Cochrane update

Slum upgrading review: methodological challenges that arise in systematic reviews of complex interventions

Ruth Turley1, Ruhi Saith2, Nandita Bhan3, Jodie Doyle4, Kirsty Jones4, Elizabeth Waters4

1Support Unit for Research Evidence (SURE), Information Services, Cardiff University, Cardiff, UK
2Oxford Policy Management, New Delhi 11003, India
3Department of Social and Behavioral Sciences, Harvard School of Public Health, Boston, USA
4Cochrane Public Health Group, Jack Brockhoff Child Health and Wellbeing Program, McCaughey Centre, Melbourne School of Population Health, The University of Melbourne, Melbourne, Australia

Address correspondence to Ruhi Saith, E-mail: ruhi.saith@wolfson.oxon.org

Background

We recently completed and published a review of significance to many developing, and low- and middle-income countries, with funding from the International Initiative for Impact Evaluation (3ie). The review is concerned with slum upgrading strategies involving physical environment and infrastructure interventions and their effects on health and socio-economic outcomes.1 Previous reviews looking at urban improvements have focused specifically on health impacts of water and sanitation interventions.2–4 This review however provides a comprehensive picture of slum upgrading involving multiple interventions and their impacts on multiple outcomes. Five studies fitted strict criteria of eligibility and nine studies fitted the criteria for being considered as supporting studies.

Within this limited evidence base, results suggest that the incidence of communicable diseases was reduced following slum upgrading interventions. Consistent improvements in the incidence of diarrhoeal diseases were observed in both main and supporting studies, whilst results were mixed for incidence and severity of parasitic infections. Evidence from one study suggested that severity and duration of diarrhoea was not affected. Regarding socioeconomic outcomes, even as the quality of the available body of evidence remains low, included studies demonstrated mixed effects on measures of financial poverty. There was also insufficient evidence available to assess the impact of slum upgrading on employment, education, social capital, crime and violence.

Addressing challenges

We discuss here contributions of this review to developing methods for systematic reviews of complex social interventions. We also highlight issues and challenges faced in the analysis and presentation of results.

Combining evidence from multiple interventions

The process for conducting this review was complex as it included slum upgrading interventions ranging from those involving the physical infrastructure (e.g. improving housing and sanitation), and improving services (e.g. access to health care) to legal action (e.g. housing tenure). The interventions were undertaken by multiple actors including governments (local or higher levels), NGOs, slum communities, etc. Naturally the interventions were also associated with a range of outcomes affecting the health, livelihoods, social and economic aspects of the life of slum dwellers. Conducting a systematic review with these complex parameters required the authors, in consultation with a Review Advisory Group, to refine the scope of the review question, identify the interventions that could be dealt with together and specify clearly the outcomes to be considered. A logic model provided an exceptionally useful contribution, graphically identifying the key elements and relationships within the system5 (Fig. 1).

The logic model, reproduced here from the review1 aided in conceptualizing the focus of the review and guided the literature search, identified groupings of multi-component interventions, upstream and proximal interventions and highlighted outcomes of interest.
Collecting evidence across multiple disciplines

Given the international policy relevance, and investment by multiple and diverse organizations, the process of review production necessitated a multi-disciplinary and multi-stakeholder lens. A Review Advisory Group was composed representing academics, policy and practitioners including expertise from public health, urban policy and planning, architecture and housing. This group provided inputs in the design and parameters of the protocol.

To identify relevant primary studies, a comprehensive search for published and grey literature was performed across 28 databases. These included multidisciplinary bibliographic databases as well as relevant specialist databases, covering health, social science, urban planning, environment and LMIC databases. The development of an inclusive, search strategy across disciplines was undertaken using SCOPUS, a multidisciplinary database, using two search concepts (related to the setting of slums and the interventions) and broad search terms. Identified studies were sifted for study designs and outcomes once the search was completed. The SCOPUS strategy was then adapted to the other databases.

Supporting study designs in social interventions

Eligibility criteria for inclusion in the review comprised study designs that reduced selection bias (through random or quasi-random allocation of intervention), had comparison groups and established the temporal order of intervention and effect/impact. This included, randomized/quasi-randomized controlled trials, controlled before–after (CBA) studies and interrupted time series with three data points before and after the intervention. Only five studies were found eligible for synthesis of main results using these study design criteria: one RCT and four CBAs. Given the paucity of information found, review authors included two additional study designs—controlled post-intervention (CPI)

![Fig. 1: Logic Model clarifying different aspects for the review (taken from fig 1, Turley et al.1).]

**ACtORS**
- Government (global, national, local)
- Private sector
- Civil society (NGOs, community groups and individuals)

**ENABLING/UPSTREAM INTERVENTIONS**
- Policy and planning
  - Supportive public policy - i.e. upgrading strategies that target urban poor. Features may include
  - Specific land use planning/land zoning policies
  - Intersectoral planning
  - Using local labour for public works
  - Policies to improve capacity for delivering strategies,
  - Training/increase urban planning manpower
  - Mobilize global political & financial commitment to slum upgrading
  - Increase political accountability
  - Improve urban management, fiscal performance, and reduce corruption

- Laws and Regulation
  - Secure tenure/land regularization
  - Privatisation and regulation of utilities

- Financial
  - Global/national financial investment
  - Private Investment to provide services/facilities for new urban residents
  - Social investment funds
  - Poverty alleviation:
    - Interventions to enhance slum dweller earnings
    - Cash transfer programmes
    - Credit schemes (village banks, mortgages etc)

- Community action/management
  - Community engagement and participation in the design, delivery and/or maintenance of interventions
  - Incorporate gender dimensions of upgrading e.g. role of women in community management
  - Interventions to increase social capital or increase civic engagement

**DIRECT INTERVENTION/CHANGE TO LIVING CONDITIONS**
- Physical environment
  - Housing or infrastructure improvements made within existing slum areas, e.g.:  
    - Water infrastructure: sanitation, clean water, storm drainage and flood prevention
    - Energy infrastructure: electricity/gas supply
    - Transportation infrastructure-road networks, emergency access roads, public transportation, street lighting, paved sidewalks/footpaths
    - Waste management
    - Mitigation of environmental hazards
    - Home improvement and reduce crowding
    - Construction of community facilities/services (e.g. nurseries, clinics, community centres, parks, banks, shops, etc.)

- Health Education and Behavioural
  - Dietary, hygiene, safety, health, healthcare-seeking

- Social Environment
  - Improve security/social protection programmes
  - Violence reduction programmes
  - Reduce illegal drugs and drug sales

- Health and Social Services
  - Access to health and social services

**OUTCOMES (individual or population level)**
- Health
  - Infant and child health (LBW, injuries etc.)
  - Injuries and violence
  - Communicable diseases
  - Respiratory health
  - Obesity
  - Cardiovascular diseases
  - Diabetes
  - Cancers
  - Mental health
  - Psychological distress
  - Disability
  - All cause mortality
  - Life satisfaction
  - Quality of Life

**IMPLEMENTATION FACTORS: COMPLETION, UPTAKE, REACH (inc equity of reach)**
- SUSTAINABILITY, RESIDENTS SATISFACTION
Synthesis and presentation of findings

Two challenges emerged regarding synthesis and presentation of findings. The first pertained to the manner of presentation of information from the main and supporting studies (combined or separately given important study design differences). The second pertained to pooling, synthesizing and presenting information on a range of interventions (single or multi-component) and a diverse number of outcomes. Systematic reviews often use meta-analyses and forest plots for this, but the diversity of slum interventions and outcome measures prevents the pooling of studies and subsequent meta-analysis.

Review findings were presented in two parts—main findings and supporting studies, clearly distinguishing between causal and supporting evidence. For synthesis and presentation, review authors developed ‘harvest plots’ using information from narrative syntheses of main and supporting findings. Harvest plots are a tool developed to synthesize evidence from complex and heterogeneous population-level interventions. An example of harvest plots mapping health outcomes is presented in Fig. 2.

As seen in Fig. 2, health outcomes are plotted on the vertical axis with outcomes combined into broad categories. For example, diarrhoea, parasitic infections and dengue fever have been combined into the communicable diseases group. Direction of effects is seen on the horizontal axis with three categories—‘favours control’, ‘no difference’ and ‘favours intervention’. Studies were represented by bars on the grid, marked with the first three letters of the primary author’s surname and placed according to the direction of effect. Bar height indicated whether study design was causal—high bar representing RCTs, medium bar representing CBA/CPI with propensity score matching and low bar representing CPI/UBA. Colour gradient was used to indicate statistical significance at 5 and 10% or if not reported at all. Risk of bias was shown by positive/negative signs on the bars using ‘+ +’ (low risk of bias), ‘+’ (mixed or unclear risk of bias) and ‘−’ (high risk of bias).

Using qualitative information to give insights into the process

In addition to the quantitative information evaluating the effectiveness of slum interventions, qualitative information was assessed on (i) living conditions of slum dwellers in unimproved areas and their perceived needs (ii) slum dwellers’ views regarding beneficial or adverse effects of interventions and (iii) factors enhancing or mediating impact, acceptability of the intervention and perceived barriers and facilitators to implementation.

Qualitative information was used if reported with the eligible quantitative studies. Stand-alone qualitative research studies were excluded. Given the paucity of qualitative information and disparate themes, rigorous thematic analyses were not possible. Analysis and synthesis of the qualitative information did provide valuable insights into implementation processes and prompted recommendations on the need for future impact evaluation studies to incorporate better qualitative data to assess what interventions work, for whom, why and how best to deliver services. It also raised questions regarding (i) strengthening existing qualitative components of systematic reviews and (ii) difficulties in assessing the quality of qualitative information from studies focused on quantitative methodology.

Conclusion

The systematic review on slum upgrading interventions highlights several methodological challenges. This paper has identified some helpful approaches which may be useful to other reviewers facing similar problems. In summary:

• Logic models can be used to simplify complex information and define the scope of the review.
<table>
<thead>
<tr>
<th>Communicable diseases</th>
<th>Maternal and perinatal</th>
<th>Nutritional deficiencies</th>
<th>Non-communicable</th>
<th>Injuries</th>
<th>General health measures</th>
<th>Quality of life</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>Mor</td>
<td>Soa</td>
<td>Cat</td>
<td>Cal</td>
<td>Abe</td>
<td>Cal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Direction of result: Favours control, No difference, Favours Intervention

**KEY**

Each bar represents a study, referenced by the first three letters of the first authors' surname. Key study characteristics are represented by the following:

**Shading of bar: statistical confidence in point estimate**
- Blue: Evidence of no effect or statistically significant effect at 5% level
- Light blue: Statistically significant effect at 10% level
- Grey: Confidence intervals and p-values not reported/estimable

**Height of bar: appropriateness of study design**
- High bar = design can examine causal effect of intervention (RCT)
- Mid-height bar = design can infer plausible causality (CBA/CPI with matching)
- Low bar = design cannot examine causality (UBA/CPI)

**Symbol: Risk of bias of study**
- ++: Low risk of bias
- +: Mixed/unclear risk of bias
- –: High risk of bias

**Fig. 2:** A Harvest plot synthesising results from studies of slum interventions (taken from fig 5, Turley et al.1).
- Using multi-disciplinary databases to design preliminary search strategy can help in developing robust adaptable strategies for literature searches.
- Inclusion of non-causal supporting study designs like CPI and UBAs can provide useful information to corroborate inferences from more robust study designs, and give insights into issues not addressed by ‘main’ studies. Separation of results from main and supporting studies, however, is necessary so that the limitations of study designs can be kept in mind when interpreting findings.
- Qualitative review of information from included studies can be useful in providing insights into implementation processes.

Methodological issues pertaining to inclusion of purposively conducted qualitative-only studies and their quality assessment, as well as that of qualitative data nested within quantitative designs, need further debate and discussion in the context of systematic review methods for complex interventions.

Acknowledgments

The author team would like to thank the International Initiative for Impact Evaluation (3ie) for funding the systematic review that this paper draws on, as well as the entire editorial team of the Cochrane Public Health Group, who provided support and time to background research, concepts, methods and early leadership of the review. CPHG acknowledges the support of the Victorian Health Promotion Foundation (VicHealth), NHMRC and the Jack Brockhoff Foundation. We would also like to thank Eva Rehfeuss and Ben Carter co-authors on the review, Professor Laurie Anderson and Dr Alison Weightman for their support through the course of the review, and Dr Tahna Pettman for administrative support with this paper. Thanks are also due to Wiley, the publishers of the systematic review on slum upgrading interventions (Turley et al 2013) in the Cochrane Library for permission to reproduce two figures in this paper.

References