

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

Denise Kendrick,^{1*} Joanne Ablewhite,¹ Felix Achana,² Penny Benford,¹ Rose Clacy,¹ Frank Coffey,³ Nicola Cooper,² Carol Coupland,¹ Toity Deave,⁴ Trudy Goodenough,⁴ Adrian Hawkins,⁵ Mike Hayes,⁶ Paul Hindmarch,⁵ Stephanie Hubbard,² Bryony Kay,⁷ Arun Kumar,¹ Gosia Majsak-Newman,⁸ Elaine McColl,⁹ Lisa McDaid,⁸ Phil Miller,³ Caroline Mulvaney,¹ Isabel Peel,³ Emma Pitchforth,¹⁰ Richard Reading,^{8,11} Pedro Saramago,¹² Jane Stewart,¹ Alex Sutton,² Clare Timblin,¹ Elizabeth Towner,⁴ Michael C Watson,¹ Persephone Wynn,¹ Ben Young¹ and Kun Zou¹

¹Division of Primary Care, University of Nottingham, Nottingham, UK

²Department of Health Sciences, University of Leicester, Leicester, UK

³Nottingham University Hospitals NHS Trust, Nottingham, UK

⁴Centre for Child and Adolescent Health, University of the West of England, Bristol, UK

⁵Newcastle upon Tyne Hospitals NHS Foundation Trust, Newcastle upon Tyne, UK

⁶Child Accident Prevention Trust, London, UK

⁷University Hospitals Bristol NHS Foundation Trust, Bristol, UK

⁸Norfolk and Norwich University Hospitals NHS Foundation Trust, Norwich, UK

⁹Clinical Trials Unit, Newcastle University, Newcastle upon Tyne, UK

¹⁰RAND (Europe), Westbrook Centre, Cambridge, UK

¹¹Norfolk Community Health and Care NHS Trust, Norwich, UK

¹²Centre for Health Economics, University of York, York, UK

*Corresponding author Denise.Kendrick@nottingham.ac.uk

Declared competing interests of authors: Elaine McColl is a subpanel member for the National Institute for Health Research (NIHR) Programme Grants for Applied Research (PGfAR) journal, but in that capacity has already declared a conflict of interest in respect of this grant and has not been involved in any discussions or decisions thereon. Elaine McColl was a NIHR journal editor for the NIHR PGfAR journal at the time that this report was written and has a declared conflict of interest in respect of this report and will not participate in any discussions, work or decisions thereon. The Keeping Children Safe programme received Flexibility and Sustainability Funding from Nottinghamshire County Teaching Primary Care Trust, University Hospitals Bristol NHS Foundation Trust and Norfolk and Suffolk Comprehensive Local Research Network and Research Capability Funding from Nottinghamshire County Teaching Primary Care Trust and Nottinghamshire Healthcare NHS Foundation Trust to support NIHR Faculty members' salaries.

Published July 2017

DOI: 10.3310/pgfar05140

Scientific summary

Keeping Children Safe: a multicentre programme of research

Programme Grants for Applied Research 2017; Vol. 5: No. 14

DOI: 10.3310/pgfar05140

NIHR Journals Library www.journalslibrary.nihr.ac.uk

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.pedsq.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 $\alpha > 0.70$). 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 centre managers 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

This trial is registered as ISRCTN65067450 and NCT01452191.

Funding

Funding for this study was provided by the Programme Grants for Applied Research programme of the National Institute for Health Research.

Programme Grants for Applied Research

ISSN 2050-4322 (Print)

ISSN 2050-4330 (Online)

This journal is a member of and subscribes to the principles of the Committee on Publication Ethics (COPE) (www.publicationethics.org/).

Editorial contact: journals.library@nihr.ac.uk

The full PGfAR archive is freely available to view online at www.journalslibrary.nihr.ac.uk/pgfar. Print-on-demand copies can be purchased from the report pages of the NIHR Journals Library website: www.journalslibrary.nihr.ac.uk

Criteria for inclusion in the *Programme Grants for Applied Research* journal

Reports are published in *Programme Grants for Applied Research* (PGfAR) if (1) they have resulted from work for the PGfAR programme, and (2) they are of a sufficiently high scientific quality as assessed by the reviewers and editors.

Programme Grants for Applied Research programme

The Programme Grants for Applied Research (PGfAR) programme, part of the National Institute for Health Research (NIHR), was set up in 2006 to produce independent research findings that will have practical application for the benefit of patients and the NHS in the relatively near future. The Programme is managed by the NIHR Central Commissioning Facility (CCF) with strategic input from the Programme Director.

The programme is a national response mode funding scheme that aims to provide evidence to improve health outcomes in England through promotion of health, prevention of ill health, and optimal disease management (including safety and quality), with particular emphasis on conditions causing significant disease burden.

For more information about the PGfAR programme please visit the website: <http://www.nihr.ac.uk/funding/programme-grants-for-applied-research.htm>

This report

The research reported in this issue of the journal was funded by PGfAR as project number RP-PG-0407-10231. The contractual start date was in April 2009. The final report began editorial review in November 2014 and was accepted for publication in February 2016. As the funder, the PGfAR programme agreed the research questions and study designs in advance with the investigators. The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The PGfAR editors and production house have tried to ensure the accuracy of the authors' report and would like to thank the reviewers for their constructive comments on the final report document. However, they do not accept liability for damages or losses arising from material published in this report.

This report presents independent research funded by the National Institute for Health Research (NIHR). The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, CCF, NETSCC, PGfAR or the Department of Health. If there are verbatim quotations included in this publication the views and opinions expressed by the interviewees are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, NETSCC, the PGfAR programme or the Department of Health.

© Queen's Printer and Controller of HMSO 2017. This work was produced by Kendrick et al. under the terms of a commissioning contract issued by the Secretary of State for Health. This issue may be freely reproduced for the purposes of private research and study and extracts (or indeed, the full report) may be included in professional journals provided that suitable acknowledgement is made and the reproduction is not associated with any form of advertising. Applications for commercial reproduction should be addressed to: NIHR Journals Library, National Institute for Health Research, Evaluation, Trials and Studies Coordinating Centre, Alpha House, University of Southampton Science Park, Southampton SO16 7NS, UK.

Published by the NIHR Journals Library (www.journalslibrary.nihr.ac.uk), produced by Prepress Projects Ltd, Perth, Scotland (www.prepress-projects.co.uk).

Programme Grants for Applied Research Editor-in-Chief

Professor Paul Little Professor of Primary Care Research, University of Southampton, UK

NIHR Journals Library Editor-in-Chief

Professor Tom Walley Director, NIHR Evaluation, Trials and Studies and Director of the EME Programme, UK

NIHR Journals Library Editors

Professor Ken Stein Chair of HTA and EME Editorial Board and Professor of Public Health, University of Exeter Medical School, UK

Professor Andree Le May Chair of NIHR Journals Library Editorial Group (HS&DR, PGfAR, PHR journals)

Dr Martin Ashton-Key Consultant in Public Health Medicine/Consultant Advisor, NETSCC, UK

Professor Matthias Beck Chair in Public Sector Management and Subject Leader (Management Group), Queen's University Management School, Queen's University Belfast, UK

Dr Tessa Crilly Director, Crystal Blue Consulting Ltd, UK

Dr Eugenia Cronin Senior Scientific Advisor, Wessex Institute, UK

Ms Tara Lamont Scientific Advisor, NETSCC, UK

Dr Catriona McDaid Senior Research Fellow, York Trials Unit, Department of Health Sciences, University of York, UK

Professor William McGuire Professor of Child Health, Hull York Medical School, University of York, UK

Professor Geoffrey Meads Professor of Health Sciences Research, Health and Wellbeing Research Group, University of Winchester, UK

Professor John Norrie Chair in Medical Statistics, University of Edinburgh, UK

Professor John Powell Consultant Clinical Adviser, National Institute for Health and Care Excellence (NICE), UK

Professor James Raftery Professor of Health Technology Assessment, Wessex Institute, Faculty of Medicine, University of Southampton, UK

Dr Rob Riemsma Reviews Manager, Kleijnen Systematic Reviews Ltd, UK

Professor Helen Roberts Professor of Child Health Research, UCL Institute of Child Health, UK

Professor Jonathan Ross Professor of Sexual Health and HIV, University Hospital Birmingham, UK

Professor Helen Snooks Professor of Health Services Research, Institute of Life Science, College of Medicine, Swansea University, UK

Professor Jim Thornton Professor of Obstetrics and Gynaecology, Faculty of Medicine and Health Sciences, University of Nottingham, UK

Professor Martin Underwood Director, Warwick Clinical Trials Unit, Warwick Medical School, University of Warwick, UK

Please visit the website for a list of members of the NIHR Journals Library Board:
www.journalslibrary.nihr.ac.uk/about/editors

Editorial contact: journals.library@nihr.ac.uk