

Title: A review of evidence on public health interventions in humanitarian crises.

Karl Blanchet, PhD^{1*}, Anita Ramesh, PhD², Severine Frison, MSc², Emily Warren, MSc², Mazedra Hossain, PhD³, James Smith, MBBS, MSc¹, Abigail Knight, MSc¹, Nathan Post, MBBS, MSc³, Christophe Lewis, MBBS, MSc⁴, Aniek Woodward, MSc³, Maysoon Dahab, PhD³, Alexander Ruby, MSc³, Vera Sistenich, MPH, MD⁵, Sara Pantuliano, PhD⁶, Bayard Roberts, PhD^{3*}.

¹ Public Health in Humanitarian Crises Group, Faculty of Public Health and Policy, London School of Hygiene and Tropical Medicine, United Kingdom.

² Faculty of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, United Kingdom.

³ ECOHOST – The Centre for Health and Social Change, Faculty of Public Health and Policy, London School of Hygiene and Tropical Medicine, United Kingdom.

⁴ United Kingdom Department for International Development, United Kingdom.

⁵ Harvard School of Public Health, United States of America.

⁶ Overseas Development Institute, United Kingdom.

* Corresponding author. Bayard Roberts, Faculty of Public Health and Policy, London School of Hygiene and Tropical Medicine, 15-17 Tavistock Place, London, WC1H 9SH.

Bayard.roberts@lshtm.ac.uk

Title: A review of evidence on health interventions in humanitarian crises.

Summary

There has been increasing recognition of the need for evidence-based interventions to help improve the effectiveness and efficiency of humanitarian responses. However, little is known on the breadth and quality of evidence on health interventions in humanitarian crises. We describe the findings of a systematic review with the aim of examining the quantity and quality of evidence on public health interventions in humanitarian crises and to identify key research gaps. We identified 345 studies published between 1980 and 2014 that met our inclusion criteria. The quantity of evidence varied substantially by health topic, from communicable diseases (N=131), nutrition (N=77) to non-communicable disease (N=8), and water, sanitation and hygiene (N=6). We observed common study design and methodological weaknesses, which substantially reduced the ability to determine causation and attribution of the interventions. Considering the substantial increase in health-related humanitarian activities in the past three decades and calls for a stronger evidence-base, this paper highlights the limited quantity and quality of health intervention research in humanitarian contexts and supports calls to scale up this research.

Key messages

- Evidence is important in guiding more effective and efficient health responses in humanitarian contexts.
- On the basis of our systematic review, we found that evidence is limited both in quantity and quality.
- The majority of studies are able to demonstrate changes in health outcomes, but most are unable to attribute these changes to the intervention because of study design used. Where logistically and ethically possible, there should be greater use of experimental and quasi-experimental study designs.
- The findings support calls to scale-up quality health research in humanitarian crises.

Title: A review of evidence on health interventions in humanitarian crises.

Introduction

There are an estimated 172 million people worldwide affected by armed conflict,¹ including 59 million people forcefully displaced from their homes as internally displaced persons (IDPs) within their countries or refugees who have crossed an international border. This is the highest number of forcibly displaced persons since the Second World War. In addition, natural disasters affect around 175 million people annually.² The health impacts for these populations can be enormous. Good information is essential in understanding these impacts and informing effective and accountable humanitarian responses. This Lancet Series on humanitarian health seeks to highlight gaps in our understanding of health responses in humanitarian crises and to discuss ways in improving these responses. It focuses particularly on the use of health data, and in this paper, the first in the Series, we examine the evidence base for health interventions in humanitarian crises.

Despite epidemiological studies being conducted over the past half century in humanitarian crises³⁻⁸, there remains a high degree of concern on the quality of data in humanitarian crises⁹⁻¹⁴, how it has been used to guide humanitarian health interventions and ultimately how effectively humanitarian relief programmes have improved health outcomes^{5, 15-18}. This reflects broader demands for greater accountability in the humanitarian sector, which includes strengthening evidence-based decision-making in order to improve the effectiveness of humanitarian responses¹⁹⁻²².

In this paper, we describe the findings from a systematic review with aim of examining the overall quantity and quality of evidence on public health interventions in humanitarian crises and identifying the key research gaps. Previous systematic reviews have been conducted on specific health topics in humanitarian crises, which has provided valuable guidance on the effectiveness on interventions for individual health topics such as mental health and psychosocial support (MHPSS), nutrition, and water, sanitation and hygiene (WASH) and nutrition²³⁻³². However, these commonly focused on specific interventions and outcomes. A more comprehensive examination across the range of key health topics can help identify key research gaps across the humanitarian health sector and guide decision-making on health interventions and research.

Panel 1 presents the methods used for the systematic review. The actual effectiveness of health interventions was not evaluated given the wide range of health outcomes and interventions and that the main focus of the review was on the overall quantity, quality and the gaps in the

evidence. Instead, we present a descriptive summary of the key findings related to the key gaps in evidence, the strength and quality of the evidence, and then discuss potential explanations for these findings and how to move forward.

Panel 1: Methods for the systematic review

Inclusion criteria

The following health topics were included (based on topics commonly used in humanitarian guidelines such as the Sphere Project): communicable disease control; water, sanitation and hygiene (WASH); nutrition; sexual and reproductive health (SRH), including gender-based violence (GBV); mental health and psychosocial support (MHPSS); non-communicable disease (NCD); and injury and physical rehabilitation.

Both armed conflicts and natural disasters were included as evidence from natural disasters can also be of value for humanitarian responses to armed conflict. We included acute and chronic humanitarian crises (including forced displacement) and early recovery periods. We only included studies from crises in low and middle income countries as this is where the majority of crises take place and preparedness and response resources are different when compared to high income settings.

We followed a broad understanding of intervention effectiveness in order to gain a comprehensive understanding of the overall evidence base³³. Therefore, we included observational study designs that measured a change in health outcomes before, during and/or after an intervention, as well as experimental and quasi-experimental study designs that compared against another intervention or control group.

Search strategy

Searches were conducted from 1980 to 2014 for studies in English or French in bibliographic databases of Medline, Embase, Global Health, IBSS and Web of Knowledge. Web-based grey literature sources were also used. The search structure consisted of: (i) terms related to humanitarian crises/early recovery; AND (ii) terms related to public health interventions and associated study designs; AND (iii) terms related to lower and middle income economies; AND (iv) terms related to each of the seven health topics above. Searches were supplemented by reviewing the reference lists ('references of references') of selected articles to find any other relevant papers.

Data collection, analysis and reporting

Returned citations were downloaded to Endnote software and a five-stage screening process applied (see Web Appendix 1). Data of the final selected studies were extracted using a standardised form. The quality of the final selected studies was assessed using a condensed version of STROBE and CONSORT standards for observational studies and clinical trials, respectively (Web Appendix 2). The score ranges for both instruments were 0-8, with *a priori* thresholds applied of scores of 0-3 rated as low quality, 4-6 as moderate quality, and 7-8 as high quality. The study selection, data extraction, and study quality assessment were independently conducted by two researchers. Descriptive analysis was used as it was not possible to undertake a meta-analysis given heterogeneity of study designs, interventions, and outcomes. The actual effectiveness of health interventions was not evaluated given the wide range of health outcomes and interventions, and the main focus of the review was on the overall quantity, quality and the gaps in the evidence. The systematic review methodology adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement ³⁴.

Limitations of the review

This review chose to concentrate only on English and French papers. However, consultation with experts suggested this would likely account the vast majority of available literature. The review included only quantitative studies, and it is recognised that qualitative and mixed methodologies are important in understanding factors influencing effectiveness, particularly the needs and perceptions of local communities towards the appropriateness, acceptability and uptake of interventions ³⁵. For the sake of brevity, we also did not include studies on health systems and broader contextual factors which may influence the delivery and effectiveness of public health interventions, but these are covered in a broader evidence review from which this paper derives ³⁶.

Gaps in evidence

From an initial retrieval of nearly 50,000 papers, this systematic literature review yielded 345 papers published between 1980 and 2014 that met the inclusion criteria (Web Appendix 1). There were 131 studies from communicable disease control, 6 from WASH, 77 from nutrition, 15 from SRH, 61 from MHPSS, 8 from NCD, and 47 from injury and rehabilitation (Figure 1; see full list in Web Appendix 3). Overall, the frequency of publication increased over time, with nearly 80% of all papers published between 2000 and 2014. Further information on types of health outcomes, intervention types, geographic distribution, crisis and population types, and study designs are given in Table 1.

There were a number of major gaps in terms of the health topics and interventions. For communicable diseases, the range of diseases addressed in the evidence broadly reflects the burden of communicable diseases in crisis settings³⁷, but there were several notable gaps. There were no studies on the effectiveness of interventions for acute respiratory infections, despite the high morbidity, mortality and case fatality rates from acute respiratory infections during humanitarian crises³⁸ and that the well documented need for further research on acute respiratory infections interventions such as short-course therapies³⁷. Similarly, only single studies were identified for yellow fever, leptospirosis, mumps, onchocerciasis, and schistosomiasis despite their burden in crisis-affected populations^{37, 39, 40}. A recent systematic review in twenty two fragile states identified the most common causes of communicable diseases outbreaks over the past decade (2000-2010) and highlighted the disconnect between the causes of outbreaks and the number of studies³⁹. For example, although seven yellow fever outbreaks occurred during this time period, only one study on yellow fever met the inclusion criteria of this review.

In WASH, only six studies met the inclusion criteria, as much WASH-related research focuses on water quality outcomes (e.g. reductions in faecal coliform levels), which are commonly used as a proxy for health outcomes (e.g. diarrhoea), rather than measuring health outcomes themselves. There is also a strong evidence-base on WASH interventions from stable settings⁴¹⁻⁴⁴. However, further WASH research specifically in crisis settings is still required, for example on the effectiveness of WASH behaviour change interventions such as use of soap.

In nutrition, while there was a greater quantity of studies than most of other topics, they were mainly focussed on acute malnutrition (53%) and children aged between 6 and 59 months old (61%). Very little was found on other vulnerable groups (e.g. pregnant women, infants, elderly, people with disabilities, etc.) and other outcomes. Few studies examined the effectiveness of Infant and Young Child Feeding (IYCF) interventions or micro-finance and voucher programme interventions.

In SRH, there were only 15 studies. Of these, only 2 examined the effectiveness of family planning interventions and 4 of emergency obstetric care. There were no studies seeking to address the effectiveness of interventions addressing the outcome of gender-based violence (e.g. prevention and reduction programmes). There were also no papers addressing interventions for post-abortion care or safe abortion. There were also no studies targeting adolescents – a key vulnerable population. These same gaps were observed over a decade ago by the Inter-Agency Working Group on Reproductive Health in Crises⁴⁵. While process indicators have been developed as reliable proxy measures of intervention effectiveness, for example for emergency

obstetric care which reduces the need to measure maternal mortality ⁴⁶, the evidence from SRH still appears extremely limited overall.

In MHPSS, there was a comparatively high number of studies (N=61) and 39 of these were experimental studies which is encouraging. However, it should be recognised that the evidence-base for MHPSS interventions in stable settings is generally weaker than for the other topics and so it less possible to generalise finding to crisis-affected settings. In addition, the cultural specificity of MHPSS combined with the particular risk-factors (e.g. trauma event exposure and acute daily stressors) and their mental health *sequelae* in crisis setting require very context-specific interventions. Therefore, a significantly greater number of MHPSS intervention studies are required from these settings, as also highlighted elsewhere ⁴⁷. The studies identified in the review focused predominantly on psychological interventions (for post-traumatic stress disorder (PTSD) in particular), and while there were a number on psychosocial interventions these provided weaker evidence on effectiveness and were of a poorer methodological quality despite them being the most commonly practiced MHPSS interventions. Particular disorders that appear neglected include alcohol and other substance use disorders (no studies identified) while there is also very limited evidence on how interventions influence overall functioning (as opposed to specific mental disorders). There is also very limited evidence on MHPSS interventions with certain vulnerable groups. For example, only 2 studies were identified on interventions addressing the MHPSS needs of survivors of gender-based violence. There were also no studies specifically with older age populations despite them commonly having a higher burden of mental health disorders ⁴⁸.

There was an extremely limited evidence-base on NCDs, with only 8 studies identified (addressing diabetes, cardiovascular disease, thalassemia, arthritis and chronic kidney disease), with no intervention studies on other major NCDs such as cancers. There were also no studies on how chronic disease interventions implemented during the acute phase were maintained over time by the local health system. There were also no intervention studies on preventing NCDs despite the potential to do so in longer-term chronic, stable and early recovery phases. This lack of evidence on NCDs is clearly a major gap given the rise of NCDs in low and middle income settings and concern on how to most effectively address them in crisis-affected populations ⁴⁹, with NCDs being the major health issues in crises such as in Syria, Iraq and Ukraine ^{49,50}.

Almost all Injury and Rehabilitation research (40 out of 47 studies) occurred in the general population (48%); and so refugees (31%), IDPs (9%), and entrapped populations (12%) are under-researched for this topic. Only 7 studies measured the effectiveness of rehabilitation interventions. The other 40 studies focused on the effectiveness of surgery and other medical

interventions. As a result, the majority of studies (62%) took place during armed conflict settings and little has been researched in natural disaster contexts.

A major gap common to all the health topics was the lack of economic data. Only 12 out of 345 studies included economic components in the study design (communicable disease=5, nutrition N=4; SRH N=1; MHPSS=1; Injury and Rehabilitation N=1). Therefore, crucial information on the costs, efficiencies, and cost-effectiveness to guide decision-making on implementing health interventions in humanitarian crises is lacking, including on the potential to scale-up interventions. While evidence does exist from stable settings on cost-effectiveness for a number of relevant interventions⁵¹, the ability of decision-makers to draw robust conclusions about comparative effectiveness and efficiency of a range of interventions for other topics remains restricted¹⁵. For example, there are increasing concerns over the costs of treating NCDs among conflict-affected populations⁵², and yet no economic studies of NCD interventions were identified in our review.

The bulk of evidence relates to refugee populations. It is now important to generate more evidence and guidelines for dispersed refugee and IDP populations, particularly those in urban areas (e.g. refugee populations in dispersed areas in Lebanon). We were also not able to categorise the crisis phase due to inconsistent or incomplete information on this in the studies. There was also a lack of inter-sectoral intervention studies despite the potential for improved effectiveness and efficiency for more integrated approaches between sectors such as protection, education, health, WASH and nutrition. For example, although most malaria studies assessing acute clinical and parasitological outcomes measured anaemia/haematocrit as part of routine malarial monitoring, none of these studies related to a nutrition intervention.

Strength and quality of evidence

The strength of evidence based upon the range of study designs was generally quite weak. In terms of study design classifications⁵³, only 39% of studies used experimental designs of randomised control trials (RCTs) (N=89) or quasi-experimental study designs (non-random trials N=45), which could demonstrate attribution of interventions to changes in health outcomes. These were also predominantly for communicable diseases amongst refugee populations in Sub-Saharan Africa, and so there is deficit of experimental studies for other outcomes in other populations and regions. Of the observational study designs, 19% (N=66) were cohort studies, 22% (N=77) were uncontrolled longitudinal studies, 9% (N=30) were uncontrolled before and after studies, 2% (N=8) was case control studies, 6% (N=19) were follow-up cross-sectional, and

3% (N=11) were cross-sectional (Figure 2). Evidence on attribution was particularly weak for the topics of SRH, NCDs, and injury and rehabilitation, with the vast majority of studies in these health topics using pre- and post-intervention follow-up cross-sectional designs. The issue was further compounded with some authors claiming attribution of interventions on health outcomes which could not be supported by the study designs, with little recognition given to the potential for bias and confounding in such study designs. The lack of comparison groups in the majority of studies also means that secular trends cannot be discounted.

Understanding whether interventions were associated with changes in health outcomes was further inhibited by the lack of statistical data. Of the 345 studies, only 218 studies (63%) provided some statistical measure of difference between intervention and outcome. This also meant that, where appropriate, insufficient adjustment for potential confounders took place. The topics of injury and rehabilitation and SRH were particularly weak on this matter. In injury and rehabilitation studies, little is reported on the dropout rate and the characteristics of cases (e.g. type and severity of injury, socio-economic status) who could not be followed up and outcomes measures are not defined with accuracy and details (e.g. infection rates without describing the type of infection and degree). Even with nutrition, which generally had a higher quantity and quality of studies than most other topics, only 27 of the 77 studies presented adjusted analysis (mainly for age and sex). Studies were also weak at describing their methodological limitations. For example, only 22 nutrition studies presented limitations.

Overall, 35% of the studies selected were graded as high quality, 35% moderate quality, and 30% low quality (Figure 3). The health topics with highest proportion of studies rated as high quality were communicable diseases, MHPSS, and NCDs (albeit of only 8 studies). Injury and rehabilitation results were graded to be of the poorest quality, with 4% (2 out of 47 studies) being graded high and 57% being graded low quality. There were a number of commonly recurring methodological weaknesses. These included that blinding was rarely used, including in the majority of RCTs, which risks reporting bias of health outcomes (although it is recognised that for a number of interventions and contexts blinding is not possible or appropriate). There was also limited use of stratification, for example by gender or age (with the exception of studies on nutrition and communicable disease), and so potentially differing health outcomes in more vulnerable groups is missing. For example, conflict-affected women and older populations commonly reported high levels of mental disorders but there was only limited stratification of results by gender or age in the MHPSS research. Other key quality weaknesses concerned the absence of reporting on sampling methods, randomisation procedures, addressing for potential confounding factors and possible biases through sampling and statistical procedures. Reporting

on missing data was weak, and while loss to follow-up is to be expected in the transient and volatile settings of humanitarian crisis, the lack of clear reporting and attempts to adjust for missing data was problematic. Similar methodological weaknesses have also been highlighted in other recent reviews of health research in humanitarian crises^{12, 14, 25, 47, 54}. Taken alone, they may not substantially impact the ability to assess the impact of a given intervention, but in combination these weaknesses have the potential to greatly undermine the interpretation of results.

What may explain this limited evidence base?

This systematic review highlights substantial gaps in the evidence, with only 345 studies identified since 1980 that met the inclusion criteria for assessing the effectiveness of health interventions in humanitarian crises. There are clearly other important sources of information on effectiveness such as mortality and nutritional surveys, routine surveillance data, case-fatality and attack rates^{55, 56}, and the use of reliable proxy process indicators⁴⁶. Similarly, evidence on effectiveness of interventions and treatments from stable settings has been successfully applied in crisis settings, such as vaccination programmes, vitamin A supplementation, insecticide-treated nets, exclusive breastfeeding, oral rehydration, antibiotics for pneumonia, and WASH activities^{41, 43, 44, 51, 57}. However, there remain many questions on how evidence generated in stable settings can really be generalised to emergency situations⁵⁸. Humanitarian interventions take place in very specific situations where populations are in a state of distress and flux, health workers in situations of insecurity, and financial and other resources are often limited. All these contextual elements influence the way health interventions are implemented (e.g. limited use of usual standard guidelines in emergency obstetrics⁵⁹) and can create selection biases as populations in need are often hard to reach⁶⁰.

What is perhaps most frustrating is that many of the gaps identified such as the limited use of experimental/quasi-experimental data, cohort data and economic data had already been identified over thirty years ago and have been regularly highlighted since then^{3, 5, 15-17}. What may explain the persistence of such gaps?

First, and most obviously, are the barriers to conducting research in crisis-affected settings such as insecurity, and logistical, time, and resource constraints⁶¹⁻⁶³. The combination of frequent population movement, potentially overlapping health services, and fluid range of other potential determinants of effectiveness further restrict the methodological ability to isolate and measure the effects of individual health interventions. Uncertain funding patterns may also lead to

interventions being added to existing services at unpredictable times, which reduces the ability to establish studies and attribute causation. However, as shown in this review, there are numerous examples of rigorous research using RCTs in humanitarian settings and their value in such settings has been recognised ⁶⁴⁻⁶⁷. There are clearly also time pressures for collecting operationally useful data in such settings given the need for prompt humanitarian responses and opportunity costs to collecting more robust data. However, alternative designs could be applied. For example, where standard RCTs are not operationally or ethically possible, adjusted approaches such as stepped wedge designs could be used more widely in order to establish a counterfactual through the use of a control group while still being operationally and ethically acceptable ⁶⁸⁻⁷⁰. There could also be greater use of longitudinal data and routine health service data, as successfully applied with antiretroviral treatment for HIV/AIDS in conflict-affected areas ⁷¹, and capitalising on statistical methods such as interrupted time series analysis. More recently, studies also provided methodological guidance on how to conduct cohort studies for NCD interventions in fragile settings ⁷². While not being able to demonstrate attribution, these types of studies can at least demonstrate changes in health outcomes over time and avoid reliance on input and output measures. In addition, there have been important studies using case study designs or surveillance data that had a positive impact on international policies and practice such as measles vaccination during humanitarian crises ⁷³, mass campaign of meningitis vaccination in refugee camps ⁷⁴ nutritional requirements for refugee populations ⁷⁵, and understanding mortality patterns ⁷⁶. In each of these examples, quasi- or experimental studies such as RCTs would have been inappropriate.

There are also many ethical challenges to conducting research in humanitarian crises given the added vulnerability of populations affected by humanitarian crises ⁷⁷⁻⁷⁹. In addition, it is often challenging to obtain ethical approval for health research studies from national authorities that, in time of distress, are often disorganised or have other priorities. In addition, there are ethical approval challenges to evaluating new interventions that have not yet been formally approved by WHO or national protocols such as new vaccines or vaccine regimens. However, there is also a strong ethical imperative to collect good data in such settings in order to ensure the most effective interventions are being delivered and best possible health outcomes achieved within the constraints of those settings ⁸⁰. In addition, there is an issue that funds earmarked for displaced persons often cannot be used for surrounding national populations and further evidence is needed on both displaced and surrounding nationals.

A further explanation may lie the culture of humanitarianism. It has been argued that, before the 1990s, it was almost considered as inappropriate to question the effectiveness of humanitarian

action in the humanitarian field, and that effectiveness research somehow questioned the noble foundations of humanitarian aid in saving lives and providing immediate assistance to victims^{20, 81}. As a result, measuring evidence on the impact of humanitarian interventions was therefore not integrated into humanitarian organisations' practice^{16, 82, 83}. Instead, they primarily focused on reporting to their donors process indicators relating to inputs and outputs rather than measuring the actual effectiveness of their activities on health outcomes^{65, 68, 84}.

The limited evidence-base may also reflect limited financial and technical capacity to conduct research in such settings. In a climate of shrinking resources relative to the burgeoning emergencies, undertaking research in these settings is not possible without resources dedicated to undertaking such studies. Too often researchers do not have sufficient funds to undertake the proposed research, and thus rely on the operational agencies to provide logistics as well as much of their precious time to understand the situation and put it in context. Therefore, the operational agencies may need funding specifically to ensure they have sufficient resources to undertake research with the academics. Research skills, particularly epidemiological skills, of national and international health professionals working in humanitarian crises need to be improved^{85, 86}, particularly for using alternative approaches such as stepped wedge designs and interrupted time series analysis. There are also limited systems in place to coordinate and share data on effectiveness and the research methods to collect such data^{17, 87}. On the other hand, the research community has also failed to adequately engage with the humanitarian sector and to collect, disseminate and share operationally useful data with practitioners and policy makers in an accessible format. As a result, research and evidence have had limited influence on decisions made by humanitarian professionals^{24, 88-90}. This will require not only a change in perspective from within the humanitarian community, but also how researchers and academics engage in research to ensure that research is perceived of value to the humanitarian community and that findings are taken up and incorporated into humanitarian practice^{66, 83, 88, 91}.

Signs of progress?

Despite the findings from this review suggesting some considerable gaps in the evidence base on health interventions in humanitarian crises, there are positive developments. Our review found that the quantity and quality of evidence has substantially increased over time, with 79% of the high quality literature being produced since 2000. There could be several reasons for this. The high profile failures in humanitarian responses to crises in Rwanda, Darfur, Sri Lanka and Haiti have focused efforts to improve the quality and accountability of humanitarian activities¹⁹⁻²². The related development and use of key guidelines and minimum standards such as the Sphere

Standards, Inter-Agency Standing Committee guidelines, and Health Cluster Guides, have provided more evidence-informed approaches to health care delivery, although some of standards are not based on evidence (e.g. the recommended 15 litres of clean drinking water in the SPHERE Handbook) ⁹²⁻⁹⁵. There have also been a number of open access platform initiatives (e.g. Twine by UNHCR and Humanitarian Data Exchange by OCHA) and guidelines to improve the quality of epidemiological data collected in humanitarian settings ^{55, 96, 97}. These have been supported by developments in methods and software in medical statistics which has facilitated their application in resource poor settings ⁹⁸. The implementation of the Global Cluster approach also sought to improve accountability and coordination in the humanitarian sector. The establishment of agencies such as ALNAP and International Initiative for Impact Evaluation (3iE) that seek to promote learning, accountability and performance in the humanitarian sector has also encouraged demand for evidence-based decision-making ^{58, 92-94}, but this needs to be supported by having a greater range of openly accessible data specifically on the effectiveness and cost-effectiveness of health interventions. There also needs to be more work analysing how evidence can be most effectively used to help inform and change practice.

Conclusions

The need for robust, high quality, useable evidence to inform, shape and adapt health interventions in humanitarian crises is increasingly recognised. However, while the number of studies on public health interventions in humanitarian crises has grown, there remain substantial gaps in the quantity and quality of evidence. It is important to develop innovative integrated funding mechanisms to enable the combination of research projects with humanitarian assistance and create a global humanitarian evidence platform where data and evidence can be accessible to all communities (national authorities, donors, academics and humanitarian agencies). Although there is usually a trade-off between the need to act quickly and the need to act well in humanitarian crises, humanitarian action can significantly benefit from the greater application of rigorous research to better understand how effectively public health interventions are working.

Funding source:

The work for this systematic review was funded through the Research for Health in Humanitarian Crises (R2HC) Programme funded by DFID and the Wellcome Trust and commissioned by Enhancing Learning and Research for Humanitarian Assistance (ELRHA).

Conflicts of interest:

The authors declare no conflicts of interest

Author Contributions:

BR and KB led the study. All authors participated in the study design, data searching and analysis. KB and BR led the writing up of the paper. All authors contributed to the paper.

References

1. CRED. People Affected by Conflict - Humanitarian needs in numbers. Brussels: Centre for Research on the Epidemiology of Disasters, 2013.
2. CRED. The human cost of natural disasters 2015: A global perspective. Brussels: Centre for Research on the Epidemiology of Disasters, 2015.
3. Logue JN, Melick ME, Hansen H. Research issues and directions in the epidemiology of health effects of disasters. *Epidemiologic reviews* 1981; **3**: 140-62.
4. Noji EK, Toole MJ. The Historical Development of Public Health Responses to Disasters. *Disasters* 1997; **21**(4): 366-76.
5. Salama P, Spiegel P, Talley L, Waldman R. Lessons learned from complex emergencies over past decade. *Lancet* 2004; **364**(9447): 1801-13.
6. Glass RI, Urrutia JJ, Sibony S, Smith H, Garcia B, Rizzo L. Earthquake injuries related to housing in a guatemalan village. *Science* 1977; **197**(4304): 638-43.
7. Parrish HM, Baker AS, Bishop FM. Epidemiology in Public Health Planning for Natural Disasters. *Public health reports* 1964; **79**: 863-7.
8. Sommer A, Mosley WH. East Bengal cyclone of November, 1970. Epidemiological approach to disaster assessment. *Lancet* 1972; **1**(7759): 1029-36.
9. Boss LP, Toole MJ, Yip R. Assessments of mortality, morbidity, and nutritional status in Somalia during the 1991-1992 famine. Recommendations for standardization of methods. *JAMA* 1994; **272**(5): 371-6.
10. Garfield R. Studies on young child malnutrition in Iraq: problems and insights, 1990-1999. *Nutr Rev* 2000; **58**(9): 269-77.
11. Spiegel PB, Salama P, Maloney S, van der Veen A. Quality of malnutrition assessment surveys conducted during famine in Ethiopia. *JAMA* 2004; **292**(5): 613-8.
12. Bostoen K, Bilukha O, Fenn B, et al. Methods for health surveys in difficult settings: charting progress, moving forward. *Emerging Themes in Epidemiology* 2007; **4**(1): 13.
13. Prudhon C, Spiegel P. A review of methodology and analysis of nutrition and mortality surveys conducted in humanitarian emergencies from October 1993 to April 2004. *Emerging Themes in Epidemiology* 2007; **4**(1): 10.
14. Spiegel PB, Le PV. HIV behavioural surveillance surveys in conflict and post-conflict situations: a call for improvement. *Glob Public Health* 2006; **1**(2): 147-56.
15. Duffield A, Reid G, Shoham J, Walker D. Evidence base for interventions in complex emergencies. *Lancet* 2005; **365**(9462): 842-3.
16. Roberts L. Advances in monitoring have not translated into improvements in humanitarian health services. *Prehosp Disaster Med* 2007; **22**(5): 384-9.

17. Banatvala N, Zwi AB. Public health and humanitarian interventions: developing the evidence base. *BMJ* 2000; **321**(7253): 101-5.
18. Griekspoor A, Collins S. Raising standards in emergency relief: how useful are Sphere minimum standards for humanitarian assistance? *BMJ* 2001; **323**(7315): 740-2.
19. Birch M, Miller S. Humanitarian assistance: standards, skills, training, and experience. *BMJ* 2005; **330**(7501): 1199-201.
20. Dijkzeul D, Hilhorst D, Walker P. Introduction: evidence-based action in humanitarian crises. *Disasters* 2013; **37**(S1): S1–S19.
21. Hofmann C, Shoham J, Roberts L. Measuring the impact of humanitarian aid: A review of current practice. London: Overseas Development Institute, 2004.
22. United Nations. Humanitarian Response Review. Geneva: UN, 2005.
23. Tol W, Barbui C, Galappatti A, et al. Mental health and psychosocial support in humanitarian settings: linking practice and research. *Lancet* 2011; **378**: 1581-91.
24. Haan N, Majid N, et al. A Review of Emergency Food Security Assessment Practice in Ethiopia. London: Overseas Development Institute, 2005.
25. Nickerson JW, Chackungal S, Knowlton L, McQueen K, Burkle FM. Surgical care during humanitarian crises: a systematic review of published surgical caseload data from foreign medical teams. *Prehosp Disaster Med* 2012; **27**(2): 184-9.
26. Young H, Borrel A, Holland D, Salama P. Public nutrition in complex emergencies. *Lancet* 2004; **364**(9448): 1899-909.
27. Hall A, Blankson B. The impact and effectiveness of emergency nutrition and nutrition-related interventions: a review of published evidence 2004-2010. London: Emergency Nutrition Network.
28. SHARE Research Consortium. Evidence review and research priorities: water, sanitation, and hygiene for emergency response: Evidence Paper. London, UK: UK Department for International Development (DfID), 2012.
29. Rowland M, Nosten F. Malaria epidemiology and control in refugee camps and complex emergencies. *Ann Trop Med Parasitol* 2001 **95**(8): 741-54.
30. Checchi F. The burden of tuberculosis in crisis-affected populations: a systematic review. *Lancet Infect Dis* 2012; **12**(12): 950-65.
31. Bellos A, Mulholland K, O'Brien K, Qazi S, Gayer M, Checchi F. The burden of acute respiratory infections in crisis-affected populations: a systematic review. *Confl Health* 2010; **4**(3).
32. Grais R, Strebel P, Mala P, Watson J, Nandy R, Gayer M. Measles vaccination in humanitarian emergencies: a review of recent practice. *Confl Health* 2011; **5**(1): 21.
33. Stern E, et al. Broadening the Range of Designs and Methods for Evaluations: Report of a Study Commissioned by the Department for International Development. London: DFID, 2012.
34. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ* 2009; **339**: b2535.
35. van der Haar G, Heijmans A, Hilhorst D. Interactive research and the construction of knowledge in conflict-affected settings. *Disasters* 2013; **37**(S1): S20–S35.
36. Blanchet K, Roberts B, Ramesh A, Frison S, Sistenich V, et al. An evidence review of research on health interventions in humanitarian crises. London: ELHRA, 2014.
37. Connolly MA, Gayer M, Ryan MJ, Salama P, Spiegel P, Heymann DL. Communicable diseases in complex emergencies: impact and challenges. *Lancet* 2004; **364**(9449): 1974-83.
38. Bellos A, Mulholland K, O'Brien KL, Qazi SA, Gayer M, Checchi F. The burden of acute respiratory infections in crisis-affected populations: a systematic review. *Conflict and health* 2010; **4**: 3.
39. Bruckner C, Checchi F. Detection of infectious disease outbreaks in twenty-two fragile states, 2000-2010: a systematic review. *Conflict and health* 2011; **5**: 13.
40. Palmer JJ, Surur EI, Goch GW, et al. Syndromic algorithms for detection of gambiense human African trypanosomiasis in South Sudan. *PLoS Negl Trop Dis* 2013; **7**(1): e2003.

41. Dangour A, Watson L, Cumming O, et al. Interventions to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children. *Cochrane Database Syst Rev* 2013; **8**(CD009382).
42. Esrey S, Potash J, Roberts L, Shiff C. Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. *Bull World Health Organ* 1991; **69**(5): 609-21.
43. Freeman MC, Stocks ME, Cumming O, et al. Hygiene and health: systematic review of handwashing practices worldwide and update of health effects. *Trop Med Int Health* 2014; **19**(8): 906-16.
44. Wolf J, Prüss-Ustün A, Cumming O, et al. Systematic review: Assessing the impact of drinking water and sanitation on diarrhoeal disease in low- and middle-income settings: systematic review and meta-regression. *Trop Med Int Health* 2014; **19**(8): 928-42.
45. UNHCR. Report of an Inter-Agency Global Evaluation of Reproductive Health Services for Refugees and Internally Displaced Persons: Geneva, 2004.
46. WHO. Monitoring emergency obstetric care: a handbook. Geneva: World Health Organization, 2009.
47. Tol WA, Barbui C, Galappatti A, et al. Mental health and psychosocial support in humanitarian settings: linking practice and research. *The Lancet* 2011; **378**(9802): 1581-91.
48. Porter M, Haslam N. Predisplacement and postdisplacement factors associated with mental health of refugees and internally displaced persons: a meta-analysis. *JAMA* 2005; **294**(5): 602-12.
49. Spiegel PB, Checchi F, Colombo S, Paik E. Health-care needs of people affected by conflict: future trends and changing frameworks. *Lancet* 2010; **375**(9711): 341-5.
50. Dewachi O, Skelton M, Nguyen VK, et al. Changing therapeutic geographies of the Iraqi and Syrian wars. *Lancet* 2014; **383**(9915): 449-57.
51. Salama P, Roberts L. Evidence-based interventions in complex emergencies. *Lancet* 2005; **365**(9474): 1848.
52. Spiegel P, Khalifa A, Mateen FJ. Cancer in refugees in Jordan and Syria between 2009 and 2012: challenges and the way forward in humanitarian emergencies. *The Lancet Oncology* 2014; **15**(7): e290-7.
53. Cochrane Collaboration. Non-randomised controlled study (NRS) designs. 2014. <http://cgg.cochrane.org/non-randomised-controlled-study-nrs-designs> (accessed 5 September 2014).
54. Betancourt TS, Borisova I, Williams TP, et al. Research Review: Psychosocial adjustment and mental health in former child soldiers – a systematic review of the literature and recommendations for future research. *Journal of Child Psychology and Psychiatry* 2013; **54**(1): 17-36.
55. Checchi F, Gayer M, Grais R, Mills E. Public health in crisis-affected populations: a practical guide for decision-makers, 2007.
56. Checchi F, Roberts L. Interpreting and using mortality data in humanitarian emergencies. London: ODI, 2005.
57. Jones G, Steketee RW, Black RE, Bhutta ZA, Morris SS, Bellagio Child Survival Study G. How many child deaths can we prevent this year? *Lancet* 2003; **362**(9377): 65-71.
58. Puri J, Aladysheva A, Iversen V, Ghorpade Y, Brück T. What methods may be used in impact evaluations of humanitarian assistance? New Delhi: International Initiative for Impact Evaluation (3ie), 2014.
59. Casey SE. Evaluations of reproductive health programs in humanitarian settings: a systematic review. *Conflict and health* 2015; **9**(1): 1-14.
60. Pitt C, Roberts B, Checchi F. Treating childhood pneumonia in hard-to-reach areas: A model-based comparison of mobile clinics and community-based care. *BMC Health Services Research* 2012; **12**(1): 1-10.
61. Armenian HK. Perceptions from epidemiologic research in an endemic war. *Soc Sci Med* 1989; **28**: 643-7.

62. Tomashek KM, Woodruff BA, Gotway C, et al. Randomized intervention study comparing several regimens for the treatment of moderate anemia among refugee children in Kigoma Region, Tanzania. *Am J Trop Med Hyg* 2001; **64**(3-4): 164-71.
63. Roberts L, Chartier Y, Chartier O, et al. Keeping clean water clean in a Malawi refugee camp: a randomized intervention trial. *Bulletin of the World Health Organisation* 2001; **79**: 280-7.
64. Bутtenheim A. Impact evaluation in the post-disaster setting: a conceptual discussion in the context of the 2005 Pakistan earthquake. London: 3iE, 2009.
65. Proudlock K, Ramalingam B, Sandison P. Improving humanitarian impact assessment: Bridging theory and practice 8th Review of Humanitarian Action: Performance, Impact and Innovation. London: ALNAP/ODI, 2009.
66. Bradt DA. Evidence-based Decision-making in Humanitarian Assistance. London: Overseas Development Institute, 2009.
67. Wingfield-Digby PK. Rapid Assessment Sampling in Emergency Situations. Thailand: UNICEF, 2010.
68. Roberts L, Hofmann C-A. Assessing the impact of humanitarian assistance in the health sector. *Emerging Themes in Epidemiology* 2004; **1**(1): 3.
69. Brown CA, Lilford RJ. The stepped wedge trial design: a systematic review. *BMC medical research methodology* 2006; **6**: 54.
70. Sanson-Fisher RW, Bonevski B, Green LW, D'Este C. Limitations of the randomized controlled trial in evaluating population-based health interventions. *American journal of preventive medicine* 2007; **33**(2): 155-61.
71. Culbert H, Tu D, O'Brien DP, et al. HIV treatment in a conflict setting: outcomes and experiences from Bukavu, Democratic Republic of the Congo. *PLoS Med* 2007; **4**(5): e129.
72. Khader A, Farajallah L, Shahin Y, et al. Cohort monitoring of persons with diabetes mellitus in a primary healthcare clinic for Palestine refugees in Jordan. *Trop Med Int Health* 2012; **17**(12): 1569-76.
73. Toole M, Steketee R, Waldman R, Nieburg P. Measles prevention and control in emergency settings. *67* 1989; **4**(381-388).
74. Haelterman E, et al.,. Impact of a mass vaccination campaign against a meningitis epidemic in a refugee camp. *Tropical Medicine and International Health* 1996; **1**(3): 385-92.
75. Toole M, Nieburg P, Waldman R. The association between inadequate rations, undernutrition prevalence, and mortality in refugee camps: Case studies of refugee populations in Eastern Thailand, 1970-1980, and Eastern Sudan, 1984-1985. *Journal of Tropical Pediatrics* 1988; **34**(5): 218-24.
76. Goma Epidemiology Group. Public health impact of Rwandan refugee crisis: what happened in Goma, Zaire, in July 1994. *The Lancet* 1995; **345**: 339-44.
77. Leaning J. Ethics of research in refugee populations. *Lancet* 2001; **357**(9266): 1432-3.
78. Ford N, Mills EJ, Zachariah R, Upshur R. Ethics of conducting research in conflict settings. *Conflict and health* 2009; **3**: 7.
79. Curry D, Waldman R, A Caplan. An Ethical Framework for the development and review of health research proposals involving humanitarian contexts. London: ELHRA, 2013.
80. Kilpatrick DG. The ethics of disaster research: a special section. *Journal of traumatic stress* 2004; **17**(5): 361-2.
81. Frerks G, Hilhorst D. Evaluation of Humanitarian Assistance in Emergency Situations. Geneva: United Nations High Commissioner for Refugees, 2002.
82. Dijkzeul D, Hilhorst D, Walker P. Introduction: evidence-based action in humanitarian crises. *Disasters* 2013; **37 Suppl 1**: S1-19.
83. Darcy J, Stobaugh H, Walker P, Maxwell D. The Use of Evidence in Humanitarian Decision Making: Feinstein International Center, Tufts University, 2013.
84. Robertson D, Bedell R, Lavery J, Upshur R. What kind of evidence do we need to justify humanitarian medical aid? *The Lancet* 2002; **360**: 330.

85. Spiegel P. Who should be undertaking population-based surveys in humanitarian emergencies? *Emerging Themes in Epidemiology* 2007; **4**(1): 12.
86. Salama P, Spiegel P, Talley L, Waldman R. Lessons learned from complex emergencies over past decade. *Lancet* 2004; **364**: 1801 - 13.
87. Mills EJ. Sharing evidence on humanitarian relief - Needs a publicly accessible, searchable, and comprehensive database. *British Medical Journal* 2005; **331**(7531): 1485-6.
88. Overseas Development Institute. Humanitarian Diagnostics: The Use of Information and Analysis in Crisis Response Decisions. London: ODI, 2009.
89. Darcy J, Anderson S, et al. A Review of the Links between Needs Assessment and Decision-Making in Response to Food Crises: Study Undertaken for the World Food Programme under the SENAC Project. London: Overseas Development Institute, 2007.
90. Blanchet K, Girois S, Urseau I, Smerdon C, Drouet Y, Jama A. Physical rehabilitation in post-conflict settings: analysis of public policy and stakeholder networks. *Disabil Rehabil* 2013.
91. Ager A, Burnham G, Checchi F, et al. Strengthening the evidence base for health programming in humanitarian crises. *Science* 2014; **345**(6202): 1290-2.
92. Sphere Project. Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response. Geneva: Sphere Project, 2011.
93. IASC. Operational Guidance for Coordinated Assessments in Humanitarian Crises. Geneva, 2012.
94. ALNAP. Active Learning Network on Accountability and Performance in Humanitarian Assistance. 2014. <http://www.alnap.org/> (accessed 26 August 2014).
95. IASC. Health Cluster Guide: A practical guide for country-level implementation of the Health Cluster. Geneva: Inter Agency Standing Committee/World Health Organisation, 2009.
96. SMART. Measuring Mortality, Nutritional Status, and Food Security in Crisis Situations: SMART METHODOLOGY (Version 1): Standardised Monitoring and Assessment of Relief and Transitions Programme (SMART), 2006.
97. Woodruff B, Bornemisza O, Checchi F, Sondorp E. The use of epidemiological tools in conflict-affected populations: open-access educational resources for policy-makers. 2014. http://conflict.lshhtm.ac.uk/page_02.htm (accessed 5 September 2014).
98. Bailar JC, Hoaglin DC. Medical uses of statistics: John Wiley & Sons; 2012.

Table 1: Selected Results per Health Topic

	Communicable disease	WASH	Nutrition	SRH	MHPSS	NCD	Injury & rehabilitation	Total N
Number of papers selected (paper references)]	N=131 (38%) (Web Appendix 3 references 1 to 131)	N=6 (2%) (Web Appendix 3 references 132 to 137)	N=77 (22%) (Web Appendix 3 references 138 to 215)	N=15 (4%) (Web Appendix 3 references 216 to 230)	N=61 (18%) (Web Appendix 3 references 231 to 291)	N=8 (2%) (Appendix 2 references 292 to 299)	N=47 (14%) (Web Appendix 3 references 300 to 346)	345
Outcome types	Malaria 47%; Tuberculosis 19%; measles 13%; cholera 4%; diphtheria/tetanus/pertussis 4%; , polio 4%; visceral leishmaniasis 4%; diarrhoea 4%.	Diarrhoea, unspecified, 83%; suspected <i>Shigella</i> : 17%	Acute malnutrition 53%; combined multiple:12 %; anaemia & under-nutrition: 9%; micronutrient s deficiencies 8%; anaemia 8%; underweight: 4%; mortality 4%; diarrhoea 3%	Family planning 13%; prevention, treatment, and care for HIV/AIDS and STIs 27%; maternal/newborn health including obstetric care 60%.	Stress disorder 45%; depression 22%; other psychiatric conditions 6%; general mental health 11%; positive outcomes 16%.	Diabetes 38%; CVD/hypertension 25%; thalassaemia 12% ; arthritis 12% ; chronic kidney disease 12%.	Abdominal/thorax 11%; orthopaedic 32%; cranio-facial 11%; nerve/pain 7%; vascular 6%; injury 8%; crush injury and/or renal failure 17%	345
Intervention types	Antimalarials 32%; vaccination 20%; vector control (e.g., insecticide treated nets, tents, clothes) 17%; ; DOTs, pre-DOTS 16%; anthelminths 9%; oral rehydration 5%; sodium stibogluconate 4%.	Safe water storage 38%; household water treatment 25%; handwashing/soap 12%; WASH education 12%; combination of all preceding interventions 13%	Deliver micronutrients 24%; treatment of SAM 21%; TSFP 15%; BSFP 10%; GFD 10%; treatment of SAM, TSFP and BSFP: 7%; Multiple: 7%; IYCF 4%; microfinance 2%	Family planning and abortion access 7%; Maternal and infant health improvement services 20%; Literacy and SRH education 7%; prevention, treatment, and care for HIV/AIDS and STIs 13 % Health system strengthening and capacity 53%.	Psychological intervention 62%; psychosocial support in education 27%; psychosocial support in other sectors 2%; safe spaces 2%; clinical management by specialists 3%; clinical management by non-specialists 2%; person-focused psychosocial support 3%	Diabetes management in PHC 38%; CVD screening & management 25%; splenectomy 12%; arthritis treatment 12%; haemodialysis 12%.	Surgery 47%; Rehab 9%; prehospital care & triage 4%; Renal therapy and/or fasciotomy 19%; surgical fixation 13%; amputation: 9%	345
Study designs								
RCT	45%	33%	8%	7%	31%	12%		89
Non-random trial	9%		13%		32%		7%	45
Cohort	27%		22%			75%	16%	66
Uncontrolled longitudinal	17%	67%	22%			12%	70%	77
Uncontrolled before and after				57%	35%			30
Case control			4%	7%	2%		7%	8
Follow-up cross sectional			22 %					19
Cross sectional			8%	29%				11
Geographic regions								
Africa	38%	83%	72%	60%	19%	25%	4%	134
Asia	58%		19%	40%	29%		34%	132
Caribbean/Latin America	2%	17%	1%		2%		2%	6
Eastern Europe			4%		21%	12%	32%	32
Middle East	2%		3%		26%	62%	28%	39
Pacific					3%			2
Crisis Type								
Conflict	90%	71%	48%	74%	74%	80%	62%	248
Disaster	10%	29%	35%	13%	18%	20%	38%	78
Both			17%	13%	8%			19

Population Type								
Entrapped				4%	66%			41
General population	32%		59%	48%	34%	38%	98%	165
IDP	9%	67%	17%	18%				32
Refugee	59%	33%	24%	30%		62%	2%	106
Multiple			1%					1
Note: Percentages are proportion of papers for each health topic								

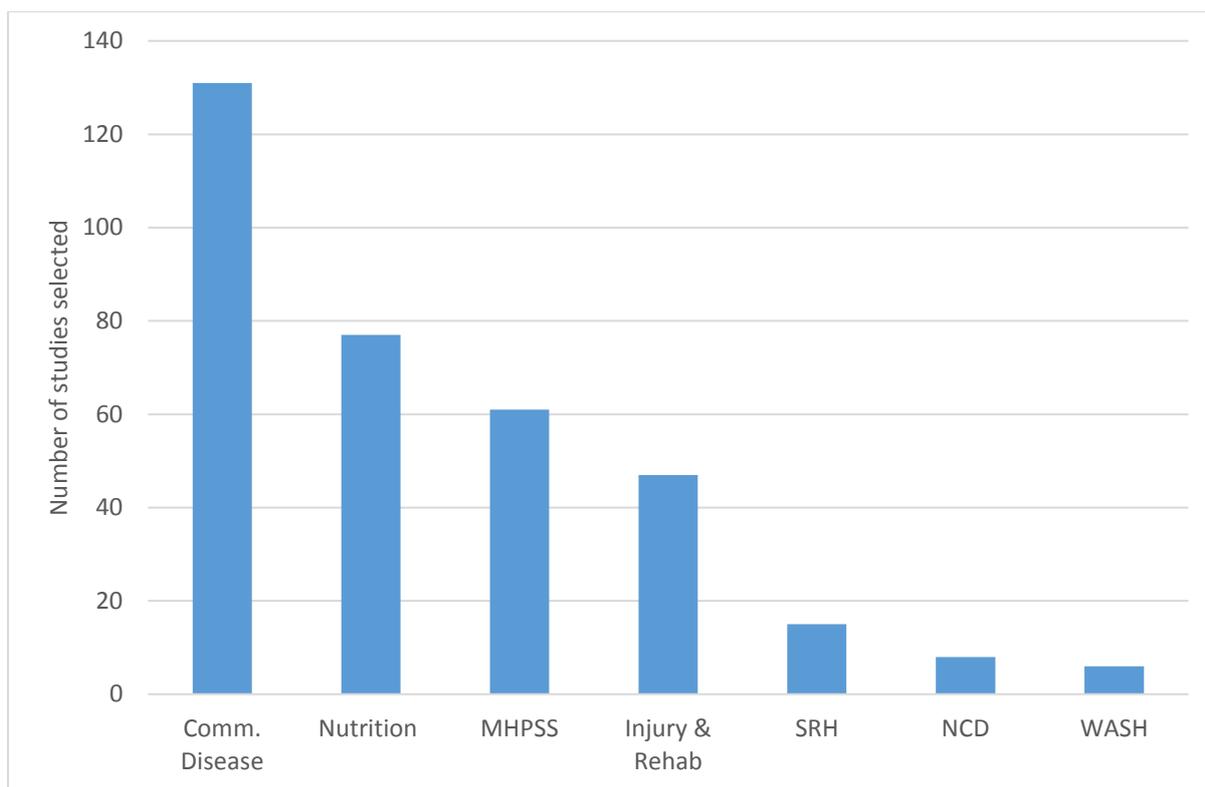


Figure 1: Number of final papers reviewed by health topics, 1980-2014

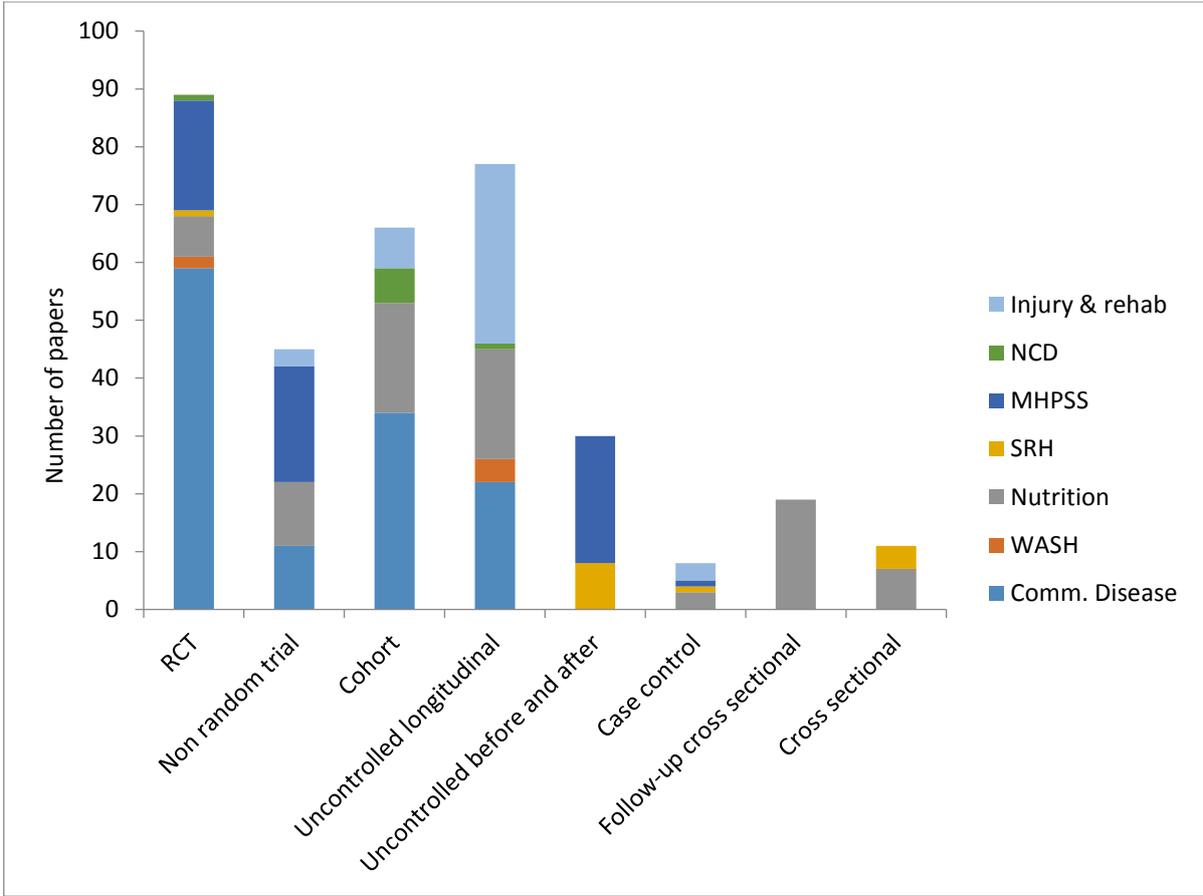


Figure 2: Number of papers per study design and health topic, 1980-2014

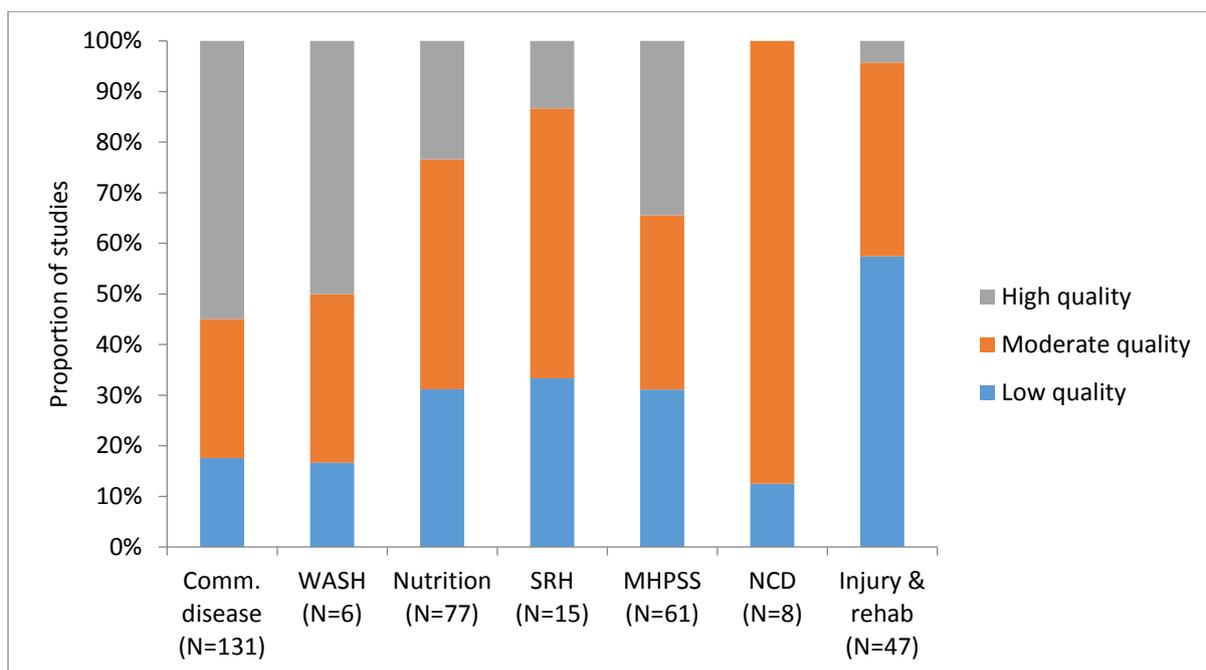


Figure 3: Quality of papers by health topic, 1980-2014