Preventing unintentional injuries to children in the home: a systematic review of the effectiveness of programmes supplying and/or installing home safety equipment

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SUMMARY
In children under the age of five, the majority of unintentional injuries occur in the home, with higher levels of injury morbidity and mortality being found among those from more deprived backgrounds. This paper presents the findings of a systematic review about the effectiveness of programmes in decreasing unintentional injury rates to children (aged up to 15 years) in the home. The effectiveness of the provision of home safety equipment with or without installation, safety education or a home risk assessment is presented by outcome: injury rates, installation of smoke alarms and installation of other home safety equipment. Analysis of the statistically significant evidence suggests that few programmes reduce injury rates in children except where home safety equipment is supplied in conjunction with a home risk assessment, although this effect was only evident in households where a child had previously suffered an unintentional injury. The distribution of smoke alarms alone is insufficient for improving installation rates; programmes containing an education component showed more success. Interventions integrated into wider health programmes, where trusting relationships with householders were cultivated and/or where specific safety issues identified by a community were responded to also showed greater success in increasing smoke alarm installation rates. The evidence of effectiveness on installation rates of other home safety equipment is highly mixed, although there is some evidence to suggest that installation rates always decrease after 6 months. Where stair gates are both supplied and installed, inequalities in rates of use may be reduced.

Key words: unintentional injuries; home environment; systematic review

INTRODUCTION
Globally, unintentional injury contributes to the top 15 causes of death across all age groups of children aged 0–19 years, with road traffic accidents, drowning, fire-related burns and falls the most common causes (Peden et al., 2008). In children under the age of five, the majority of injuries occur in the home. It is known that higher levels of injury morbidity and mortality are found among those from more deprived backgrounds, whatever measure is used (parental occupation, deprivation index of local area etc.), although to date there has been little robust research about the impact of programmes on different socio-economic groups (Dowswell and Towner, 2002). In addition, unintentional injury is more common and more
serious in boys than girls, and this gap increases with a child’s age (Healthcare Commission and Audit Commission, 2007).

Given the variation in injury rates both between and within countries, it is clear that many injuries in the home are preventable. The review reported here was conducted in mid-2009 as part of a suite of reviews commissioned by the Centre for Public Health Excellence (National Institute for Health and Clinical Excellence, UK) on the prevention of unintentional injuries to children on the road, in the home and during outdoor play and leisure. This paper presents the findings of a systematic review about the effectiveness of programmes for decreasing injury rates in the home for children aged under 15 years and increasing the correct installation of smoke alarms and other home safety equipment in homes where one or more children aged under 15 years reside. A previous systematic review has reported modest impacts on smoke alarm installation rates for programmes that supplied alarms in conjunction with home safety education, but no impact on injury rates (DiGuiseppi et al., 2001). Rates of home safety equipment installation (designed to reduce thermal injuries and falls) have shown mixed results following education and equipment provision programmes (Kendrick et al., 2008; Kendrick et al., 2009a), although there is evidence to suggest that education increases the installation rate of fireguards (Kendrick et al., 2009a). In our systematic review, only programmes where home safety equipment was supplied and/or installed, or where a home risk assessment was conducted, were included.

METHODS

Identification of evidence
A search strategy, using text words and thesaurus headings relating to home safety devices, type of programme and home risk assessments, was used in a range of databases (Box 1). Filters for publication year (from 1990-date of search) and English language were applied. Websites and the citations of included studies were also searched. The full search strategy, which was also designed to locate studies for potential inclusion in a parallel cost-effectiveness review (Pearson et al., 2009) and review of qualitative research (Smithson et al., 2009), is shown in Supplementary data, File #1.

Box 1: Databases searched
Medline
PsycINFO
ISI Web of Knowledge Social Science Citation Index (SSCI)
Science Citation Index Expanded (SCI-EXPANDED)
Health Management Information Consortium (HMIC), CINAHL
Applied Social Science Index and Abstracts (ASSIA)
The Cochrane Library database of systematic reviews
EconLit
SafetyLit
EPPI-Centre
TRoPHI
DoPHER
Bibliomap
Centre for Reviews and Dissemination databases
Database of Abstracts of Reviews of Effects (DARE)

Screening and quality appraisal
All report titles and abstracts (where available) were screened independently by one reviewer (MP or RG) for inclusion according to a pre-defined checklist of criteria. Where there was uncertainty over inclusion, this was resolved by discussion. The QUORUM flow chart (including the cost-effectiveness review and review of qualitative research) is shown in Figure 1. Included reports were quality appraised using a checklist based on the GATE quality appraisal tool (Jackson et al., 2006; NICE, 2009), with each criterion rated as either ‘++’ (minimal risk of bias), ‘+’ (potential sources of bias remain), or ‘−’ (significant sources of bias persist). The overall validity of each study was also rated using a similar system; ‘++’ (all or most of the quality criteria have been fulfilled), ‘+’ (some of the quality criteria have been fulfilled, but where this is judged as being unlikely to alter the study’s conclusions) or ‘−’ (few or none of the quality criteria has been fulfilled). The results of the quality appraisal in full are shown in Supplementary data, File #2.

Data extraction
For each included report, information about the nature of the programme and its core outcomes of interest, research methods used and
statistical analyses conducted, were extracted into a structured evidence table by one reviewer (MP or RG). Data extracted from a random sample of 10% of the included papers were double-checked by a third reviewer (ZL).

Data analysis and synthesis
Odds ratios (ORs) (with 95% confidence intervals) for outcomes comparing intervention and control groups are used wherever these have been presented by a report’s authors, or where sufficient data are provided to have allowed calculation by us. Where the reporting of continuous data precluded the calculation of ORs, mean differences (with 95% confidence intervals) were calculated. In some reports, the limited data published prevented the calculation of data in a common metric that would facilitate synthesis. A formal meta-analysis was not conducted in view of the heterogeneity of both the programmes and the outcome measures.

Characteristics of included reports
Twenty-two reports met the inclusion criteria. Two of these reports included outcomes data from a later follow-up of a sample originally reported in another included report (DiGuiseppi et al., 2002; King et al., 2005) and a further report included an additional analysis of data sets from an earlier included report (Kendrick et al., 2009b). Of the 19 included studies, 9 were randomized-controlled trials, 3 were cluster randomized-controlled trials, 3 were controlled before and after studies and 4 were before and after studies. Quality appraisal resulted in 10 of the included reports being rated as ‘++’, 8 as ‘+’ and 4 as ‘−’. Details of the study design, quality appraisal rating, programme components (for example, whether home safety equipment
was simply offered, or supplied and installed) and study context are shown in Table 1. Key characteristics of programmes and substantive study strengths and weaknesses are reported in the following section.

**FINDINGS**

The synthesis of the effectiveness of programmes is presented under three headings: impact on injury rates, installation and functioning of smoke alarms and the correct installation of other home safety equipment. Similar programmes are reported together (those with the shortest follow-up time reported first) to aid understanding of the effectiveness of different types of programme. Key details about the context in which programmes were implemented are also reported in order to inform understanding of their applicability in local contexts.

**Injury rates**

Table 2 provides an overview of the impact of programmes on injury rates reported in the seven studies that measured this outcome. Programmes where smoke alarms were supplied and installed resulted in no statistically significant reduction in child injury rates, as measured by health records (Mallonee et al., 1996; DiGuiseppi et al., 2002). Both of these programmes used door-to-door canvassing as a means of distributing the smoke alarms in areas that were socio-economically deprived. The programme evaluated by DiGuiseppi et al. (DiGuiseppi et al., 2002) used a range of community professionals and volunteers to distribute the smoke alarms, whilst in the Mallonee et al. (Mallonee et al., 1996) study the main method of distribution was via fire service personnel driving a decommissioned fire engine through neighbourhoods, sounding the siren and encouraging residents to come out to collect a free smoke alarm. In both studies, the uptake of the offer to install the smoke alarm in residents’ homes was <10%.

One programme that supplied and installed other home safety equipment such as window locks and fire guards, in addition to smoke alarms, similarly showed no statistically significant reduction in child injury rates (Watson et al., 2005). This programme was delivered in a socio-economically deprived population using the existing community health professional infrastructure. Whilst the home safety equipment was supplied and delivered free of charge regardless of a household’s income, it was only installed in households that were in receipt of means tested benefits.

Evidence of the impact of programmes where a home risk assessment was conducted and home safety equipment supplied is mixed. One study conducted in a socio-economically deprived urban area supplied home safety equipment such as stair gates and smoke alarms at a discounted rate (Kendrick et al., 1999). Contact with householders was maintained in this programme through routine Health Visitor and Community Nurse visits. Follow-up at 25 months, based on health records, showed no statistically significant effect of the programme on child injury rates. The programme evaluated by King et al. (King et al., 2001; King et al., 2005) also made home safety equipment available at a discounted rate, in this instance to households (predominantly non-socio-economically deprived) where a child had previously presented to an emergency department with an unintentional injury. At 12-month follow-up, a statistically significant reduction in child injury rates (as measured by parents’ reports) was achieved (King et al., 2001), but this was not sustained at 36-month follow-up (King et al., 2005).

Programmes where home safety equipment was also installed report similar results, based on health records, when follow-up was conducted at between 6 and 12 months. A statistically significant reduction in child injury rates at 6–9-month follow-up was reported by Cagle et al. (Cagle et al., 2006) for a programme where thermostatic valves were supplied and installed, whilst the data reported by Carman et al. (Carman et al., 2006) simply reports a percentage reduction in child injury rates at 12-month follow-up (7.4 and 4.0% in the intervention and control groups, respectively) for a programme where a wide range of home safety equipment was supplied and installed.

**Installation and functioning of smoke alarms**

Figure 2 shows a forest plot of the effect sizes of the nine studies with a control group that evaluated the impact of programmes upon the correct installation and functioning of smoke alarms. An effect size with confidence intervals
Table 1: Characteristics of the 22 included reports

<table>
<thead>
<tr>
<th>Report, study design (quality)</th>
<th>Sup. Ed.</th>
<th>Instal.</th>
<th>HRA</th>
<th>Part of a wider programme?</th>
<th>Ongoing contact with programme team?</th>
<th>Other key characteristics of programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bablouzian et al. (1997); BA [-]; USA</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes—the Healthy Baby Programme (initiated 1987)</td>
<td>Yes—participants continued to have routine child health contact with community staff</td>
<td>Small safety kit (electrical outlet covers, safety latches)</td>
<td></td>
</tr>
<tr>
<td>Babul et al. (2007); RCT [+]; Canada</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes—participants continued to receive routine care visits from their Community Health Nurse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cagle et al. (2006); BA [−]; USA</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Carman et al. (2006); BA [−]; UK</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes—undertaken as part of a Sure Start programme; also part of a multi-agency programme within the Primary Care Trust that delivered population-wide outreach and child injury prevention education</td>
<td>Unclear—nature of Primary Care Trust programme suggests that there would have been ongoing contact, but this is not explicitly stated</td>
<td></td>
</tr>
<tr>
<td>Clamp and Kendrick (1998); RCT [+ +]; UK</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
<td></td>
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</tbody>
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<thead>
<tr>
<th>Report, study design (quality)</th>
<th>Sup. Ed.</th>
<th>Instal.</th>
<th>HRA Part of a wider programme?</th>
<th>Ongoing contact with programme team?</th>
<th>Other key characteristics of programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>DiGuiseppi et al. (1999; 2002); cRCT [++]; UK</td>
<td>Yes</td>
<td>No</td>
<td>Potentially—or example, where district nurses or health visitors were responsible for smoke alarm distribution</td>
<td>Smoke alarms supplied free of charge in the course of community workers’ day-to-day visits to people in their homes</td>
<td></td>
</tr>
<tr>
<td>Gielean et al. (2002); RCT [++]; USA</td>
<td>Yes Yes Yes No</td>
<td>Yes—Children’s Safety Centre provided a central point for parents to call to discuss safety issues</td>
<td>Safety counselling delivered both by paediatric residents (who had received a 5 h training programme) during child health clinics and a professional health educator at the Children’s Safety Centre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvey et al. (2004); cRCT [+]; USA</td>
<td>Yes Yes No</td>
<td>No</td>
<td>Smoke alarm (or voucher for free smoke alarm) supplied through door-to-door canvassing by trained health workers, firefighters and local residents (mix varied from state to state). Where a smoke alarm was supplied, it was also installed</td>
<td>Home risk assessments conducted by specially trained community health workers</td>
<td></td>
</tr>
<tr>
<td>Johnston et al. (2000); CBA [+] USA</td>
<td>Yes</td>
<td>Yes part of a Head Start programme (USA equivalent of Sure Start)</td>
<td>Yes—participants continued to have contact with their case workers</td>
<td>Smoke alarms supplied if indicated</td>
<td></td>
</tr>
<tr>
<td>Kendrick et al. (1999); cRCT [++]; UK</td>
<td>Yes</td>
<td>No</td>
<td>Yes—participants continued to have contact with Health Visitors and Community Nurses during routine home visits</td>
<td>Range of discounted (20 p–£5.00) safety equipment made available from Health Visitor</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Report, study design (quality)</th>
<th>Sup. Ed.</th>
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<th>HRA</th>
<th>Part of a wider programme?</th>
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<th>Other key characteristics of programme</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>King et al. (2001), King et al. (2005); RCT [++]; Canada</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Home risk assessment conducted by Health Visitors during routine visits Discount coupons ($10 per item) for obtaining home safety equipment from a national store</td>
</tr>
<tr>
<td><strong>Klitzman et al. (2005); BA [+]; USA</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes—a relatively minor component of a programme that assessed for and addressed pre-1940 property issues related to mould, vermin, and lead-based paint hazards No</td>
<td>Safety kit supplied contained window guard, smoke alarm and fire extinguisher</td>
<td></td>
</tr>
<tr>
<td><strong>Mallonene et al. (1996); CBA [+]; USA</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Programme promoted through mass media, churches, and schools and meetings held with the principals of all elementary school in the sample area in order to promote the smoke alarm giveaway (through schools, door-to-door canvassing, fire stations). Free installation was offered (note that only 6% of participants took up the offer of free installation)</td>
</tr>
<tr>
<td><strong>Posner et al. (2004); RCT [++]; USA</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Safety kit supplied contained cupboard and drawer latches, electrical outlet covers, non-slip bath decals, bathwater thermometer, choking tube, and poison control centre telephone number</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Report, study design (quality)</th>
<th>Sup. Ed. Instal. HRA</th>
<th>Part of a wider programme?</th>
<th>Ongoing contact with programme team?</th>
<th>Other key characteristics of programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sangvai et al. (2007); RCT [−]; USA</td>
<td>Yes Yes No</td>
<td>No</td>
<td>Safety counselling delivered by trained lay personnel</td>
<td></td>
</tr>
<tr>
<td>Schwarz et al. (1993); CBA [+]; USA</td>
<td>Yes Yes Yes No</td>
<td>Yes—community liaison workers endeavoured to cultivate a network of community-based representatives who would continue to be involved with home safety education</td>
<td>Safety kit supplied contained smoke alarms, bathwater thermometer, nightlight, syrup of ipecac, and telephone sticker with emergency telephone numbers</td>
<td>Smoke alarms were installed by community workers</td>
</tr>
<tr>
<td>Sznajder et al. (2003); RCT [+]; France</td>
<td>Yes Yes No</td>
<td>No</td>
<td>Safety kit supplied contained cupboard and drawer latches, door handle covers, table protection corners, electrical outlet covers, non-skid bath mat, smoke alarm, phone sticker with telephone number of poison control centre</td>
<td>Health professional provided safety counselling in participants’ own home</td>
</tr>
<tr>
<td>Watson et al. (2005), Kendrick et al. (2009b); RCT [++]; UK</td>
<td>Yes Yes Yes No</td>
<td>Yes — participants continued to receive routine care visits from their Health Visitor</td>
<td>Safety kit supplied contained stair gate, fire guard, smoke alarm, cupboard locks, and window locks—supplied and installed free of charge for families in receipt of benefits (others received free delivery only)</td>
<td>Safety counselling delivered by Health Visitors</td>
</tr>
</tbody>
</table>

*Continued*
that do not include one shows a statistically significant difference between intervention and control groups. The findings of evaluations which did not use a control group, or did not report an OR or provide sufficient data to allow an OR to be calculated (and as a result of which are not presented in Figure 2), are reported in the text below.

Programmes that supplied smoke alarms

Evidence for the effect of providing a smoke alarm on installation rates is mixed. One programme delivered in a socio-economically deprived urban area showed no statistically significant difference in the rate of smoke alarm installation in households to which a free smoke alarm had been supplied (DiGuiseppi et al., 2002), whilst an evaluation of a similar programme reported 61, 51 and 45% (at 3-, 12- and 48-month follow-up, respectively) of households to have an installed and functioning smoke alarm (pre-programme installation results not reported) (Mallonee et al., 1996). No comparisons were made with rates of smoke alarm installation in the control group by Mallonee et al. (Mallonee et al., 1996). A further evaluation compared the free supply and installation of a smoke alarm with the offer of a discount voucher for a smoke alarm (Harvey et al., 2004). The programme was implemented in five US states, with the variations in how it was delivered differently in these states remaining unclear. Follow-up at 6–12 months showed a statistically significantly higher rate of smoke alarm installation in households that had received a smoke alarm. In all three studies, the presence or absence of a smoke alarm was assessed by observation within the home.

Programmes that supplied smoke alarms and safety education

Programmes where home safety education was provided (in addition to the provision of smoke alarms) did so using existing health professionals, either within a primary care setting (Clamp and Kendrick, 1998; Sangvai et al., 2007) or in the community (Sznajder et al., 2003; Watson et al., 2005). Two of these evaluations were conducted in socio-economically deprived areas (Clamp and Kendrick, 1998; Watson et al., 2005). Although it might be expected that smoke alarm installation rates would reduce over time, evaluation of these programmes showed a statistically significantly higher rate of installation of smoke alarms that persisted from 6-week follow-up (Clamp and Kendrick, 1998; Sznajder et al., 2003) through to follow-up at 6 months (Sangvai et al., 2007) and 12 and 24 months (Watson et al., 2005).

One report presented a statistical analysis of the effect of a programme (providing smoke alarms and safety education) on rates of installed and functioning smoke alarms with regard to key socio-economic status indicators.

### Table 1: Continued

<table>
<thead>
<tr>
<th>Report, study design (quality)</th>
<th>Sup. Ed. Instal. HRA Part of a wider programme?</th>
<th>Ongoing contact with programme team?</th>
<th>Other key characteristics of programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woolf et al. (1992); RCT [+]; USA</td>
<td>Yes No No</td>
<td>Limited safety kit (safety latches and now non-recommended Ipecac syrup) No personal contact with participants as safety kit was mailed to participants’ homes</td>
<td></td>
</tr>
</tbody>
</table>

**Key:** Sup., Supply of home safety equipment, either for free or at a discounted rate; Ed., Education (a safety counselling component that was semi-structured and lasted for ten or more minutes); Instal., Installation (of supplied home safety equipment); HRA, Home risk assessment.

**Key for study design:** BA, before and after study; CBA, controlled before and after study; cRCT, cluster randomized-controlled trial; RCT, Randomized-controlled trial.

**Key for study quality appraisal:** [++] all or most of the quality criteria have been fulfilled; [+], some of the quality criteria have been fulfilled, but where this is judged as being unlikely to alter the study’s conclusions; [–], few or none of the quality criteria have been fulfilled.
<table>
<thead>
<tr>
<th>Programme</th>
<th>Control</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DiGuiseppi <em>et al.</em> (1999; DiGuiseppi <em>et al.</em>, 2002)</td>
<td>12/18 mFU</td>
<td>9.1 (95% CI 0.7, 2.3)</td>
</tr>
<tr>
<td>Mallonee <em>et al.</em> (1996)</td>
<td>48 mFU (annualized rate)</td>
<td>IDR, 0.2 (95% CI 0.1, 0.4)</td>
</tr>
<tr>
<td>Watson <em>et al.</em> (2005)</td>
<td>24 mFU</td>
<td>IDR, 1.1 (95% CI 0.7, 1.7)</td>
</tr>
<tr>
<td>Kendrick <em>et al.</em> (1999)</td>
<td>25 mFU</td>
<td>— — 1.02 (95% CI 0.70, 1.48)</td>
</tr>
<tr>
<td>King <em>et al.</em> (2001)</td>
<td>12 mFU; King <em>et al.</em> (2005)</td>
<td>7 9 0.75 (95% CI 0.58, 0.96)</td>
</tr>
<tr>
<td>Cagle <em>et al.</em> (2006)</td>
<td>6–9 mFU</td>
<td>137/100 000 59/100 000 2.32 (95% CI 1.71, 3.15)</td>
</tr>
<tr>
<td>Carman <em>et al.</em> (2006)</td>
<td>12 mFU</td>
<td>— — — — —</td>
</tr>
</tbody>
</table>

**Key:** MFU, time of follow-up (months); OR, odds ratio; IDR, incidence density ratio; RR, rate ratio; CI, confidence interval; A&E, accident & emergency department; aRates/1000 person years, Primary care attendance and minor injury severity score ≥2 not reproduced here. bWeighted mean of %. cRate of injury per person year. dCalculated by authors of systematic review. eInsufficient data supplied to calculate OR.
Programmes that supplied smoke alarms following a home risk assessment

Evidence for the effect of conducting a home risk assessment (in addition to the provision of a smoke alarm) on rates of smoke alarm installation is mixed. Programmes evaluated at <6-month follow-up reported a statistically significant change in installation rates for pre-versus post-programme \( p < 0.0001 \) (Klitzman et al., 2005) or between intervention and control groups (Johnston et al., 2000). Both of these interventions were part of wider programmes that either addressed health issues arising from poorly-maintained housing (Klitzman et al., 2005) or were designed to minimize child health inequalities through a ‘Head Start’ programme (Johnston et al., 2000). Programmes evaluated at later follow-up periods showed less positive outcomes where there was no statistically significant increase in rates of smoke alarm installation (King et al., 2001; Babul et al., 2007), although these interventions were not integrated into any wider health programme. However, one programme evaluated at 12-month follow-up did report a statistically significant change in the absence of smoke alarms in the intervention group (OR 0.14 95% CI 0.09, 0.20) (Schwarz et al., 1993). This programme had an explicit emphasis on community involvement and therefore also addressed non-home safety issues identified by the community such as violence and homicide.

Other programme

One programme implemented an extensive range of components; a home risk assessment, home safety education delivered by paediatric department doctors (who had undertaken a 5 h training programme on childhood injuries and safety counselling) and the provision of discounted smoke alarms (in addition to other home safety equipment) at a specially constructed ‘children’s safety centre’ (Gielen et al., 2002). Ninety-four percent of participants were African American, and the study’s authors note that a likely self-selection bias existed in that families who visited the children’s safety centre and made use of the opportunity to obtain smoke alarms were more socio-economically advantaged than those who did not. There was no statistically significant increase in the rate of smoke alarm installation at 12-month follow-up (Gielen et al., 2002).

Correct installation of other home safety equipment

Figure 3 shows a forest plot of the effect sizes of the six studies with a control group that evaluated the impact of programmes upon the installation of other home safety equipment such as locks, fireguards and stair gates. A range of programmes were evaluated where safety devices to prevent children from gaining access to medicines or poisons were supplied free or at a discount. One study with a short-term follow-up (6 weeks) reported a statistically significant increase in installation solely for locks used on cupboards where poisons were stored (Clamp and Kendrick, 1998). Two further studies reported statistically significant increases in the installation and use of cupboard locks \( p = 0.01 \) (Woolf et al., 1992) and safety latches \( p < 0.01 \) (Bablouzian et al., 1997) at 3-month follow-up. Households in the study by Woolf et al. (Woolf et al., 1992) (~90% White, with a mean parental education period of 14 years) all had a child who had recently suffered an acute poisoning episode, whilst the study by Bablouzian et al. (Bablouzian et al., 1997) contained no control group, instead simply analysing the differences in installation rates before and after the programme.

A number of other programmes where safety locks or catches were supplied and home safety education was provided by health professionals (either in a primary care setting or in participants’ own homes) reported no statistically significant increase in the installation or use of these items. This trend applies to locks and catches used for both medicines and poisons cupboards and to the use of child-resistant caps on bottles containing hazardous substances. However, evidence for the installation and use of window locks is more mixed, with short-term follow-up showing no statistically significant effect at 6 weeks (Clamp and Kendrick,
but a statistically significant effect in a study with no control group at 5 months \((p < 0.0001)\) \citep{klitzman2005}. Longer-term follow-up of a programme where home safety equipment was supplied and education provided by a Health Visitor showed a statistically significant increase in the use of window locks at 12-month follow-up, but that this increase did not remain at 24-month follow-up \citep{watson2005}.

Programmes where home safety education was provided and safety devices to prevent impact injuries (from doors slamming shut or from sharply angled table corners) were supplied showed a statistically significant increase in the installation and use of these devices at short-term follow-up \citep{clamp1998,sznajder2003}. A statistically significant increase in the use of smooth table-top corners \((p < 0.001)\) was also reported in a programme that conducted a home risk assessment only, but did not supply any home safety equipment \citep{paul1994}.

One evaluation reported outcomes where a bath mat was supplied and home safety education provided \citep{sznajder2003}. No statistically significant increase in the use of bath mats was reported.

Evidence on the effectiveness of programmes that supplied electrical socket covers in addition to home safety education is mixed. Short-term follow-up of electric socket cover use at 6 weeks \citep{clamp1998} and 2 months \citep{sznajder2003} was statistically significant in the former study, but not the latter. One study without a control group reported a statistically significant improvement \((p < 0.05)\) in electric socket cover use at 3-month follow-up \citep{babulouzian1997}. However, longer-term follow-up at 12 months showed no statistically significant improvement in electric socket cover use \citep{babulouzian2007}.

There is evidence that programmes that supplied fire guards in addition to home safety education being provided are effective only in the short-term (6 weeks) \citep{clamp1998}....
whereas no statistically significant improvement in their installation is shown in the longer-term (12- and 24-month follow-up) 
(Watson et al., 2005).

A range of programmes supplied stair gates in addition to home safety education being provided. The majority of evaluations, including those of programmes where an additional home risk assessment component was included, showed no statistically significant increase in the use of stair gates in either the short- or long-term. The exception to this trend was the programme evaluated by Watson et al. (Watson et al., 2005) where installation of stair gates was also provided for families in receipt of means-tested benefits. This programme resulted in a statistically significant increase in stair gates installation at 12-month follow-up, although this effect was not maintained at 24 months 
(Watson et al., 2005). One report (Kendrick et al., 2009b) presented further analysis of data (at 12-month follow-up) evaluating the

programme reported by Watson et al. (Watson et al., 2005). The programme was reported to have had a statistically significant effect on reducing inequalities in the continued use of installed stair gates among families living in rented housing ($p$-value for interaction term = 0.006) and families who were in receipt of means-tested benefits ($p$-value for interaction term = 0.04), but not on any other markers of socio-economic inequalities.

The continued installation (that is, non-disablement) of thermostatic valves to limit domestic water temperature was evaluated by Cagle et al. (Cagle et al., 2006) at between 6 and 9 months following a home risk assessment and the installation of thermostatic valves. The only data reported was that 60% of the thermostatic valves that had been installed remained in situ (Cagle et al., 2006).

One evaluation did not report differences in the uptake of individual items of home safety equipment, instead simply reporting ‘safety
scores’ that measured safety device use as a whole (including safety latches, electrical outlet covers and non-slip bathroom items) (Posner et al., 2004). A statistically significant difference ($p < .001$) between intervention and control group’s ‘safety scores’ (on a 100-point scale) was reported. However, the confidence intervals around the mean difference in these scores ($+21.1 \ (95\% \ CI \ +13.90, +28.30$) were very wide.

**Discussion and conclusion**

This systematic review, based on explicit and policy-relevant review questions, was conducted according to a pre-defined review protocol and used explicit search strategies (developed by an information specialist) of a wide range of electronic databases to identify relevant studies. Time and resource limitations for the completion of the review meant that it was not possible to consider non-English language sources for inclusion, or for each reviewer (MP and RG) to independently conduct quality appraisal and data extraction on each included study. However, there was a constant flow of communication between the two reviewers (MP and RG) about the appraisal of specific aspects of included studies. In the latter stages of the review, this discussion widened to include revisiting each report’s quality appraisal in order to ensure consistency between reviewers in the application of the appraisal checklist and judgements made about study quality. This resulted in the revision of some of the initial gradings so as to ensure consistency between reviewers. Nevertheless, we acknowledge that some potential for bias remains.

In considering this evidence synthesis, it is important to keep in mind the limitations of the included studies as summarized by the quality appraisal ratings shown in Table 1. Furthermore, regarding the installation of home safety equipment, it is notable that only eight studies (Schwarz et al., 1993; Mallonee et al., 1996; DiGuiseppi et al., 2002; Gielen et al., 2002; Harvey et al., 2004; Klitzman et al., 2005; Cagle et al., 2006; Sangvai et al., 2007) physically observed the presence of the equipment at follow-up rather than relying on households’ self-report. Limitations in the reporting of data by included studies also limited the extent to which it was possible in the synthesis to identify which components were crucial to the effectiveness of programmes. Where this has been possible these programme components are identified below, but our conclusions are inevitably pitched more at the level of principles that underlie effective programmes rather than details of specific programme packages.

The only statistically significant reductions in injury rates attained (in the seven studies that measured this outcome) were following programmes that conducted a home risk assessment in conjunction with the provision of a smoke alarm (King et al., 2001) or the installation of a thermostatic valve (Cagle et al., 2006). This reduction in injury rates occurred at 12-month follow-up (King et al., 2001), but was not sustained at 36 months (King et al., 2005). Moreover, the initial effectiveness of the programme may be explained by two characteristics that differentiate this study from the majority of other studies in this review. First, the children in the study had sustained a recent unintentional injury, potentially sensitizing their parents to the need for home safety equipment to be installed; and second, the included households were predominantly not socio-economically deprived. The reduction in injury rates reported by Cagle et al. (Cagle et al., 2006) should be treated with caution in view of the absence of a control group and a small sample size ($n = 48$) that would be unlikely to have the power to detect relatively rare injury events.

In the absence of data on injury outcomes, reporting of installation rates of home safety equipment is a reasonable proxy. Installation rates of smoke alarms did not statistically significantly increase following programmes that distributed the alarms without also installing the device or providing safety education (Mallonee et al., 1996; DiGuiseppi et al., 2002), although in one large-scale study ($n = 3140$) in which results were aggregated across five US states, such an approach resulted in statistically significant increased rates of smoke alarm installation (Harvey et al., 2004). Programmes where smoke alarms were supplied in conjunction with home safety education all resulted in statistically significant increase in smoke alarm installation rates (Clamp and Kendrick, 1998; Sznajder et al., 2003; Watson et al., 2005; Sangvai et al., 2007), although it should be noted that only two of these studies (Clamp and Kendrick, 1998; Watson et al., 2005) were conducted in socio-economically deprived areas. The very low uptake of the offer to install the...
supplied smoke alarms in the studies by DiGuiseppi et al. (2002) and Mallonee et al. (1996) (<10%) suggest that there may be significant distrust of authority figures (on the part of householders) that programmes need to address. The relative success of the programmes where safety education was also provided suggests that trust may develop from an educational approach and facilitate the installation of smoke alarms.

It is unclear whether conducting a home risk assessment in addition to supplying a smoke alarm and providing home safety education makes a difference to smoke alarm installation rates. Whilst programmes comprising these components resulted in statistically significant increases in installation rates in the short term (Johnston et al., 2000; Klitzman et al., 2005), they were also integrated into wider health programmes that may have equally been responsible for the programme’s effectiveness. Longer-term follow-up at 12 months suggests that this integration may be a key factor, as statistically significant increases in installation rates were reported in the study where this integration occurred (Schwarz et al., 1993), but not in those interventions which were implemented outside of a broader health programme (King et al., 2001; Babul et al., 2007). It is notable that the programme evaluated by Schwarz et al. Schwarz et al. (1993) prioritized addressing safety issues identified by the community, including those occurring outside the home such as violence and homicide. This form of community engagement may be particularly important where marginalized communities distrust authority figures, an important barrier to programme success identified in the review of qualitative research conducted alongside this effectiveness review (Smithson et al., 2010). It is also notable that the extensive programme evaluated by Gielen et al. (Gielen et al., 2002), which involved the construction of a ‘children’s safety centre’ and the delivery of extended counselling training to paediatric doctors, did not result in a statistically significant increase in smoke alarm installation rates.

Outcomes for rates of installation of other home safety equipment are mixed and show no pattern in the relationship between the type of programme and outcome. Parents who have been recently sensitized to a particular risk, such as the parents of those children who had recently suffered a poisoning episode in the study by Woolf et al. (Woolf et al., 1992), showed a statistically significant increase in rates of installation equipment directly related to the adverse event that occurred. However, there is little evidence to suggest that parents respond in the same way when not sensitized to the risks through personal experience, or even when a child has endured a recent unintentional injury of a different kind to that which home safety equipment is designed to prevent. Neither is there evidence to suggest that parents in socio-economically deprived communities respond in the same way as the relatively privileged households reported in Woolf et al. (Woolf et al. 1992).

One observation that can be made is that there is a pattern of device installation rates decreasing at around 6 months after all programme types, although this may also be as a result of parents making rational decisions about whether it is necessary to leave home safety equipment in situ as their children mature. One study reported a statistically significant increase in the installation of stair gates at 12-month follow-up (Watson et al., 2005) after a programme that installed stair gates as well as providing home safety education, suggesting that, for items of home safety equipment that require skilled fitting, the offer of installation may be vital. This may be of particular importance given the further analysis of this data set by Kendrick et al. (Kendrick et al., 2009b) which found inequalities in installation rates (as measured by key socio-economic markers) to have been reduced by the programme.

In conclusion, there are three main implications for future research, policy and practice from this systematic review. First, the success of programmes designed to increase rates of smoke alarm installation may be dependent on the development of trusting relationships with parents (for example, through education or integration into wider community health programmes). This finding resonates with the findings of the companion review of qualitative research (conducted to complement this effectiveness review), where the issue of trust between practitioners responsible for delivering the programme and parents was identified as a key factor (Smithson et al., 2010). Second, where home safety equipment such as stair gates requires skilled fitting, there is evidence
that in socio-economically deprived communities the offer of installation may be vital if the equipment is to remain installed in the longer-term. For parents to agree to installation again requires the development of a trusting relationship. Finally, our understanding of the mixed effectiveness results for programmes supplying other types of home safety equipment is weak. There is a clear role here for qualitative research to produce richer understandings of why, and in what contexts, these programmes are effective.

SUPPLEMENTARY DATA

Supplementary data are available at Health Promotion International online.

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REFERENCES


