


A Systematic Review of Longitudinal Cohort Studies Examining Unintentional Injury in Young Children

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Abstract

Objective. Injury is the leading cause of death and long-term disability in children. Longitudinal cohorts are designed to follow subjects longitudinally in order to determine if early-life exposures are related to certain health outcomes. **Methods.** We conducted a systematic review to identify studies of children from birth through 5 years who were followed longitudinally with unintentional injury as an outcome of interest. **Results.** Of the 1892 unique references based on the search criteria, 12 (published between 2000 and 2013) were included. The studies varied on the population of focus, injury definition, and incidence rates. Existing studies that longitudinally follow children aged 0 to 5 years are limited in number, scope, and generalizability. **Conclusions.** Further study using population-based longitudinal cohorts is necessary to more comprehensively estimate incidence of injury in young children.

Keywords

childhood injury, longitudinal cohort study, birth cohort

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Introduction

Injury results in significant morbidity and mortality in young children.^{1,2} Injury incidence is typically estimated using visits to the emergency department and primary care settings. However, these methods do not capture non-medically attended injuries nor represent a true population-based incidence.³ There is a need to follow young children prospectively and longitudinally in order to maximize identification of injury incidents, ideally also including “near misses.”⁴ Birth cohorts are used to collect data longitudinally and estimate true incidence or prevalence of disease, as well as identify the influence of various exposures.⁵ A prior systematic review of such cohort studies focused on school-age children and adolescents 5 to 18 years old,³ but no prior study has summarized similar literature for infants, toddlers, and pre-school-age children. Therefore, the goal of this systematic review was to identify longitudinal studies of children birth through 5 years with unintentional injury captured as an outcome to better estimate injury incidence in this subgroup.

Methods

Inclusion and Exclusion Criteria

Inclusion criteria for selected studies were the following: (1) subjects from birth through 5 years, including part or all of this age range (eg, 0-2 years) without overlapping older age groups without specific subgroup data (eg, not 3-6 years); (2) observational study (not interventional); (3) study of injury patterns and/or risk factors; (4) must examine overall or specific type of injury frequency with population-based (or cohort-based) rate (or with the ability to recalculate a rate based on the injury frequency and

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Table 1. Search Criteria.

1	(cohort adj1 stud\$).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
2	(longitudinal adj1 stud\$).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
3	exp Cohort Studies/
4	exp Longitudinal Studies/
5	Prospective.mp [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
6	1 or 2 or 3 or 4
7	5 and 6
8	exp Newborn/ or exp Newborn, Hospitalized/
9	exp Infant/ or exp Infant, Hospitalized/
10	exp Preschool/ or exp Preschool, Hospitalized/ or exp Preschool, Institutionalized
11	exp Pediatrics/
12	exp Disabled Children/
13	8 or 9 or 10 or 11 or 12
14	exp accident prevention/ or exp accidental falls/ or exp accidents, home/ or exp accidents, traffic/ or exp drowning/
15	exp "Wounds and Injuries"/ep [Epidemiology]
16	14 or 15
17	7 and 13 and 16
18	exp accident/ or exp unintentional injury/
19	"incident"
20	exp Animal/ OR exp Bite/ OR exp Burn/ OR exp Fire/ OR exp Firearm/ OR exp "Foreign body"/ OR exp Homicide/ OR exp Motor Vehicle/ OR exp Pedestrian/ OR exp Sting/ OR exp Trauma/
21	"chok*" OR "daycare" OR "gun" OR "gym" OR "overexert*" OR "cut*" OR "pierce" OR "playground" OR "poison" OR "struck by" OR "struck against" OR "suffocat*" OR "traffic"
22	22 and 23
23	7 and 13 and 14
24	7 and 13 and 15
25	7 and 13 and 18
26	7 and 13 and 19
27	7 and 13 and 20
28	7 and 13 and 22

denominator); and (5) must follow a group longitudinally. Studies were excluded if the injury was intentional (assault or abuse) or if participants were recruited because of a specific diagnosis or because they participated in an activity that put them at risk of injury.

Search Process

An initial search was conducted to determine whether a birth cohort systematic review regarding injury patterns in children ages 0 through 5 years had been previously conducted. Using the Mytton et al protocol as a guide,³ PubMed and Medline databases were searched using the search terms that had been identified and agreed on by the investigators (Table 1). Furthermore, potentially relevant articles were found in PubMed while searching for

abstracts using the selected terms. Any eligible articles in the database published through April 2016 were included.

All duplicate articles that appeared in both databases or appeared in the same database multiple times were removed and the resulting article abstracts were scanned first by research assistants for relevance using the inclusion and exclusion criteria outlined above (Figure 1). The remaining abstracts were then divided among the 3 injury prevention physician researchers for further screening. During this second phase of abstract review, the physician researchers identified several abstracts that were of questionable relevance. These abstracts were discussed as a group and were excluded if irrelevant. If a determination could not be made by review of the abstract, full-text versions of the article was reviewed

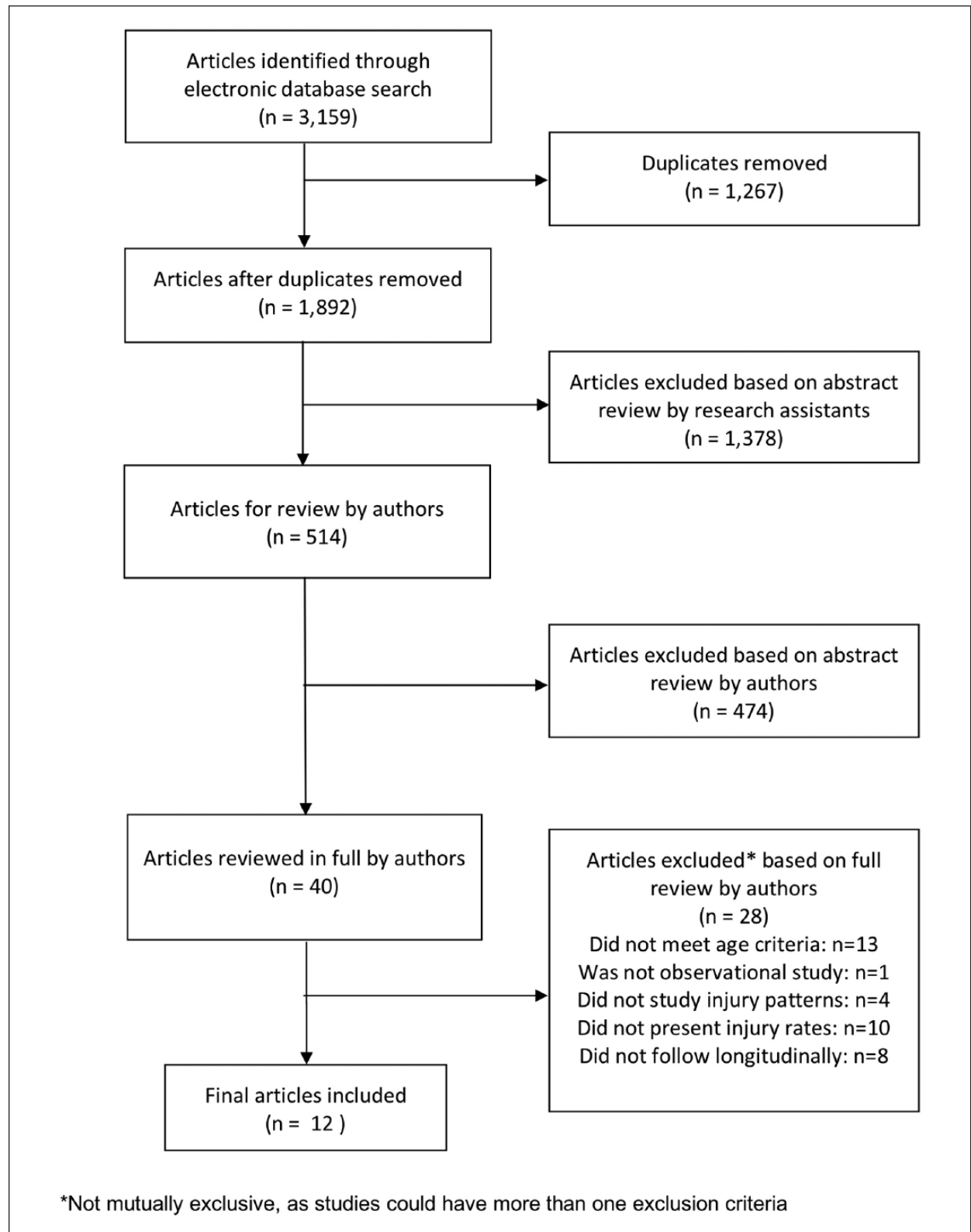


Figure 1. Flow chart of search strategy.

Table 2. Study Characteristics, Potential Biases, Results, and Rates of Injury.

Study Characteristics		Potential Biases, Results, and Rates										
Year of Publication	First Author	Aim of Study	Data Source and Population	How Subjects Chosen	Country	Exposure	Outcome (Injury Definition)	Follow-up Interval Frequency and Duration	Potential Biases	Detailed Description of Total Number Included	Main Results; Include Serial Longitudinal Subresults	Rate Calculated/ Reanalysis Required
2000	O'Connor ⁶	Determine whether family type and psychosocial risks associated with differences in health outcomes in children	Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC) from 1991 to 1992 Sample of pregnant women, their partner, and an index child	Pregnant mother in UK health district and Completed participation in birth cohort	United Kingdom	Family type and psychosocial risks	Parent-reported burns, scalds, falls requiring medical attention	9 months (between 15 months and 24 months old)	One health district in the UK Self-reported Inadequate details of injured (mechanism vs injury) More likely to recall serious than minor injury No tracking of fatal injury	10 431 families	Burn or scalding: 785 Major fall: 2471	Burn or scalding: 1047 per 10 431 families per year Major fall 3295 per 10 431 families per year
2000	Alkon ⁷	Examine child characteristics (age, gender) and child care center environments that predict injury	Part of a larger study of children from child care centers from 1990 to 1991 Sample of children from day care centers	Preschool-aged children from day care centers participating in a larger longitudinal study	United States	Amount of time (hours) in daycare	Teacher-reported event resulting in bodily harm, reflected by physical mark or sustained complaint more than 5 minutes in duration	2-year period	Only 4 centers; all private Lack of details on inclusion criteria and those who declined Teacher-reported injury without any medical evaluation	360 children	Injuries: 1886 Mean injury rate: 5.7 per 2000 exposure hours for entire sample	No
2004	Dal Sarno ⁸	Examine relationships between maternal perceptions of risk, stress, social support, safety-proofing behaviors, supervision practices and unintentional injuries to children	Child Safety Survey (telephone survey) and Home Safety Survey (in-home subsample) from 1988 to 1989 Random-digit dial in a single southeastern US metropolitan area	Mothers with at least one child between 6 months and 5 years old A working telephone	United States	Endogenous: Perceived risks of hazards and injury, perceived child behavioral characteristics, parental safety behaviors, and injury history Exogenous: sociodemographics, housing, and psychosocial variables	Mother-reported (from their diaries) discrete event that produced pain lasting at least 10 minutes or discernable tissue damage	1 year	Bias of original sample (including those who did not agree to participate or without a telephone) Self-reported injury Incomplete diaries Underrepresentation of low-income/education households	159 mothers of children	Injury events: 1273 Injury totals: 1299	Injury event rates: 1273 per 159 children per year Injury total rate: 1229 per 159 children per year

(continued)

Table 2. (continued)

Study Characteristics											Potential Biases, Results, and Rates	
First Author	Year of Publication	Aim of Study	Data Source and Population	How Subjects Chosen	Country	Exposure	Outcome (Injury Definition)	Follow-up Interval Frequency and Duration	Potential Biases	Detailed Description of Total Number Included	Main Results; Include Serial Longitudinal Subresults	Rate Calculated/ Reanalysis Required
Schwebel ⁹	2004	Determine interactions between child behavior patterns and parenting and unintentional injury	Study 1: Incoming kindergarteners from National Head Start/ Public School Early Childhood Transition Demonstration Study from 1992 to 1994 Study 2: Sample from hospitals from a Study of Early Child Care Institute of Child Health and Human Development (NICHD)	Study 1: Child transitioning from Head Start or non-Head Start program to kindergarten Study 2: Recruited from hospitals (details not included)	United States	Child behavior (hyperactivity) and parenting resources	Caregiver-reported medically attended injury	Study 1: one time (in previous year) Study 2: over a 30-month period	Study 1: Injury reported by caregivers Study 2: Not clear who followed-up; and injury reported by caregivers	Study 1: 10 829 children Study 2: 1041 children	Study 1: 2523 (with at least 1 injury) Study 2: 46 with at least 1 injury	Study 1: Rate 2523 per 10 829 per year Study 2: 18.4 per 1041 per year
Soubhi ¹⁰	2004	Examine independent and combined effects of child, family, and neighborhood on childhood injuries	National Longitudinal Survey of Children and Youth from 1996 Sample of children from households	Household with one or more child ages 0-11 years	Canada	Individual, family, and neighborhood characteristics	Caregiver-reported medically attended injury	2 years	Self-reported injury	10 261 households	Injuries (in <2 years): 58 380 Injuries (in 2-3 years): 47 389	Rate (in <2 years old): 29 190 per 507 654 per year Rate (in 2-3 year olds): 23 694 per 473 893 per year
de Lourdes Drachler ¹¹	2007	Examine effects of home environment on unintentional domestic injury and related health care attendance	Cohort of patients recruiting from trial of breast feeding advice and weaning from 2001 to 2002 Sample of women in maternity wards	Mother of normal, single, full-term baby, birth weight at least 2500 g, without impediments to breastfeeding	Brazil	Socioeconomic factors, family characteristics, household psychosocial aspects	Parent-reported medically attended unintentional domestic injury	12 months (at 1 year of age)	Breastfeeding study Mechanisms not recalled More likely to recall serious than minor injury No tracking of fatal injury	394 children	Injuries: 338	Injury rate: 338 per 394 children per year

(continued)

Table 2. (continued)

Study Characteristics										Potential Biases, Results, and Rates		
First Author	Year of Publication	Aim of Study	Data Source and Population	How Subjects Chosen	Country	Exposure	Outcome (Injury Definition)	Follow-up Interval Frequency and Duration	Potential Biases	Detailed Description of Total Number Included	Main Results; Include Serial Longitudinal Subresults	Rate Calculated/ Reanalysis Required
Erkaj ²	2008	<ul style="list-style-type: none"> Determine rates of occurrence, consequences of, and risk factors for animal-related injuries 	<ul style="list-style-type: none"> Regional Rural Injury Study from 1999 and 2001 Random selection from agricultural operations in each of 5 US states involved 	<ul style="list-style-type: none"> Household with operation that included children <20 years Actively farming/ranching since first of year eligibility or involved in conservation reserve program Produced or had sales of at least US\$1 000 Willingness to complete phone interviews every 6 months 	United States	<ul style="list-style-type: none"> Participating in an active agricultural operation 	<ul style="list-style-type: none"> Parent-reported event resulting in one or more of: <ol style="list-style-type: none"> (1) restriction from normal activities for 4+ hours; (2) loss of consciousness/awareness or amnesia for any duration; (3) use of health care 	<ul style="list-style-type: none"> 6 months to 3 years (two 6-month recall periods during 2 phases of study in 1999 and 2001) 	<ul style="list-style-type: none"> Recall bias Injury misclassification 	<ul style="list-style-type: none"> 4402 eligible operations (farms/ranches) in Phase I 3765 participated in full study 2301 children 0-4 years exposed 	<ul style="list-style-type: none"> Injuries in children 0-4 years old: 17 (7.7 per 1000) (4.7, 12.8) 	No
Kouloufio ¹³	2009	<ul style="list-style-type: none"> Explore relationship between lack of everyday routines and children's unintentional injury; examine how children's sleep and maternal supervision could influence lack of routines; explore influence of maternal fatigue in routines and supervision 	<ul style="list-style-type: none"> Rochester Preschool Children Injuries Study from 2002 to 2004 Cohort from study of mother-child dyads 	<ul style="list-style-type: none"> Selected for prior prospective, longitudinal descriptive study 	United States	<ul style="list-style-type: none"> Maternal supervision, maternal fatigue, and child temperament at age 3; children's routines and sleep at age 4 	<ul style="list-style-type: none"> Mother-reported medically attended injury 	<ul style="list-style-type: none"> 30 months (between 18 months and 4 years old) 	<ul style="list-style-type: none"> Lack of injury detail and meaning of medically attended injury One city and predominantly minority population 	<ul style="list-style-type: none"> 278 mother-child dyads completed first interview 264 completed 1-year follow-up interview 	<ul style="list-style-type: none"> 78 injuries 	<ul style="list-style-type: none"> Injury rate: 31.2 injuries per 264 per year
Hallal ¹⁴	2009	<ul style="list-style-type: none"> Evaluate the incidence of and effect of early life variable on the risk of fractures 	<ul style="list-style-type: none"> All hospital delivered children born in 1993 in a single city Cohort of mothers and their newborns 	<ul style="list-style-type: none"> Hospital delivered mother and their newborn child 	Brazil	<ul style="list-style-type: none"> Maternal age, BMI, smoking during pregnancy and family income; child's birth weight and length 	<ul style="list-style-type: none"> Mother-reported fracture in child 	<ul style="list-style-type: none"> 11 or 12 years 	<ul style="list-style-type: none"> Single location and only hospital births Recall bias Unreported or nonaccidental fractures, including: undiagnosed minor fractures; intentional injury; pathological fractures Patients who died 	<ul style="list-style-type: none"> 5249 children 141 died 656 lost to follow-up 	<ul style="list-style-type: none"> In those <5 years, 156 fractures 	<ul style="list-style-type: none"> 14 fractures per 5249 children per year

(continued)

Table 2. (continued)

Study Characteristics										Potential Biases, Results, and Rates		
Year of Publication	Aim of Study	Data Source and Population	How Subjects Chosen	Country	Exposure	Outcome (Injury Definition)	Follow-up Interval Frequency and Duration	Potential Biases	Detailed Description of Total Number Included	Main Results; Include Serial Longitudinal Subresults	Rate Calculated/ Reanalysis Required	
Fujiwara ¹⁵	<ul style="list-style-type: none"> Investigate influence of paternal involvement in childcare on childhood injury 	<ul style="list-style-type: none"> Longitudinal Survey of Babies in 21st Century in 2001 All children from birth record list of vital statistics 	<ul style="list-style-type: none"> Returned mailed questionnaire sent to them 	Japan	<ul style="list-style-type: none"> Parental involvement in childcare 	<ul style="list-style-type: none"> Parent-reported fall, near drowning, ingestion, foreign body, burn 	<ul style="list-style-type: none"> 6-month questionnaire for parental involvement, 18-month questionnaire for injury 	<ul style="list-style-type: none"> Self-reported injury No specific injury definition 	<ul style="list-style-type: none"> 53 575 eligible children 47 015 responded to 6 month questionnaire 43 925 responded to 18-month survey After exclusions, sample size 42 144 	<ul style="list-style-type: none"> 678 injuries per 100 person-year 	No	
Darling ¹⁶	<ul style="list-style-type: none"> Determine if programs that allow body checking in hockey have increased injury rates, and to describe the nature of those injuries 	<ul style="list-style-type: none"> Sample of youth hockey players from 2002 to 2007 	<ul style="list-style-type: none"> Participation in youth hockey program 	Canada	<ul style="list-style-type: none"> Hours at play 	<ul style="list-style-type: none"> Trainer and physician-reported injury resulting in at least 24 hours of missed activity 	<ul style="list-style-type: none"> 5-year period 	<ul style="list-style-type: none"> Limited to one league Only boys included Injury reported by trainers Variable participation by players 	<ul style="list-style-type: none"> 13 292 player-years of data 247 injuries total 	<ul style="list-style-type: none"> Rates (in 4.5 year olds): 0.00 injuries per 1000 game hours and 0.10 injuries per 1000 practice hours 	No	
Shah ¹⁷	<ul style="list-style-type: none"> Identify risk factors for scald injury 	<ul style="list-style-type: none"> The Health Improvement Network (THIN) from children born between 1998 and 2004 Database of patient records representing general practices 	<ul style="list-style-type: none"> Child identified from mother's health records, cases and controls chosen from prior study exploring risk factors for injury 	United Kingdom	<ul style="list-style-type: none"> Individual, maternal, and family factors 	<ul style="list-style-type: none"> Scald read codes in the health records based on ICD-10 categories 	<ul style="list-style-type: none"> Continuous, 5 years 	<ul style="list-style-type: none"> Biases inherent to this sample Patient without ICD10 codes Non-medically attended injury not included 	<ul style="list-style-type: none"> 180 064 eligible mother-child dyads 986 with scald 	<ul style="list-style-type: none"> 986 with scald 	<ul style="list-style-type: none"> 197 per 180 064 per year 	

Abbreviations: BMI, body mass index; ICD, International Classification of Diseases.

by the group to determine if it met eligibility. The remaining selected articles were screened and additional potentially relevant articles were extracted from the references of those articles.

For purposes of this review, we summarized study characteristics including the study aim, data source and population, how subjects were chosen, country of study, exposure, outcome (injury definition), follow-up frequency/duration, potential biases, total number included, and rates of injuries. We included studies and injury outcomes only for those with clear definitions and excluded any incidents that were solely injury mechanisms. We included information available only in the articles reviewed. Similarly, we included only injury-related outcomes (ie, no other study results) and frequencies/rates of injuries for the age groups of interest (ie, not for children 6 years or older). All time periods of injury surveillance were adjusted to 1-year increments, with corresponding adjustment to the injury frequencies, when this information was available. If there was a range of time periods of surveillance (eg, 3 to 4 years of follow-up), the average of the time periods was used for the previously mentioned adjustments.

Results

Figure 1 shows a flow chart of the search strategy. There were 1892 unique references based on the search criteria, with 12 ultimately included in the analysis, published between 2000 and 2013. Table 2 lists the study characteristics and injury results. Of the studies, 5 were from the United States, 2 from the United Kingdom, 2 from Brazil, 2 from Canada, and 1 from Japan. Eleven of the studies had participant-reported injury outcomes, either from parents/caregivers (9), a trainer/physician (1), or daycare worker (1), while one study used documented injuries in the health record as outcomes.

There were a variety of populations, injury definitions, and injury rates among the 12 studies. Eleven of the studies used reported injuries (either through guardians, caregivers, or by athletic team leadership) with only one based on medical records.

Discussion

We found 12 eligible studies, all published within a contemporary 14-year time period. Most included a subgroup of the 0- to 5-year-old age range but not the entire group. Many of the studies were limited by either incomplete definition of injury and self (guardian)-reported injury. Also, notably missing was the lack of “near miss” information (mechanisms and scenarios that almost resulted in injury). The studies were fairly heterogeneous in nature: some focused on very

specific injury types (eg, agricultural, sports-related) and with a limited target population (eg, focused in one specific city or district), which inherently limits generalizability. In addition, while some studies included child and family demographic information associated with injury, many lacked environmental information including family composition and dynamic (eg, if single parent, multiple siblings, etc), which is also known to influence injury.¹⁸ Similar to the findings in the Mytton et al article,³ few studies were conducted in low- to middle-income countries with higher injury burden.

Limitations of the review included the heterogeneity of the studies, especially in the cohort or sample population, and the injury type studied. Multiple potential biases in the individual studies included lack of detail in the methods (specific inclusion/exclusion criteria, information about those who declined or withdrew) and the challenges of self-reported injury.

Conclusion

The existing longitudinal cohorts captured in this systematic review and focused on the outcome of injury in children aged 0 to 5 years are limited in number, scope, well-defined and objective injury outcomes, and generalizability. There is opportunity to expand on this literature by conducting a longitudinal population-based birth cohort study with comprehensive measures and injury outcomes in order to estimate accurate rates of injury in young children.

Author Contributions

MRZ: Contributed to conception or design; contributed to acquisition, analysis, and interpretation of data; drafted the manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring integrity and accuracy.

JGL: Contributed to conception or design; contributed to acquisition, analysis, and interpretation of data; critically revised the manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring integrity and accuracy.

ESY: Contributed to conception or design; contributed to acquisition of data; critically revised the manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring integrity and accuracy.

MJM: Contributed to conception or design; contributed to acquisition, analysis, or interpretation; critically revised the manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring integrity and accuracy.

Declaration of Conflicting Interests

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