals) were provided for bed sharing data.[14,17,19,22,27,47,48,53,54,59,63] The results can be grouped as follows:

- Five studies reported a non-significant OR for bed sharing in multivariate analysis [14,17,19,53,63], four of these five studies[14,17,53,63] used *routine practice* as their definition of bed sharing.
- One study[48] reported a non significant odd ratio when parents were bed sharing (last sleep) but a significant one for any bed sharing (with anyone including siblings).
- Five studies reported a significant OR for bed sharing (2 reported only OR for univariate analysis[22,54] and 3 for multivariate analysis[27,47,54]); four of the five

studies used bed sharing during last sleep/reference sleep [27,47,54,59] as their definition of bed sharing.

As mentioned in the Methods section, when there is significant interaction between a factor and bed sharing (smoking for instance) an association between bed sharing and SIDS (as summarized above) might not be meaningful. We will therefore explore factors investigated for interactions in the following section.

Bed sharing as a risk factor for SIDS

Studies that investigated an association between bed sharing and SIDS, ignoring potential interactions with bed sharing, are summarized in Table 17. The choice of variables matched for in the design and adjusted for in the analysis varied widely between studies, as did definitions of bed sharing. Reported associations between bed sharing and SIDS, ignoring potential interactions, also varied widely between studies, as well as between definitions of bed sharing within studies.

Table 17 - Bed sharing as a risk factor for SIDS

Study Identification	Factor(s)	(N=) Cases/Controls	OR (low to hi; 95% CI)	Adjusted/matched variables
Arnestad, M[53] (2001)	Co-sleeping usual mode of sleep	Cases = 174 Controls = 375	1.66 (0.57 to 4.85)	Matched for age, sex Adjusted for birth weight, gestational age, birth order, breast feeding over three months, waking at night, sleeping position, dummy use, mother's and father's smoking habit during pregnancy, and social class/occupational status at the time of pregnancy
Blair, PS[19] (1999)	1. Bed sharer (at end of sleep) 2. Sofa sharer 3. Bed sharer (put back in own cot)	Cases = 321 Controls = 1299	1. 9.78 (4.02 to 23.83) 2. 48.99 (5.04 to 475.60) 3. 0.67 (0.22 to 2.00)	Matched for birth date (within ± 2 weeks) Adjusted for maternal age, parity, gestational age, birth weight, multiple births, unemployment, overcrowding, maternal smoking during pregnancy, paternal smoking, paternal drug use, daily postnatal exposure to tobacco smoke, previous episode of apparent life-threatening event according to parents, maternal anxiety over infant becoming too hot, infant put down in prone or side position for last sleep, infant being found after last sleep with bedcovers over head, use of dummy for any part of last sleep, use of pillow, recent maternal alcohol consumption before last sleep, parental estimate of poor health, parental tiredness, change in routine affecting infant, non-parental carer, sleeping under duvet and thickness.

Study Identification	Factor(s)	(N=) Cases/Controls	OR (low to hi; 95% CI)	Adjusted/matched variables
Brooke, H[63] (1997)	Routinely sleeps with parents	Cases = 201 Controls = 276	2.9 (0.75 to 11.26)	Matched for age, season, maternity unit Adjusted for exposure to smoking, does not regularly change position during sleep, old mattress used at night, maternal age <27, deprivation score of 7, drug treatment in previous week, routine position put down to sleep, has moved under bedclothes, unmarried mother, social class IV or V, male sex, cot bumper not used routinely, any symptoms in previous week, gestation <=36 weeks, was usually swaddled in previous week, other infant death in family, usually sweaty on waking, tog value >=10, mother left school aged <=16, not currently breast fed, two or more previous live births, birth weight <2.5kg
Carpenter, RG[54]{ (2004)	Sharing in last sleep	Cases = 745 Controls = 2411	2.93 (2.3 to 3.72)	Matched for none Adjusted for centre
Hauck, FR[48] (2003)	1. Shared bed with mother alone or with mother and father 2. Shared bed in other combinations 3. Shared bed with anyone	Cases = 260 Controls = 260	1. 1.4 (0.7 to 9.4) 2. 3.6 (1.4 to 9.4) 3. 2.0 (1.2 to 3.3)	Matched for maternal race/ethnicity, age at death/interview, birth weight Adjusted for maternal age, marital status, education, index of prenatal care, pacifier use, soft sleep surface, maternal smoking in pregnancy, prone sleep position, pillow use
Iyasu, S[17] (2003)	Bed sharing with parent	Cases = 33 Controls = 66	1.1 (0.5 to 2.6)	Matched for postnatal age, community or reservation of residence Adjusted for none

Study Identification	Factor(s)	(N=) Cases/Controls	OR (low to hi; 95% CI)	Adjusted/matched variables
Kelmanson, IA[66] (1993)	1.Sleeps at night in bed with parents 2. Sleeps at night with brother or sister	Cases = 48 Controls = 48	1. 15.8 (NR) 2. 5.3 (NR)	Matched for sex, age, geographical distribution Adjusted for none
L'Hoir, MP[62] (1998)	NR	Cases = 73 Controls = 146	1.78 (0.58 to 5.50)	Matched for date of birth Adjusted for none
McGarvey, C[47] (2003)	1. Co-sleeping last/reference sleep period (including only infants who were co-sleeping specifically at the time of death/awakening 2. Bed-sharing during last sleep period (put back in cot) 3. Bed-sharing during last sleep period (bed sharing entire sleep period) 4. Co-sleeping usual practice (night)	Cases = 203 Controls = 622	1. 16.47 (3.72 to 72.75) 2. 1.29 (0.41 to 3.95) 3. 9.28 (1.69- to 50.90) 4. 4.31 (1.07 to 17.37)	Matched for date of birth, geographical location Adjusted for maternal age, education, smoking and drinking during pregnancy, social disadvantage, z scores for weight by gestation, whether breast feeding was initiated at birth, baby being ill, crying/colic problems, symptoms in 48h prior to last/reference sleep, tog of bed covering $\geq$ 10, use of pillows, duvets, prone position, absence of routine soother use during the last/reference sleep period.
Mitchell, EA[59] (1992)	Sharing bed in last or nominated sleep	Cases = 393 Controls = 1592	2.02 (1.35 to 3.04)	Matched for none Adjusted for region, time of day, baby's age, antenatal class, months pregnant when mother started attending antenatal clinic, school-leaving age of mother, marital status of mother, sex of baby, admission to neonatal unit, number of previous pregnancies, socio-economic status, birth weight, gestational age, race of

Study Identification	Factor(s)	(N=) Cases/Controls	OR (low to hi; 95% CI)	Adjusted/matched variables
				baby, season, mother's age at first pregnancy, mother's age at birth, sleeping position, maternal smoking, breast feeding
Mitchell, EA[22] (1997)	1.Factor bed sharing (2 months) 2. Factor bed sharing (initial)	Cases = 127 Controls = 922	1. 2.43 (1.24 to 4.69) 2. 1.76(1.11 to 2.78)	Matched for none Adjusted for none
Schellscheidt, J[27] (1997)	Slept in parental bed	Cases = 59 Controls = 156	3.3 (1.1 to 9.8)	Matched for age (within 4 weeks) and sex Adjusted for none
Tappin, D[64] (2002)	Sharing bed, couch, or chair during last sleep	Cases = 117 Controls = 265	3.62 (1.69 to 7.77)	Matched for birth date, maternity unit Adjusted for deprivation category, maternal age, parity, admitted neonatal intensive care, infant age, use of dummy during last sleep, exposure to smoking, position placed to sleep, infant mattress used, number of users, mattress used in same or other home, mattress used in last sleep and not sharing used

Because interactions were not modeled in these results, however, a cautious interpretation is required. As noted previously, in the presence of a significant interaction, an association based on a model ignoring the interaction is misleading. Furthermore, because these are observational studies, the problem of residual confounding due to other unknown or unaccounted-for differences between the bed sharing and non-bed sharing populations cannot be discounted.

Factors Investigated for Interactions with Bed sharing, as a Risk Factor, for SIDS

Smoking

While the investigation of interactions is one of the objectives of the present work, reports of interactions frequently lacked sufficient detail for our purposes. It was often unclear from reports exactly which interactions had been considered[27,63], whether statistical tests of these interactions had been performed[22], and what other combinations of variables were included in the model[22,47,53] Unless an interaction was of specific interest to the authors of a report, the information provided was often sparse. When interactions were reported, it was not always clear if they were statistically significant.[19,22,54] When interactions were not found to be statistically significant, further information such as a p-value was often not reported.[14,17,48] From the perspective of potential meta-analysis, this selective reporting poses a problem akin to publication bias, in which statistically non-significant study results may not be available. Pooling only the available results may lead to bias. In part, for this reason, formal meta-analytic pooling was not conducted.

For the outcome of SIDS, the most frequently investigated interaction with bed sharing was smoking (most commonly by the mother either during pregnancy or postpartum). For the purpose of reporting interactions, we have listed the primary publication. The source publication of the data has been noted below the table. A total of 10 studies provided data on interactions for smoking.[14,17,19,22,47,48,53,54,59,63] Due to varying definitions of exposure (e.g. maternal smoking during pregnancy or postpartum), a total of 15 investigations of this interaction are summarized (Table 18).

Table 18 - Interactions between smoking and bed sharing as a risk factor for SIDS

Author	Smoking	Bed sharing	Cases	Controls	Odds ratio: with smoking¶	Odds ratio: without smoking	Interaction ratio¶	Significant
Mitchell[22]	maternal smoking at first contact	first contact	79	679	2.98‡ (5.01/1.68)	0.55 (0.17,1.78)	5.42# (5.01/(0.55x1.68)	NC
Mitchell[22]I	maternal smoking at 2 months of age	2 months of age	38	588	3.51‡ (5.02/1.43)	1.03 (0.21,5.06)	3.41# (5.02/(1.03x1.43)	NC
Carpenter[54]	maternal smoking last occasion	all night with an adult on last occasion	745	2411	between 7.28 and 11.64*	1.56 (0.91,2.68)	between 4.67 and 7.46*	S
Arnestad[53]	maternal smoking during pregnancy	at time of death	174	375	-	-	8.63 (1.87,39.85)	S
Mitchell[59a]	mother smoked in last 2 weeks	last 2 weeks	393	1592	2.77‡ (3.94/1.42)	1.73 (1.11,2.7)	1.60# (3.94/(1.73x1.42)	NS
Mitchell[59a]	mother smoked in last 2 weeks	last sleep	391	1584	2.94‡ (4.55/1.55)	0.98 (0.44,2.18)	3.00# (4.55/(0.98x1.55)	S
Mitchell[59₂]	maternal smoking	for the nominated sleep/death and usually bed shared	370	1550	2.81 (1.93,4.09)	0.38 (0.14,1.05)	7.39¥ 2.81/0.38	S
Mitchell[59₂]	maternal smoking	for the nominated sleep/death when usually slept alone	370	1550	10.09 (2.16,47.06)	1.24 (0.15,10.17)	8.14¥ 10.09/1.24	NS
Iyasu[17]	maternal cigarette smoking	usual	33	66	-	-	-	NS

Author	Smoking	Bed sharing	Cases	Controls	Odds ratio: with smoking¶	Odds ratio: without smoking	Interaction ratio¶	Significant
Klonoff-Cohen[14]	passive smoking (mother, father, live in adult, or daycare provider)	routine	200	200	-	-	-	NS
Brooke[63]	maternal smoking	routine	147	276	-	-	-	S increase
McGarvey[47]	maternal smoking during pregnancy	last sleep period	203	622	-	-	29.23 (2.69,316.78)	S
Blair[19]	at least one parent smokes (at time of interview)	found bed-sharing (or bed shared during reference sleep)	325	1300	2.31‡ 12.35/5.34	1.08 (0.45,2.58)	2.14# (12.35/(5.31x1.08)	NC
Hauck[48]	maternal smoking during pregnancy	reference sleep	260	260	-	-	-	NS
Hauck[48]	maternal smoking postpartum	reference sleep	260	260	-	-	-	NS

* Because results were partially reported according to number of cigarettes smoked per day (<10 or >10), it was not possible to properly recover these odds ratios. The ranges quoted are based on an approximation.
¶ Confidence intervals generally not available due to reporting, where available reported 95% (hi,low)
- Not reported and not estimable
ª Results from Scragg[4], ² Results from Schluter[37]
‡ calculated as ORsb/ORs; # calculated as ORsb/(ORsxORb); ¥ calculated as ORb (smoker)/Orb (nonsmoker)
ª Results from Scragg[13]
² Results from Schluter[82]

Reported interaction ratios are all greater than 1 (range 1.6 to 29.23), suggesting that the association between bed sharing and SIDS is greater among smokers than non-smokers. Of the fifteen, interaction ratios, 6 were statistically significant[47,53,54,63,83], 6 were not statistically significant[14,17,48,59] and three were unclear [19,22] Interaction ratios are not available for a number of studies (primarily those where the interaction was

reported to be statistically non-significant) and might be substantially lower in these cases. [14,17,48,63] Because of the way results are reported in the studies, the confidence interval is not consistently available for the odds ratio among smokers. In total 6 such confidence intervals were not available. [19,22,54,59] Two confidence intervals were available for the odds ratio among smokers and both were statistically significant.[59] Of 8 odds ratios among non-smokers[19,22,54,59], only one[59] was statistically significant.

On the basis of these results, it appears that there is a relationship between bed sharing and SIDS among smokers, but among non-smokers no clear relationship between bed sharing and SIDS has been identified. This does not mean that no relationship between bed sharing and SIDS exists among non-smokers, but simply that existing evidence does not convincingly establish such a relationship.

Additional factors investigated for interactions with bed sharing and SIDS

A large number (20) of other factors (not including smoking) were reported. Unfortunately, for most factors only one estimated interaction was available. We summarized these estimated interactions in Table 19.

Table 19 - Additional factors investigated for interactions with bed sharing as a risk factor for SIDS

Factor	Total number of studies	Significant (direction)	Unclear	Non-significant
Maternal alcohol consumption	3		Carpenter, RG[54] (2004)	Iyasu, S[17] (2002), Klonoff, H[14] (1995) Scragg et al.[13] (1993)
Maternal recreational drug consumption	1			Klonoff, H[14] (1995)
Age of infant	3	Carpenter, RG[54] (2004)(decrease) Blair, PS[19] (1999) (decrease) Mc Garvey, C[47] (2003) (decrease)		
Birth weight	1			Arnestad, M[53] (2001)
Daytime	1	Williams, SM[83] (2002)(decrease)		
Weekend	1			Mitchell, EA[59] (1992)
Away from home	1			Schluter, PJ[65] (1998)
At least 2 layers of clothing	1			Iyasu, S[17] (2002)
At least 2 layers of covers	1			Iyasu, S [17] (2002)
Use of duvets	1			McGarvey, C[47] (2003)
Tog of bedding>=10	1			McGarvey, C[47] (2003)
Pillows used	1			McGarvey, C[47] (2003)

Factor	Total number of studies	Significant (direction)	Unclear	Non-significant
Found prone	1			McGarvey, C[47] (2003)
Absence of routine soother use	1			McGarvey, C[47] (2003)
Breast feeding initiated at birth	1	McGarvey, C[47] (2003) (decrease)		
History of illness since birth	1	McGarvey, C[47] (2003) (decrease)		
Symptoms in 48h prior to death	1			McGarvey, C[47] (2003)
Social disadvantage	1			McGarvey, C[47] (2003)
Surface softness	1			McGarvey, C[47] (2003)
Sofa	1		Blair, PS[19] (1999)	

There were 25 interactions reported. Of those, 6 were statistically significant[19,47,54,83], 17 were not statistically significant[14,17,47,53,59,65], and 2 were unclear.[19,54] Of the 6 estimated interactions that were statistically significant, it is of interest to note that 3 of them[19,47,54] were for age of infant, and were all in the same direction, namely indicating a decreased association between bed sharing and SIDS with increasing age. The other 3 statistically significant interactions were for daytime[83] (indicating a decreased association between bed sharing and SIDS during the daytime); breast feeding initiated at birth[47] (indicating a decreased association between bed sharing and SIDS for mothers who initiated breast feeding at birth); and history of illness

since birth[47] (indicating a decreased association between bed sharing and SIDS for infants who had a history of illness since birth). For the interaction between history of illness since birth and bed sharing, the authors of the report comment that this raises the question of whether some babies are taken into the parental bed specifically due to illness, and speculate that it may have been the illness rather than bed sharing per se which is the cause of death.

The study outcomes for both (1) smoking interactions and (2) additional factors investigated for interactions with bed sharing as a risk factor for SIDS are summarised in the tabled 17 and 20. These tables include data pertaining to the number of cases and controls, the ratio of odds ratios, and variables that were either matched or adjusted for.

Table 20 - Risk factors (other than smoking) investigated as risk factors associated with bed sharing as a risk factor for SIDS

Study Identification	Factor(s)	(N=) cases/controls	OR (low to hi; 95% CI)	Adjusted/matched variables
Arnestad, M[53] (2001)	Birth weight	Cases = 174 Controls = 375	NS (p=0.18)	Birth weight, gestational age, birth order, breast feeding over three months, waking at night, sleeping position, dummy use, mother's and father's smoking habit during pregnancy, and social class/occupational status at the time of pregnancy
Blair, PS[19] (1999)	Age of infant	Cases = 325 Controls = 1325	0.90 per week (statistically significant decrease in association as age increases)	None
Carpenter, RG[54] (2004)	1. Maternal alcohol consumption in last 24 hours 2. Age of infant	Cases = 745 Controls = 2411	1. Unclear statistical significance. Increase in association in presence of maternal alcohol consumption. 2. 0.95 per week (p=0.002 decrease in association as age increases)	Age, centre, position last left, other smoking, dummy use, history of apparent life-threatening events, sex, multiple birth, birth weight, admitted to special care baby unit, urinary tract infection in pregnancy, mother's age, previous live births, marital status, partner unemployed
Iyasu, S[17] (2002)	1. Maternal alcohol consumption 2. At least 2 layers of clothing 3. At least 2 layers of covers	Cases = 33 Controls = 66	NS at 0.10 level	none.

Study Identification	Factor(s)	(N=) cases/controls	OR (low to hi; 95% CI)	Adjusted/matched variables
Klonoff-Cohen H[14] (1995)	1. Maternal alcohol consumption 2. Maternal drug use	Cases = 200 Controls = 200	NS	Matched for birth hospital, date of birth, sex, race Adjusted for routine sleep position, birth weight, medical conditions at birth, passive smoking, exclusive breast feeding, intercom use, maternal age and education
McGarvey, C[47] (2003)	1. Use of duvets 2. Tog bedding (≥10) 3. Pillow used 4. Absence of routine use of soother 5. Found prone 6. Breast feeding initiated at birth 7. History of illness since birth 8. Symptoms in 48h prior	Cases = 203 Controls = 622	1. 0.44 (0.10, 1.90) 2. 1.10 (0.28, 4.25) 3. 0.55 (0.15, 1.94) 4. 0.51 (0.13, 2.01) 5. 0.21 (0.38, 1.20) 6. 0.41 (0.03, 0.80) 7. 0.30 (0.09, 0.97) 8. 0.46 (0.11, 1.84)	None.

[6] Social disadvantage index scoring system 0-5 (5 being most disadvantaged) which was devised by adding a score of 1 for each of the following: having a medical card, being in a rented accommodation (excluding private), not having a car, both parents unemployed, and mother on social welfare.

Study Identification	Factor(s)	(N=) cases/controls	OR (low to hi; 95% CI)	Adjusted/matched variables
	to death/awakening 9. Social disadvantage (3-5[6]) 10. Placed in the prone position		9. 0.68 (0.15, 3.04) 10. OR not available from report	
Schluter, PJ[65] (1998)	Co-sleeping away from home	Cases = 393 Controls = 1592	0.94 (NS)	None.
Williams, SM[83] (2002)	Co-sleeping daytime	Cases = 368 Controls = 1558	0.33 (p=0.013 decrease in association during the daytime)	SES, marital status, school leaving age, mother's age at birth of infant, antenatal class attended, months pregnancy when mother started attending antenatal classes, number of previous pregnancies, mother's age at first pregnancy, sex of baby, ethnicity, birth weight, gestation, region, baby's age time of death/nominated time, season, sleeping position, maternal smoking, breast feeding.

Benefits

Through an iterative process with our technical expert panel and clinical content experts, we chose to examine three child related benefits of bed sharing (breast feeding, sleep-related issues, and parent-child bonding). Studies identified by our searches are summarized below.

Breast feeding

Our searches identified a total of 3 studies (in 4 publications) that examined the impact of bed sharing on the practice of breastfeeding.[15,71,73,89] All were prospective cohort in design and were published between 1999 and 2004. The studies had diverse representation from England[89], USA [15,71] and New Zealand [73] and were also heterogeneous in terms of follow-up time interval with a range from 3 months and the longest interval being 18 years. The ethnicity of the study populations were similar with Caucasian subjects being the predominant representation while one included African American non-Hispanic, Hispanic and Asian participants [15]. Maternal age was reported in 3 studies [15,71,73]. Birth weights and gestational age were not recorded in 2 studies.[71,89] Parents were interviewed at home in 1 study[89], by telephone [73] and by mailed questionnaire. [15] The most extensive assessments included home observations, child assessments, school grades and parent and adolescent questionnaires and interviews. [71]

Within the studies, breast-feeding was most likely to be defined in quite general terms e.g., any breastfeeding [71,73]; however, one study defined it as ‘present if it occurred within the previous 24hours. [15]

McCoy et al., 2004 [15] was a large US study of 2 urban populations of (N = 10,355) infant-mother pairs who were predominantly Caucasian (77.7%), but also included non-Hispanic Blacks (8.7%), Hispanics (8.8%) and Asians (4%). The objective of the study was to determine the prevalence of bed sharing and its association with maternal and infant characteristics during the first 6 months of life. Questionnaires were mailed at 1, 3 and 6 months. The proportion of infants who both breastfed for most of the previous night and shared a bed with a parent decreased with increasing infant age (13% at 1 month, 7% at 3 months, 5% at 6 months). The overall prevalence of breast-feeding also declined during this time (53% at 1 month, 39% at 3 months, 26% at 6 months). In contrast, bed sharing among those who did not breastfeed remained fairly constant (7% at 1 month, 6% at 3 months and 7% at 6 months At 1 month, the prevalence of bed sharing and breastfeeding combined was almost twice that of isolated bed sharing whereas at 6 months the two prevalence estimates were approximately the same. Breastfeeding was also associated with bed sharing between one to six months of life (adjusted for race/ethnicity, breastfeeding, maternal age, marital status, maternal education, income, tobacco smoke exposure, language spoken at home, parity, season, enrolment site, and year of birth) OR 3.6 (95% CI 3.0, 4.2). Although absolute rates of breastfeeding and bed sharing decreased with infant age, the approximate threefold odds ratio for breastfeeding and bed sharing remained consistent over the three time points, indicating that breastfed infants were more likely to bed share at all ages.

Three studies examined bed sharing and its impact on the duration of breastfeeding in mother-infant pairs. [71,73,89] Ball et.al.,[89] studied 253 mother-infant pairs

in order to examine how parents manage night time feedings during the first 4 months, with a particular focus on the relationship between breast feeding, infant sleep location and sleep bout duration. Mother and their healthy infants were recruited from the postnatal ward in a hospital in the north of England. Mothers were asked to complete a set of 7 sleep logs at home, over a period of 7 consecutive days during their infant's first and third month of life. Along with these logs, information regarding bed sharing and breastfeeding were collected through face-to-face interviews at the end of each of the first and third months. Breastfed infants could be categorised in several ways: 'ever breastfed', 'currently breastfed', breastfed for a particular time', 'breastfed exclusively', 'breastfed in conjunction with artificial formula' and 'breast milk fed' to differentiate expressed breast milk. Sleep logs showed that 65% of infants who had 'ever breastfed' slept in their parent's bed (at least occasionally), whereas only 33% of 'formula fed' infants did so. For infants who were 'breastfed' for a month or more, the association with breast-feeding was even greater (72% of these infants were bed sharers compared with 38% of formula fed infants, $p < 0.0001$). The data also suggest that bed sharing prolongs the duration of breastfeeding, particularly for mothers likely to give it up. The proportion of mother's breastfeeding declined less steeply over 16 weeks for bed sharers than for non bed sharers with 27% (16/60) of non-bed sharers vs. 46% (41/90) of bed sharers continuing to breastfeed until at least 16 weeks. The association between bed sharing at 1 month and breastfeeding to at least 16 weeks was significant ($p = 0.02$). The data also suggests that bed sharing prolongs the duration of breastfeeding, particularly for those mothers who are likely to give it up (i.e. mothers in Occupational Class 5 and among those who were unemployed who bed shared with

their infants (10 weeks), compared with those who were not (3 weeks)(p= 0.032). Another study which examined bed sharing and duration of breastfeeding was carried out by Vogel et. al.[73] This study examined (N = 350) mainly Caucasian middle-class infant-mother pairs from New Zealand who were contacted by telephone at 1, 2, 3, 6, and 12 months in order to identify factors associated with breast-feeding duration. Full breast feeding was defined as infants receiving breast milk with or without supplements of water or juice, but without formula, other milk or solids. Adjusted risk ratios for shorter duration of breastfeeding were maternal age <25 years, planned duration of 6 months or less of breast feeding, or those with no plan, daily pacifier use, or use of formula in the first month. They found that there were few (3.8%) infants who bed shared at 3 months for 'most of the night'; and the authors report that these infants breastfed for significantly longer durations than other non-bed sharing infants (adjusted for maternal age <25, 25-34, marital status, parity, income, full-time work, smoking, planned time of cessation of breastfeeding, inverted nipples, self-reported mastitis, daily use of dummy in the first month, sharing bedroom with mother at 3 months, bed sharing with mother at 3 months) RR 0.30 (95% CI 0.11, 0.83).

The very low rate of bed sharing noted in this study is likely due to a national campaign that discourages bed sharing as way to reduce the risk of SIDS.

A unique study examining the impact of bed sharing on breastfeeding was conducted by Okami et al. in a longitudinal prospective cohort study.[71] This study included 205 Californian infants who were categorized as either living in conventional or non-conventional families and were followed from birth in 1975 to 18 years of age. Non-conventional families were those supporting natural values that include a de-emphasis

on materialism, use of prolonged breastfeeding and the practice of more “natural” child care practices including bed sharing. The objective of the study was to assess outcomes and correlates of bed sharing. Sixteen waves of longitudinal data were collected and involved both parental and child interviews. Of the 181 families with complete data on breastfeeding frequency, 89.5% indicated that they breastfed at least some of the time. Bed sharing was not significantly correlated to the binary measure (p-value NR), but was related to the duration of breastfeeding ($r=.17$, $p<0.05$).

All three studies concluded that there was relationship between bed sharing, and all are in the direction of a ‘positive effect’ (i.e. increased duration of breastfeeding), however, it is difficult to make any definitive conclusions based on the relatively small number of observational studies we examined, and the heterogeneity (inconsistency) between studies. The data cannot clarify the issue of ‘causality’. It is difficult to make the assumption of whether a. bed sharing promotes breastfeeding or whether b. breastfeeding promotes bed sharing. Although the data appear to support the hypothesis that bed sharing promotes breastfeeding, it is possible that these data simply reflect the propensity for women who are most likely to practise prolonged breastfeeding to also prefer bed sharing.

Bonding

There were no studies that examined the relationship between bed sharing and bonding, which included a contemporaneous comparator, identified by our review. The association between attachment and bed sharing has not been systematically studied.

Bed sharing .and sleep related issues

Our searches identified 5 studies that examined bed sharing and sleep-related issues [67,68,70,71,74;]. Four studies[67,68,70,71] examined infant sleep/wake patterns or problems (i.e. night wakings) and two examined infant sleep physiology.[67,74]

Infant sleep/wake patterns

The studies that examined infant sleep/wake patterns[67,68,70,71] were published between 1996 – 2004 and had diverse socioeconomic representation from the US[68,70] and New Zealand.[67] Two studies were case-control in design and all three included infant aged from 5 weeks to 48 months.

In one study by Mao et.al.,[70] 3-15 month old healthy infants were studied to determine whether bed sharing infants displayed differences in time spent in active versus quiet sleep and in the number of night awakenings compared with solitary sleeping infants. Nine bed sharing and 9 solitary sleeping infants were matched on age, gender, ethnicity, maternal age and family socioeconomic status (SES). Exclusion criteria were any abnormal pregnancy or delivery, chronic health problem in the mother or infant or if either parent had a sleep problem. Video recordings of nighttime sleep were made. The results indicated that across age co sleeping infants had significantly more awakenings per night [mean 5.8 +/-1.50 vs. 3.2 +/-1.95; t = 3.16 (p = .0006)). The percentage of nighttime spent awake did not differ between groups suggesting that though co sleeping infants awoke more frequently, they had shorter awakenings. It is not possible to draw a conclusion on the clinical significance of this data.

Another study was primarily designed to identify differences in thermal characteristics between bed sharing and crib sleeping infants.[67] Although the primary

focus of the report was not examining night wakings, they do however, report night wakings as a distal measure. Forty bed sharing infants were recruited through postnatal organizations and the media whereas the 40 crib-sleeping infants were recruited from the postnatal ward of the local maternity hospital, matched on age and season. All infants were without pre or postnatal complications and were aged 5-27 weeks at the time of study. Overnight video and physiological data of the infants were recorded in the infant's own home. The results are consistent with the previously-mentioned study[70] and showed that bed sharing infants woke more frequently than crib sleeping infants (mean wake times/night: 4.6 v 2.5) although the total time awake did not significantly differ between groups [bed sharers N=38 (mean, range) 4.6 (1-10) cot-sleeping 2.5 (0-7) RR 2.32 (95% CI 1.76-3.06) $p<0.001$]. Again the clinical significance of this data is not known.

The final study examined ethnic and socio-economic differences in the relationship between bed sharing and sleep problems in the US[68] The sample consisted of 186 urban families with a healthy 6 – 48 month old child grouped as follows: Caucasian lower SES (n = 40), Caucasian higher SES (n = 54), African American lower SES (n = 43) and African American higher SES (n = 47). The children were recruited at well care appointments at paediatric facilities. Parental interviews lasting 30 – 45 minutes concentrated on children's sleep patterns over the one-month prior to the interview. Within each study group, the proportion of co sleeping children with night wakening occurring 3 or more times per week was approximately double that of the non-co sleeping children. The difference was remarkable for lower SES Caucasians (75% vs. 29% p = .006), was suggestive trend for higher SES African

Americans (46% vs. 21% p = .008) and was of similar magnitude for higher SES Caucasians but was not statistically significant because of small numbers of regular co sleepers in this group (50% vs. 25% p = .2).

All studies have shown that co sleeping infants have an increased number of awakenings when compared to solitary sleeping infants. Two of the studies[67,70] showed that the awakenings were shorter in the co sleepers than the solitary sleepers.

Infant sleep problems

In addition to night waking, Lozoff et al.,[68] asked about the presence of stressful sleep problems which were considered to exist if bedtime protests and/or night wakings occurred regularly and were accompanied by conflict, frustration, or distress for the child or parents. Among lower SES Caucasian families, stressful or conflictual sleep problems were reported more frequently among bed sharing than non-bed sharing children. In bed sharing black families, regardless of SES, there was no increase in reports of conflictual sleep problems. Among bed sharing families overall (combining SES groups), Caucasian families were more likely than black families to consider the child's sleep behavior to be a problem, i.e. conflictual, distressing or upsetting as well as regularly occurring (56 vs. 23% p=.01).

The study shows that ethnicity and socioeconomic status must be considered when trying to understand patterns of bed sharing and their relationship to early childhood sleep problems.

One other study examined sleep problems as a secondary outcome of the study. Okami, et al.[71] reported that there was no significant association between bed sharing at 5 months with measures for any sleep problems at 2 and 3 years. Likewise sleep

problems at age 2 and 3 years did not predict bed sharing from ages 3 to 6 years. There were only a few reports of any sleep problems beyond age 3 years; less than 3% of all families reported any sleep problems at ages 4 and 6.

Infant homeostasis and sleep physiology

Infant homeostasis and infant sleep physiology were studied in two papers. These studies were included to inform the reader as to other possible contributing factors reported within the bed sharing literature. Baddock et al studied the thermal environment in a home setting and showed that bed sharing infants (5-27 weeks) were in a significantly warmer environment (more bedding and closer to an adult) and more likely to become face covered than cot sleeping infants, but were able to maintain adequate thermoregulation to maintain a normal core temperature. The mean rectal temperature two hours after sleep onset for bed sharing infants was 36.79°C and for cot-sleeping infants 36.75°C (difference of 0.05°C, 95% CI -0.03, 0.14). The rate of change was higher in bed sharers thereafter (0.04°C vs. 0.03°C /hour). These results however were drawn from a small sample of babies. In total, there were 40 in each of the 2 sets of infants. Of those, only 28/40 bed sharers and 28/40 cot-sleepers had rectal temperatures assessed because parents would not allow this. The limited data makes it impossible to draw any conclusions as to whether or not healthy infants are at an increased risk of overheating when bed sharing. Richard et al.,[74] found that the bed sharing sleeping condition is associated with an increase in infant (11-15 weeks) heart rate compared to the solitary sleepers in all 3 infant sleep states. An analysis of variance indicated that, irrespective of routine sleeping condition, heart rate was lower during solitary sleeping than during bed sharing in all sleep stages. In addition, heart

rate variability was found to be lower during bed sharing in Stage 1-2 and REM sleep. The main finding was that infant heat rate and variability are affected by bed sharing when sleeping with their mothers.

There is limited evidence regarding the association between bed sharing and infant sleep/wake patterns, infant sleep problems, and infant homeostasis, limiting the ability to draw definitive conclusions by which to base recommendations.

Strategies to reduce child-related harms associated with bed sharing

No primary studies examining strategies to reduce child-related harms associated with t bed sharing were identified by our searches.

Non-Comparative Studies

Our review identified 43 non-comparative studies which were met our inclusion criteria. Of those studies 8 were cross-sectional[2,91-97], 2 were prospective opportunistic samples[85,98,99] 13 were case series [52,100-111], 4 were categorized as retrospective review[29,51,112,113], 1 was an interview [114], 1 was observational[115], 9 were quasi-experimental[116-124] and 5 were not able to be classified (and were described as 'other').[18,125-128]

There is a substantial body of non-comparative literature available related to bed sharing and bed sharing. These reports provide prevalence data, event rate data, and descriptive information to the reader, but they are extremely limited in what can be reported for associations. These studies, at best, can suggest a direction of effect, but cannot define causality. It is important to highlight that among the 43 studies summarized in the tables only 17 were investigating harms associated with bed sharing,

and of those 4 were examining injuries (asphyxia, overlying) and 13 examined SIDS related factors. For benefits, a total of 25 were summarized. Of those 12 were focused on sleep-related issues (e.g., night awakenings, arousal patterns, etc.), 2 on breast feeding-related issues, and 11 examined mostly prevalence data and other topics.

Discussion

The objective of our systematic review was to determine the evidence for benefits and harms associated with the practice of bed sharing. There is an emerging literature on the benefits and harms associated with the practice of bed sharing, including the 30 case control and 12 prospective cohort studies identified by this systematic review. The largest body of evidence found by our searches were studies investigating harms associated with the practice of bed sharing, and more specifically, data examining the possible association between bed sharing and sudden infant death syndrome.

We will first summarize and discuss our findings on harms, focusing on the injury and mortality search, followed by results of the systematic review which is concerned with the studies evaluating the risk of bed sharing and SIDS as well as the benefits of bed sharing; we will then present the strengths and limitations of the review and finally discuss the implications of this evidence-based report.

Harms associated with bed sharing

We have explored two different aspects of the harms associated with bed sharing: a) injury and deaths directly associated with bed sharing; and b) bed sharing as a potential risk factor for sudden unexplained deaths.

Injury and deaths directly related to bed sharing

One of our primary questions was ‘how many child-related deaths and injuries have been directly linked with the practice of bed sharing in Canada and other comparable jurisdictions? Our searches for data on injury/mortality related to the practice of bed sharing was far from fruitful with most located data not being specific to bed sharing, and thus limiting our ability to report accurate event rates. Indeed, most of the data available from national databases do not differentiate the type of bed (e.g. adult bed or crib) in which the injuries or deaths occurred. Nevertheless, the number of deaths directly related to suffocation of Canadian infants (less than one year of age) in bed (which includes bed sharing) was found to be less than a dozen cases per year with the number of injuries being slightly higher.

The most comprehensive dataset concerning mortality is the unpublished data from the province of Quebec. It was important to examine these data because, to date, it is the first time patient-level data (full review of each case) have been examined and coded in a fashion that permits determination of event rates in infants who are bed sharing. All cases of accidental deaths in cribs and adult beds were reviewed as well as all other causes of infant deaths for a period of 10 years. The number of cases is quite small and bed sharing-related deaths represent only approximately one quarter of the total number of deaths due to suffocation/asphyxia in bed or cradle.

In summary, child-related deaths and injuries directly linked with the practice of bed sharing are not frequent occurrences in Canada. Limited data from other comparable jurisdictions seems to confirm the low prevalence.

Bed sharing as a potential risk factor for sudden unexplained deaths

In view of the impossibility of distinguishing asphyxial deaths from SIDS at autopsy,[39,40] it is therefore possible that some of the deaths classified as sudden unexplained deaths or SIDS are bed sharing related. This has led many researchers to investigate whether bed sharing is a risk factor for SIDS and this association is the major component of our systematic review.

One set of results we presented was for the association between bed sharing and SIDS, ignoring potential interactions with bed sharing. Reported associations varied greatly; and since the interactions were not modeled in these results, any interpretation of these results should be made with caution. As noted previously, in the presence of a significant interaction, an association based on a model ignoring this interaction may be misleading.

The second set of results we presented were specifically concerned the interaction between potential risk factors and bed sharing as a risk factor for SIDS. From the perspective of potential meta-analysis, the selective reporting in many of these studies posed a problem akin to publication bias, in which statistically non-significant study results may not be available. Pooling only the available results may lead to bias. In part, for this reason, formal meta-analytic pooling was not conducted. The most frequently investigated interaction with bed sharing was smoking (most commonly by the mother either during pregnancy or postpartum). Due to varying definitions of exposure (maternal smoking during pregnancy or postpartum, mother and father smoking, etc.), a total of 15 investigations of this interaction were summarized. The evidence does suggest that there may be an association between bed sharing and SIDS among smokers (however smoking status is defined); particularly when the

mother is a smoker (during pregnancy and/or after) but that this association may not be present among non-smokers. This does not mean that no relationship between bed sharing and SIDS exists among non-smokers but simply that existing evidence does not convincingly establish such a relationship.

The evidence also suggests that bed sharing may be more strongly associated with SIDS for younger infants. For this last association, we have mentioned the fact that of the three [19,47,54] studies which showed that association, the data of two of them[19,47] were included in the third. [54] This finding is also supported by the recent publication by Tappin and colleagues (July 2005) from Scotland [129] which reported an increase risk of SIDS for bed sharing infants ages less than 11 weeks.[7]

These above mentioned statements, concerning infants of non-smoking parents and younger infants, need to be qualified in that differences between study designs and limitations of both the data and reporting preclude definitive conclusions from being drawn. In particular, it is not possible to discern these conclusions because of the limited attention paid to the control of confounders present in the studies.

Although there are many data pertaining to the risk factors and harms associated with the practice of bed sharing, the results of the systematic review were difficult to interpret for a number of reasons: Firstly, the quality of the studies was fairly good, however, even the highest rated case control study cannot provide answers regarding causality because of the difficulty that arises when trying to verify temporality; that is, demonstrating that an exposure preceded the outcome, and some studies were unusable in the final report either because no data were reported for controls, no analysis of bed sharing data was performed or the study was not completed and as

[7] This study was not available at the time we did the systematic review.

such, the authors were forced to rely on a preliminary publication that incompletely reported on the relevant outcomes. Secondly, the definition of risk exposure (bed sharing and smoking) varied considerably between studies. The definitions of bed sharing included 'bed sharing on a specific night' (night of death or night before the interview), 'bed sharing as a routine practice', and 'bed sharing in the past two weeks'. The duration of bed sharing (whether it was for routine or specific night practice) varied as well. The definition used to describe the exposure to smoking was heterogeneous across studies as well with the following variations 'maternal smoking during pregnancy', 'mother smoked in previous 2 weeks', 'any parents smoking.' Attempts to compare results across these studies are therefore extremely difficult.

Studies were also, for the most part, derived from population-based case-control studies undertaken in the mid 1990s. Most of those studies were not undertaken to evaluate the risks and/or harm of bed sharing, but rather to study a variety of potential risk factors for SIDS. Typically, in the larger national-based studies, very comprehensive and complete questionnaires were administered to parents of sudden unexpected death victims and to parents of matched controls. Embedded in these questionnaires were items soliciting information on bed sharing. After completion of data collection in these large epidemiological studies, multiple papers – each relying on the same dataset but focusing on a different aspect of risk factor - were produced. Many of the studies published in this field are not hypothesis-driven. More specifically, much of the data analyses were often exploratory in nature, with bed sharing being one of many variables examined as possible risk factors; bed sharing data were reported because the data were available. In many of the reports, data were presented only narratively (i.e. 'our

findings suggest no significant interaction between factor X and bed sharing') and no numeric data were provided to substantiate these statements. This is a dangerous practice since sound conclusions are never formulated this way. It is extremely difficult to make any conclusions from these reports as they were, more often that not, intended to generate rather than test hypotheses by exploring a multitude of potential risk factors and by performing multiple tests of statistical significance.

Benefits of bed sharing

Searches for studies related to the benefits of bed sharing did not yield many studies. However, there is evidence of an association between bed sharing and breastfeeding, but the data cannot clarify the issue of causality (e.g. whether bed sharing promotes breastfeeding or whether breast feeding promotes bed sharing). The results of our systematic review suggest that they are in a positive direction of effect (i.e. increase duration of breastfeeding). Although the data appear to support the hypothesis that bed sharing promotes breast feeding, it is possible that these data reflect the propensity for women who are most likely to practice prolonged breast feeding to also prefer to bed share. The evidence also suggests that there may be an important relationship between bed sharing infants and the bed sharing adult whereby they have an increased number of awakenings during the evening when compared to solitary sleeping infants. It has been suggested, but could not be clearly determined, that these awakenings are potentially protective against SIDS, which may relate to the infants' ability to rouse. There were no studies directly examining the impact of bed sharing on bonding, which included a contemporaneous comparator, identified by our review.

Strengths and limitations of the review

It is first important to note that the scope of the review does not focus on risk factors independently associated with the benefits or harms (use of pillow and SIDS independent of bed sharing, for instance). For some risk factors there may have been a statistically significant association between the risk factor and SIDS, in which case the adjustment could have a substantial effect. However for the same risk factor, the association between bed sharing and SIDS may not vary with the risk factor, in which case there would not be a significant interaction between the risk factor and bed sharing as a risk factor for SIDS. Failure to find a significant interaction with bed sharing does not preclude the existence of a statistically significant association between a risk factor and SIDS.

Our systematic review has many strengths, which included a structured and thorough search of electronic databases, web-based organizations, coroner's offices, reference lists, and content-specific journals to retrieve an extensive body of literature. To the best of our knowledge this is the first and largest, rigorous systematic review examining benefits and harms of bed sharing in the literature. This is an important statement in that most recommendations and guidelines for bed sharing are based on non-systematic samples of evidence, which may be prone to bias. In order to further retrieve literature that perhaps is not indexed electronically, attempts were made to contact experts in the field to inquire about unpublished or 'grey' literature. All screening for literature was done in duplicate, and discrepancies in responses between reviewers were resolved through consensus.

There are also limitations within our review. Our review was limited to English-language literature. Although this is not an atypical practice for systematic reviews it should be noted that there may be published, non-English reports available which were not identified in our report. Secondly, our reporting and assessment of each study was limited to published data because no attempts were made to contact authors for additional information or missing data. In many cases, the reporting of study details was inadequate, particularly for risk factors among the bed sharers in the included studies. For example, most studies were focused on risk factors for SIDS. As such, bed sharing was listed as one component of the dataset; smoking was likely to be reported, but often, only in the total cases identified and not specifically in the total cases that were specifically bed sharing. Although these data likely exist, the process of obtaining them is not always conducive to a timely review. A recommendation is for these authors to re-publish the data pertaining to the bed sharing infants in these studies. An additional limitation to this review stems from the potential for publication bias whereby studies that demonstrate an association are more likely to be published.

Strategies to Reduce Harms

Bed sharing continues to be a controversial issue. We have already alluded to the absence of data evaluating strategies to reduce harms potentially associated with bed sharing. When injury and mortality due to entrapment or compression are considered, there have been statements from health authorities, particularly in the United States. Those concerned mostly the avoidance of adult bed for infants (not specifically in the context of bed sharing) and the use of standard cribs. However, bed sharing, especially when viewed in the context of mother-infant routine bed sharing and

breast feeding, is very complex and is surrounded by controversy. Because of this, there had been no formal recommendations to either encourage or discourage the practice of bed sharing in general in Canada until the recent statement put forth by the Canadian Pediatric Society.

New Zealand was the first country to issue recommendations against bed sharing following the publication of results from the New Zealand Cot Death Study.[130] The message specifically addressed the safety (or lack thereof) of bed sharing for smoking families and also when awareness is impaired by alcohol, marijuana or other drugs. In a follow-up case-control study (risk of SIDS)[22], the prevalence of bed sharing among control infants was shown to be 11.6% as compared to 10.5% prior to the campaign.[13] No data are available specific to the rates of bed sharing among smoking mothers/parents and as such, this precludes any determination of whether the New Zealand recommendations to not to bed share if the mother/parents smoked were followed. Therefore, the strategy of making public health recommendations to discourage bed sharing in certain situations has not been evaluated in that country.

In the USA, there have been no national recommendations. However, the Consumer Product Safety Commission, The American Academy of Pediatrics (AAP) and the National Institutes of Health (NIH) have all taken positions. The CPSC, following the publication of a case series identifying infant deaths in an adult bed,[131] stated that the only safe place for babies to sleep is in a crib that meets current safety standards. The CPSC also warned against placing babies in adult beds (solitary sleep on adult beds). There was also a statement in 2000 by a Task Force of the American Academy of Pediatrics[132] In this statement, bed sharing was not explicitly discouraged, except among infants whose

mothers who smoke. The authors listed a series of conditions associated with hazards while bed sharing and these included situations while arousal is impaired by substances like alcohol or drugs. The NIH www.nichd.nih.gov/sids also made recommendations which were similar; without explicitly discouraging bed sharing, they stated that 'for mothers who choose to bring their baby to bed for breastfeeding, it is safest to return the baby to his or her crib for sleep'. There has been no evaluation of these strategies to reduce the harms potentially associated with infant sleep on adult beds or more specifically bed sharing between infants and adults.

In the United Kingdom, a statement was published by the Department of Health in early 2004 (Department of Health with the Foundation for the Study of Infant Deaths. Reduce the Risk of Cot Death www.dh.gov.uk/publications and www.doh.gov.uk/cotdeath/index.htm). The recommendations were more explicit than those of other countries and were derived mostly from the results of the European concerted action on SIDS report. [54] It was recommended that parents should *never* bed share with their baby if he or she is less than eight weeks old, if they are a smoker, if they have been consuming alcohol, if they are taking medications that make them drowsy, or if they are extremely tired. The recommendations also included not falling asleep with the baby while sitting or lying on a sofa. Additionally, it should be noted that they recommended, for the first six months, that the safest place for a baby to sleep is in a crib, in the parents' room. There has been no evaluation of the impact of these recommendations in the UK.

In Canada, the Canadian Paediatric Society published a statement in November 2004 [133] recommending that the best place for an infant to sleep is in his/her own bed,

in the parents' bedroom for the first six months of life. There is acknowledgement that some parents will still elect to bed share with their infants, and as such, recommendations are made for safe bed sharing (similarly to recommendations from the USA and other countries). The statement review most of the type of bedding and recommendations are made against using quilt, comforters, pillows and other pillow-like items. Waterbeds, makeshift beds and sofas are discouraged as sleeping surface. Room sharing is recommended as well as the avoidance of smoking exposure. It is obviously too early to attempt at measuring the impact of these recommendations.

There are a number of additional Canadian entities working to produce statements around this controversial topic. To date, the Canadian Foundation for the Study of Infants Deaths (the SIDS Foundation in Canada) has not yet issued a statement on bed sharing (information available from one of the authors of this evidence review AC), and Health Canada is currently in the process of reviewing documents pertaining to SIDS with the intention of expanding the section on bed sharing following a workshop held in Edmonton, Alberta in July 2004 during the 8th SIDS International Conference.

Future Recommendations

a) Public Health recommendations

Based on our systematic review of the literature, can we make a general recommendation for or against bed sharing?

Our review of the case-control studies on potential harms of bed sharing highlighted the difficulties with the studies we identified by our review, the heterogeneity in the definition of bed sharing and the problems within the studies (i.e. insufficient

reporting of data pertaining to bed sharing, heterogeneity of matching/adjusting for controls, missing data, or no formal analysis). The existing evidence is conflicting and does not allow a general recommendation for or against bed sharing to be made.

Based on our systematic review of the literature, can we make a recommendation for or against bed sharing in certain circumstances?

Our review has shown that the evidence suggests that there may be an association between bed sharing and SIDS among smokers (however smoking status is defined), particularly in mothers (during and/or after pregnancy). Among non-smokers, such an association was not found. This does not mean that no relationship between bed sharing and SIDS exists among non-smokers but simply that existing evidence does not convincingly establish such a relationship. As mentioned previously, these statements should be qualified in that differences in study designs and limitations of both data and reporting preclude definitive conclusions. In particular, it is not possible to discern definitive conclusions because of the relative ill-attention paid to the control of confounders in the included studies. Bias related to confounders is inherent in any of the study designs included in this review. Therefore, we can say that there is fair evidence against the practice of bed sharing when the mother in particular is a smoker (exposure to smoking before and/or after birth).

In addition, the evidence summarized in this review also there is evidence to suggest an association between bed sharing and the practice of breastfeeding (positive direction of effect both with respect to the rate of breastfeeding as well as its duration) among bed sharing mother-infant dyads.

b) Recommendations for future studies

There has been no study in Canada on the prevalence of bed sharing in the general population of infants. As long as the prevalence of the practice of bed sharing is not known for a given population, the rate of deaths or injuries cannot be determined because it is being related to an inappropriate denominator. In addition, there has been no Canadian study that specifically addresses the potential harms or benefits of bed sharing. And, because of the absence of a high quality case-control study --in Canada or elsewhere-- designed *a priori* to test the hypothesis that bed sharing is a risk factor for sudden death, it would be next to impossible to gauge the impact of a strategy to reduce harms.

There is also a paucity of information on injury and mortality directly related to bed sharing in Canada, as well as for other countries. National statistics do not provide specific enough information, and better codification of these events might be needed. Similarly, codification, or better codification, in the databases' of provincial coroners or medical examiners' offices would be important. Bed sharing and sudden deaths are both incredibly complex issues. Research studies and designs must acknowledge the limitations in this field and be diligent to collect data that will truly answer, or at the very least, attempt to answer some of these questions. The gathering of adequate information is the key issue. To that end, there has been an international protocol agreed upon in the field of sudden infant death for the purpose of the death scene investigation [134] The protocol includes many items related to the sleeping surface and any potential bed sharers. This protocol should be adhered to by all provinces (and all countries as well).

That being said, better codification alone, for bed sharing deaths, will not solve the problem entirely. It is impossible to derive high quality data with the contribution of different factors just from databases. The issue of bed sharing and sudden death demands re-evaluation, in Canada and in those countries where national studies have already been undertaken to identify risk factors for sudden unexpected and unexplained deaths (SIDS or SUD). Indeed, most of the studies were undertaken in the early 1990s, more than a decade ago. The prevalence of bed sharing, particularly following some of the previously outlined national statements and recommendations, may have changed. It is also important that examinations include data pertaining to deprive, low socio-economic families because this group, within the published literature, now represents the majority of SIDS victims. There may be a social, as well as physiological phenomenon, occurring. Without these data it is impossible to determine primary risk factors associated with harms. The exact sleep environment of those families, as well as other potential confounders remains unknown.

Future research also needs to include accurate and detailed comparisons of solitary sleep and bed sharing in order to ascertain differences in neuroanatomical and physiological development between the two groups of infants as well as to elucidate psychological mechanisms associated with bed sharing and the co-existent exploration of interrelationships of meanings and values associated with various types of sleeping arrangements.

Reference List

(1) Abel S, Park J, Tipene-Leach D et al. Infant care practices in New Zealand: a cross-cultural qualitative study. Soc Sci Med 2001; 53(9):1135-1148.

(2) Nelson EA, Taylor BJ, Jenik A et al. International Child Care Practices Study: infant sleeping environment. Early Hum Dev 2001; 62(1):43-55.

(3) Olmstead RW. Infant care: Cache or carry. J Pediatr 1979; 95:478-483.

(4) Morelli GA, Oppenheim D, Rogoff B et al. Cultural variations in infant's sleep arrangements: questions of independence. Dev Psychol 1992; 28:604-613.

(5) McKenna JJ, Thoman EB, Anders TF et al. Infant-parent co-sleeping in an evolutionary perspective: implications for understanding infant sleep development and the sudden infant death syndrome. [Review] [123 refs]. Sleep 1993; 16(3):263-282.

(6) McKenna J. Sleep In Development and Pediatrics. New York: Marcel Dekker, 2000.

(7) Barry H, Paxton L. Infancy and early childhood: cross-cultural codes 2. Ethnology 1971; 10:466-508.

(8) Nelson EA, Schiefenhoevel W, Haimerl F. Child care practices in nonindustrialized societies. Pediatrics 2000; 105(6):E75.

(9) Hanks CC, Rebelsky FG. Mommy and the midnight visitor: a study of occasional co-sleeping. Psychiatry 1977; 40(3):277-280.

(10) Elias MF, Nicolson NA, Bora C et al. Sleep/wake patterns of breast-fed infants in the first 2 years of life. Pediatrics 1986; 77(3):322-329.

(11) Caudill W, Plath DW. Who sleeps by whom? Parent-child involvement in urban Japanese family. Psychiatry 1966; 29:344-366.

(12) Fukumizu M, Kaga M, Kohyama J et al. Sleep-Related Nighttime Crying (*Yonaki*) in Japan: A Community-Based Study. Pediatrics 2005; 115:217-224.

(13) Scragg R, Mitchell EA, Taylor BJ et al. Bed sharing, smoking, and alcohol in the sudden infant death syndrome. New Zealand Cot Death Study Group. BMJ 1993; 307(6915):1312-1318.

(14) Klonoff-Cohen H, Edelstein SL. Bed sharing and the sudden infant death syndrome. BMJ 1995; 311(7015):1269-1272.

(15) McCoy RC, Hunt CE, Lesko SM et al. Frequency of bed sharing and its relationship to breastfeeding. J Dev Behav Pediatr 2004; 25(3):141-149.

(16) Willinger M, Ko CW, Hoffman HJ et al. Trends in infant bed sharing in the United States, 1993-2000: the National Infant Sleep Position study.[see comment]. ARCH PEDIATR ADOLESC MED 2003; 157(1):43-49.

(17) Iyasu S, Randall LL, Welty TK et al. Risk factors for sudden infant death syndrome among northern plains Indians.[erratum appears in JAMA. 2003 Jan 15;289(3):303]. JAMA 2002; 288(21):2717-2723.

(18) Clements MS, Mitchell EA, Wright SP et al. Influences on breastfeeding in southeast England. Acta Paediatr 1997; 86(1):51-56.

(19) Blair PS, Fleming PJ, Smith IJ et al. Babies sleeping with parents: case-control study of factors influencing the risk of the sudden infant death syndrome. CESDI SUDI research group. BMJ 1999; 319(7223):1457-1461.

(20) Hooker E, Ball HL, Kelly PJ. Sleeping like a baby: attitudes and experiences of bedsharing in northeast England. Med Anthropol 2001; 19(3):203-222.

(21) Blair PS, Ball HL. The prevalence and characteristics associated with parent-infant bed-sharing in England. ARCH DIS CHILD 2004; 89(12):1106-1110.

(22) Mitchell EA, Tuohy PG, Brunt JM et al. Risk factors for sudden infant death syndrome following the prevention campaign in New Zealand: a prospective study. Pediatrics 1997; 100(5):835-840.

(23) Tuohy PG, Counsell AM, Geddis DC. Sociodemographic factors associated with sleeping position and location. ARCH DIS CHILD 1993; 69(6):664-666.

(24) Tuohy PG, Smale P, Clements M. Ethnic differences in parent/infant co-sleeping practices in New Zealand. N Z Med J 1998; 111(1074):364-366.

(25) Ford RP, Schluter PJ, Cowan S. Changes to infant sleep practices in Canterbury.[see comment]. N Z Med J 2000; 113(1102):8-10.

(26) Stein MT, Colarusso CA, McKenna JJ et al. Cosleeping (bedsharing) among infants and toddlers. J Dev Behav Pediatr 2001; 22(2 Suppl):S67-S71.

(27) Schellscheidt J, Ott A, Jorch G. Epidemiological features of sudden infant death after a German intervention campaign in 1992. Eur J Pediatr 1997; 156(8):655-660.

(28) Kemp JS, Thach BT. Sudden death in infants sleeping on polystyrene-filled cushions. N Engl J Med 1991; 324(26):1858-1864.

(29) Kemp JS, Unger B, Wilkins D et al. Unsafe sleep practices and an analysis of bedsharing among infants dying suddenly and unexpectedly: results of a four-year, population-based, death-scene investigation study of sudden infant death syndrome

and related deaths. Pediatrics 2000; 106(3):E41.

(30) Scheers NJ, Dayton CM, Kemp JS. Sudden infant death with external airways covered: case-comparison study of 206 deaths in the United States. Arch Pediatr Adolesc Med 1998; 152(6):540-547.

(31) Williams FL, Lang GA, Mage DT. Sudden unexpected infant deaths in Dundee, 1882-1891: overlying or SIDS? Scottish Medical Journal, 2001; 46(2):43-47

(32) Templeman C. Two hundred fifty-eight cases of suffocation in infants. Edin Med J 1892; 38:322-329.

(33) Norvenius G. Is SIDS a new phenomenon? Sudden infant death syndrome: New trends in the nineties. Scandinavian University Press, 1995: 11-14.

(34) Cote A, Russo P, Michaud J. Sudden unexpected deaths in infancy: what are the causes? J Pediatr 1999; 135(4):437-443.

(35) Wedgewood RJ, Benditt EP, editors. Sudden death in infants. Proceedings of the conference on causes of Sudden death in infants. Seattle, Washington: US department of Health, Education, and Welfare, 1963.

(36) Bergman AB, Beckwith JB, Ray CG, editors. Sudden Infant Death Syndrome. Proceedings of the Second International Conference on Causes of Sudden Death in Infants. 70; University of Washington Press, 1970.

(37) Willinger M, James LS, Catz C. Defining the sudden infant death syndrome (SIDS): deliberations of an expert panel convened by the National Institute of Child Health and Human Development. Pediatr Pathol 1991; 11(5):677-684.

(38) Sudden Infant Death Syndrome and the Sleeping position. Proceedings of the workshop on reducing the risk of SIDS in Canada. 93; Health Canada, 1993.

(39) Valdés-Dapena M, McFeely PA, Hoffman HJ et al. Histopathology atlas for the sudden infant death syndrome. Armed Forces Institute of Pathology, 1993.

(40) Christoffel KK, Scheidt PC, Agran PF et al. Standard definitions for childhood injury research: excerpts of a conference report. Pediatrics 1992; 89(6 Pt 1):1027-1034.

(41) Blair P, Fleming P. Epidemiological investigation of sudden infant death syndrome infants--recommendations for future studies. Child Care Health Dev 2002; 28 Suppl 1:49-54.

(42) Byard RW, Hilton J. Overlaying, accidental suffocation and sudden infant death. J SIDS Infant Mort 1997;(2):161-165.

(43) Beal SM, Byard RW. Accidental death or sudden infant death

syndrome? J Paediatr Child Health 1995; 31(4):269-271.

(44) Mitchell E, Krous HF, Donald T et al. Changing trends in the diagnosis of sudden infant death. Am J Forensic Med Pathol 2000; 21(4):311-314.

(45) Byard RW, Beal SM. Has changing diagnostic preference been responsible for the recent fall in incidence of sudden infant death syndrome in South Australia? J Paediatr Child Health 1995; 31(3):197-199.

(46) Bourbeau R B-GCCA. Le syndrome de mort subite du nourrisson au Québec: qualité de l'enregistrement et nouvelles estimations. Les cahiers québécois de démographie 2000; 29:307-333.

(47) McGarvey C, McDonnell M, Chong A et al. Factors relating to the infant's last sleep environment in sudden infant death syndrome in the Republic of Ireland. ARCH DIS CHILD 2003; 88(12):1058-1064.

(48) Hauck FR, Herman SM, Donovan M et al. Sleep environment and the risk of sudden infant death syndrome in an urban population: the Chicago Infant Mortality Study. Pediatrics 2003; 111(5 Part 2):1207-1214.

(49) Public Health Agency of Canada (PHAC). For the Safety of Canadian Children and Youth. 2003.

(50) Malloy MH, MacDorman M. Changes in the Classification of Sudden Unexpected Infant Deaths: United States. Pediatrics 2005;(115):1247-1253.

(51) Scheers NJ, Rutherford GW, Kemp JS. Where should infants sleep? A comparison of risk for suffocation of infants sleeping in cribs, adult beds, and other sleeping locations. Pediatrics 2003; 112(4):883-889.

(52) Office of the Chief Coroner, Province of Ontario. First report of the paediatric death review committee. 2004.

(53) Arnestad M, Andersen M, Vege A et al. Changes in the epidemiological pattern of sudden infant death syndrome in southeast Norway, 1984-1998: implications for future prevention and research. ARCH DIS CHILD 2001; 85(2):108-115.

(54) Carpenter RG, Irgens LM, Blair PS et al. Sudden unexplained infant death in 20 regions in Europe: case control study.[see comment]. Lancet 2004; 363(9404):185-191.

(55) Shojania KG, Bero LA. Taking advantage of the explosion of systematic reviews: an efficient MEDLINE search strategy. Eff Clin Pract 2001; 4(4):157-162.

(56) West R. Does blinding of readers affect results of meta-analyses? Lancet 1997; 350(9081):892.

(57) Doll R, Hill AB. Lung cancer and other causes of death in relation

to smoking; a second report on the mortality of British doctors. Br Med J 1956; 12(5001):1071-1081.

(58) Hill AB. The environment and disease: Association or causation? Proc R Soc Med 1965; 58:295-300.

(59) Mitchell EA, Taylor BJ, Ford RP et al. Four modifiable and other major risk factors for cot death: the New Zealand study. J Paediatr Child Health 1992; 28 Suppl 1:S3-S8.

(60) Findeisen M, Vennemann M, Brinkmann B et al. German study on sudden infant death (GeSID): design, epidemiological and pathological profile. Int J Legal Med 2004; 118(3):163-169.

(61) Mukai T, Tamaki N, Sato Y et al. Sleeping environments as risk factors of sudden infant death syndrome in Japan. Leg Med (Tokyo) 1999; 1(1):18-24.

(62) L'Hoir MP, Engelberts AC, van Well GT et al. Case-control study of current validity of previously described risk factors for SIDS in The Netherlands. ARCH DIS CHILD 1998; 79(5):386-393.

(63) Brooke H, Gibson A, Tappin D et al. Case-control study of sudden infant death syndrome in Scotland, 1992-5.[see comment]. BMJ 1997; 314(7093):1516-1520.

(64) Tappin D, Brooke H, Ecob R et al. Used infant mattresses and sudden infant death syndrome in Scotland: case-control study. BMJ 2002; 325(7371):1007-1009.

(65) Schluter PJ, Ford RP, Mitchell EA et al. Residential mobility and sudden infant death syndrome. J Paediatr Child Health 1998; 34(5):432-437.

(66) Kelmanson IA. An assessment of the microsocial environment of children diagnosed as "sudden infant death" using the "process" inventory. Eur J Pediatr 1993; 152(8):686-690.

(67) Baddock SA, Galland BC, Beckers MG et al. Bed-sharing and the infant's thermal environment in the home setting. ARCH DIS CHILD 2004; 89(12):1111-1116.

(68) Lozoff B, Askew GL, Wolf AW. Cosleeping and early childhood sleep problems: effects of ethnicity and socioeconomic status. J Dev Behav Pediatr 1996; 17(1):9-15.

(69) Mitchell EA, Esmail A, Jones DR et al. Do differences in the prevalence of risk factors explain the higher mortality from sudden infant death syndrome in New Zealand compared with the UK? N Z Med J 1996; 109(1030):352-355.

(70) Mao A, Burnham MM, Goodlin-Jones BL et al. A comparison of the sleep-wake patterns of cosleeping and solitary-sleeping infants. Child Psychiatry Hum Dev 2004; 35(2):95-105.

(71) Okami P, Weisner T, Olmstead R. Outcome correlates of parent-child bedsharing: an eighteen-year longitudinal study. J Dev

Behav Pediatr 2002; 23(4):244-253.

(72) Thomas KA, Burr R. Preterm infant temperature circadian rhythm: possible effect of parental cosleeping. BIOL RES NURS 2002; 3(3):150-159.

(73) Vogel A, Hutchison BL, Mitchell EA. Factors associated with the duration of breastfeeding.[see comment]. Acta Paediatr 1999; 88(12):1320-1326.

(74) Richard CA, Mosko SS. Mother-infant bedsharing is associated with an increase in infant heart rate. Sleep 2004; 27(3):507-511.

(75) Fleming PJ, Blair PS, Bacon C et al. Environment of infants during sleep and risk of the sudden infant death syndrome: results of 1993-5 case-control study for confidential inquiry into stillbirths and deaths in infancy. Confidential Enquiry into Stillbirths and Deaths Regional Coordinators and Researchers. BMJ 1996; 313(7051):191-195.

(76) Wailoo M, Ball H, Fleming P et al. Infants bed-sharing with mothers. ARCH DIS CHILD 2004; 89(12):1082-1083.

(77) Mitchell EA, Stewart AW, Scragg R et al. Ethnic differences in mortality from sudden infant death syndrome in New Zealand. BMJ 1993; 306(6869):13-16.

(78) Scragg R, Stewart AW, Mitchell EA et al. Public health policy on bed sharing and smoking in the sudden infant death syndrome. N Z Med J 1995; 108(1001):218-222.

(79) Mitchell EA, Thompson JM, Ford RP et al. Sheepskin bedding and the sudden infant death syndrome. New Zealand Cot Death Study Group. J PEDIATR 1998; 133(5):701-704.

(80) Becroft DM, Thompson JM, Mitchell EA. Nasal and intrapulmonary haemorrhage in sudden infant death syndrome. ARCH DIS CHILD 2001; 85(2):116-120.

(81) Scragg RK, Mitchell EA, Stewart AW et al. Infant room-sharing and prone sleep position in sudden infant death syndrome. New Zealand Cot Death Study Group.[see comment]. Lancet 1996; 347(8993):7-12.

(82) Schluter P, Ford R, Mitchell E et al. Novel events and sudden infant death syndrome. Ambulatory Child Health 2000; 6(Suppl 1):24-25.

(83) Williams SM, Mitchell EA, Taylor BJ. Are risk factors for sudden infant death syndrome different at night? ARCH DIS CHILD 2002; 87(4):274-278.

(84) Williams SM, Mitchell EA, Scragg R. Why is sudden infant death syndrome more common at weekends? The New Zealand National Cot Death Study Group.[see comment]. ARCH DIS CHILD 1997; 77(5):415-419.

(85) Hauck FR, Moore CM, Herman SM et al. The contribution of

prone sleeping position to the racial disparity in sudden infant death syndrome: the Chicago Infant Mortality Study. Pediatrics 2002; 110(4):772-780.

(86) McDonnell M, Mehanni M, McGarvey C et al. Smoking: the major risk factor for SIDS in Irish infants. Ir Med J 2002; 95(4):111-113.

(87) Matthews T, McDonnell M, McGarvey C et al. A multivariate "time based" analysis of SIDS risk factors. ARCH DIS CHILD 2004; 89(3):267-271.

(88) Lee N. Observations based upon multiple telephone contacts with new breastfeeding mothers. J HUM LACT 1997; 13(2):147-150.

(89) Ball HL. Breastfeeding, bed-sharing, and infant sleep. Birth 2003; 30(3):181-188.

(90) Ball HL. Reasons to bed-share: why parents sleep with their infants. J REPROD INFANT PSYCHOL 2002; 20(4):207-221.

(91) Adams SM, Jones DR, Esmail A et al. What affects the age of first sleeping through the night? J Paediatr Child Health 2004; 40(3):96-101.

(92) Byard RW. Is breast feeding in bed always a safe practice? J Paediatr Child Health 1998; 34(5):418-419.

(93) Lindgren C, Thompson JM, Haggblom L et al. Sleeping position, breastfeeding, bedsharing and passive smoking in 3-month-old Swedish infants. Acta Paediatr 1998; 87(10):1028-1032.

(94) Ottaviano S, Giannotti F, Cortesi F et al. Sleep characteristics in healthy children from birth to 6 years of age in the urban area of Rome. Sleep 1996; 19(1):1-3.

(95) Scragg LK, Mitchell EA, Tonkin SL et al. Evaluation of the cot death prevention programme in South Auckland. N Z Med J 1993; 106(948):8-10.

(96) Watson L, Potter A, Gallucci R et al. Is baby too warm? The use of infant clothing, bedding and home heating in Victoria, Australia. Early Hum Dev 1998; 51(2):93-107.

(97) Flick L, White DK, Vemulapalli C et al. Sleep position and the use of soft bedding during bed sharing among African American infants at increased risk for sudden infant death syndrome. J PEDIATR 2001; 138(3):338-343.

(98) Ball H, Hooker E, Kelly PJ. Parent-infant co-sleeping: Fathers' roles and perspectives. Infant & Child Development 2000; 9(2):67-74.

(99) Hills-Bonczyk SG, Tromiczak KR, Avery MD et al. Women's experiences with breastfeeding longer than 12 months. Birth 1994; 21(4):206-212.

(100) Beal SM, Byard RW. Sudden infant death syndrome in South Australia 1968-97. Part 3: is bed sharing safe for infants? J

Paediatr Child Health 2000; 36(6):552-554.

(101) Byard RW, Beal S, Blackbourne B et al. Specific dangers associated with infants sleeping on sofas. J Paediatr Child Health 2001; 37(5):476-478.

(102) Mitchell EA, Brunt JM, Everard C. Reduction in mortality from sudden infant death syndrome in New Zealand: 1986-92. ARCH DIS CHILD 1994; 70(4):291-294.

(103) Panaretto KS, Whitehall JF, McBride G et al. Sudden infant death syndrome in Indigenous and non-Indigenous infants in north Queensland, 1990-1998.[see comment]. J Paediatr Child Health 2002; 38(2):135-139.

(104) Person TL, Lavezzi WA, Wolf BC. Cosleeping and sudden unexpected death in infancy. Arch Pathol Lab Med 2002; 126(3):343-345.

(105) Scragg RK, Mitchell EA, Ford RP et al. Maternal cannabis use in the sudden death syndrome. Acta Paediatr 2001; 90(1):57-60.

(106) Collins KA. Death by overlaying and wedging: a 15-year retrospective study.[see comment]. Am J Forensic Med Pathol 2001; 22(2):155-159.

(107) Drago DA, Dannenberg AL. Infant mechanical suffocation deaths in the United States, 1980-1997.[see comment]. Pediatrics 1999; 103(5):e59.

(108) Ford RP, Mitchell EA, Scragg R et al. Factors adversely associated with breast feeding in New Zealand. J Paediatr Child Health 1994; 30(6):483-489.

(109) Fuamatu N, Finau S, Tukuitonga C et al. Sudden infant death syndrome among the Auckland Pacific communities 1988-1996: is it increasing? N Z Med J 2000; 113(1116):354-357.

(110) Unger B, Kemp JS, Wilkins D et al. Racial disparity and modifiable risk factors among infants dying suddenly and unexpectedly. Pediatrics 2003; 111(2):E127-E131.

(111) Gessner BD, Ives GC, Perham-Hester KA. Association between sudden infant death syndrome and prone sleep position, bed sharing, and sleeping outside an infant crib in Alaska. Pediatrics 2001; 108(4):923-927.

(112) Carroll-Pankhurst C, Mortimer EA, Jr. Sudden infant death syndrome, bedsharing, parental weight, and age at death.[see comment]. Pediatrics 2001; 107(3):530-536.

(113) Nakamura S, Wind M, Danello MA. Review of hazards associated with children placed in adult beds.[see comment]. ARCH PEDIATR ADOLESC MED 1999; 153(10):1019-1023.

(114) Latz S, Wolf AW, Lozoff B. Cosleeping in context: sleep practices and problems in young children in Japan and the United States. ARCH PEDIATR ADOLESC MED 1999; 153(4):339-346.

(115) Quillin SI, Glenn LL. Interaction between feeding method and co-sleeping on maternal-newborn sleep. J Obstet Gynecol Neonatal Nurs 2004; 33(5):580-588.

(116) McKenna JJ, Mosko SS, Richard CA. Bedsharing promotes breastfeeding.[see comment]. Pediatrics 1997; 100(2 Pt 1):214-219.

(117) McKenna J, Mosko S, Richard C et al. Experimental studies of infant-parent co-sleeping: mutual physiological and behavioral influences and their relevance to SIDS (sudden infant death syndrome). Early Hum Dev 1994; 38(3):187-201.

(118) McKenna JJ, Mosko S. Evolution and infant sleep: an experimental study of infant-parent co-sleeping and its implications for SIDS. Acta Paediatr Suppl 1993; 82 Suppl 389:31-36.

(119) McKenna JJ, Mosko SS. Sleep and arousal, synchrony and independence, among mothers and infants sleeping apart and together (same bed): an experiment in evolutionary medicine. Acta Paediatr Suppl 1994; 397:94-102.

(120) Mosko S, McKenna J, Dickel M et al. Parent-infant cosleeping: the appropriate context for the study of infant sleep and implications for sudden infant death syndrome (SIDS) research. J Behav Med 1993; 16(6):589-610.

(121) Mosko S, Richard C, McKenna J. Infant arousals during mother-infant bed sharing: implications for infant sleep and sudden infant death syndrome research. Pediatrics 1997; 100(5):841-849.

(122) Mosko S, Richard C, McKenna J et al. Infant sleep architecture during bedsharing and possible implications for SIDS. Sleep 1996; 19(9):677-684.

(123) Mosko S, Richard C, McKenna J et al. Maternal proximity and infant CO2 environment during bedsharing and possible implications for SIDS research. Am J Phys Anthropol 1997; 103(3):315-328.

(124) Richard C, Mosko S, McKenna J et al. Sleeping position, orientation, and proximity in bedsharing infants and mothers. Sleep 1996; 19(9):685-690.

(125) Hunsley M, Thoman EB. The sleep of co-sleeping infants when they are not co-sleeping: evidence that co-sleeping is stressful. Dev Psychobiol 2002; 40(1):14-22.

(126) James C, Klenka H, Manning D. Sudden infant death syndrome: bed sharing with mothers who smoke. ARCH DIS CHILD 2003; 88(2):112-113.

(127) Richard CA, Mosko SS, McKenna JJ. Apnea and periodic breathing in bed-sharing and solitary sleeping infants. J Appl Physiol 1998; 84(4):1374-1380.

(128) Yilmaz G, Gurakan B, Cakir B et al. Factors influencing sleeping

pattern of infants. Turk J Pediatr 2002; 44(2):128-133.

(129) Tappin D, Ecob R, Brooke H. Bedsharing, Roomsharing, and Sudden Infant Death Syndrome in Scotland: A Case-control Study. J PEDIATR 2005; 147(1):32-37.

(130) Mitchell E. Fighting the highest SIDS rate. Proceeding of the 8th SIDS International conference, Edmonton Alberta 2004.

(131) Consumer Product Safety Commission. CPSC Warns against placing babies in adult beds; study finds 64 deaths each year from suffocation and strangulation. 1999. Washington, D.C., CPSC.

(132) American Academy of Pediatrics.Task Force on Infant Sleep Position and Sudden Infant Death Syndrome. Changing concepts of sudden infant death syndrome: implications for infant sleeping environment and sleep position. [see comment]. [Review] [120 refs]. Pediatrics 2000; 105(3 Pt 1):650-656.

(133) Canadian Paediatric Society. Recommendations for safe sleeping environments for infants and children. Paediatrics & Child Health 2004; 9(9):659-663.

(134) Centers for Disease Control and Prevention (CDC). Guidelines for Death Scene Investigation of Sudden Unexplained Infant Deaths. Recommendations of the Interagency Panel on Sudden Infant Death Syndrome. 1996. 45.