Keeping Children Safe: a multicentre programme of research to increase the evidence base for preventing unintentional injuries in the home in the under-fives

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Scientific summary

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Scientific summary

Introduction

Unintentional injuries at home in the under-fives are a major public health problem, incurring substantial NHS, individual and societal costs. However, evidence on the effectiveness and cost-effectiveness of preventative interventions is lacking. The Keeping Children Safe (KCS) programme of research aimed to enhance the evidence base for preventing the most common types of child home injury.

Work stream 1

Research question

What are the associations between modifiable risk and protective factors and medically attended injuries resulting from five common injury mechanisms in children under the age of 5 years?

Methods

Five multicentre case–control studies were undertaken (study A), one each for falls from furniture, falls on one level, stair falls, poisonings and scalds. Cases were 0- to 4-year-olds attending secondary care with one of these injuries, matched with primary care recruited control subjects (controls). Exposures were measured using parent-completed questionnaires, validated by home observations in 162 participants (study B). Odds ratios (ORs) were estimated using conditional logistic regression.

Results

Comparisons between self-report and home observations found sensitivities of $\geq 70\%$ for 19 out of 30 exposures and specificities of $\geq 70\%$ for 20 out of 30 exposures.

Case–control studies recruited between 338 (scalds) and 672 (falls from furniture) cases and between 1438 (scalds) and 2658 (stair falls) controls.

Comparing cases with controls, for falls from furniture, case households were more likely not to use safety gates [adjusted odds ratio (AOR) 1.65, 95% confidence interval (CI) 1.29 to 2.12] and not to teach children rules about climbing on kitchen objects (AOR 1.58, 95% CI 1.16 to 2.15). Cases aged 0–12 months were more likely to have been left on, had nappies changed on or been put in car/bouncing seats on raised surfaces (AOR 5.62, 95% CI 3.62 to 8.72; AOR 1.89, 95% CI 1.24 to 2.88; and AOR 2.05, 95% CI 1.29 to 3.27, respectively). Cases aged $>36$ months played or climbed on furniture more frequently (AOR 9.25, 95% CI 1.22 to 70.07).

No significant associations were found for any exposures and falls on one level.

For stair falls, compared with controls, case households were more likely not to use stair gates (AOR 2.50, 95% CI 1.90 to 3.29) and to leave gates open (AOR 3.09, 95% CI 2.39 to 4.00), not to have carpeted stairs (AOR 1.52, 95% CI 1.09 to 2.10), not to have landings part-way up stairs (AOR 1.34, 95% CI 1.08 to 1.65) and to report stairs not being safe to use (AOR 1.46, 95% CI 1.07 to 1.99) or needing repair (AOR 1.71, 95% CI 1.16 to 2.50).

For poisonings, compared with controls, case households were more likely not to store medicines out of reach (AOR 1.59, 95% CI 1.21 to 2.09) or safely (locked away or out of reach) (AOR 1.83, 95% CI 1.38 to 2.42) and not to put medicines (AOR 2.11, 95% CI 1.54 to 2.90) or household products (AOR 1.79, 95% CI 1.29 to 2.48) away immediately after use.
For scalds, compared with controls, case households were more likely to leave hot drinks within children’s reach (AOR 2.33, 95% CI 1.63 to 3.31) and to not teach children rules about climbing on kitchen objects (AOR 1.66, 95% CI 1.12 to 2.47), about behaviour when parents are cooking (AOR 1.95, 95% CI 1.33 to 2.85) or about hot kitchen objects (AOR 1.89, 95% CI 1.30 to 2.75).

**Conclusions**

Modifiable risk factors were found for falls from furniture and on stairs, poisonings and scalds in children aged 0–4 years.

**Work stream 2**

**Research question**

What are the NHS, child and family costs of falls, poisonings and scalds? Is the Pediatric Quality of Life Inventory [PedsQL™; see www.pedsql.org/ (accessed 6 January 2017)] an acceptable and psychometrically sound measure of health-related quality of life (HRQL) in children aged ≥ 2 years in an emergency medicine setting?

**Methods**

Health-related quality of life was measured using the toddler version of the PedsQL with parents completing questionnaires immediately post injury, 2 weeks post injury, and 1, 3 and 12 months post injury. Instrument acceptability, internal consistency reliability, construct validity and responsiveness to change were measured. Resource use and expenditure questions were included in the HRQL questionnaire. Resource use data were combined with unit costs to calculate health-care and non-health-care costs (study C).

**Results**

Internal consistency reliability was adequate (Cronbach’s α > 0.70). Retrospectively reported pre-injury scale, summary and total scores were (except for the nursery/school subscale) higher than previously reported in healthy UK toddlers and among study A community controls. Children with long-term health conditions had poorer pre-injury PedsQL scores than those without long-term health conditions, and hypotheses regarding post-injury physical functioning scores for groups defined by injury severity were supported. There were reductions from pre injury to post injury in physical functioning for children with more severe injuries, with most effect sizes being large (≥ 0.8).

In total, 344 parents completed resource use questionnaires. Over 95% of children recovered within 2 weeks of injury and almost 99% recovered within 1 month. Mean NHS costs across injury mechanisms ranged from £2588 to £2989 for admissions of ≥ 2 days, from £719 to £1011 for admissions of 0–1 days and from £97 to £178 for those only attending the emergency department (ED). NHS costs were highest for scalds for admissions of 0–1 days and for ED attendances. Small numbers prevented comparisons between injury mechanisms for longer admissions. Mean family costs across injury mechanisms ranged from £99 to £399 for admissions of ≥ 2 days, from £38 to £200 for admissions of 0–1 days and from £18 to £68 for those only attending the ED. Family costs were highest for scalds for admissions of 0–1 days and for falls from furniture for ED attendances. Family costs mainly consisted of costs for informal child care and time off work.

**Conclusions**

The PedsQL was a feasible and acceptable measure of HRQL in this population, showing internal consistency reliability, discrimination between varying levels of injury severity and sequelae and responsiveness to change. Findings relating to construct validity were equivocal.

Injuries result in high NHS costs for admissions lasting ≥ 2 days, but these are uncommon. More common injuries requiring shorter inpatient stays incur moderate costs, and common injuries requiring only ED attendance incur small costs. Costs to families can be substantial, especially for injuries requiring admission.
Work stream 3

Research question
What interventions are undertaken by children’s centres to prevent thermal injuries, falls and poisoning?

Methods
Two national postal surveys of children’s centres were undertaken (study D). Surveys covered injury prevention activity, knowledge and attitudes, barriers and facilitators, and partnership working. The first survey (2010) covered fire-related injuries and the second (2012) covered falls, poisoning and scalds.

Results
Response rates were 56% in 2010 and 61% in 2012. In both surveys, around 60% of children’s centres identified unintentional injuries as one of their three main priorities, but fewer than half had written injury prevention strategies. Attitudes were positive towards injury prevention, but gaps in knowledge were reported. Two-thirds of centres had access to safety equipment schemes in 2010, but only 42% had access in 2012. Common barriers limiting injury prevention were staff capacity, funding and engaging ‘hard-to-reach’ groups. Common facilitators were good relationships with families, partnership working, safety equipment schemes, and trained and knowledgeable staff.

Conclusions
Most children’s centres lack an evidence-based strategic approach to child injury prevention and need support to deliver effective injury prevention.

Work stream 4

Research question
What are the barriers to, and facilitators of, implementing thermal injury, falls and poisoning prevention interventions among children’s centres, professionals and community members?

Methods
This work stream consisted of three studies.

1. Study E. Quantitative papers were identified from the systematic review carried out in study I, supplemented with a systematic review of qualitative evidence. Bibliographic databases and other sources were searched (May 2009 for quantitative papers, March 2010 for qualitative papers). Data were explored using framework analysis and synthesised narratively.
2. Study F. Semistructured interviews were conducted with children’s centre staff across four study sites. Interviews explored health and safety promotion programmes including injury prevention, barriers and facilitators. Data were analysed using framework analysis.
3. Study G. Semistructured interviews were conducted with parents of injured and uninjured children. Interviews explored injury prevention beliefs and strategies, control over injury prevention actions, and barriers and facilitators. Data were analysed using a thematic analysis.

Results
The review included 64 papers (57 quantitative, seven qualitative). Interviews were conducted with 33 children’s centre staff and 64 parents. A range of barriers and facilitators were found consistently across studies E–G. These included the need for trust between families and those delivering interventions, tailoring interventions to family needs and child development, focusing on specific injury prevention topics, and providing simple and reinforced messages. Parents felt that ‘real-life’ stories of how injuries had happened may help to raise awareness.
Conclusions
Facilitators of and modifiable barriers to children’s centres and parents undertaking injury prevention were identified. The effect of addressing barriers and facilitators within interventions requires evaluation.

Work stream 5

Research question
How cost-effective are strategies for preventing thermal injuries, falls and poisonings?

Methods
This work stream consisted of four studies.

- **Study H.** Systematic overviews were carried out, with bibliographic databases and other sources searched (fires, March 2009; falls, October 2010; poisoning, January 2012; scalds, October 2012). Data were synthesised narratively.
- **Study I.** A systematic review was carried out, with bibliographic databases and other sources searched to May 2009. Random-effects pairwise meta-analyses (PMAs) were used to estimate pooled ORs and incidence rate ratios.
- **Study J.** Random-effects network meta-analyses (NMAs) were used to estimate pooled effect sizes for all combinations of interventions.
- **Study K.** Decision analyses were used to estimate incremental cost-effectiveness ratios (ICERs) and probabilities of interventions being cost-effective.

Results
There was little evidence about the impact of home safety interventions on risk of injury or death from fires, scalds, falls or poisonings.

Fire prevention
Most evidence related to smoke alarms. Several case–control studies found that smoke alarm ownership was associated with a lower risk of house fire death and injury. PMA showed that interventions increased functional alarm ownership (OR 1.81, 95% CI 1.30 to 2.52). NMA found that education plus home safety inspection plus providing and fitting low-cost/free equipment was most effective in increasing functional alarm ownership [OR 7.15, 95% credible interval (CrI) 2.40 to 22.73; probability (p) best = 0.66]. Education plus providing and fitting low-cost/free equipment was the most cost-effective intervention (£34,200 per quality-adjusted life-year (QALY), reducing to £4500 per QALY assuming 1.8 children aged < 5 years per household).

Scald prevention
Most evidence related to ‘safe’ hot bathwater temperatures. Narrative reviews and PMA found that interventions promoted ‘safe’ temperatures (OR 1.41, 95% CI 1.07 or 1.86). NMA found that education plus providing and fitting low-cost/free equipment [thermostatic mixer valves (TMVs)] was the most effective intervention (OR 38.82, 95% CrI 3.58 to 599.10; p best = 0.97). However, this was the most cost-effective intervention only if TMVs were fitted during major refurbishment or in new builds for families in social housing, in which case money was saved.

Falls prevention
Most evidence related to safety gates and baby walker use. Narrative reviews and PMA found that interventions increased safety gate use (OR 1.61, 95% CI 1.19 to 2.17). NMA found that education plus home safety inspection plus providing and fitting low-cost/free equipment was the most effective intervention (OR 7.80, 95% CrI 3.18 to 21.3; p best = 0.97). Usual care (p = 0.999) had the highest probability of being cost-effective (at £30,000 per QALY). Education had the lowest ICER (£284,068 per QALY). Narrative reviews and PMA found that interventions reduced baby walker use (OR 1.57, 95% CI
1.18 to 2.09). NMA found that education was most effective (OR for walker use 0.48, 95% CrI 0.31 to 0.84). Decision analyses were not undertaken for interventions to reduce baby walker use.

Poisoning prevention
Most evidence related to safe storage of medicines and household products. Narrative reviews and PMA found that interventions increased the safe storage of medicines (OR 1.53, 95% CI 1.27 to 1.84) and household products (OR 1.55, 95% CI 1.22 to 1.96). NMA found that education plus providing and fitting low-cost/free equipment was the most effective intervention for medicines (OR 2.51, 95% CrI 1.01 to 6.00; p best = 0.39) and that education plus home safety inspection plus providing and fitting low-cost/free equipment was the most effective intervention for household products (OR 2.59, 95% CrI 0.59 to 15.16; p best = 0.37). Usual care (p = 0.83) had the highest probability of being cost-effective (at £30,000 per QALY) for the safe storage of medicines. Education had the lowest ICER compared with usual care, at £41,330 per QALY, reducing to £19,315 per QALY if education was targeted at families in the most disadvantaged areas where injury rates were higher. For safe storage of cleaning products, all interventions were more costly and less effective than usual care.

Conclusions
In general, more intensive interventions (e.g. education plus providing and fitting low-cost/free equipment and in some cases home safety inspection) were more effective than less intensive interventions, but the most effective interventions were not necessarily the most cost-effective.

Work stream 6

Research question
How effective and cost-effective is implementing an injury prevention briefing (IPB) for one exemplar injury prevention intervention?

Methods
Work stream 6 consisted of a review of reviews of implementation and facilitation of health promotion interventions (study L) and a randomised controlled trial (RCT) of an IPB for preventing fire-related injury (study M). The findings were incorporated into a second IPB covering fire-related injury, falls, poisoning and scalds.

Study M was a three-arm multicentre cluster RCT in 36 children’s centres. Participants were families with a child aged 0–2 years. Children’s centres were randomly allocated to (1) IPB plus support (training and facilitation) (IPB+), (2) IPB without support (IPB only) and (3) usual care (control). IPB+ children’s centres received training and four facilitation contacts over the 12-month intervention period. The primary outcome was the proportion of families with a fire escape plan. Secondary outcomes included other fire safety behaviours, measures of IPB implementation, resource use and expenditure. Random-effects modelling was used to compare outcomes between treatment arms and for the economic analysis. Qualitative data were analysed thematically.

Results
In study L, 10 reviews were identified. Common themes emerged about factors affecting the implementation of community prevention programmes. The Promoting Action on Research in Health Services (PARIHS) framework and Carroll et al.’s fidelity framework were identified and informed intervention design and measurement of fidelity and implementation.

In total, 36 children’s centres and 1112 families participated in study M. Follow-up data were obtained from all children’s centres and from 751 (68%) families.
The IPB was implemented by children’s centres in both intervention arms, with greater implementation in the IPB+ arm. Compared with the usual-care arm, more IPB+ families received fire prevention advice and more families in each intervention arm attended fire safety sessions. Compared with the usual-care arm, the intervention did not increase fire escape plan prevalence (AOR IPB only 0.93, 95% CI 0.58 to 1.49; AOR IPB+ 1.41, 95% CI 0.91 to 2.20) but did increase other fire escape behaviours (AOR IPB only 2.56, 95% CI 1.38 to 4.76; AOR IPB+ 1.78, 95% CI 1.01 to 3.15). Fewer IPB-only families reported match play by children (AOR 0.27, 95% CI 0.08 to 0.94) and IPB-only families reported more bedtime fire safety routines (AOR for a 1-unit increase in number of routines 1.59, 95% CI 1.09 to 2.31). The IPB-only intervention was less costly and marginally more effective than usual care. The IPB+ intervention was more costly and marginally more effective than usual care.

Conclusions
Neither intervention increased fire escape planning by parents, but both interventions increased fire prevention activity by children’s centres and improved some family fire escape behaviours.

Overall conclusions
The KCS programme has enhanced the evidence base for preventing falls, poisoning and thermal injuries in the under-fives. Our findings suggest that some falls, poisonings and scalds may be prevented by incorporating specific safety advice into child health contacts. Children’s centres can increase some safety behaviours in families if provided with evidence-based resources. The KCS programme findings, including evidence of effectiveness and activities for use with parents, are summarised in an IPB covering the prevention of fire-related injuries, falls, poisonings and scalds. This is freely available from www.nottingham.ac.uk/research/groups/injuryresearch/projects/kcs/index.aspx (accessed 29 September 2016).

Further studies are required to evaluate the effectiveness and cost-effectiveness of home safety interventions, including other injury prevention interventions within children’s centres and IPBs implemented by different professional groups and in different settings. Further meta-analyses (NMAs if possible) and decision analyses of home safety intervention studies are required, if possible incorporating covariates to evaluate the impact of targeting interventions at specific population groups.

Trial registration
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