International Journal of Injury Control and Safety Promotion

ISSN: 1745-7300 (Print) 1745-7319 (Online) Journal homepage: http://www.tandfonline.com/loi/nics20

Prevention of childhood poisoning in the home: overview of systematic reviews and a systematic review of primary studies

Persephone M. Wynn, Kun Zou, Ben Young, Gosia Majsak-Newman, Adrian Hawkins, Bryony Kay, Jacqueline Mhizha-Murira & Denise Kendrick

To cite this article: Persephone M. Wynn, Kun Zou, Ben Young, Gosia Majsak-Newman, Adrian Hawkins, Bryony Kay, Jacqueline Mhizha-Murira & Denise Kendrick (2016) Prevention of childhood poisoning in the home: overview of systematic reviews and a systematic review of primary studies, International Journal of Injury Control and Safety Promotion, 23:1, 3-28, DOI: 10.1080/17457300.2015.1032978

To link to this article: http://dx.doi.org/10.1080/17457300.2015.1032978

Published online: 24 Sep 2015.

International Journal of Injury Control and Safety Promotion, 2016
Vol. 23, No. 1, 3–28, http://dx.doi.org/10.1080/17457300.2015.1032978

Prevention of childhood poisoning in the home: overview of systematic reviews and a systematic review of primary studies

Persephone M. Wynn[a]*, Kun Zou[a], Ben Young[a], Gosia Majsak-Newman[b], Adrian Hawkins[c], Bryony Kay[d], Jacqueline Mhizha-Murira[a] and Denise Kendrick[a]

[a]*Division of Primary Care, University of Nottingham, Nottingham, UK;* [b]*NHS Clinical Research and Trials Unit, Norwich Medical School, University of East Anglia, Norwich, UK;* [c]*Great North Children's Hospital, New Victoria Wing, Royal Victoria Infirmary, Newcastle upon Tyne, UK;* [d]*Centre for Child and Adolescent Health, University of the West of England, Bristol, UK*

(*Received 20 December 2013; accepted 3 December 2014*)

Unintentional poisoning is a significant child public health problem. This systematic overview of reviews, supplemented with a systematic review of recently published primary studies synthesizes evidence on non-legislative interventions to reduce childhood poisonings in the home with particular reference to interventions that could be implemented by Children's Centres in England or community health or social care services in other high income countries. Thirteen systematic reviews, two meta-analyses and 47 primary studies were identified. The interventions most commonly comprised education, provision of cupboard/drawer locks, and poison control centre (PCC) number stickers. Meta-analyses and primary studies provided evidence that interventions improved poison prevention practices. Twenty eight per cent of studies reporting safe medicine storage (OR from meta-analysis 1.57, 95% CI 1.22–2.02), 23% reporting safe storage of other products (OR from meta-analysis 1.63, 95% CI 1.22–2.17) and 46% reporting availability of PCC numbers (OR from meta-analysis 3.67, 95% CI 1.84–7.33) demonstrated significant effects favouring the intervention group. There was a lack of evidence that interventions reduced poisoning rates. Parents should be provided with poison prevention education, cupboard/drawer locks and emergency contact numbers to use in the event of a poisoning. Further research is required to determine whether improving poison prevention practices reduces poisoning rates.

Keywords: poisoning; childhood; unintentional injuries; prevention; home

1. Introduction

Unintentional poisonings are a global health problem for children and young people, with an estimated 45,000 deaths in those aged 0–20 years of age in 2004 (Peden et al., 2008). Poisoning also results in substantial numbers of hospital admissions in children and young people. In 2012/13, approximately 6500, 0–14 year olds in England were admitted to hospital with actual or suspected poisoning, of which 70% were under the age of 5 years (Health and Social Care information Centre, 2012/13). During 2009/10, more than 3000. 0–14 year olds were admitted to Australian hospitals following a poisoning incident, of which approximately 70% were aged 0–4 years old (Tovell, McKenna, Bradley, & Pointer, 2012). In the USA, over 300, 0–19 year olds receive treatment in an emergency department every day, as a result of being poisoned (Centers for Disease Control and Prevention, 2013). Poisonings, the associated medical costs, lost earnings and reduced quality of life are a burden to society, health care systems and affected individuals. The lifetime cost of poisonings in children aged 0–15 years in the USA has been estimated to be close to US$ 400 million (Finkelstein, Corso, & Miller, 2006). In the UK poisoning costs the NHS an estimated £2 million annually for children under 15 years old (Child Accident Protection Trust, 2013).

Globally, children aged 0–4 years old account for a disproportionate number of poisoning related deaths (Peden et al., 2008) , emergency department attendances (Department of Trade & Industry, 2002; Guyodol & Danel, 2004; McCaig & Burt, 1999) and hospital admissions (McCaig & Burt, 1999; Tovell et al., 2012). This age group are particularly susceptible to the ingestion of poisons, possibly as a result of development of dexterity, mobility, exploratory, mouthing and imitation behaviours, in addition to a lack awareness of the possible consequences of their actions (Agran et al., 2003; Flavin, Dostaler, Simpson, Brison, & Pickett, 2006; MacInnes & Stone, 2008; Rodgers, Franklin, & Midgett, 2012; Schmertmann, Williamson, & Black, 2008; World Health Organisation, 2008). Most unintentional poisonings of young children occur in the home (Agran et al., 2003; McCaig & Burt,

*Corresponding author. Email: persephone.wynn@nottingham.ac.uk

1999; Tovell et al., 2012) where many poisoning hazards such as medicines and household products are present (Flavin et al., 2006). Poisonings also demonstrate a steep deprivation gradient, with significantly higher hospital admission rates for poisonings from a range of substances, in those from the most deprived areas compared to the least deprived areas (Groom, Kendrick, Coupland, Patel, & Hippisley-Cox, 2006).

Previous systematic reviews have focussed on various interventions to prevent a range of unintentional injuries (Towner, Dowswell, & Jarvis, 2001), including home modification (Lyons, John et al., 2006; Lyons, Sander et al., 2003), parenting interventions (Kendrick, Groom et al., 2007), community-based interventions (Nilsen, 2004; Nixon, Spinks, Turner, & McClure, 2004; Spinks, Turner, McClure, & Nixon, 2004; Waters et al., 2001), provision of safety equipment,(Kendrick, Coupland et al., 2007; Pearson, Garside, Moxham, & Anderson, 2009) interventions in a clinical setting (DiGuiseppi & Roberts, 2000) and home visiting by health visitors (Elkan et al., 2000). Very few reviews have focussed specifically on preventing unintentional poisoning in childhood. The most recent review by Nixon et al., published in (2004), evaluated the effectiveness of community-based childhood poisoning prevention programmes, finding a dearth of evidence and concluding there was a clear need to develop the evidence base in this area. Our overview updates and extends the most recent review as we include a wider range of interventions than community-based interventions and we include poison prevention practices in addition to poisoning rates as outcomes. Our overview also presents data from previous systematic reviews and meta-analyses, in addition to that from primary studies. Overviews of reviews are useful where there are multiple interventions for the same condition or problem reported in separate systematic reviews (Higgins & Green, 2011). Overviews synthesize all available evidence on a topic, are more accessible to decision-makers than multiple systematic reviews and can avoid uncertainty created by conflicting conclusions from different reviews, which may vary in scope and quality (Smith, Declan, Begley, & Clarke, 2011). This overview aims to synthesize evidence from systematic reviews investigating the effectiveness of non-legislative interventions to reduce childhood poisonings in the home, promote poisoning prevention practices and minimize the effects of poisoning. The overview is supplemented with a systematic review of primary studies published since the latest review to enable the most up-to-date information on poisoning prevention interventions to be evaluated. As most non-legislative interventions will be provided in the community by health or social care providers (e.g. by children's centres in England which provide community-based, co-ordinated services, health education, information and support for families with young children), this overview focusses on interventions that could be implemented in Children's Centres or other community health and social care services in high income countries.

2. Methods

2.1. Eligibility criteria

Overviews of reviews, systematic reviews (defined using the Cochrane Handbook definition) (Higgins & Green, 2011) and meta-analyses of experimental and controlled observational studies were eligible for inclusion. Primary studies of experimental or controlled observational design published since the most recent reviews were also assessed for inclusion. Eligible interventions targeted the primary or secondary prevention of acute poisoning at home amongst children aged 0–19 years. Studies were included if they reported medically or non-medically attended poisonings, possession or use of home safety equipment to prevent poisonings, or other poisoning prevention practices. Only interventions that could plausibly be implemented by Children's Centres in England were eligible for inclusion. Evaluations of complex home visiting programmes, WHO Safe Community Programmes, legislative interventions and programmes to prevent poisonings from substance misuse, snakebites, allergic reactions and interventions providing devices intended to be used exclusively with kerosene containers were excluded.

2.2. Information sources

MEDLINE, Embase, CINAHL, ASSIA, PsycINFO and Web of Science were searched from date of inception to January 2012. We also searched a range of other electronic sources in January 2013 and undertook hand searching as described in the following.

2.3. Search

Search terms for MEDLINE are shown in Table 1, with the strategy adapted as necessary for other databases. Other electronic sources searched are shown in Table 2. The journal 'Injury Prevention' (March 1995–January 2012) and abstracts from 1st–10th World Conferences on Injury Prevention and Control (1989–2010) were hand searched independently by two researchers. Reference lists of included reviews and primary studies were searched for relevant citations. Full-text articles were retrieved regardless of language and translated where necessary. The search terms were adapted for study design and the same sources were searched from 2001 to January 2012 for primary studies, as we considered the most comprehensive review to date that included poison prevention outcomes was that published by Towner et al. (2001).

Table 1. MEDLINE search terms.

1. review.m_titl.
2. systematic.m_titl.
3. meta-analysis.m_titl.
4. review.pt.
5. meta-analysis.pt.
6. 1 or 2 or 3 or 4 or 5
7. limit 6 to humans
8. exp child/
9. exp infant/
10. exp adolescent/
11. exp minors/
12. (child$ or adolesc$ or infan$ or young$ or toddl$ or bab$).tw.
13. or/8-12
14. exp "early intervention (education)"/
15. exp education/
16. exp public health/ed
17. exp parenting/
18. exp counseling/
19. (educat$ or train$ or teach$ or parent$ or counsel$ or supervis$).tw.
20. exp accident prevention/ or injury prevention.tw.
21. exp safety/
22. exp safety management/
23. safety practice$.tw.
24. safetyequipment.tw. or exp equipment safety/
25. exp infant equipment/
26. exp protective devices/ or (protect$ adj3 device$).tw.
27. exp "interior design and furnishings"/
28. exp consumer product safety/
29. exp drug storage/
30. ((medicine$ or drug$) adj3 storage).tw.
31. exp hazardous substances/ae, po or (hazardous adj3 substance$ adj3 storage).tw.
32. exp household products/ae, po or (household adj3 product$ adj3 storage).tw.
33. (((child adj3 resistant) or childproof) adj3 (closure$ or cap$ or container$)).tw.
34. ((cupboard$ or cabinet$ or drawer$ or box$) adj3 ($lock$ or latch$)).tw.
35. (medicine$ or cosmetics or ((clean$ or beauty or make-up or household or hazardous or industrial) adj3(supplies or products or materials))).tw.
36. ((toiletries or vitamin$ or cigarette$) adj3 (storage or cupboard$ or cabinet$ or drawer$ or box$ or reach or label$)).tw.
37. ((toxi$ or pollutant$ or gas$) adj3 prevent$).tw.
38. ((toxic or poison$) adj3 plant$ adj3 prevent$).tw.
39. exp ipecac/
40. (poison$ adj3 (control or sticker$ or telephone or number or emergenc$)).tw.
41. or/14-40
42. exp accidents/ or exp accidents, home/
43. exp poisoning/
44. exp "wounds and injuries"/
45. (accident$ or poison$ or injur$ or ingest$ or swallow$ or inhal$).tw.
46. or/42-45
47. 7 and 13 and 41 and 46

Table 2. Other electronic search sources.

Cochrane database of systematic reviews
Database of Abstracts of Reviews of Effects
NHS Economic Evaluation Database and the Health Technology Assessment Database
Injury Prevention Research Centers at the Centers for Disease Control (USA)
National Institute for Health and Clinical Excellence (NICE) (UK)
Children's Safety Network (USA)
International Society for Child and Adolescent Injury Prevention (International)
Child Accident Prevention Trust (UK)
Royal Society for the Prevention of Accidents (UK)
Injury Control Resource Information Network (USA)
National Injury Surveillance Unit (Australia)
SafetyLit (USA)
The National Research Register (UK) (up to September 2007)
UKCRN Clinical Research Portfolio

2.4. Study selection

Titles and abstracts of articles were scanned independently by two researchers to identify relevant articles to retrieve in full. An inclusive approach was adopted, with full articles retrieved where articles appeared potentially eligible, even if no abstract was available. Discrepancies in the identification of relevant articles between researchers were resolved by mutual discussion and referral to a third researcher if necessary.

2.5. Data collection process

Full articles were independently assessed for inclusion by two researchers (P. Wynn and B. Young) using a standardized data extraction form and discrepancies between researcher decisions were referred to a third researcher. Evidence in included reviews was not included in the overview when it originated from primary studies with a design not meeting our inclusion criteria.

2.6. Risk of bias in individual studies

The risk of bias was assessed independently by two researchers (P. Wynn and B. Young) using the Overview Quality Assessment Questionnaire (OQAQ) (Oxman & Guyatt, 1991) for included reviews and the Cochrane Collaboration's risk of bias tool for included primary studies of experimental design. Controlled observational studies were assessed using the Newcastle−Ottawa scale (Wells et al., 2013). A third researcher (D. Kendrick) made the final decision in the event of discrepancies in assessments.

3. Results

3.1. Study selection

Figure 1 shows the process of identification and selection. Two meta-analyses (which also contained a narrative systematic review) and 13 systematic reviews were included in the overview. 37 primary studies were identified from the 15 reviews and 10 primary studies were identified from additional searches for primary studies

3.2. Study characteristics

Characteristics of included reviews are shown in Table 3. Reviews included between 1 and 31 (median = 4) primary studies relevant for our review, some of which were included in multiple systematic reviews (range 1−7, median = 2). One review focussed on community-based programmes to prevent poisoning (Nixon et al., 2004), and the remainder covered a range of injury mechanisms. Only four reviews drew conclusions specific to poisoning prevention interventions (Kendrick, Coupland et al., 2007; Nixon et al., 2004; Towner et al., 2001; Waters et al., 2001). There was some evidence that education in poisoning prevention may be effective in increasing knowledge of poisons and poisoning prevention behaviours such as safe storage of medicines and household cleaning products, but no evidence that this reduces poisoning injuries(Kendrick, Coupland et al., 2007; Towner et al., 2001; Waters et al., 2001). One review concluded that education increases availability of poison control centre (PCC) telephone number stickers and possession of syrup of ipecac (Kendrick, Coupland et al., 2007). One review concluded that there was little evidence on effectiveness of community-based childhood poisoning prevention programmes (Nixon et al., 2004) and Waters et al. (2001) found the strongest evidence on poisoning prevention lay with child resistant closures (CRCs).

Characteristics of all included primary studies are shown in Table 4. Of the 47 primary studies, 31 were randomized controlled trials (RCTs), seven were non-randomized controlled trials (NRCTs), eight were controlled before and after studies (CBAs) and one was a case-control study (CCS). A table of excluded reviews and primary studies is available online (Appendix 1).

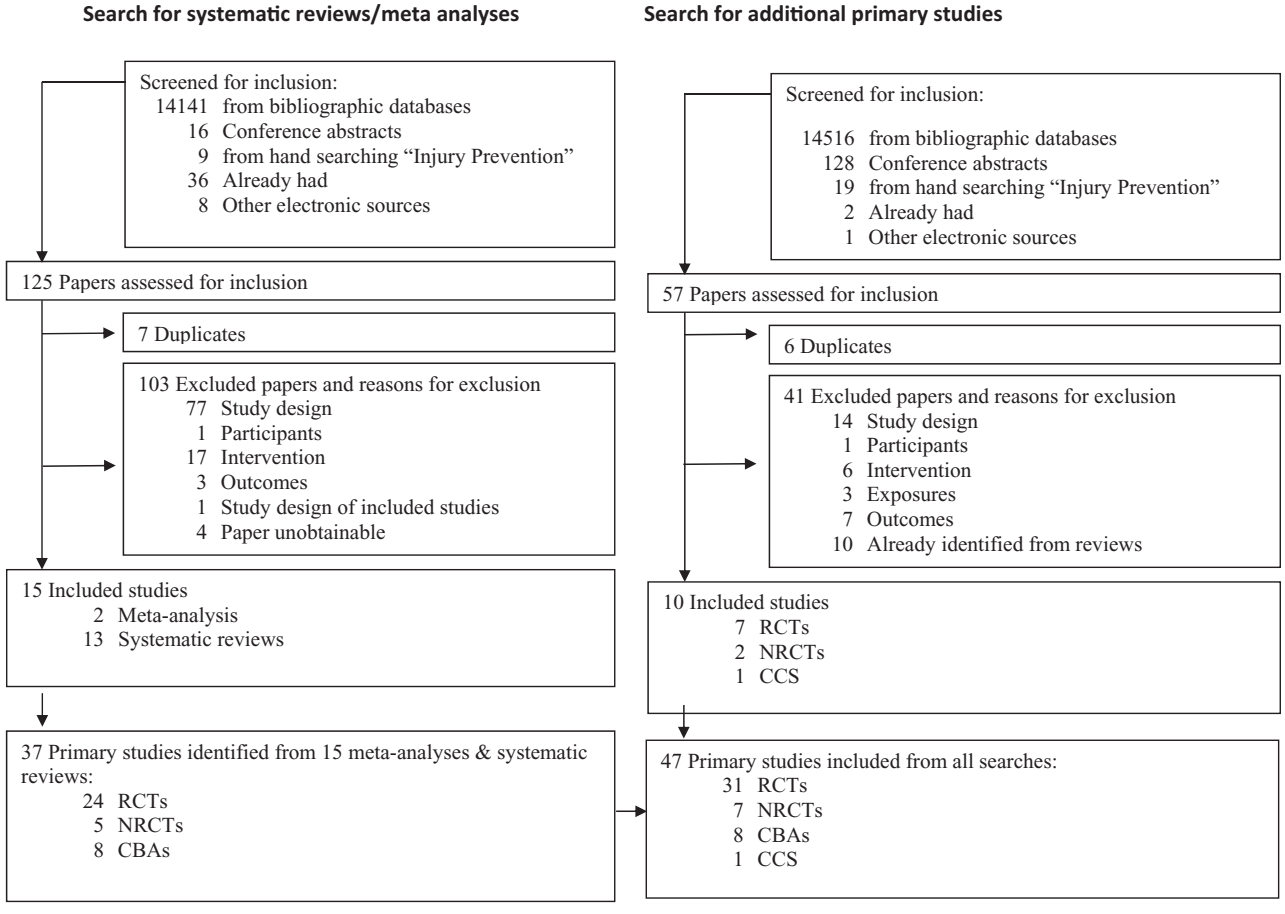

Figure 1. PRISMA flow chart.

Table 3. Characteristics of systematic reviews included in the overview of poisoning prevention interventions.

First author	Narrative review or meta-analysis	Included study designs*	Review quality (OQAQ)	Dates searched	Language restriction	Age	Intervention setting	Delivered by	Content of interventions	Outcome measures
DiGuiseppi 2000 (DiGuiseppi & Roberts, 2000)	Narrative review and meta-analysis	RCTs	5	Date of inception to 1998	None	0–19	Clinical settings	Physicians, health visitors, nurses	Counselling, safety equipment provision, home safety checks	Injuries, use of safety equipment
Elkan 2000 (Elkan et al., 2000)	Narrative review	RCTs, NRCTs, CBAs	5	1966–1997	Not reported	All ages	Home	Health visitors	Home visiting by British health visitors and non-British studies in which home visiting was undertaken by personnel with responsibilities within the remit of British health visitors	Injuries, use of safety equipment, prevention practices
Guyer 2009 (Guyer et al., 2009)	Narrative review	Experimental, quasi-experimental	4	1996–2007	English	0–5 years	All settings	General practitioners, community health workers, paediatricians	Counselling, safety equipment, home visits	Use of safety equipment, prevention practices
Kendrick 2007 (Kendrick, Barlow et al., 2007)	Narrative review	RCTs, NRCTs, CBAs	7	Date of inception to 2005	None	0–18 years	Home	Health visitors and nurses	Parenting interventions including written materials at home visit, education, support	Injuries, use of safety equipment, home hazards
Kendrick 2007 (Kendrick, Coupland et al., 2007)	Narrative review and meta-analysis	RCTs, NRCTs, CBAs	7	Date of inception to 2004	None	0–19 years	Health care settings, schools, homes	Health or social care professionals, school teachers, lay workers or voluntary or other organisations	Education, counselling, provision of safety equipment	Injuries, possession and use of safety equipment, prevention practices
Lyons 2003 (Lyons et al., 2003)	Narrative review	RCTs, NRCTs, CBAs, ITS	7	Date of inception to 2002	None	All ages	Home	Community health workers, trained researchers/volunteers, general practitioners, paediatricians	Reduction of physical hazards	Injuries, safety equipment, hazards
Lyons 2006 (Lyons et al., 2006)	Narrative review	RCTs	5	Date of inception to 2004	None	All ages	Home, health care, clinical	Community nurses, trained researchers, project assistants, occupational therapists, health visitors	Education, safety equipment, reduction of hazards	Injuries, safety equipment, hazards
Nilsen 2004 (Nilsen, 2004)	Narrative review	CBAs	3	Not reported	Not reported	All ages	Community	Paediatricians, local health staff, school staff	Multi-strategy: education, home inspection, environmental improvements	Injuries
Nixon 2004 (Nixon et al., 2004)	Narrative review	CBAs, HCTs	3	Date of inception to 2003	Not reported	0–15 years	Community	Paediatricians, local health staff	Targeted education, household hazard identification and control, promotion of poison control telephone information service	Poisonings
Pearson 2009 (Pearson et al., 2009)	Narrative review	RCTs, NRCTs, CBAs, BAs	5	1990–2009	English	0–14 years	Various	General practitioners, doctors, nurses, research assistants, paediatricians, community health workers, health visitors	Safety equipment provision/ installation home safety checks	Injuries, use of safety equipment, prevention practices
Spinks 2004 (Spinks et al., 2004)	Narrative review	CBAs, HCTs	4	Date of inception to 2002/3	Not reported	0–13 years	Community	Paediatricians, health staff	Counselling, hazard identification	Injuries

(*continued*)

Table 3. (*Continued*)

First author	Narrative review or meta-analysis	Included study designs*	Review quality (OQAQ)	Dates searched	Language restriction	Age	Intervention setting	Delivered by	Content of interventions	Outcome measures
Towner 1996 (Towner et al., 1996)	Narrative review	RCTs, NRCTs, CBAs, BAs	4	1975–1995	Not reported	0–14 years	All settings	Paediatricians, local health staff, school staff, community outreach workers	Home inspection, modification, education	Injuries, use of safety equipment, prevention practices
Towner 2001 Towner, Dowswell, Mackereth, & Jarvis, 2001)	Narrative review	RCTs, NRCTs, CBAs, BAs	2	1975–2000	Not reported	0–14 years	All settings	Paediatricians, local health staff, school staff, community outreach workers	Home inspection, modification, education	Injuries, use of safety equipment, prevention practices
US Preventive Services Task Force 1996 (United States Preventive Services Task Force, 1996)	Narrative review	All designs	2	To 1995**	English	All ages	Clinical	Paediatricians	Counselling	Injuries
Waters 2001 (Waters et al., 2001)	Narrative review	All designs	3	Not reported	Not reported	0–4	All settings	Not reported	Education, environmental modification, safety equipment provision, legislation, policy	Injuries, use of safety equipment, safety practices

*RCT = Randomized controlled trial, QRCT = Quasi-randomized controlled trial, NRCT = Non-randomized controlled trial, CBA = Controlled before and after study, BA = Uncontrolled before and after study, ITS = Interrupted time series design, HCT = Historically controlled trial.

3.3. Risk of bias in reviews and in primary studies

Assessment of risk of bias in reviews is shown in Table 3 for reviews and Table 4 for primary studies. For reviews, OQAQ scores ranged from 2 to 7. For primary studies, 13 of the 31 RCTs (42%) had adequate allocation concealment, 14 (45%) had blinded outcome assessment and 14 (45%) followed up at least 80% of participants in each group. Of the 15 NRCTs and CBAs, none had blinded outcome assessment, 3 (20%) followed up at least 80% of participants in each group and 5 (33%) had a balanced distribution of confounders between treatment groups. The one CCS had a Newcastle–Ottawa Score of 8/9.

3.4. Characteristics and findings from included reviews and primary studies

Characteristics of included reviews are shown in Table 3 and characteristics and findings from primary studies in Table 4.

3.4.1. *Interventions to prevent poisoning-related injuries*

Nine reviews included seven studies (see Table 4) reporting poisonings (Elkan et al., 2000; Kendrick, Coupland et al., 2007; Nilsen, 2004; Nixon et al., 2004; Pearson et al., 2009; Spinks et al., 2004; Towner, Dowswell, Jarvis, & Simpson, 1996; Towner et al., 2001; United States Preventive Services Task Force, 1996). In addition, one primary study not included in any of the reviews reported poisonings (Zhao, Qiu, & Qiu, 2006). One meta-analysis reported poisoning rates from three studies and found a lack of evidence that interventions reduced poisoning rates (rate ratio 1.03, 95% CI 0.78–1.36) (Kendrick, Coupland et al., 2007).

Of the eight primary studies, two studies reported significant effects on medically attended or self-reported poisonings including one RCT, evaluating a school-based educational intervention (IRR 0.30, 95% CI 0.10–0.94), (Zhao et al., 2006) and one CBA evaluating use of child resistant containers (CRCs) to prevent aspirin poisoning which reported a reduction in the proportion of all medically attended poisonings due to aspirin in the intervention area (pre-intervention: intervention area = 71%, control area = 29%; post-intervention: intervention area = 23%, control area = 77%) (Scherz, 1968).

Six studies found no significant effect of the intervention on medically attended poisonings. These included a CBA evaluating a community injury prevention programme (OR 0.95, 95% CI 0.57–1.58 (Guyer et al., 1989)), one NRCT evaluating poison prevention education (IRR 0.98, 95% CI 0.45–2.13 (Fergusson, Horwood, Beautrais, & Shannon, 1982)), one NRCT evaluating safety education and safety equipment provision covering

Table 4. Characteristics of primary studies included in the review.

First author	Design and risk of bias[a]	Participants	Content of intervention	Outcomes*Poisoning/Prevention Measuresn (%) or effect size (95% CI)*
Babul 2007*(Babul, Olsen, Janssen, McIntee, & Raina, 2007)	RCT A − Y B − N F − N	Parents of new born infants at general hospital serving mainly urban or suburban communities First Nation peoples and non-English speakers excluded. Single parent families = 11% Rented accommodation = 39% In unpaid work = 55% Income < $20,000 = 17% Canada ($n = 600$).	I_1: Home visit from community health nurse to identify hazards and teach parents how to remove or modify the hazards; free safety kit (smoke alarm, safety gate 50% discount coupon, table corner cushions, cabinet locks, blind cord windups, water temperature card, doorstoppers, electrical outlet covers, poison control sticker); instructional brochure targeting falls, burns, poisoning and choking; risk assessment checklist. I_2: Free safety kit (see I_1). C: Usual care.	Poison control emergency number available OR 0.64 (0.40 1.00)[1] Use of drawer latches OR 1.32 (0.82−2.31)[1] Preventative safety behaviours and removal of hazards: I_1 vs C Medicines safely stored[4] OR 0.90 (0.17−4.70) Plants out of reach[4] OR 0.90 (0.57−1.43)
Baudier 1988* (Baudier et al., 1988)	RCT A − U B − U F - N	Infant school children from 42 schools and their parents Exploratory phase was carried out in 'a working class area'. Operational phase carried out in the whole department of le Doubs. Data on socio-economic status not reported France ($n = 494$)	Exploratory phase in two schools: I: Use of safety teaching kit by teachers in school, cartoon book and sticker given to children to take home, weekly posters displayed on classroom doors to inform parents, exhibition in school hall, leaflets distributed, meeting held with parents about the risk of accidents discussed in school. C: None of the above. Operational phase in 40 schools: I: Provision to schools of safety teaching kit with user guide, leaflets, stickers, posters, suggestion of a mini exhibition, meeting with parents (6 took place in 20 schools with parent participation at meetings ranging from 0% to 20%). C: None of the above.	Parent made a change in safe storage of medicines or cleaning products: Exploratory phase in two schools: I: 27.0% C: 6.0% Numerators and denominators not reported. $P < 0.001$[1] Operational phase in 40 schools: I: 15.0% C:14.0% No significant difference Numerators, denominators and P value not reported.[1]
Bulzachelli 2009** (Bulzacchelli et al., 2009)	NRCT B − N F − N Balance of confounders − N	Parents of children aged onde month to seven years attending well-child clinic in low-income, English speaking, urban communities I_1= 96 I_2= 98 C= 100 Data on socio-economic status not reported USA ($n = 210$)	I_1 = prescribed visit to mobile child safety centre (MSC) I_2 = optional visit to MSC C = told about purpose of MSC and given more information on request but not referred to MSC	Safe storage of poisons[4] OR 1.08 (0.35−3.35) Change in poison storage between baseline and follow-up in those who visited the MSC and those who did not. MSC Visitor = 25/71 (35%) with positive change[1] Non-visitor = 27/101 (27%) with positive change $P = 0.49$[1]
Campbell 2001* (Campbell et al., 2001)	RCT (C) Allocation at level of schools A - U B − Y F − B	Hispanic migrant youths, aged 11−16 years, low income youths and their parent/carer) Boys = 51% Household income ≤ $15,000 = 67%. USA ($n = 660$)	I = Eight sessions of multimedia first aid and home safety training presented by bilingual and bicultural college students C = Eight sessions of multimedia tobacco and alcohol prevention education presented by bilingual and bicultural college students	Safe storage of medicines 95%.[1] Numerators, denominators and P value not reported. Safe storage of cleaning products 90%.[1] Numerators, denominators and P value not reported.
Clamp 1998* (Clamp & Kendrick, 1998)	RCT A − Y B − N F − Y	Families with children <5 years registered at one GP practice Receiving state benefits = 29% Single parent = 9% Rented accommodation = 19% Unemployed = 43% UK ($n = 165$)	I: General practitioner safety advice, leaflets and low cost safety equipment (smoke alarms, window locks, cupboard and drawer catches, socket covers, door slam devices, fire guards, stair gates). Discounted items offered to families in receipt of means tested state benefits (36%). C: Usual care.	Safe storage of cleaning materials RR 1.19 (0.95−1.49)[1] Safe storage of medicines RR 1.15 (1.03−1.28)[1]

(*continued*)

Table 4. (*Continued*)

First author	Design and risk of bias[a]	Participants	Content of intervention	Outcomes*Poisoning/Prevention Measuresn (%) or effect size (95% CI)*
Colver 1982* (Colver et al., 1982)	RCT A − U B − U F − N	Families with children <5 years attending child health clinics, day nurseries, nursery classes and toddler group in deprived area Receiving state benefits = 52% Council accommodation = 89% No parent in full employment = 54% Single parent family = 21% Social class IV, V, or unclassified = 81% UK (n = 80).	I: Encouraged to watch TV safety campaign; home visit; advice on benefits to obtain safety equipment and local availability of safety equipment. C: Encouraged to watch TV safety campaign.	Safety changes made to home (included storage of medicines and domestic fluids and other safety practices) OR 14.30 (4.22 - 48.46)[2]
Dershewitz 1977/1979* (Dershewitz, 1979)	RCT A − U B − Y F − N	Mothers of children attending a medical clinic enrolled in pre-paid medical plan Household head attended college = 90% White = 81% Median household annual income $19,000 in 1973. USA ($n$ = 205)	I = safety advice + safety booklet + free safety equipment provided by researcher C = free safety equipment provided by researcher	Safe storage of non-prescription medicines OR 0.34 (0.03−3.29)[2] Use of cupboard locks (not specified for cupboards containing poisonous substances) OR 1.14 (0.64−2.05)[2]
Fergusson 1982* (Fergusson et al., 1982)	NRCT B − U F − Y Balance of confounders − Y	Families of children aged 2−3 years participating in the Christchurch Child Development Study Mean annual gross income = NZ$10,494 Mean family size = two children Mean age of mother = 28 years Mean age of father = 31 years Ethnicity − Maori Pacific Islander = 7% One parent family = 9% Professional, executive, clerical occupations = 40% Below average standard of living = 6% New Zealand (n = 1126)	I = 'Mr Yuk' stickers for poisonous substances + list of substances to which sticker should be attached + educational leaflet provided by researcher C = none of the above	Medically attended poisonings IRR 0.98 (0.45−2.13)[4] Mean number of poisons within child's reach C = 14.80, I = 17.70, $P > 0.05$[4] Poisoning hazards score C = 79.96, I = 78.29, $P > 0.05$[4].
Garcia 1996* (Garcia, 1996)	CBA (C) Allocation at level of schools B − U F − U Balance of confounders − U	Fourth grade elementary school children and their parents Data on socio-economic status not reported USA (n = 3904)	I = safety fair at schools which included interactive safety stations on poisons, fires, and home injuries. C = no safety fairs	Poison safety Intervention school students showed significant improvement in poison safety. Numerators, denominators and P values not reported[1].
Gielen 2002* (Gielen et al., 2002)	RCT A − U B − U F − U	First and second year paediatric residents and their patient-parent dyads, low income population of parents of children aged 0−6 months Parent employed (full or part-time) = 66% Income < $5000/year = 39% Married = 13% More than high school education = 12% USA (n = 187).	I: Safety counselling by professional health educator; discounted home safety equipment during visit to Children's Safety Centre; home visit involving hazard assessment (targeting falls, burns and poisonings) and safety recommendations. C: Safety counselling by professional health educator; discounted home safety equipment during visit to Children's Safety Centre.	Possession of ipecac OR 1.22 (0.55−2.69)[2] Safe storage of poisons OR 0.81 (0.25−2.57)[2]

(*continued*)

Table 4. (*Continued*)

First author	Design and risk of bias[a]	Participants	Content of intervention	Outcomes*Poisoning/Prevention Measuresn (%) or effect size (95% CI)*
Gielen 2007** (Gielen et al., 2007)	RCT A − Y B − N F − Y	English speaking parents of children aged 4−66 months attending an urban paediatric ED Black = 93% Unmarried = 69% Between 20 and 29 years old = 58% High school education = 75% Annual income < $5000 = 63% USA ($n$ = 520)	I = personalized report containing tailored, stage-based messages based on the precaution adoption process model C = report on other child health topics	Safe storage of medicines OR 1.61 (1.10−2.36)[4] Safe storage of cleaning products OR 1.46 (0.67−3.18)[4] Safe storage of poisons OR 0.63 (0.45−0.89)[4]
Guyer 1989*(Guyer et al., 1989)	CBA B − U F − Y Balance of confounders − N	Population of 14 cities and towns in Massachusetts Data on socio-economic status not reported USA(n = 286,676)	I: Community injury prevention programme including injury counselling by paediatricians to parents of young children and home safety inspections. C: No community injury prevention programme.	Rate of medically attended poisonings I = 36.14/10,000 person years C = 92.71/10,000 person years OR 0.95 (0.57−1.58) (adjusted for socio-economic group)[2] Poisoning preventive behaviour score (14 items) I = 34.3, C = 30.5. P value not reported[2]
Hendrickson 2005 (Hendrickson, 2005)	RCT A − N B − N F − Y	Mothers with children aged 1−4 years, predominantly Mexican/Mexican American Hispanic = 87% White = 13% Married = 53.6% Never married = 16% Cohabiting = 20% Separated/divorced = 11% Housing in need of repair = 38% USA (n = 82)	I: Safety counselling from researchers; identification of home hazards; provision of safety equipment (door knob covers, smoke detectors or new batteries if smoke alarm already *in situ*, fire extinguisher, cabinet latches and outlet covers). C: None of the above.	Safe storage of cleaning products OR 15.79 (4.65−53.62)[2] Poison control centre sticker available OR 34.00 (9.32−123.97)[2]
Johnston 2000* (Johnston et al., 2000)	RCT (C) Allocation at level of preschool enrichment programme centres A − N B − N F − Y	Families of children aged 4−5 years enrolled in Head Start programme provided to socio-economically disadvantaged children Caucasian = 60% African-American = 5% Hispanic = 12% Asian/Pacific Islander = 2% Native American/Alaskan Native = 7% Other = 1% USA (n = 362)	I = home safety inspections + educational material + provision of ipecac, smoke alarms and batteries provided by educational paraprofessionals C = home safety inspection + written information only	Possession of ipecac OR 16.91(6.25−45.78)[2] Removed poisons from home OR 2.48 (1.42 to 4.36)[2] Disposed of unused medicine OR 0.72 (0.35−1.47)[2]
Johnston 2006* (Johnston et al., 2006)	NRCT ($I_1 + I_2$ vs C) with nested RCT (I_1 vs I_2) B − U F − N Balance of confounders − N	Pregnant women <22 weeks' gestation White = 79% Family income: <$40,000 = 16% $40,000−$75,000 = 44% >$75,000 = 40% Single parent = 5% In receipt of public assistance = 9% USA (n = 343).	I_1: Three home visits during pregnancy including home safety information; well-child visits enhanced by the addition of a 'Healthy Steps' professional. I_2: Well-child visits enhanced by the addition of a 'Healthy Steps' professional. C: Usual care. 'Healthy Steps Programme', which included child safety, for the first 3 years of life including extended well child office visits (average 11 in first 2.5 years of life), home visits (average <2 in first 2.5 years of life), telephone helpline, parent groups, written information. Healthy steps professionals − nurses, nurse practitioners, social workers and early childhood educators.	Safety latches on cabinets I_1 v C: RR 0.88 (0.83−0.93)[1] Poison control telephone number available I_1 v C: RR 1.08 (10.3−1.12)[1]

(*continued*)

Table 4. (*Continued*)

First author	Design and risk of bias[a]	Participants	Content of intervention	Outcomes*Poisoning/Prevention Measuresn (%) or effect size (95% CI)*
Kelly 1987* (Kelly, Sein, & McCarthy, 1987)	RCT A − U B − Y F − N	Parents of 6 month old children attending primary care centre for well child care Black = 74% Hispanic = 21% White = 5% Father in household = 19% Receiving welfare = 90% Home ownership = 11% Car ownership/access = 52% USA (n = 129)	I: Three-part individualized safety course at well-child care visits. C: Routine safety education.	Possession of ipecac OR 2.35 (0.99−5.57)[2] Storage of medicines out of reach I = 55/55 (0%) C = 54/54 (0%). P = NS[2] Storage of cleaning products out of reach OR 2.09 (0.71−6.13)[2]
Kelly 2003* (Kelly et al., 2003)	RCT (C) Allocation at level of well-child care class A − U B − Y F − Y	Low income parents of children aged 15 months to 6 years attending women, infant and children Clinics Latino = 82% White = 7% Asian/Pacific Islander = 5% African-American/other = 6% English speaking/other = 11% Spanish speaking = 64% Bilingual = 25% USA (n = 289)	I = videotape + poison control centre pamphlet + poison control centre stickers C = usual care	Behaviour score combining possession of ipecac and having poison centre number accessible Mean difference I vs C: 0.59 (0.47−0.72)[1] Possession of ipecac OR 0.84 (0.49−1.47)[2] Poison control centre sticker accessible OR 8.94 (5.11−15.65)[2]
Kendrick 1999* (Kendrick et al., 1999)	NRCT B − N F − N Balance of confounders − Y	Children 3−12 months registered at 36 GP practices In receipt of means tested benefits = 32% No access to car = 20% Non-owner occupation = 32% Single parent = 12% Non-white ethnic group = 6% Living in deprived area = 14% One parent unemployed = 9% Single parent or both parents unemployed = 2% UK (n = 2119)	I: Health visitor safety advice at child health surveillance; low cost equipment (stair gates, fire guards, cupboard and drawer locks, smoke alarms); home safety checks; first aid training. C: Usual care.	Medically attended poisonings IRR 1.09 (0.68−1.76)[4] Safe storage of cleaning products OR 1.24 (0.80−1.93)[2]
Kendrick 2007** (Kendrick Groom et al., 2007)	RCT A − Y B − Y F − Y	Children aged 7−10 years in state funded primary schools Males = 52% Child age − 7 years = 20% Child age − 8 years = 33% Child age − 9 years = 33% Child age − 10 years = 14% Family does not have car = 14% UK (n = 459)	I: Injury prevention curriculum including a poisoning prevention lesson, delivered by school teachers. C: Usual care.	Child never gets medicines without asking adult OR 0.69 (0.30−1.59)[4]
King 2001* (King et al., 2001)	RCT A − Y B − Y F − Y	Children <8 years attending A&E for injury or medical complaint Parents average age = 33 years Age mother had first child = 27 years (median) Parent's minimum education = 13 years (median) Child's age = 2 years (median) Males = 59% Canada (n = 1172)	I: Home safety inspection; information on correcting any deficiencies; discount vouchers for safety equipment; demonstrations of use of safety devices; information on preventing specific injuries provided by researcher. C: Home safety inspection and safety pamphlet.	Safe storage of cleaning products CRCs on cleaning products in kitchen OR 0.98 (0.77−1.27)[2] Safe storage of bathroom cleaning products OR 0.90 (0.69−1.16)[2] CRC's on bathroom cleaning products OR 0.98 (0.74−1.31)[2]

(*continued*)

Table 4. (*Continued*)

First author	Design and risk of bias[a]	Participants	Content of intervention	Outcomes*Poisoning/Prevention Measuresn (%) or effect size (95% CI)*
Lacouture 1978* (Lacouture et al., 1978)	CBA (C) Allocation at level of towns A − U B − N F − U Balance of confounders − Y	School children aged 6−14 years in Wilmington (intervention) and Scituate (control), Massachusetts Median school years completed. $I = 2.2$ years; $C = 12.9$ years Median family income − $I = \$11{,}713$ $C = \$13{,}401$ Per cent of population with incomes below poverty level. $I = 3.6\%$. $C = 4.2\%$ USA ($n = 400$)	I = community poison prevention education programme, directed at school children C = no community poison prevention education programme	Possession of ipecac Significantly more intervention group families had ipecac than control group families after intervention. Numerators and denominators not reported. $P < 0.05$[1]
LeBailley 1990*(LeBailley et al., 1990)	NRCT Sequential allocation to treatment group A − U B − U F − N Balance of confounders − U	Families attending two paediatric group practices, one in urban area, other in suburban area Data on socio-economic status not reported USA ($n = 407$)	I_1 = well child visit + safety equipment I_2 = well child visit + safety equipment + safety counselling by physician I_3 = well child visit + safety counselling by physician C = well-child visit	Possession of ipecac− Significantly more Intervention families possessed ipecac. Numerators, denominators and *P* values not reported[1].
LeBlanc 2006** (LeBlanc et al., 2006)	Matched CCS NOS for CCS 8/9	Children aged younger than 8 years who presented to an emergency department with injuries from falls, burns or scalds, ingestions or choking. and children presenting to same emergency department with non-injury diagnosis Mother's education < 12 years = 16% Either parent in labour or service sector = 40% Father unemployed or house-parent = 4% Canada ($n = 692$)	Exposures measured:	No child-resistant lids on bathroom bottles OR 1.70 (1.18−2.44)[1] No child-resistant lids on household cleaning supplies OR 1.02 (0.70−1.48)[1] Easy access to bathroom beauty supplies or medications OR 1.06 (0.76−1.47)[1] Easy access to household cleaning supplies OR 1.05 (0.77−1.45)[1]
McDonald 2005*(McDonald et al., 2005)	RCT A − Y B − U F − N	Parents of children aged 6 weeks - 24 months attending well child clinic in urban areas African-American = 93% Housing status Home renter 82% Home owner 6% Neither rent nor own 12% Children living with two parent family 46% Children living with siblings − 65% USA ($n = 144$)	I: Tailored safety advice in kiosk in well-child clinic; feedback report to paediatrician to encourage safety counselling; information on safety equipment savings at child safety centre. C: Usual care.	Storage of medicines out of reach OR 1.47 (0.39−5.51)[2] Storage of cleaning products out of reach OR 1.96 (0.47−8.25)[2] Possession of syrup of ipecac OR 5.57 (1.93−16.03)[2]

(*continued*)

Table 4. (*Continued*)

First author	Design and risk of bias[a]	Participants	Content of intervention	Outcomes*Poisoning/Prevention Measuresn (%) or effect size (95% CI)*
Minkovitz 2003* (Minkovitz et al., 2003)	RCT& a cluster allocated CBA RCT: A − Y B − U F = N CBA (C) F − N A − Y B − U Balance of confounders-N	Participants were children enrolled at birth and followed up through age 3 years. English or Spanish speaking only Mother's education; ≤11y = 14.6% High school graduate = 26% Some college/vocational school = 29% College graduate = 31% Mother's race White = 62% African-American = 23% Asian/native American = 4% Other = 11% Married = 68% Single parent = 20% Mother employed = 36% Father employed = 89% Home owner = 57% Income at baseline Low (<$20,000) = 29% Middle ($20,000−40,000) = 36% High (≥$50,000) = 35% USA Randomisation trial, $n = 2235$ Cluster CBA, $n = 3330$	Intervention arm: 'Healthy Steps Programme',which included child safety, for the first 3 years of life including extended well-child office visits (average 11 in first 2.5 years of life), home visits (average <2 in first 2.5 years of life), telephone helpline, parent groups, written information. Programme delivered by paediatricians and Healthy Steps Specialists (nurses, nurse practitioners, social workers and early childhood educators). Control arm: conventional paediatric care.	Safety latches on cabinets $I = 1277/2021$ (63%) $C = 1059/1716$ (62%) $p = 0.34$[1]
Nansel 2002* (Nansel et al., 2002)	RCT A − Y B − U F − Y	Parents of children aged 6−20 months attending well-child check Number of adults in home: One = 19% Two = 50% Three or more = 31% African-American = 85% Caucasian = 5% Other = 10% Education: High school or less = 54% College = 47% Income < $10,000 = 25% $10,000−$24,999 = 30% $25,000−$49,999 = 25% >$50,000 = 20% USA ($n = 213$).	I: Tailored computer-generated safety advice in well-child clinic. C: Generic computer-generated safety advice in well-child clinic	Storage of medicines out of reach OR 0.95 (0.29−3.08)[2] Storage of cleaning products out of reach OR 1.28 (0.64−2.56)[2] Possession of ipecac OR 1.38 (0.68−2.80)[2] Poison control centre sticker available OR 1.46 (0.76−2.80)[2]

(*continued*)

Table 4. (*Continued*)

First author	Design and risk of bias[a]	Participants	Content of intervention	Outcomes*Poisoning/Prevention Measuresn (%) or effect size (95% CI)*
Nansel 2008** (Nansel et al., 2008)	NRCT B − N F − N Balance of confounders − N	Parents of children aged ≤ 4 years attending well-child visits at three paediatric clinics with mainly low to middle income patients Race − African-American = 58% Race − Caucasian = 34% Race − Other = 8% Education − <High school degree = 13% Education − High school degree or equiv. = 44% Education − any college = 42% Relationship to child Mother/stepmother = 85% Father/stepfather = 6% Grandparent/other = 9% Income − $10,000 = 40% $10,000−14,999 = 17% $15,000−24,999 = 16% $25,000−49,999 = 17% >$50,000 = 8% Home owner = 30% Home renter = 70% USA ($n = 305$)	I_1: Tailored injury prevention advice. I_2: Tailored injury prevention advice and feedback to health care provider. C: Generic injury prevention advice.	Storage of medicines out of reach OR 0.97 (0.17−5.43)[4] Storage of cleaning products out of reach OR 1.03 (0.50−2.11)[4] Poison control centre sticker available OR 0.56 (0.25−1.27)[4]
Odendaal 2009** (Odendaal et al., 2009)	RCT A - N B − Y F − Y	Households with children ≤ 10 years old living in low-income communities Single parent household = 41% Unemployed = 86% Main caregiver − Mother = 75% Education level No schooling = 1% Primary and secondary school only = 97% After school training = 4% South Africa ($n = 211$)	I: Home safety check; safety advice; free safety devices (insulation tape for connecting electrical cords, safety nails for attaching electrical cords to walls or floors, paraffin storage container with CRC and warning label and bag and hook for safe storage of poisonous substances). C: Usual care.	Poisoning score (mean (se) and mean difference) $I = 2.9$ (0.23), $C = 4.0$ (0.25), IE1.1 (0.44−1.77)[1]
Paul 1994* (Paul et al., 1994)	RCT A − U B − U F − N	Families with children aged 10 months to 2 years born at local rural hospital Married = 93% Home owner = 15% Home renter = 85% More than 1 child = 72% Education − high school cert or higher = 64% Australia ($n = 198$)	I: Home safety check; tailored education booklet; local safety equipment retail outlets identified, mail order addresses provided or equipment ordered through research team and made available at local hospital. C: None of the above.	Lockable cabinet for storage of poisons in kitchen/bathroom/laundry Intervention group more likely to have lockable cabinets post-intervention than pre-intervention. Numerators and denominators not reported. $P < 0.05$[1]. Possession of ipecac Intervention group more likely to have ipecac than control group. Numerators and denominators not reported. $P < 0.01$[1].
Petridou 1997* (Petridou et al., 1997)	CBA B − N F − Y Balance of confounders − Y	Random sample of households containing children or adolescents from towns on two Greek islands, Naxos and Spetse Data on socio-economic status not reported Greece ($n = 349$).	I: Community intervention including safety seminars for parents, courses with primary and secondary school children on safety and resuscitation, and leaflets; focussed intense intervention including lay home visitors, weekly visits to discuss home safety in households with children or older people. C: None of the above.	Poison control centre sticker available OR 1.30 (0.70−2.38)[2] Possession of ipecac OR 10.28 (2.31−45.83)[2]

(*continued*)

Table 4. (*Continued*)

First author	Design and risk of bias[a]	Participants	Content of intervention	Outcomes*Poisoning/Prevention Measuresn (%) or effect size (95% CI)*
Phelan 2011** (Phelan et al., 2011)	RCT A – Y B – N F - Y	Pregnant women, aged 18 years and over, < 19 weeks gestation, attending pre-natal practices Residing in houses built prior to 1978 White non-Hispanic = 68% Black non-Hispanic = 25% Other race = 7% Maternal education: ≤High school = 19% < College = 25% College graduate/postgraduate = 56% Income: <$30,000 = 26% $30,000–49,999 = 15% $50,000–69,000 = 15% $70,000–89,999 = 22% $90,000–119,999 = 8% >$120,00 = 12% Unknown = 1% USA ($n = 355$).	I: Home safety inspection; provision and fitting of free safety equipment (stair gates, non-slip matting under rugs, window guards, repair of stair handrails, cupboard/drawer locks, door knob covers, storage bins, socket covers, smoke detectors, CO detectors, stove guards, stove locks); safety advice handout. C: Safety advice handout.	Poison control centre sticker available OR 7.96 (4.29–14.77)[4] Storage of poisons out of reach OR 0.10 (0.02–0.46)[4]
Posner 2004* (Posner et al., 2004)	RCT A – Y B – Y F – N	Caregivers of children <5 years attending ED for home injury Urban Predominantly black lower income Caregiver mother = 84% Caregiver father = 13% Caregiver grandparent = 1% Caregiver other = 2% Caregiver education <High school = 5% High school = 30% >High school = 46% No response = 19% Employed = 61% Home renter = 50% Home owner = 43% Child age (mean) years = 2 Child gender male = 89% Child race: Black = 76% Child race: Hispanic = 1% Child race: White = 15% Child race: Other = 8% USA ($n = 96$)	I: Home safety counselling by trained lay personnel; home safety kit (cupboard and drawer locks, socket covers, bath tub spout covers, non-slip bath decals, bath water thermometer, poison control centre number stickers, free small parts tester); home safety literature. C: Home safety literature.	Storage of medicines out of reach OR 1.49 (0.64–3.49)[2] Storage of cleaning products out of reach OR 2.58 (1.12–5.94)[2] Poison control centre sticker available OR 1.85 (0.79–4.32)[2] Storage of plants out of reach OR 0.58 (0.14–2.48)[2] Never stores chemicals in drinks bottle $I = 49/49$ (100%), $C = 46/47$ (98%) OR not calculable[2] Possession of CO detector OR 1.31 (0.52–3.27)[2] Tested CO detector within 6 months OR 0.27 (0.04–1.85)[2] Poisoning safety practices score $I = 74.4$, $C = 64.9$, $P < 0.02$[1]

(*continued*)

Table 4. (*Continued*)

First author	Design and risk of bias[a]	Participants	Content of intervention	Outcomes*Poisoning/Prevention Measuresn (%) or effect size (95% CI)*
Reich 2011** (Reich et al., 2011)	RCT A − U B −U F - U	Ethnically diverse Primiparous women in their third trimester of pregnancy Education: High school = 56% College = 44% Marital status: Married/living as married = 20% Other = 80% Race: Black non-Hispanic = 61% Other = 39% Income: <$8000 = 15% $8000−$21,000 = 26% $21,001−$40,000 = 14% $40,001−>$50,000 = 9% Missing income data = 37% USA (n = 198)	I_1 (n = 53): educational intervention book during third trimester and additional books when baby was 2, 4, 6,9, and 12 months old via a home visit I_2 (n = 56): books with the same illustrations but with different non-educational text on the same schedule as I_1. C (n = 58): did not receive any books.	Low reffort items: Odds ratio (SE)[1] No poisonous substances in house[1] I_1 v C: 1.01 (0.82) I_1 v I_2: 1.28 (0.72) I_2 v C: 0.90 (0.56) High effort items: Odds ratio (SE)[1] Latches on cabinets[1] I_1 vs C: 0.80 (0.41) I_1 vs I_2: 0.85 (0.40) I_2 vs C: 0.89 (0.35) Latches on drawers[1] I_1 vs C: 1.89(1.72) I_1 vs I_2: 3.85 (4.44) I_2 vs C: 0.72 (0.53)
Sangvai 2007* (Sangvai, Cipriani, Colborn, & Wald, 2007)	RCT A − Y B − Y F − N	Parents of children aged 0-5 years enrolled at three paediatric practices in rural and urban areas serving low/middle income population Public insurance = 46% Private insurance = 54% Race − White = 52% Race − African-American = 43% Race − Other = 5% Maternal education: ≤HS = 38% HS + any college = 32% ≥ College grad = 29% Unknown = 1% Housing: Single home = 55% Duplex/attached = 14% Apartment = 29% Mobile home = 2% USA (n = 319)	I = safety counselling from physician and researcher, free safety equipment (smoke detectors, gun locks, cabinet locks, and water temperature cards) and brief educational hand-out for parents C = usual care	Storage of poisons out of reach OR 0.10 (0.02−0.63)[4]

(*continued*)

Table 4. (*Continued*)

First author	Design and risk of bias[a]	Participants	Content of intervention	Outcomes*Poisoning/Prevention Measuresn (%) or effect size (95% CI)*
Scherz 1968* (Scherz, 1968)	CBA (C) Allocation at level of geographic area covering Army Post Exchanges A – U B – U F – U Balance of confounders – U	Families of army personnel Data on socio-economic status not reported USA No '*n*' reported 270,00 CRC distributed with children's aspirin	I = free child-resistant container attached to boxes of children's aspirin, sold at Post Exchanges C = children's aspirin sold at other sites without CRC attached	Medically attended aspirin poisoning proportion of all poisonings due to aspirin: Pre-intervention; intervention area = 71%, control area = 29%[1] Post-intervention; intervention area = 23%, control area = 77%[1] No *P* value reported
Schwarz 1993* (Schwarz et al., 1993)	CBA B – N F – N Balance of confounders – Y	Population of nine census tracts, predominantly low income, urban, African-American Median family income = $19,021 Race: African-American = 96% Race: Other = 4% Age: <5 years = 10% Age: 5—17 years = 18% Age: 18 – 64 years = 56% Age ≥65 years = 16% USA (*n* = 34,203).	I: Home inspection, modification and education in homes and at block and community meetings; provision of syrup of ipecac, smoke alarms and batteries, bath water thermometers, night lights, emergency centre number sticker and fridge sticker with information on preventing injury. C: None of the above.	Possession of ipecac OR 22.24 (13.53–36.54)[2] Storage of medicines out of reach OR 1.94 (1.35–2.78)[2] Medicines not in CRCs[2] OR 1.83 (1.81–2.83)
Steele1985a* (Steele & Spyker, 1985a)	CBA (C) Allocated at level of cities A – U B – U F – U Balance of confounders – U	Populations of Escondido (intervention) and Chula Vista (control), California Data on socio-economic status not reported USA (*n* = 137,000)	I = community poison prevention programme including mass media, training of health care, *n* = 62,000 personnel to provide poison prevention education to clients, safety fairs C = no community poison prevention programme *n* = 75,000	Medically attended poisonings – No significant difference in post versus pre injury rates in intervention or control communities[1]. Poison centre utilization No significant difference[1] Possession of ipecac No significant difference[1] Numerators, denominators and *P* values not reported
Steele 1985b* (Steele & Spyker, 1985b)	RCT A – U B – U F – U	Parents of children aged 6 months to 4 years attending well baby clinics, primary caretakers aged ≥ 18 years, Virginia, English speaking with a telephone available No socio-economic information on study population provided USA (*n* not reported)	I_1 = one-to-one poisoning education, with reinforcement by physician $I_2 = I_1$ + burns education I_3 = one-to-one burns education, with reinforcement by physician C = no education	Self-reported poisoning No significant difference for poison injury rates[1] Poison centre utilization Intervention groups exhibited significantly more likely to call a poison control centre[1]. Numerators, denominators and *P* values not reported

(*continued*)

Table 4. (*Continued*)

First author	Design and risk of bias[a]	Participants	Content of intervention	Outcomes*Poisoning/Prevention Measuresn (%) or effect size (95% CI)*
Swart 2008** (Swart et al., 2008)	RCT A – N B – Y F – Y	Households with children under 10 years in low-income communities Respondent is mother or father = 79% Respondent is brother or sister = 5% Child left in care of person <16 years = 19% Caretaker has only primary education = 32% South Africa ($n = 410$).	I: Home visits with safety advice on prevention of burns, poisoning and falls; free safety devices (childproof locks and paraffin container safety caps). C: Usual care.	Beauty products properly labelled in tightly closed non-glass containers. OR 0.75 (0.17 to 3.42)[4] Safe storage of beauty products. OR 2.13 (1.00 to 4.53)[2] Medicines properly labelled in tightly closed non-glass containers. OR 0.33 (0.03 to 3.23)[4] Storage of medicines out of reach OR 1.59 (0.54–4.69)[4] Cleaning products properly labelled in tightly closed non-glass containers. OR 6.04 (0.44 to 83.02)[4] Cleaners stored on same shelf as food. OR 0.84 (0.17 to 4.14)[4] Storage of cleaning products out of reach OR 1.71 (0.61–4.76)[4] Paraffin properly labelled in tightly closed non-glass containers. OR 5.02 (1.26 to 19.98)[4] Safe storage of paraffin. OR 1.47 (0.51–4.25)[4] Paraffin stored in CRC. OR 3.39 (1.28–9.02)[4] Alcohol properly labelled in tightly closed non-glass containers. OR 1.01 (0.20–5.07)[4] Safe storage of alcohol. OR 1.76 (0.48–6.50)[2] Rat poison properly labelled in tightly closed non-glass containers. OR 1.01 (0.14–7.25)[4] Safe storage of rat poison. OR not calculable[4] Poisoning safety practices score. Mean (SE) score, Mean difference. $I = 1.9$ (0.11) $C = 2.4$ (0.20), −0.45 (−1.01 to 0.11) [1]

(*continued*)

Table 4. (*Continued*)

First author	Design and risk of bias[a]	Participants	Content of intervention	Outcomes*Poisoning/Prevention Measuresn (%) or effect size (95% CI)*
Sznajder 2003* (Sznajder et al., 2003)	RCT A − Y B − N F − Y	Socio-economically disadvantaged families, with medical or psychological difficulties which place them at high risk Respondent − mother = 87% One parent family = 13% Two parent family = 82% Reconstituted family = 4% Living in house = 6% Living in block of flats = 92% Temporary and unknown dwelling = 2% Parental education Primary school = 6% Secondary school = 23% Grammar school = 15% University = 52% Unknown = 4% Employment: Salaried = 61% Independent = 1% Training = 1% Jobless = 3% Home = 31% France (n = 100)	I: Free home safety kit (cupboard and drawer locks, door handle covers, furniture corner protectors, socket covers, non-slip bath mat, smoke alarm, poison control centre number stickers); home safety counselling by health professionals; safety leaflets. C: Home safety counselling by health professionals; safety leaflets.	Safe storage of medicines OR 2.44 (0.45−13.28)[2] Safe storage of cleaning products OR 1.41 (0.49−4.06)[2] Storage of plants out of reach OR8.20 (0.97−69.40)[4] Safe storage of home maintenance products (weed killers, insecticides, kerosene) I = 10/14 (71%) C = 6/17 (35%)[1] Safe storage of beauty products (bath oil, shampoos, aftershave lotions) I = 21/32 (66%) C = 13/25 (52%)[1] Safe storage of alcohol I = 10/18 (56%) C = 2/16 (13%)[1] No P values reported
Vineis 1994* (Vineis, Ronco, Ciccone, & Gogliani, 1994)	NRCT B − N F − N Balance of confounders − U	Parents of newborn babies in Rivoli Data on socio-economic status not reported Italy (n = 1015)	I: 15 minutes counselling by nurse; distribution of three educational booklets − one on prevention of home injuries in childhood, one on smoking and one on passive smoking C: None of the above	Poisoning preventive behaviours No significant difference in preventive behaviours for cleaning products or medicines − score ranging from 0 (least risky behaviour) to 3 (most risky behaviours) No P values reported.[1]
Watson 2005* (Watson et al., 2005)	RCT A − Y B − N F − N	Families with children <5 years on caseloads of health visitors in deprived areas In receipt of means tested benefits = 48% No car = 30% Living in rented accommodation = 45% Overcrowding = 11% Single parent family = 27% Non-white ethnic group = 14% Lives in deprived area = 70% One parent unemployed = 35% Both parents unemployed = 33% UK (n = 3428)	I: Health visitor safety consultation; free fitted safety equipment (stair gates, fire guards, cupboard and drawer locks, smoke alarms, window locks). Free items supplied and fitted for families in receipt of benefits, free delivery for other families. C: Usual care.	Storage of medicines out of reach OR 1.15(0.77−1.71)[2] Safe storage of cleaning products out of reach OR 1.18(0.96−1.46)[2] Medicines in kitchen OR 1.55 (1.00−2.40)[1] Cleaning products in kitchen OR 1.31 (1.07−1.60)[1] Cleaning products in bathroom OR 1.06 (0.86−1.31)[1]

(*continued*)

Table 4. (*Continued*)

First author	Design and risk of bias[a]	Participants	Content of intervention	Outcomes*Poisoning/Prevention Measuresn (%) or effect size (95% CI)*
Wissow 1989* (Wissow et al., 1989)	RCT A − U B − Y F − N	Families with children <6 years attending paediatric ED or clinic following injury Data on socio-economic status not reported USA ($n = 62$)	I: Home hazard inspection, education and free safety equipment provided at home (smoke alarm battery, poison control sticker, syrup of ipecac, safety latches, outlet plugs). $I = 36$ C: Free safety equipment provided at hospital. $C = 26$	Possession of ipecac − Significantly more control group families had ipecac. $P = 0.009$[1] Poison centre number accessible [1]
Woolf 1987* (Woolf et al., 1987)	RCT (C) A − U B − Y F − N	Families attending medical ED with children < 5 years Urban poor population White = 44% Black = 35% Hispanic = 13% Other = 8% Marital status: Married = 58% Single = 26% Divorced, separated, other = 16% Education: minimum of high school certificate Mother = 79% Father = 71% Mother unemployed = 56% Father unemployed = 14% USA ($n = 202$)	I = Counselling by medical staff on poisoning treatment methods, leaflet on poison prevention, poison control centre number sticker + ipecac C = none of the above	Possession of ipecac OR 2.95 (1.77−4.90)[2] Poison centre number accessible OR 2.57 (1.48−4.44)[2] Storage of cleaning products, medicines, perfume Numerators, denominators and *P* values not reported [1]
Woolf 1992* (Woolf et al., 1992)	RCT (C) A − U B − Y F − Y	Families of children less than or equal to 5 years with a poisoning who contacted the poison control centre and did not have ipecac White = 90% Median income $30,000 Maternal age (mean) = 30 years Paternal age (mean) = 32 years Maternal education (mean) = 14 years Paternal education (mean) = 14 years Married = 90% USA ($n = 301$)	I = mailed $1 coupon for ipecac, one cupboard lock, checklist for poison proofing the home, leaflets C = none of the above	Self-reported repeat poisoning No significant difference. Numerators, denominators and *P* values not reported[1] Possession of ipecac OR 1.22 (0.78−1.93)[2] Poison centre number accessible OR 5.53 (3.33−9.17)[2] Safe storage of cleaning products OR 2.21 (1.40−3.51)[2]
Zhao 2006**(Zhao et al., 2006)	RCT A − U B − U F − Y	Children aged 7−13 years attending four primary schools Data on socio-economic status not reported Two rural schools, two urban schools China	I = safety education provided to parents and children C = usual care	Self-reported poisoning 1 year after intervention $I = 6/3172$ $C = 8/2669$; not significant. *P* value not reported.[1] Self- reported poisoning 2 years after intervention IRR 0.30 (0.10−0.94)[1]

* Study identified from an included systematic review/meta-analysis.
** Study identified from subsequent searches for additional primary studies. [a]Risk of bias: A = allocation concealment, B = blinding of outcome assessment, F = follow up on ≥80% of participants. For NRCTs and CBAs confounders were judged to be balanced if their prevalence did not differ between groups by >10%. Y = yes, N = no, U = unclear. NOS = Newcastle−Ottawa Score.
[1]= results from primary study.
[2]= results from systematic review − Kendrick et al. (2007).
[3]= results from systematic review − Pearson et al. (2009).
[4]= unpublished data provided to the authors from which ORs calculated.

a range of injuries (IRR 1.09, 95% CI 0.68−1.76 (Kendrick, Marsh, Fielding, & Miller, 1999)), and one CBA evaluating a community wide safety education programme which did not report figures or *P* values (Steele & Spyker, 1985a). One RCT (Steele & Spyker, 1985b) evaluated one-to-one safety education covering poisonings and burns but did not report any figures or *P* values. One RCT (Woolf, Saperstein, & Forjuoh, 1992) evaluated the provision of safety equipment by a PCC for poison proofing the home but reported no significant differences for self-reported repeat poisoning and no figures or *P* values were provided.

3.4.2. *Interventions promoting safe storage of medicines*

Interventions to promote the safe storage of medicines (defined as use of safety catches or locks on cupboards/drawers, locked medicine cabinets, child resistant containers, and storage out of reach of children) were reported in 18 studies (see Table 4) from 10 reviews (DiGuiseppi & Roberts, 2000; Elkan et al., 2000; Guyer et al., 2009; Kendrick, Barlow, Hampshire, Polnay, & Stewart-Brown, 2007; Kendrick, Coupland et al., 2007; Lyons et al., 2006; Lyons et al., 2003; Pearson et al., 2009; Towner et al., 1996; United States Preventive Services Task Force, 1996) and in a further 7 primary studies not included in the reviews (Bulzacchelli, Gielen, Shields, McDonald, & Frattaroli, 2009; Gielen et al., 2007; LeBlanc et al., 2006; Nansel, Weaver, Jacobsen, Glasheen, & Kreuter, 2008; Phelan et al., 2011; Reich, Penner, & Duncan, 2011; Swart, van Niekerk, Seedat, & Jordaan, 2008). One meta-analysis (Kendrick, Coupland et al., 2007) found evidence that education, with or without the provision of safety equipment, was effective in increasing safe storage of medicines (OR 1.57, 95% CI 1.22−2.02).

Of the 25 primary studies, seven reported significantly more intervention group families stored medicines safely than control group families. This included six RCTs (Baudier et al., 1988; Clamp & Kendrick, 1998; Colver, Hutchinson, & Judson, 1982; Gielen et al., 2007; Paul, Sanson-Fisher, & Redman, 1994; Watson et al., 2005) and one CBA (Schwarz, Grisso, Miles, Holmes, & Sutton, 1993), evaluating interventions providing safety education (OR 1.61, 95% CI 1.10−2.36 (Gielen et al., 2007)) and safety education plus equipment, with effect sizes ranging from RR 1.15 95% CI 1.03−1.28 (Clamp & Kendrick, 1998) to OR 14.30 95% CI 4.22−18.46 (Colver et al., 1982). The remaining 18 studies (see Table 4) evaluating a range of interventions including safety education, tailored safety education, safety education plus equipment found no significant difference in safe storage of medicines between treatment groups.

3.4.2.1. *Interventions promoting safe storage of household and other products.*

Interventions promoting the safe storage of household and other products (defined as use of safety catches or locks on cupboards/drawers, use of CRCs, and storage out of reach of children), were reported in 24 primary studies included in 11 reviews (DiGuiseppi & Roberts, 2000; Elkan et al., 2000; Guyer et al., 2009; Kendrick, Barlow et al., 2007; Kendrick, Coupland et al., 2007; Lyons et al., 2006; Lyons et al., 2003; Pearson et al., 2009; Towner et al., 1996, 2001; United States Preventive Services Task Force, 1996) and in a further 7 studies not included in any reviews (Bulzacchelli et al., 2009; Gielen et al., 2007; LeBlanc et al., 2006; Nansel et al., 2008; Phelan et al., 2011; Reich et al., 2011; Swart et al., 2008) (see Table 4). One meta-analysis (Kendrick, Coupland et al., 2007) found evidence that education, with or without the provision of safety equipment was effective in increasing safe storage of household products (OR 1.63, 95% CI 1.22−2.17). A second meta-analysis (DiGuiseppi & Roberts, 2000) of similar interventions in a clinical setting reported that intervention families were 1.8 times more likely to store cleaning agents safely, but did not provide confidence intervals or a *p* value.

Of the 31 primary studies, six reported significantly more intervention group families stored household and other products safely. Four RCTs (Colver et al., 1982; Hendrickson, 2002; Paul et al., 1994; Watson et al., 2005) provided safety education plus equipment and home safety inspections with effect sizes ranging from OR 1.31 95% CI 1.07−1.60 (Watson et al., 2005) to OR 15.79, 95% CI 4.65−53.62(Hendrickson, 2005). One RCT provided safety education plus equipment (OR 2.21 95% CI 1.40−3.51 (Woolf et al., 1992)) and one RCT gave home safety counselling and safety equipment with specific injury focussed instructions in the ED prior to discharge (OR 2.58 95% CI 1.12−5.94) (Posner, Hawkins, Garcia-Espana, & Durbin, 2004). The remaining 25 studies (see Table 4) reporting a range of interventions including safety education, tailored safety education, safety equipment and home safety inspections found no significant difference in the safe storage of household and other products between treatment groups.

3.4.2.2. *Interventions promoting use of child resistant containers.*

Interventions promoting the use of child resistant containers (CRCs) were reported from two studies (see Table 4) included in six reviews (Elkan et al., 2000; Kendrick, Coupland et al., 2007; Lyons et al., 2006; Lyons et al., 2003; Pearson et al., 2009; Towner et al., 1996) and a further two studies not included in reviews. One RCT evaluating the effects of home visits providing safety education, home safety inspection, and provision of child proof locks and child resistant caps (CRCs) reported significantly more intervention group families stored paraffin in containers with CRCs (OR 3.39, 95% CI 1.28−9.02) (Swart et al., 2008). The remaining three

studies (see Table 4) evaluating a range of interventions including safety education, safety equipment and home safety inspections reported no significant difference in CRC use between treatment groups.

3.4.2.3. Interventions promoting possession and use of syrup of ipecac. Nine reviews reported findings from 15 studies (see Table 4) evaluating interventions promoting the possession and use of syrup of ipecac (DiGuiseppi & Roberts, 2000; Elkan et al., 2000; Guyer et al., 2009; Kendrick, Coupland et al., 2007; Lyons et al., 2003; Pearson et al., 2009; Towner et al., 1996, 2001; United States Preventive Services Task Force, 1996). One meta-analysis (Kendrick, Coupland et al., 2007) found evidence that education, with or without the provision of safety equipment, was effective in increasing possession of syrup of ipecac (OR 3.34, 95% CI 1.50−7.41).

Eight of the 15 primary studies showed a significant effect favouring the intervention group. This included three RCTs (Johnston, Britt, D'Ambrosio, Mueller, & Rivara, 2000; Paul et al., 1994; Woolf, Lewander, Filippone, & Lovejoy, 1987) evaluating safety education, and provision of ipecac with effect sizes ranging from OR 2.95, 95% CI 1.77−4.90 (Woolf et al., 1987) to OR 16.91, 95% CI 6.25−45.78(Johnston et al., 2000) and one RCT (McDonald et al., 2005) evaluating tailored safety education (OR 5.57 95% CI 1.93−16.03). Three CBAs evaluating community programmes providing safety education, safety education with the provision of ipecac, safety education with home inspections and safety education with modification in the home (Lacouture, Minisci, Gouveia, & Lovejoy, 1978; Petridou, Tolma, Dessypris, & Tricholpoulos, 1997; Schwarz et al., 1993) reported significantly more families in the intervention group possessed syrup of ipecac with effect sizes ranging from OR 10.21, 95% CI 2.31−45.83 (Petridou et al., 1997) to OR 22.24, 95% CI 13.53−36.54 (Schwarz et al., 1993). One NRCT (LeBailley et al., 1990) evaluating safety education, provision of ipecac and well-child visits reported significantly more intervention families possessed syrup of ipecac but did not report any figures or *P* values. One RCT found that significantly more control group families possessed ipecac on home inspection, $p = 0.009$ (Wissow, Warshaw, Turner, & Wilson, 1989). The remaining six studies (see Table 4) evaluating safety education, tailored safety education, provision of ipecac and community programmes providing safety education did not find any significant difference in the possession of syrup of ipecac between treatment groups. Guidance about the use of ipecac syrup has changed over time, and this is no longer recommended (American Academy of Pediatrics, Committee on Injury, Violence and Poison Prevention, 2003) despite being measured in a number of our included studies.

3.4.2.4. Interventions to promote use of poison control centre stickers and telephone numbers. Eight reviews reported 11 primary studies (see Table 4) evaluating interventions promoting use of PCC stickers and/or telephone numbers (DiGuiseppi & Roberts, 2000; Guyer et al., 2009; Kendrick, Coupland et al., 2007; Lyons et al., 2006; Pearson et al., 2009; Towner et al., 1996, 2001; United States Preventive Services Task Force, 1996) as did two further RCTs not included in any of the reviews (Nansel et al., 2008; Phelan et al., 2011). One meta-analysis (Kendrick, Coupland et al., 2007) found evidence that education, with or without the provision of safety equipment, was effective in increasing availability of PCC numbers (OR 3.67, 95% CI 1.84−7.33).

Six of the 13 primary studies reported significant effects, favouring the intervention group. This included five RCTs and one NRCT (Johnston, Huebner, Anderson, Tyll, & Thompson, 2006). The five RCTs (Hendrickson, 2002; Kelly, Huffman, Mendoza, & Robinson, 2003; Phelan et al., 2011; Woolf et al., 1987, 1992) evaluating safety education, provision of PCC stickers and telephone numbers, and home safety inspections reported effect sizes ranging from OR 2.57, 95% CI 1.48−4.44 (Woolf et al., 1987) to OR 34.00, 95% CI 9.32−23.97 (Hendrickson, 2002). The NRCT evaluated the Healthy Steps child development and behaviour programme which had two intervention groups. The first received the Healthy Steps programme (HS) and the second received the HS programme and antenatal home visits. The study found a significant effect for one intervention only, HS only vs usual care (RR 1.08, 95% CI 1.03−1.12) (Johnston et al., 2006). The remaining seven studies (see Table 4), evaluating a range of interventions including education, tailored safety education , provision of PCC stickers and home inspections, did not report any significant differences in use of PCC stickers and telephone numbers between treatment groups.

3.4.4.5. Interventions to promote other poisoning prevention practices. Twelve reviews reported nine studies (see Table 4) evaluating interventions promoting other poisoning prevention practices (Elkan et al., 2000; Guyer et al., 2009; Kendrick, Coupland et al., 2007; Lyons et al., 2003, 2006; Nilsen, 2004; Nixon et al., 2004; Pearson et al., 2009; Spinks et al., 2004; Towner et al., 1996, 2001; United States Preventive Services Task Force, 1996) as did a further four studies not included in any reviews (Kendrick Groom et al., 2007; Odendaal, van Niekerk, Jordaan, & Seedat, 2009; Reich et al., 2011; Swart et al., 2008). Of the 13 primary studies, one CBA study (Garcia, 1996) reported that the intervention group showed a significant improvement in poison safety scores after a school safety fair but no figures or *p* value were reported. Two RCTs (Odendaal et al., 2009; Swart et al., 2008) both evaluated the effects of education, provision

of safety equipment and home safety inspections on poisoning hazards scores with both finding significant effects favouring the intervention group (difference between means) 1.1 95% CI 0.44−1.77 (Odendaal et al., 2009) and −0.45, 95% CI −1.01 to 0.11 (Swart et al., 2008)) and one found significantly safer storage in the intervention group of beauty products OR 2.13 95% CI 1.00−4.53, and paraffin properly labelled and stored in tightly closed non-glass containers OR 5.02, 95% CI 1.26−19.98 (Swart et al., 2008). The remaining 10 studies (see Table 4) evaluated a range of interventions including community injury prevention programmes, safety education, tailored safety education and provision of safety equipment but found no significant differences between the intervention and control groups.

4. Discussion

Our review has highlighted the dearth of high quality evidence in the field of non-legislative interventions to prevent poisoning in childhood and the limited methodological quality of many of the studies we found. Although we found 13 systematic reviews and two meta-analyses which included a narrative review, only one review focussed on community-based programmes to prevent poisoning (Nixon et al., 2004), and the remainder covered a range of injury mechanisms. Only two meta-analyses reported poison prevention outcomes and only four reviews drew conclusions specific to poisoning prevention interventions. Very few studies measured poisoning as an outcome, and of these only two reported a significant reduction in poisonings and one meta-analysis reported a lack of evidence that interventions reduced poisoning rates. Two meta-analyses reported poison prevention practices; one found education with or without the provision of safety equipment was effective in promoting safe storage of medicines and household products, possession of ipecac and availability of emergency contact numbers. The second meta-analysis of similar interventions provided in a clinical setting found intervention group families were more likely to store household products safely, although the significance of this was not reported. In terms of primary studies, approximately half of the studies measuring possession of ipecac syrup or availability of the PCC number reported significant effects favouring the intervention group, whilst fewer than one-third reporting storage of medicines or household products out of reach reported significant effects favouring the intervention group. Whilst this was not a universal finding, studies that did report significant effects on poison prevention practices tended to provide education and cupboard/drawer locks, PCC number stickers or ipecac syrup. Some, but not all, also provided home safety inspections. Other differences between primary studies in terms of study populations, interventions, outcome measures and follow up periods makes it difficult to draw further conclusions about why particular interventions may or may not have been effective.

4.1. *Strengths and limitations*

To our knowledge, this is the first published overview of reviews of non-legislative education and engineering interventions to prevent childhood poisoning. It has summarized and updated the evidence from multiple systematic reviews of a range of interventions in this area. To ensure our review was as comprehensive as possible, and because many existing systematic reviews provided only limited information about poison prevention interventions, we reviewed primary studies included in existing systematic reviews and more recently published primary studies. Our review used a comprehensive search, robust methods for study selection and data extraction, had no language restrictions and assessed risk of bias of included studies. We have minimized bias in the reporting of review findings by examination of primary studies contained within those reviews. Our overview focussed on interventions that could be implemented in Children's Centres in England, or by other community health and social care providers in high income countries and our findings should be generalizable to these settings.

There are several limitations to our overview. The quality of included studies was very variable and the number of studies reporting most outcomes was relatively small, especially for those reporting poisonings. There was considerable heterogeneity between studies in the characteristics of study participants, content and delivery of interventions and the follow up periods. Most studies had small sample sizes; hence they would only have sufficient power to detect very large effect sizes. Many interventions had multiple components, it was not always possible to determine which components were responsible for observed effects. Guidance about the use of ipecac syrup has changed over time, and this is no longer recommended (American Academy of Pediatrics, Committee on Injury, Violence and Poison Prevention, 2003) despite being measured in a number of our included studies. Our findings are unlikely to be generalizable beyond higher income countries, as very few studies came from low or middle income countries. Although summarising evidence across multiple reviews helped minimize outcome reporting bias, some primary studies reported insufficient data and reviews did not always report all relevant outcomes from included primary studies, so some outcome reporting bias is still possible. Finally, it is important to remember that other interventions, outside of the scope of this review, have been demonstrated to be effective and cost effective. Legislation about medicines packaging and child-resistant closures has been associated with

significant reductions in poisonings (British Columbia Ministry of Health, 2007). PCCs have been shown to be cost effective, resulting in an estimated $1.8 billion saved in the USA per year on medical costs and lost productivity (Lewin Group, 2012). The education and engineering interventions included in our review should therefore be considered alongside these better evidenced interventions.

4.2. Implications for research and practice

Current published systematic reviews covering a range of injury mechanisms provide insufficient detail for policy-makers and practitioners to make decisions on the commissioning or provision of poison prevention interventions. Future systematic reviews will be more useful if they draw conclusions and make recommendations for specific injury mechanisms. Future overviews are likely to need supplementing with a review of primary studies as we have done to provide a comprehensive synthesis of the evidence. Network meta-analysis may be useful in future to enable comparison of findings across studies with a range of interventions (Cooper et al., 2012).

Further research is required to assess effectiveness of non-legislative interventions in reducing poisoning. Large, probably multi centre studies are likely to be required to have sufficient power to demonstrate reductions in poisoning rates, or multiple smaller studies that are similar enough to combine effect sizes in meta-analyses. The use of standardized outcome measures and tools across studies would facilitate evidence synthesis. More data on cost-effectiveness of poisoning prevention measures is needed to guide evidence-based decision-making by commissioners, practitioners and policy-makers on poison prevention interventions. Interventions involving education and provision of home safety equipment should be provided by health and social care providers alongside broader strategies (e.g. packaging legislation, PCCs) to prevent poisoning in childhood.

4.3. Conclusion

There is evidence that non-legislative education and engineering poison prevention interventions improve poison prevention practices, but there is insufficient evidence that they reduce poisonings in childhood. Interventions involving parent education and provision of home safety equipment should be considered alongside broader strategies (e.g. packaging legislation, PCCs) to prevent childhood poisoning. Further research is required to assess the effectiveness and cost-effectiveness of non-legislative interventions including education, the provision of home safety equipment and PCCs to enhance the evidence base in this area.

Acknowledgements

All contributors to this paper are listed as authors.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

Agran, P.F., Anderson, C., Winn, D., Trent, R., Walton-Haynes, L., & Thayer, S. (2003). Rates of pediatric injuries by 3-month intervals for children 0 to 3 years of age. *Pediatrics, 111*(6 Pt 1), e683–692.

American Academy of Pediatrics, Committee on Injury, Violence and Poison Prevention. (2003). Poison treatment in the home. *Pediatrics, 112*(5), 1182–1185. doi:10.1542/peds.112.5.1182

Baudier, F., Marchais, M., Ferry, B., Bourderont, D., Pinochet, C., & Blum, D. (1988). A cooperative program for the prevention of domestic accidents in children at the department of the Doubs. II. Educative aspects and evaluation. *Archives Francaises de Pediatrie, 45*(7), 499–503.

British Columbia Ministry of Health. (2007). *Unintentional injury prevention; evidence Review*. British Columbia: Author. Retrieved from http://www.health.gov.bc.ca/public-health/pdf/Unintentional_Injury-Evidence_Review.pdf.

Bulzacchelli, M., Gielen, A., Shields, W., McDonald, E.M., & Frattaroli, S. (2009). Parental safety-related knowledge and practices associated with visiting a mobile safety center in a low-income urban population. *Family & Community Health, 32*(2), 147–158.

Centers for Disease Control and Prevention. (2013). *Protect the ones you love - poisoning*. Retrieved from http://www.cdc.gov/safechild/Fact_sheets/Poisoning-Fact-Sheet-a.pdf

Child Accident Protection Trust. (2013). Poisoning – how to reduce hospital admissions.Retrieved from http://makingthelink.net/news/14-01-13/poisoning-how-reduce-hospital-admissions

Clamp, M., & Kendrick, D. (1998). A randomised controlled trial of general practitioner safety advice for families with children under 5 years. *British Medical Journal, 316*(7144), 1576–1579.

Colver, A.F., Hutchinson, P.J., & Judson, E.C. (1982). Promoting children's home safety. *British Medical Journal, 285* (6349), 1177–1180.

Cooper, N.J., Kendrick, D., Achana, F., Dhiman, P., He, Z., Wynn, P., … Sutton, A.J. (2012). Network meta-analysis to evaluate the effectiveness of interventions to increase the uptake of smoke alarms. *Epidemiologic Reviews, 34*(1), 32–45. doi:10.1093/epirev/mxr015

Department of Trade & Industry (UK). (2002). *Home &leisure accident surveillance system annual*. (Report). Retrieved from http://www.hassandlass.org.uk/reports/2002data.pdf

DiGuiseppi, C., & Roberts, I.G. (2000). Individual-level injury prevention strategies in the clinical setting. *Future of Children, 10*(1), 53–82.

Elkan, R., Kendrick, D., Hewitt, M., Robinson, J.J., Tolley, K., Blair, M., … Brummell, K. (2000). The effectiveness of domiciliary health visiting: A systematic review of international studies and a selective review of the British literature. *Health Technology Assessment (Winchester, England), 4* (13), i-v, 1–339.

Fergusson, D.M., Horwood, L.J., Beautrais, A.L., & Shannon, F. T. (1982). A controlled field trial of a poisoning prevention method. *Pediatrics, 69*(5), 515–520.

Finkelstein, E.A., Corso, P.S., & Miller, T.R. (2006). *Incidence and economic burden of injuries in the United States*. Oxford: Oxford University Press.

Flavin, M.P., Dostaler, S.M., Simpson, K., Brison, R.J., & Pickett, W. (2006). Stages of development and injury patterns in the early years: A population-based analysis. *BMC Public Health, 6*, 187.

Garcia, V.F. (1996). *Safety Fairs: Evaluation of a school-based injury prevention program*. Paper presented at the 3rd International Conference on Injury Prevention and Control, Melbourne, Australia.

Gielen, A.C., McDonald, E.M., Wilson, M.E.H., Hwang, W.-T., Serwint, J.R., Andrews, J.S., & Wang, M.-C. (2002). Effects of improved access to safety counseling, products, and home visits on parents' safety practices. *Archives of Pediatric and Adolescent Medicine, 156*, 33−40.

Gielen, A.C., McKenzie, L.B., McDonald, E.M., Shields, W.C., Wang, M.C., Cheng, Y.J., . . . Walker, A.R. (2007). Using a computer kiosk to promote child safety: Results of a randomized, controlled trial in an urban pediatric emergency department. *Pediatrics, 120*(2), 330−339. doi:10.1542/peds.2006-2703

Groom, L., Kendrick, D., Coupland, C., Patel, B., & Hippisley-Cox, J. (2006). Inequalities in hospital admission rates for unintentional poisoning in young children. *Injury Prevention, 12*(3), 166−170. doi:10.1136/ip.2005.011254

Guyer, B., Gallagher, S.S., Chang, B.-H., Azzara, C.V., Cupples, L.A., & Colton, T. (1989). Prevention of childhood injuries: Evaluation of the statewide childhood injury prevention program (SCIPP). *American Journal of Public Health, 79*(11), 1521−1527.

Guyer, B., Ma, S., Grason, H., Frick, K.D., Perry, D.F., Sharkey, A., & McIntosh, J. (2009). Early childhood health promotion and its life course health consequences. *Academic Pediatrics, 9*(3), 142−149.e171. doi:http://dx.doi.org/10.1016/j.acap.2008.12.007

Guyodol, G., & Danel, V. (2004). Childhood poisoning: Data from the French poison control and toxico vigilance centres (2002). *Therapie, 59*(6), 589−593.

Health and Social Care information Centre. (2012/13). *Hospital episode statistics*. Retrieved from http://www.hscic.gov.uk/searchcatalogue?productid=13264&q=title%3a%22Hospital+Episode+Statistics%2c+Admitted+patient+care+-+England%22&sort=Relevance&size=10&page=1#top

Hendrickson, S. (2002). *Injury surveillence and safe community initiatives. Safety home visits in a low-income community*. Paper presented at the 6th World Conference on Injury Prevention and Control, Montreal, Canada.

Hendrickson, S.G. (2005). Reaching an underserved population with a randomly assigned home safety intervention. *Injury Prevention, 11*(5), 313−317.

Higgins, J., & Green, S. (2011). *The cochranehandbook for systematic reviews of interventions*. Retrieved from http://www.cochrane-handbook.org

Johnston, B.D., Britt, J., D'Ambrosio, L., Mueller, B.A., & Rivara, F.P. (2000). A preschool program for safety and injury prevention delivered by home visitors. *Injury Prevention, 6*, 305−309.

Johnston, B.D., Huebner, C.E., Anderson, M.L., Tyll, L.T., & Thompson, R.S. (2006). Healthy steps in an integrated delivery system: Child and parent outcomes at 30 months. *Archives of Pediatrics & Adolescent Medicine, 160*(8), 793−800.

Kelly, N.R., Huffman, L.C., Mendoza, F.S., & Robinson, T.N. (2003). Effects of a videotape to increase use of poison control centers by low-income and spanish-speaking families: A randomized, controlled trial. *Pediatrics, 111*(1), 21−26.

Kendrick, D., Barlow, J., Hampshire, A., Polnay, L., & Stewart-Brown, S. (2007). Parenting interventions for the prevention of unintentional injuries in childhood. *Cochrane Database of Systematic Reviews,* (4), CD006020.

Kendrick, D., Coupland, C., Mulvaney, C., Simpson, J., Smith, S.J., Sutton, A., . . . Woods, A. (2007). Home safety education and provision of safety equipment for injury prevention. *Cochrane Database of Systematic Reviews,* (1), CD005014.

Kendrick, D., Groom, L., Stewart, J., Watson, M., Mulvaney, C., & Casterton, R. (2007). "Risk Watch": Cluster randomised controlled trial evaluating an injury prevention program. *Injury Prevention, 13*(2), 93−98.

Kendrick, D., Marsh, P., Fielding, K., & Miller, P. (1999). Preventing injuries in children: Cluster randomised controlled trial in primary care. *British Journal of Medicine, 318*, 980−983.

King, W.J., Klassen, T.P., LeBlanc, J., Bernard-Bonnin, A.-C., Robitaille, Y., Pham, B., . . . Pless, I.B. (2001). The effectiveness of a home visit to prevent childhood injury. *Pediatrics, 108*(2), 382−388.

Lacouture, P., Minisci, M., Gouveia, W.A., & Lovejoy, F.H. (1978). Evaluation of a community based poison education program. *Clinical Toxicology, 13*(5), 623−629.

LeBailley, S., Freel, K., Hicks-Bartlett, S., Kirschenman, S., Ritts-Benally, J., & Sasicki, J. (1990). *The children's safety research project (pp. Abstract)*. Elk Grove Village, IL: American Academy of Pediatrics.

LeBlanc, J.C., Pless, I.B., King, W.J., Bawden, H., Bernard-Bonnin, A.-C., Klassen, T., & Tenenbein, M. (2006). Home safety measures and the risk of unintentional injury among young children: A multicentre case-control study. *CMAJ Canadian Medical Association Journal, 175*(8), 883−887.

Lewin Group. (2012). *Final report on the value of the poison center system* (pp. 46). Falls Church, VA: American Association of Poison Control Centers.

Lyons, R.A., John, A., Brophy, S., Jones, S.J., Johansen, A., Kemp, A., . . .Weightman, A. (2006). Modification of the home environment for the reduction of injuries. *Cochrane Database of Systematic Reviews,* (4). doi:10.1002/14651858.CD003600.pub2

Lyons, R.A., Sander, L.V., Weightman, A.L., Patterson, J., Jones, S.A.L.S., Rolfe, B., . . .Johansen, A. (2003). Modification of the home environment for the reduction of injuries. *Cochrane Database of Systematic Reviews (Online),* (4), CD003600−CD003600.

MacInnes, K., & Stone, D.H. (2008). Stages of development and injury: An epidemiological survey of young children presenting to an emergency department. *BMC Public Health, 8*, 120.

McCaig, L.F., & Burt, C.W. (1999). Poisoning-related visits to emergency departments in the United States, 1993−1996. *Clinical Toxicology, 37*(7), 817−826. doi:10.1081/CLT-100102460

McDonald, E.M., Solomon, B., Shields, W., Serwint, J.R., Jacobsen, H., Weaver, N.L., . . .Gielen, A.C. (2005). Evaluation of kiosk-based tailoring to promote household safety behaviors in an urban pediatric primary care practice. *Patient Education and Counseling, 58*, 168−181.

Nansel, T.R., Weaver, N.L., Donlin, M., Jacobsen, H., Kreuter, M., Simons-Morton, B. (2002). Baby, be safe: The effect of tailored communications for pediatric injury prevention provided in a primary care setting. *Patient Education and Counseling, 46*, 175−190.

Nansel, T.R., Weaver, N.L., Jacobsen, H.A., Glasheen, C., & Kreuter, M.W. (2008). Preventing unintentional pediatric injuries: A tailored intervention for parents and providers. *Health Education Research, 23*(4), 656−669.

Nilsen, P. (2004). What makes community based injury prevention work? In search of evidence of effectiveness. *Injury Prevention, 10*(5), 268−274.

Nixon, J., Spinks, A., Turner, C., & McClure, R. (2004). Community based programs to prevent poisoning in children 0-15 years. *Injury Prevention, 10*(1), 43−46.

Odendaal, W., van Niekerk, A., Jordaan, E., & Seedat, M. (2009). The impact of a home visitation programme on household hazards associated with unintentional childhood injuries: A randomised controlled trial. *Accident Analysis and Prevention, 41*(1), 183−190. doi:10.1016/j.aap.2008.10.009

Oxman, A.D., & Guyatt, G.H. (1991). Validation of an index of the quality of review articles. *Journal of Clinical Epidemiology, 44*(11), 1271−1278. doi:http://dx.doi.org/10.1016/0895-4356(91)90160-B

Paul, C.L., Sanson-Fisher, R.W., & Redman, S. (1994). Preventing accidental injury to young children in the home using volunteers. *Health Promotion International, 9* (4), 241−249

Pearson, M., Garside, R., Moxham, T., & Anderson, R. (2009). Systematic reviews of effectiveness and cost-effectiveness of home safety equipment and risk assessment schemes. In M. Pearson (Ed.), (pp. 1−316). Plymouth: Penisular Technology Assessment Group (PenTAG), Peninsular Medical School, Universities of Exeter and Plymouth.

Peden, M., Oyegbite, K., Ozanne-Smith, J., Hyder, A., Branche, C., Rahman, A., . . .Bartolomeos, K. (2008). *World report on child injury prevention* (pp. 123−145). Geneva: World Helath Organisation.

Petridou, E., Tolma, E., Dessypris, N., & Tricholpoulos, D. (1997). A controlled evaluation of a community injury prevention project in two Greek Islands. *International Journal of Epidemiology, 26*(1), 173−179.

Phelan, K.J., Khoury, J., Xu, Y., Liddy, S., Hornung, R., & Lanphear, B.P. (2011). A randomized controlled trial of home injury hazard reduction: The HOME injury study. *Archives of Pediatrics & Adolescent Medicine, 165*(4), 339−345.

Posner, J.C., Hawkins, L.A., Garcia-Espana, F., & Durbin, D.R. (2004). A randomized, clinical trial of a home safety intervention based in an emergency department setting. *Pediatrics, 113*(6), 1603−1608.

Reich, S.M., Penner, E.K., & Duncan, G.J. (2011). Using baby books to increase new mothers' safety practices. *Academic Pediatrics, 11*(1), 34−43. doi:http://dx.doi.org/10.1016/j.acap.2010.12.006

Rodgers, G.B., Franklin, R.L., & Midgett, J.D. (2012). Unintentional paediatric ingestion poisonings and the role of imitative behaviour. *Injury Prevention, 18*(2), 103−108.

Scherz, R.G. (1968). Childhood poisonings from medications: Three prevention programs that worked. *Military Medicine, 133*(11), 911−913.

Schmertmann, M., Williamson, A., & Black, D. (2008). Stable age pattern supports role of development in unintentional childhood poisoning. *Injury Prevention, 14*(1), 30−33.

Schwarz, D.F., Grisso, J.A., Miles, C., Holmes, J.H., & Sutton, R.L. (1993). An injury prevention program in an Urban African-American community. *American Journal of Public Health, 83*(5), 675−680.

Smith, V., Declan, D., Begley, C.M., & Clarke, M. (2011). Methodology in conducting a systematic review of systematic reviews of healthcare interventions. *BMC Medical Research Methodology, 11*(15), 6 pp.

Spinks, A., Turner, C., McClure, R., & Nixon, J. (2004). Community based prevention programs targeting all injuries for children. *Injury Prevention, 10*(3), 180−185.

Steele, P.S., & Spyker, D.A. (1985a). Symposium on injuries and injury prevention: Poisonings. *Pediatric Clinics of North America, 32*(1), 77−86.

Steele, P.S., & Spyker, D.A. (1985b). Poisonings. *Pediatric Clinics of North America, 32*(1), 77−86.

Swart, L., van Niekerk, A., Seedat, M., & Jordaan, E. (2008). Paraprofessional home visitation program to prevent childhood unintentional injuries in low-income communities: A cluster randomized controlled trial. *Injury Prevention, 14*(3), 164−169.

Sznajder, M., Leduc, S., Janvrin, M.P., Bonnin, M.H., Aegerter, P., Baudier, F., Chevallier, B. (2003). Home delivery of an injury prevention kit for children in four French cities: A controlled randomized trial. *Injury Prevention, 9*(3), 261−265.

Tovell, A., McKenna, K., Bradley, C., & Pointer, S. (2012). *Hospital separations due to injury and poisoning, Australia 2009−10*. Retrieved from http://www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=60129542180.

Towner, E., Dowswell, T., & Jarvis, S. (2001). Updating the evidence. A systematic review of what works in preventing childhood unintentional injuries: Part 2. *Injury Prevention, 7* (3), 249−253.

Towner, E., Dowswell, T.,Jarvis, S., & Simpson, G. (1996). Preventing unintentional injuries in children and young adolescents. *Health Technology Assessment (HTA) Database*: NHS Centre for Reviews and Dissemination. York: University of York.

Towner, E., Dowswell, T., Mackereth, C., & Jarvis, S. (2001). *What works in preventing unintentional injuries in children and young adolescents? An updated systematic review (pp. 114)*. London: NHS Health Development Agency.

United States Preventive Services Task Force. (1996). Guide to clinical preventive services: Report of the U.S. preventive services task force. In C. DiGuiseppi, D. Atkins, & S.H. Woolf (Eds.), (2nd ed., pp. 659−685). Baltimore, MD: United States Preventive Services Task Force.

Waters, E., Shield, J., Nolan, T., Green, J., Elkingtong, J., Moller, J., . . . Scott, S. (2001). *Evidence based health promotion - No 4 child injury prevention*. Melbourne: Centre for Community Child Health, the University of Melbourne and the Safety Centre of the Royal Children's Hospital.

Watson, M., Kendrick, D., Coupland, C., Woods, A., Futers, D., & Robinson, J. (2005). Providing child safety equipment to prevent injuries: Randomised controlled trial. *BMJ, 330* (7484), 178.

Wells, G.A., Shea, B., O'Connell, D., Peterson, J., Welch, V., Losos, M., & Tugwell, P. (2013). *The Newcastle−Ottawa Scale (NOS) for assessing the quality of nonrandomized studies in meta-analysis*. Ottawa, CA: University of Ottawa.

Wissow, L.S., Warshaw, M.A., Turner, K., & Wilson, M.H. (1989). *Home hazards in the inner city*. Paper presented at the First World Conference on Accident and Injury Prevention., Stockholm, Sweden.

Woolf, A., Lewander, W., Filippone, G., & Lovejoy, F.H. (1987). Prevention of childhood poisoning: Efficacy of an educational program carried out in an emergency clinic. *Pediatrics, 80*(3), 359−363.

Woolf, A., Saperstein, A., & Forjuoh, S. (1992). Poisoining prevention knowledge and practices of parents after a childhood poisoning incident. *Pediatrics, 90*, 867–870.

World Health Organisation. (2008). *World report on child injury prevention - children and poisoning fact sheet*. Retrieved from http://www.who.int/violence_injury_prevention/child/injury/world_report/Poisoning_english.pdf

Zhao, C.H., Qiu, H.S., & Qiu, H.X. (2006). Interventions to prevent accidental injuries in children between 7 and 13 years of age. *Chinese Journal of Contemporary Pediatrics, 8*(4), 331–333. [Chinese].