REVIEW

# Updating the evidence. A systematic review of what works in preventing childhood unintentional injuries: Part 2

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## Injuries in the home environment

Four recent studies focus on the prevention of home accidents at a general level.[1–4] These papers suggest that, while educational campaigns and equipment loan schemes may be potentially effective in terms of promoting behavioural change, there is little evidence that injury reductions are achieved by these means (table 1).

There is increasing evidence from the United States of the positive effect of campaigns promoting the use of smoke alarms (table 2).[5–9] A smoke alarm giveaway programme in the central area of Oklahoma City, where there was a high fire risk, showed an 80% annual injury rate decline from 15.3/100 000 to 3.1/100 000, compared with a slight increase in the rest of the city.[5] The authors point out that, *"interventions that target areas with high rates of fires may be especially efficient ways to lower the incidence of injuries and deaths from residential fires"*. This is the first community based study to demonstrate the effectiveness of a smoke alarm promotion programme on health outcomes. There is also evidence that smoke alarm promotion programmes lead to changes in behaviour which are sustained over a long period of time (3–4 years), resulting in greater numbers of households with functioning smoke alarms.[7]

Additional evidence related to the prevention of childhood poisoning comes from a long term follow up of legislation in the United States introduced in 1974, which required child resistant packaging for all prescription drugs.[10] For children aged 0–4 years the mortality rate for oral prescription drugs declined from 3.5 per million in the late 1960s (before legislation), to fewer than 2 deaths per million in the early 1990s. This represented 460 fewer deaths for the period 1974 to 1992 (table 3).[10 11]

## Injuries in the leisure environment

There remains very little evidence regarding the effectiveness of health promotion in preventing injuries in the leisure environment (table 4).[12–16]

An Australian study of an educational intervention, directed at parents and teachers, aimed to increase compliance with safety standards in school playgrounds. There was a small improvement in the number of hazards observed in school playgrounds after the intervention.[14] A study conducted in Wales evaluated the effect of environmental changes to playgrounds, including increasing the depth of bark surfaces in some playgrounds and changes in playground equipment. Changes in injury rates and in rates of fractures were noted.[16]

Two papers describing interventions, set within the leisure environment, by D'Argenio

*Table 1 The home environment: prevention of general home accidents*

| *Author, date, and country* | *Injury target group and setting* | *Aims and content of intervention* | *Study type and sample size* | *Outcome measures* | *Key results* |
|---|---|---|---|---|---|
| Bablouzian *et al* (1997),[1] USA | Preschool. Low income. Home setting | **Healthy Baby Program** Home visits, counselling, and safety assessment | Before and after study I=72 | (A) Observed hazards (B) Knowledge | (A) Reduction for 4 hazards. (B) Reported increased use of safety restraints in cars *Partially effective* **Reasonable/weak** evidence |
| Clamp and Kendrick (1998),[2] UK | 0–5 years. Low income. Primary care settings | General practitioner safety advice. Single 20 minutes consultation. Subsidised smoke alarms and other safety equipment | Randomised controlled trial I=83 families C=82 families | (A) Reported behaviour Use of safety equipment | (A) Use of safety equipment increased in I families (for example, fireguards 36/65 *v* 19/60 controls) *Effective in short term* **Good/reasonable** evidence |
| Thompson *et al* (1998),[3] UK | Under 5 years. Low income areas. Home | Home safety equipment loan schemes and health visitor counselling | Before and after study | A and E attendance data | Home accidents in children under 5 10% decrease 1990–94. Not able to demonstrate effect on injury outcomes *Inconclusive* **Reasonable/weak** evidence |
| Kendrick *et al* (1999),[4] UK | 0–2 years. Primary care. Component targeting deprived community | I=targeted advice, low cost safety equipment, home safety checks and first aid training C=routine child surveillance | Randomised controlled trial I=18 GP practices n=1124 children C=18 GP practices n=1028 children | (A) Medically attended injuries. (B) Self reported behaviour. (C) Knowledge. (D) Penetration of intervention | (A) No significant differences between I and C groups. (B) No differences in unsafe practices between I and C. (C) No differences in knowledge in I and C. (D) In I 22% no interventions, 27% 1 intervention *Ineffective* **Good/reasonable** evidence |

C = control; I = intervention.

*Table 2 The home environment: prevention of burns and scalds*

| *Author, date, and country* | *Injury target group and setting* | *Aims and content of intervention* | *Study type and sample size* | *Outcome measures* | *Key results* |
|---|---|---|---|---|---|
| Mallonee *et al* (1996),[5] USA | Total population. Low income. High risk groups. Home setting | Smoke alarm giveaway programme. Door to door distribution and supporting educational material | Controlled trial without randomisation I=73 301 in 24 square mile area C=rest of Oklahoma | (A) Mortality and morbidity data. (B) Observed behaviour | (A) In 4 years annual injury rate declined 80%, from 15.3 to 3.1/100 000 compared to an increase of 8% 3.6 in I to 3.9/100 000 in C Injury rate per 100 residential fires decreased 74% in I and increased 32% in C (B) 45% of alarms still functioning 4 years later *Effective* **Good/reasonable** evidence |
| McConnell *et al* (1996),[6] USA | 3–5 years attending child care centres | **"Kid Safe" program** To increase fire safety knowledge by a classroom programme. 30 hours over 18 weeks including role play and simulation | Controlled trial with random allocation at group level I=6 child care centres C=4 child care centres | Pre-test and post-test Knowledge scores of children aged 3,4 and 5 years | 3 year old children: knowledge scores increased by 30.2 in I, and 10 in C 4 year old children: scores increased by 22 in I and 12 in C 5 year old children: scores increased 20.9 in I and 7.3 in C *Effective* **Good/reasonable** evidence |
| Shults *et al* (1998),[7] USA | General population. Older adults and children under 5. Home setting | 3 smoke detector promotion programmes: $I_1$ Home inspections and installation of detectors, $I_2$ Detectors distributed and installed to households requesting them, $I_3$ Oklahoma—door to door distribution (<10% installed) | Before and after studies to 3 different groups: $I_1$=338 Minnesota, $I_2$=702 North Carolina, $I_3$=9291 Oklahoma | Observed behaviour Reported behaviour | Overall 88% of households had at least one smoke detector on premises and 64% at least one functioning device. Battery replaced as part of follow up: 79% $I_1$, 93% $I_2$, 73% $I_3$ had functioning detectors at end of follow up *Partially effective* **Reasonable** evidence |
| DiGuiseppi *et al* (1999),[8] UK | General population. Deprived communities. Home setting | Smoke detector giveaway campaign and fire safety information | Randomised controlled trial I=20 inner city wards (approx 80 000 households) C=20 inner city wards | (A) Alarm distribution (B) Process and impact measures | (A) 20 050 alarms distributed. (B) Programme cost: £145 087 *Effective* **Good/reasonable** evidence (Preliminary results only reported) |
| King *et al* (1999),[9] Australia | 0–4 years. Vietnamese, Chinese, and Arabic families. Mass media | Mass media campaign. Information distributed via newspapers and radio. In appropriate languages | Before and after study without control group. Before: 254 After: 302 | (A) Knowledge (B) Impact | (A) Knowledge of correct first aid increased from 42% before to 63%. (B) 40% aware of the campaign *Partially effective* **Reasonable** evidence |

C = control; I = intervention.

*et al*[12] and Malinowska-Cieslik and Borne[13] provide examples of innovative content. These two interventions highlight the importance of the cultural setting of some interventions.

### Community-wide studies

Five recent papers evaluate community based interventions (table 5).[17–21] The findings of these studies are not simple to interpret. While there is some evidence that such programmes can result in health gain, the quality of the evidence is limited.

### Mass media interventions

Table 6 summarises findings relating to mass media and more general training events.[22–24] Exhibitions and public information campaigns can increase knowledge, but there is no new evidence that such approaches have any impact on injury rates.

### New target groups and implementation strategies

In our first systematic review of childhood injury prevention studies, published in 1993, very few intervention studies targeted deprived groups in society, despite the strong associations between social deprivation and childhood injury.[25] Our second review, published in 1996, contained more studies which targeted social deprivation.[26] This trend has continued in the current review. Between 1995 and 1998 studies which have targeted deprived groups or communities include Thomson and Whelan's evaluation of practical roadside training of children in a deprived area of Glasgow.[27] Bicycle helmet educational campaigns targeting more deprived groups include programmes evaluated in Canada[28] and the United States.[29 30] Economic barriers to helmet purchase were recognised in several programmes where helmets were either distributed free or discount vouchers provided. Mallonee *et al*'s evaluation of a smoke alarm giveaway programme in a high risk, central city location[5] and four other studies in the home safety field targeted low income families: Bablouzian *et al* in

*Table 3 The home environment: prevention of poisoning*

| *Author, date, and country* | *Injury target group and setting* | *Aims and content of intervention* | *Study type and sample size* | *Outcome measures* | *Key results* |
|---|---|---|---|---|---|
| Rodgers (1996),[10] USA | 0–4 years. Legislation | Child resistant packaging for prescription drugs 1974 | Time series 1964–92 | Mortality data. National Centre for Health Statistics | Mortality rate for prescription drugs declined from 3.5 per million in the late 1960s to <2 deaths per million in early 1990s. 460 fewer deaths between 1974–92 *Effective* **Good/reasonable** evidence |
| Liller *et al* (1998),[11] USA | 5–9 years. School based | **"More Health"** poison prevention lesson and letters to parents | After study with control group I = 194 children C = 184 children | Knowledge. Parent reported behaviour | I had more knowledge of poisons compared with C, for example 99% of I recognised poison centre sticker compared with 31% of C *Inconclusive*. **Reasonable/weak** evidence |

C = control; I = intervention.

*Table 4 The leisure environment: prevention of leisure injuries*

| *Author, date, and country* | *Injury target group and setting* | *Aims and content of intervention* | *Study type and sample size* | *Outcome measures* | *Key results* |
|---|---|---|---|---|---|
| D'Argenio *et al* (1996),[12] Italy | General population and focus on children 10–14 | **"Capodanno Senza Danno" (New Year's without Harm!)** Firework campaign and law enforcement | Before and after study. I = 18 emergency rooms | (A)Morbidity data—emergency room records. (B) Fireworks confiscated | (A) In 10–12 year olds rate of firework injuries dropped 51% from 46/100 000 to 22.3/100 000. (B) 12.5 million fireworks confiscated by police (82% more than previous year) *Inconclusive* **Reasonable/weak** evidence |
| Malinowska-Cieslik and Borne (1998),[13] Poland | 6–11 years. Schools and community | Multimethod mushroom poisoning prevention programme | Before and after study. I=693 children | (A)Mortality, morbidity (B) Knowledge | (A) Unspecified reductions in hospitalisations and mortality. (B) Knowledge levels increased *Partially effective* **Reasonable/weak** evidence |
| Withaneachi and Meehan (1998),[14] Australia | Primary school aged children. School | Educational intervention on playground safety standards in school playgrounds | Before and after study. No control. I pre-test=20 schools Post-test=19 schools | (A) Observed hazards in playground | (A) Improvements on most of safety standards Before 99/125 pieces of equipment met safety standard on fall height compared with 88/94 *Partially effective/inconclusive* **Reasonable/weak** evidence |
| Bennett *et al* (1999),[15] USA | 1–14 years. Community based | Drowning prevention campaign, life vest loan programme, and bulk discount schemes | Before and after study without control group $I_1$=(before) 332 $I_3$=(after) 480 | Reported ownership and use of life vests | Reported ownership 69% before and 75% after campaign. Reported use increased from 20% to 29% *Effective* **Reasonable/weak** evidence |
| Sibert *et al* (1999),[16] Wales, UK | Children using public playgrounds | Environmental changes to playgrounds, depth of impact absorbing surfaces (bark) and changes to equipment | Controlled trial without randomisation. I=5 parks, C=18 parks (no changes) | (A) Injury rates (B) Number of fractures | In I, (A) Injury rate changed from 0.719 before to 0.297 after. In C, from 0.433 to 0.346 after (B) in I, fractures changed from 23 to 6. In C, from 12 to 10 *Partially effective* **Reasonable** evidence |

C = control; I = intervention.

the USA who evaluated a community based home hazard reduction programme,[1] Clamp and Kendrick's study of general practitioner safety advice and provision of safety equipment,[2] Kendrick *et al*'s package of home safety interventions,[4] and Thompson *et al*'s study of home safety equipment loan schemes.[3]

We found more evidence of educational interventions which targeted very young children. For example Britt *et al* targeted children aged 3–4 years in a classroom intervention to increase bicycle helmet use.[29] McConnell *et al* evaluated the effect of a fire safety programme in the classroom on the safety knowledge of 3–5 year old children.[6] Interestingly what emerged in this programme was that knowledge changes were greatest in the youngest age group. What has not been demonstrated, however, is whether such knowledge change leads to changes in behaviour and, at a more general level, doubts remain about the benefits of education in such young children.

Other programmes have employed innovative approaches to deliver programmes. These include Thomson and Whelan's pedestrian training programme in Glasgow where parent volunteers have been recruited to train children (other than their own) in developing safer pedestrian skills.[27] In some interventions the focus has not been children or parents. Targeting interventions at teachers and childcare staff (along with parents) achieved modest reductions in playground hazards in an Australian study.[14] Professionals were also targeted in a UK study in an intervention aiming to increase knowledge among health care staff.[24]

### Additions to the way interventions have been evaluated

The study by Ni *et al* illustrates how a greater use of data collection techniques has been employed in evaluating interventions.[31] This utilised statewide observation of bicycle helmet use, local observations of use, and self report of helmet use by both children and their parents. This range of sources of data allowed greater confidence in the results. Another study of bicycle helmet promotion, this time targeted at preschool children, used home visits to observe young children playing on bicycles and wearing their helmets.[29] Observations of helmet wearing are difficult to conduct in this age group and this study represents an innovative approach to attempt to capture this information. A study in the UK evaluating the effects of changes to playgrounds on childhood injuries, included the use of exposure data.[16] This allowed the rates of injury to be calculated based on a unit of exposure. More specific data on injury type (fractures) were also included in this study. A community based programme from Motala, Sweden, provides the first example in the literature of a study using injury severity data as an outcome.[20] In the UK, Kendrick *et al*'s trial of a package of interventions delivered in a primary care setting, used both frequency and severity of medically attended injuries as an outcome measure.[4]

Hazinski *et al*'s study of a Children's Traffic Safety Programme made an attempt to assess the level of programme implementation (that is, the degree to which teachers delivered the programme as it had been planned) and compared this with the outcomes achieved.[32] Schools with good programme implementation achieved better results.

## Discussion and conclusions

The review drew on the world literature on child injury prevention. The search strategy attempted to include a range of databases, including the Transport Research Laboratory road safety database and also included the reference lists of a range of recently published articles. However, some areas, such as product safety and engineering, may be underrepresented, leading to some bias in the results we have reported.

*Table 5 Community based studies*

| *Author, date, and country* | *Injury target group and setting* | *Aims and content of intervention* | *Study type and sample size* | *Outcome measures* | *Key results* |
|---|---|---|---|---|---|
| Svanstrom *et al* (1995),[17] Sweden | 0–14 years. Community-wide | **Lidköping Accident Prevention Programme** Bicycle helmet campaigns, first aid training, loan schemes, local hazard removal | Controlled trial without randomisation. $I_1$=Lidköping 35 949. $C_1$=4 surrounding municipalities 42 078, $C_2$=Skarabourg county 278 162 | (A) Hospital discharge register data | (A) From 1983 to 1991 a reported annual decrease in hospitalised injuries of 2.4% (boys) and 2.1% (girls) in $I_1$. In $C_1$, increase of 0.6% (boys) and 2.2% (girls). In $C_2$ decrease of 1.0% (boys) and 0.3% (girls) *Inconclusive* **Reasonable/weak** evidence |
| Day *et al* (1997),[18] Australia | General population. Community-wide | **Latrobe Valley Better Health Project** All age programme to prevent injuries, reduce hazards and increase awareness | Before and after study (non-targeted injuries used for comparison data). (A) Injury surveillance system. (B) Telephone survey 375 pre-test, 400 post-test | (A) Emergency Department presentations. (B) Self reported injury (C) Playground hazards | (A) Decline in attendance rate from 6594 to 4821/100 000 for targeted injuries. Small decrease in non-targeted injuries. (B) Decrease in self-reported injuries from 62.7 to 48.2/1000 (not significant). Increase in injuries requiring medical attention from 24.5% to 31.9% (not significant). (C) Some hazard removal in playgrounds *Partially effective/inconclusive* **Reasonable/weak** evidence |
| Petridou *et al* (1997),[19] Greece | 0–18 years. Older adults 65+. Community based | Multifaceted intervention with activities for parents, teachers, and children. Home visits, counselling on home hazards | Controlled trial without randomisation. I=172 households on island of Naxos C=177 households on island of Spetses | (A) Self report injuries. (B) Observed hazards Attitudes Knowledge | (A) No difference in accidents reported in I and C. (B) For I: improvements on 11 out of 28 hazards C: improvements in 1 out of 28 hazards *Partially effective* **Reasonable/weak** evidence |
| Lindquist *et al* (1999),[20] Sweden | General population. Community based | **Motala WHO Safe Community** All age, all injury programme. Traffic, sport, and recreation targeted | Before and after study I=Motala 41 000 | Hospital admissions, severity and length of stay | In under 20 age group, total injuries decreased by 18% between before and after period *Inconclusive* **Reasonable/weak** evidence |
| Ytterstad *et al* (1998),[21] Norway | 0–4 years | **Harstaad WHO Safe Community Programme** All age, all injury prevention Educational activities in a range of settings. Mass media | Controlled trial without randomisation. $I_1$=Harstaad 23 000, $I_2$=6 towns around Harstaad 14 000 C=Trondheim 134 000 | Morbidity data Outpatient admissions records | Decrease in burn injury rates at 51.5% in $I_1$ , 40.1% in $I_2$ and increase of 18.1% in C *Inconclusive* **Reasonable/weak** evidence |

C = control; I = intervention.

However, the studies published are not evenly spread across the various injury types and do not reflect the injury burden. The studies reviewed included a relatively large number (10/42) relating to the use of bicycle helmets. The prevention of child pedestrian injuries was addressed in a relatively small number of studies (and exclusively in only one study) despite the fact that it remains the main cause of child injury death. This bias in the literature may reflect the fact that some injury areas can be researched relatively easily compared with others. Injuries where there is a simple, single intervention (such as a bicycle helmet) that can be evaluated relatively simply within closed systems (for example, schools) are more likely to receive research attention.[26]

Recent studies have included a larger concentration of studies focusing on high risk or socially deprived groups. These studies represent an important addition to the literature. In one such study, parent volunteers carried out the child pedestrian training programme. Using locally available resources may be more likely to result in low cost and sustainable child injury prevention programmes. As in our earlier review, the cost of the interventions was rarely considered in the studies included here.

The quality of the evidence was very mixed. Fewer than a third of the studies used research designs where the evidence was rated as good/reasonable. The remaining studies had weaker designs and it was therefore more difficult to interpret and have confidence in the results. Experimental methods are not always appropriate to evaluate injury prevention programmes, especially where more than one injury type is targeted or where interventions are aimed a large groups. Nevertheless, the inclusion of appropriate control groups, well defined target groups, and an adequate sample size increases the strength of the evidence. Few studies included process information; such information is useful to understand issues such

*Table 6 Mass media general interventions*

| *Author, date, and country* | *Injury target group and setting* | *Aims and content of intervention* | *Study type and sample size* | *Outcome measures* | *Key results* |
|---|---|---|---|---|---|
| Gielen *et al* (1996),[22] USA | 7/8 years. Rural area. Safety centre | 2 day visit to community safety centre. Exhibitions, videos, simulations, skills training | Before and after study. No control. $I_1$=158 Parents=302 | Reported behaviour. Attitudes. Knowledge | $I_1$: knowledge scores increased from 58% to 78%; 1/3 of parents reported making safety changes in home *Effective in some groups* **Reasonable/weak** evidence |
| Sundelin *et al* (1996),[23] Sweden | 0–6 years and their parents. Mass media | National TV campaign; 8 × 10 minute programmes. Local campaign—families received personal letters | Controlled trial without randomisation. I=1699 C=144 | Reported behaviour. Attitudes | 59% of I and 43% of C had seen at least one programme 33% of those seeing 2+ programmes reported behaviour changes *Inconclusive* **Reasonable/weak** evidence |
| Marsh and Kendrick (1998),[24] UK | Primary health care team members. Training setting | One day multidisciplinary workshop to increase knowledge | Controlled trial without randomisation. I=58, C=58 | Reported behaviour. Attitudes. Knowledge | Significant but small increases in knowledge in I. Health visitors—some changes in reported practice *Partially effective* **Reasonable/weak** evidence |

C = control; I = intervention.

*Table 7 What interventions work? (that is, reduce injury or change behaviour). Bold type indicates areas where there is new evidence or increased evidence, italic = injury reduction, and roman = behavioural change*

| | |
|---|---|
| INTERVENTIONS IN THE ROAD ENVIRONMENT | |
| (Good evidence***, reasonable evidence**, some evidence*) | |
| *General* | |
| Area wide urban safety measure | *Injury reduction*** |
| **20 mph zones** | *Injury reduction**** |
| | **Behaviour change***** |
| *Pedestrian injuries* | |
| Education/enforcement aimed at driver | Behaviour change* |
| Education aimed at child/parent | Behaviour change** |
| | *Injury reduction** |
| *Bicycle injuries* | |
| **Bicycle training** | **Behaviour change**** |
| **Bicycle helmet educational campaigns** | **Behaviour change***** |
| Bicycle helmet legislation | Behaviour change*** |
| | *Injury reduction*** |
| *Car passengers* | |
| Child restraint educational campaigns | Behaviour change** |
| Seat belt educational campaigns | Behaviour change** |
| Child restraint loan schemes | Behaviour change*** |
| Child restraint legislation | Behaviour change*** |
| | *Injury reduction*** |
| *Bus passengers* | |
| **Education aimed at child** | **Behaviour change*** |
| INTERVENTIONS IN THE HOME ENVIRONMENT | |
| *General* | |
| Product design | Injury reduction* |
| Safety devices | *Injury reduction** |
| *Burns and scalds* | |
| **Smoke detector promotion programmes** | **Behavioural change***** |
| | *Injury reduction**** |
| Tap water temperature reduction | Behavioural change* |
| | *Injury reduction** |
| Parent and child education | Behavioural change* |
| *Poisoning* | |
| **Child resistant packaging** | **Injury reduction***** |
| Parent education | Behavioural change* |
| *Falls prevention* | |
| Window bars (education and environmental modification and legislation) | Behavioural change** |
| | *Injury reduction** |
| Parent education | *Injury reduction** |
| *General campaigns* | |
| Parent education on hazard reduction | Behaviour change** |
| INTERVENTIONS IN THE LEISURE ENVIRONMENT | |
| *Drowning* | |
| Parent and child education | Behaviour change* |
| Adult supervision of public swimming pools, beaches, etc | *Injury reduction** |
| Pool design and protection | *Injury reduction** |
| *Play and leisure injuries* | |
| **Environment improvement—playground layout, equipment and surfacing** | **Hazard reduction*** |
| Training schemes for adult supervision | Little evidence |
| Protective equipment | *Injury reduction** |
| COMMUNITY BASED STUDIES | |
| Programmes targeting a range of injury types in a range of different groups | Behaviour change** |
| | Injury reduction** |

as programme reach and impact and assists in study replication in different settings.

Given the complexity of the injury problem, there are unlikely to be simple solutions which result in dramatic changes in injury rates. Over the past decade, our knowledge has increased incrementally and the last four years has seen the publication of further evidence on strategies to reduce the injury burden. There remains a need for further research. A concerted attempt is needed, however, to implement established interventions, both nationally and locally.

The results are summarised in table 7.

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