

LONDON
SCHOOL of
HYGIENE
& TROPICAL
MEDICINE



LSHTM Research Online

Jawad, Mohammed; Vamos, Eszter P; Najim, Muhammad; Roberts, Bayard; Millett, Christopher; (2019) Impact of armed conflict on cardiovascular disease risk: a systematic review. Heart. ISSN 1355-6037 DOI: <https://doi.org/10.1136/heartjnl-2018-314459>

Downloaded from: <http://researchonline.lshtm.ac.uk/4653960/>

DOI: <https://doi.org/10.1136/heartjnl-2018-314459>

Usage Guidelines:

Please refer to usage guidelines at <https://researchonline.lshtm.ac.uk/policies.html> or alternatively contact researchonline@lshtm.ac.uk.

Available under license: <http://creativecommons.org/licenses/by-nc-nd/2.5/>

<https://researchonline.lshtm.ac.uk>

1 **The impact of armed conflict on cardiovascular disease risk: a systematic**
2 **review**

3 Mohammed Jawad¹, Eszter P Vamos¹, Muhammad Najim¹, Bayard Roberts², Christopher
4 Millett¹

5 ¹Imperial College London, Hammersmith, London, W6 8RP, United Kingdom

6 ²London School of Hygiene and Tropical Medicine, London, WC1H 9SH, United Kingdom

7

8 Correspondence to:

9 Dr Mohammed Jawad

10 Public Health Policy Evaluation Unit

11 Imperial College London

12 3rd Floor, Reynold's Building

13 St Dunstan's Road

14 Hammersmith

15 London W6 8RP

16 mohammed.jawad06@imperial.ac.uk;

17 Tel: +44 (0) 207 594 33368

18

19 Word count: 3,389

20 Number of figures: 6

21 Number of tables: 2

22

1 **KEY QUESTIONS**

2 **What is already known about this subject?**

- 3 • Civilians from low- and middle-income countries (LMICs) are disproportionately
4 affected by cardiovascular disease
- 5 • Most armed conflicts occur in LMICs
- 6 • Protracted armed conflict may exacerbate cardiovascular disease risk

7 **What does this study add?**

- 8 • This is the first systematic review to assess the association between armed conflict
9 and cardiovascular disease risk
- 10 • We assessed 65 studies and 23 armed conflicts, and found evidence that armed
11 conflict is associated with increased coronary heart disease, cerebrovascular, and
12 endocrine diseases, in addition to increased blood pressure, lipids, alcohol, and
13 tobacco use
- 14 • This risk may manifest itself during periods of active conflict, but also in the acute
15 and chronic post-conflict period.

16 **How might this impact on clinical practice?**

- 17 • Whole population and high risk interventions need greater policy attention in settings
18 affected by armed conflict
- 19 • Primary care may be best positioned to deliver such interventions
- 20 • Training of healthcare professionals is required to deliver cardiovascular disease
21 prevention and control measures in the post-conflict period

1 **ABSTRACT**

2 **Objectives**

3 Prolonged armed conflict may constrain efforts to address non-communicable disease in
4 some settings. We assessed the impact of armed conflict on cardiovascular disease (CVD)
5 risk among civilians in low- and middle-income countries (LMICs).

6 **Methods**

7 In February 2019 we performed a systematic review (Prospero ID: CRD42017065722)
8 searching Medline, Embase, PsychINFO, Global Health, and Web of Science without
9 language or date restrictions. We included adult, civilian populations in LMICs. Outcomes
10 included CVDs and diabetes, and eight clinical and behavioural factors (blood pressure,
11 blood glucose, lipids, tobacco, alcohol, body mass index, nutrition, physical activity). We
12 systematically re-analysed data from original papers and presented them descriptively.

13 **Results**

14 Sixty-five studies analysed 23 conflicts, and 66% were of low quality. We found some
15 evidence that armed conflict is associated with an increased coronary heart disease,
16 cerebrovascular, and endocrine diseases, in addition to increased blood pressure, lipids,
17 alcohol, and tobacco use. These associations were more consistent for mortality from chronic
18 ischaemic heart disease or unspecified heart disease, systolic blood pressure, and tobacco use.
19 Associations between armed conflict and other outcomes showed no change, or had mixed or
20 uncertain evidence. We found no clear patterning by conflict type, length of follow up, and
21 study quality, nor strong evidence for publication bias.

22 **Conclusions**

1 Armed conflict may exacerbate CVDs and their risk factors, but the current literature is
2 somewhat inconsistent. Post-conflict reconstruction efforts should deliver low resource
3 preventative interventions through primary care to prevent excess CVD-related morbidity and
4 mortality.

5 Keywords: conflict; cardiovascular disease; diabetes; smoking; tobacco; alcohol; diet;
6 physical activity; LMICs

1 INTRODUCTION

2 Non-communicable diseases (NCDs), such as cardiovascular disease (CVD) and diabetes, are
3 the leading cause of death and disability worldwide and are increasing in low- and middle-
4 income countries (LMICs).¹ Target 3.4 of the Sustainable Development Goals is to reduce by
5 one third premature mortality from NCDs by 2030 and resolution WHA66.10 of the World
6 Organization includes a target to reduce by 25% premature mortality from NCDs by 2025.
7 The WHO recommends reaching this target by enhancing national capacity, strengthening
8 health systems, and creating health promoting environments.

9 One factor that may slow or reverse political and societal gains to meet these targets is the
10 presence of armed conflict. According to the Uppsala Conflict Data Program, 73 armed
11 conflicts were recorded globally in 2015, the highest on record, with these mainly occurring
12 in LMICs.² Increased military expenditure and political instability arising from conflict can
13 weaken national infrastructures vital to health which in turn can alter the demand and supply
14 of health care services. It can also discourage positive health behaviours through adverse
15 stress-mediated coping mechanisms such as increased alcohol and tobacco use and the
16 reduction in physical activity and consumption of healthy foods.³

17 Armed conflicts are no longer synonymous with high mortality rates from infectious disease
18 epidemics and malnutrition.⁴ In addition to better control of infectious disease through
19 vaccination, contemporary armed conflicts are characterised by low intensity, protracted
20 duration, intrastate violence, internal displacement, and ethnic rivalry, and now include a
21 greater proportion of middle-income countries.⁴ In the context of an ageing population and a
22 rising life expectancy at birth, it is therefore plausible that CVDs are the biggest contributor
23 of excess deaths during armed conflict, rather than military violence and communicable
24 diseases.⁵

1 The effect of armed conflict on CVD and its risk factors has received a paucity of attention in
2 the academic literature.^{6,7} This is disconcerting given that governments, humanitarian
3 organisations and international agencies are challenged with how to effectively tackle CVDs
4 during conflicts and into the post-conflict setting. Better understanding around which
5 components of CVD risk change during and after conflict can improve the preparation and
6 implementation of evidence-based health systems interventions designed to address CVDs.
7 Therefore, the aim of this study is to systematically review the literature to examine the
8 impact of armed conflict on CVD and its risk factors among civilian populations in LMICs.

9 **METHODS**

10 This systematic review is registered on Prospero (ID: CRD42017065722) and follows the
11 PRISMA reporting standards. Our research question is: “What is the association between
12 armed conflict and CVD risk for civilians in LMICs, compared to civilians with less or no
13 exposure to armed conflict?”

14 **Search strategy and selection criteria**

15 In February 2019 we searched Medline, Embase, PsychINFO, Global Health, and Web of
16 Science without language or date restrictions. We used synonyms and spelling variations of
17 “armed conflict” and combined these with our outcomes of interest (CVDs/diabetes, clinical,
18 and behavioural factors), and with LMIC countries (Supplementary File 1). In addition, we
19 hand-searched citation lists of included studies to identify additional relevant articles. We
20 requested unpublished data from corresponding authors of studies where appropriate, and we
21 also contacted corresponding authors for studies which we could not acquire a full text. We
22 did not search the grey literature as this yielded limited information on a preliminary search.
23 We included adult, civilian populations (including internally displaced persons and refugees)
24 in LMICs exposed to author-defined armed conflict. Outcomes of interest were CVD and

1 diabetes (categorised according to ICD-10), relevant clinical parameters (blood pressure,
2 blood glucose, lipids), and key behavioural factors (tobacco use, alcohol use, body mass
3 index (BMI), diet, and physical activity). CVD categories used in this review included stroke,
4 acute myocardial infarction, chronic ischaemic heart disease, ill-defined descriptions of heart
5 disease, angina pectoris, other cardiac arrhythmias, and other ischaemic heart disease.

6 We had no restrictions on quantitative study designs although to measure impact in a more
7 robust manner they had to include a component of comparison, such as by time or inclusion
8 of a conflict-unexposed group, in order to be eligible. We therefore included cross-sectional
9 studies that used retrospective recall and self-reported changes in outcomes. For studies
10 collecting serial data points during and after the conflict, we restricted studies to those with at
11 least one measurement within three years of the end of the conflict given the unclear
12 definition of “post-conflict”.³

13 We excluded studies reporting on military veterans, combatants, children, external migrants
14 (e.g. economic migrants), and refugees displaced to high income countries. The latter was
15 justified given that the vast majority of refugees live in LMICs, and available resources that
16 shape cardiovascular health are very different to those in high income countries.

17 **Data analysis**

18 Two reviewers screened in duplicate and independently the title and abstract of captured
19 citations to identify potentially eligible studies. We retrieved full texts of studies considered
20 potentially eligible by at least one reviewer. Two reviewers conducted a calibration exercise
21 before screening in duplicate and independently the full texts, then abstracting data, using a
22 standardised and pilot-tested screening form. They resolved disagreements by discussion, and
23 when needed with the help of a third reviewer. Data abstraction details are found in
24 Supplementary File 1.

1 Two reviewers used the Newcastle-Ottawa Scale (NOS) in duplicate and independently to
2 conduct a quality assessment for each study. We scored cross-sectional and cohort studies out
3 of eight, and case-control studies out of nine. Cohort studies are usually scored out of nine
4 but the domain “Was follow-up long enough for outcomes to occur?” was not relevant to our
5 review so this was omitted. Although the NOS has no established threshold of quality, we
6 defined studies of low quality as those that scored less than 5, those of moderate quality as
7 those that scored 5 or 6, and those of high quality as those that scored 7 or more. We
8 calculated mean quality scores by study design and year of publication, stratified by the
9 domains of the NOS (selection, comparability, and outcome).

10 We analysed data descriptively as conducting meta-analysis was not feasible given
11 substantial heterogeneity between populations, armed conflicts, exposure ascertainment
12 methods, and outcome measures across studies. Given the varied statistical approach among
13 included studies (including many where measures of precision were not reported and effect
14 directions were not commented on by authors), we systematically re-analysed reported data.
15 We ensured data from case-control studies were recalculated as odds ratios, and data from
16 cross-sectional or cohort studies were recalculated as relative risks (for binary outcomes) and
17 differences in means (for continuous outcomes). We ensured all effect estimates were
18 presented with 95% confidence intervals and reported an effect direction (increasing,
19 decreasing, or no change) by considering confidence intervals that did not overlap as
20 statistically significant at an alpha level of 0.05. We did not re-analyse data already presented
21 as odds ratios, beta-coefficients or hazard ratios.

22 To avoid weighted bias from studies that reported on the same outcome in multiple ways (e.g.
23 hypertension measured by both sphygmomanometer and self-report), we ensured no study
24 contributed more than once to each outcome by selecting a single best outcome. This was
25 done by abstracting the more valid measurement (e.g. from medical records rather than self-

1 report), followed by the one adjusted for more variables, then by the one presented as a
2 continuous variable (e.g. change in blood pressure) than categorical (e.g. the prevalence of
3 systolic blood pressure ≥ 140). In studies where outcomes were reported only by population
4 subgroups (e.g. by age and sex), we combined stratified outcomes into an overall estimate,
5 and used the overall outcome in our analysis. Finally, in studies that reported serial data
6 before, during, and after a conflict, we focused our analysis on outcomes that compared pre-
7 to during-conflict data.

8 We summarised the effect directions and study quality by broader-level outcomes e.g.
9 Cardiovascular diseases (I00-159, I70-199), Cerebrovascular diseases (I60-I69), Endocrine
10 diseases (E00-E90), stratifying by incidence, prevalence, or mortality where available. We
11 then reported outcomes by the first level ICD-10 codes (e.g. Essential (primary) hypertension
12 I10) using qualitative visualisations ('Harvest plots'). These take aspects of a forest plot to
13 display data on a matrix of effect direction weighted by several variables.⁸ The x-axis for our
14 Harvest plots showed the effect direction (increase, decrease, no change), and the y-axis
15 showed the study quality (low or moderate-to-high). Each study was represented only once in
16 each Harvest plot. Among outcomes measured by at least three studies, consistency was
17 considered present when at least 60% of studies were in one effect direction, with moderate
18 to high quality studies being weighted double than that of low quality studies. We visually
19 assessed publication bias by constructing an adapted funnel plot, using the sample size and
20 effect direction in place of the standard error and effect size, respectively.

21 **RESULTS**

22 **Description of included studies**

1 Of 149 potentially eligible studies, we excluded 84 mostly due to absence of a control group
2 or only analysing one time point (n=23), or having not defined armed conflict explicitly or at
3 all (n=19). Figure 1 shows the study flow and full details of study exclusions.

4 The included 65 studies analysed 23 armed conflicts; a summary of their characteristics and
5 methodological quality are presented in Table 1. A high proportion of studies had cross-
6 sectional designs (56.9%), most used control groups (61.5%) rather than time trend analyses
7 (38.5%), and nearly half analysed either the Croatian War of Independence (1991-1995)
8 (24.6%) or the Bosnian War (1992-1995) (18.5%). Most studies were conducted in
9 community settings (56.9%) and at the city level (41.5%). Two-thirds (66.2%) of studies
10 were of low quality (score <5), 18.5% were of moderate quality (score 5-6) and 15.4% were
11 of high quality (score >6). No studies assessing temporal trends employed an interrupted time
12 series or other quasi-experimental designs. The characteristics of individual studies are shown
13 in Supplementary File 1.

14 Table 2 reports mean quality scores by study design and year of publication, stratified by the
15 three domains of the Newcastle-Ottawa Scale (selection, comparability, and outcome). In
16 general, case-control studies scored the highest mean quality score (6.7/9; although only three
17 were included) and ecological studies the lowest (1.1/8). Ecological studies, nearly all of
18 which (84%) assessed Croatian and Bosnian Wars of the 1990s, had lower mean quality
19 scores in every domain compared to other study designs. Despite the generally low quality of
20 included studies, there was a consistent stepwise increase in the mean quality score across all
21 three domains and overall as the year of publication increased (e.g. overall scores increased
22 from 2.3 for studies published in 1999 or earlier, to 2.8 for studies published between 2000
23 and 2009, to 4.3 for studies published in 2010 or later).

24 **Summary of results**

1 Figure 2 presents the summary of results by broader-level outcomes and study quality. While
2 results were somewhat inconsistent, some important patterns were noted. There was evidence
3 from some studies that incidence and prevalence of coronary heart, cerebrovascular, and
4 endocrine diseases and mean blood pressure increased following exposure to armed conflict.
5 For blood sugars and lipids there was no consistent evidence of impact. For behavioural
6 factors, there was evidence from some studies that alcohol use increased and consistent
7 evidence that tobacco use increased following exposure to armed conflict. There was no
8 evidence that armed conflict was associated with changes in BMI. This pattern remained
9 relatively consistent when restricted to moderate-to-high quality studies, except in the case of
10 lipids where more studies indicated increased lipid levels following exposure to armed
11 conflict. Figure 2 is broken down further by Figures 3-5 which show the summary of results
12 by individual-level outcomes.

13 **Individual outcomes**

14 Supplementary File 2 presents the summary of 22 individual outcomes with at least three
15 studies, stratified by quality to provide a better indication of the consistency of findings (i.e.
16 >60% of studies suggesting an effect direction). No outcome was shown to consistently
17 decrease following exposure to armed conflict. Outcomes assessing mortality from chronic
18 ischaemic heart disease (ICD-10 code I25; 3 studies),⁹⁻¹¹ mortality from unspecified heart
19 disease (I51; 5 studies),^{9,12-15} systolic blood pressure (8 studies),^{9-11,16-20} and tobacco use (11
20 studies)²¹⁻³¹ had consistent evidence of an increase following exposure to armed conflict.
21 Nine outcomes assessed showed consistent evidence of no change following exposure to
22 armed conflict. These included four diseases (acute myocardial infarction (I21; 7 studies),³²⁻³⁸
23 angina pectoris (I20; 5 studies),^{19,33-36} chronic ischaemic heart disease (I25; 4
24 studies),^{10,18,19,39} mortality from unspecified stroke (I64; 4 studies)^{10,11,14,40}), three clinical

1 factors (fasting blood glucose (6 studies),^{17-19,21,41,42} HbA1c (3 studies),^{17,41,42} total cholesterol
2 (7 studies)^{9,17-19,29,41,42}), and two behavioural factors (BMI (11 studies),^{9,10,17-19,24,41,43-46}
3 overweight (5 studies)^{10,16,17,24,47}).

4 Nine outcomes assessed showed inconsistent evidence of change following exposure to
5 armed conflict. These included four diseases (essential hypertension (I10; 12 studies),
6 unspecified heart disease (I51; 5 studies), unspecified stroke (I64; 5 studies), unspecified
7 diabetes mellitus (E14; 11 studies)), three clinical factors (diastolic blood pressure (8 studies),
8 high density lipoprotein (3 studies), triglycerides (9 studies)), and two behavioural factors
9 (alcohol (16 studies), obesity (7 studies)) (see Supplementary File 1 for citations).

10 A further 19 outcomes had inadequate evidence (<3 studies per outcome) for an assessment
11 of the impact of armed conflict. These included a range of cardiovascular diseases, impaired
12 glucose tolerance, low density lipoprotein, access to iodised salt, underweight, and physical
13 inactivity (see Supplementary File 1 for citations).

14 Data on individual-level outcomes are expanded on in Harvest plots, shown in
15 Supplementary File 2, in order to reveal patterns by study quality, study type, length of
16 follow up, and armed conflict type. We found no obvious patterns by these factors due to the
17 low number of studies in each outcome.

18 **Publication bias**

19 Figure 6 shows an adapted funnel plot to assess publication bias, which includes all outcomes
20 from all studies. While the absence of actual effect estimates limits interpretation, the plot
21 does not present convincing evidence of asymmetry or the absence of small studies showing
22 no effect, which are indicative of publication bias.

23 **DISCUSSION**

1 This review found some evidence that armed conflict is associated with increased coronary
2 heart disease, cerebrovascular disease, and endocrine disease, in addition to increased blood
3 pressure levels, alcohol, and tobacco use. Associations were more consistent for mortality
4 from chronic ischaemic heart disease or unspecified heart disease, systolic blood pressure,
5 and tobacco use. Evidence for a link between armed conflict and other outcomes remains
6 absent, uncertain or inadequate. Inferences are limited by the small number and low quality
7 of included studies, the wide range of reported outcomes and methods of assessment.
8 Associations between armed conflict and some outcomes were inconsistent (e.g.
9 cardiovascular disease outcomes, Figure 3). The explanation for this inconsistency is unclear
10 given the underlying causal pathways are conceptually similar (e.g. stress-induced or
11 disruption of disease prevention programs) but may reflect methodological shortcomings and
12 the low number of studies for some outcomes. Some results should therefore be interpreted
13 with caution until better designed research are performed. However, both the number and
14 quality of studies examining the relationship between armed conflict and cardiovascular
15 disease has increased in recent years.

16 Our findings show that patterning of associations by conflict type, length of follow up, and
17 study quality are unclear. Differential effects by conflict type may reflect underlying methods
18 of warfare, for example siege tactics affecting BMI more than aerial bombardment, in
19 addition to the baseline health system performance and the health status of the underlying
20 population. These stratifications are important and may serve as confounding variables in the
21 association between armed conflict and CVD and should be incorporated into the study
22 designs of future work.

23 Included studies did not provide sufficient detail to understand causal pathways between
24 armed conflict and CVD risk, such as the deterioration of risk factors at population level or
25 changes in the clinical management of high risk individuals. However, the increase in blood

1 pressure, tobacco, and alcohol use identified following exposure to armed conflict has
2 important implications. Previous work suggests that these risk factors may be sensitive to
3 exposure to armed conflict^{6,7} and they are leading risk factors in the global disease burden¹.
4 The explanation of this finding is likely to be complex and multi-factorial, possibly driven by
5 a stress response and change in health behaviours at the individual level and disruptions to
6 healthcare provision at the population level. Notably, tobacco industries are often among the
7 first to establish themselves in post-conflict settings which is a cause for concern when
8 rebuilding conflict-affected areas³. Previous research suggests a positive association between
9 stress and the development of type 2 diabetes mellitus⁴⁸ and poor glycaemic control,⁴⁹ and
10 reduced health care access during times of armed conflict could exacerbate this association
11 further, but our review did not find enough evidence to corroborate this link.

12 The research literature on the association between armed conflict and CVD and its clinical
13 and behavioural factors is skewed towards three main conflicts (the Bosnian War, Croatian
14 War of Independence, and the Colombian Civil War). The almost complete lack of attention
15 given to conflicts within the Middle East is of concern given that it remains the world's least
16 peaceful region. There is a research need for further studies on the impact of armed conflict
17 on nutrition and physical activity, in addition to better examining the link between stress and
18 CVD and its risk factors among conflict-affected populations. We identified only one study
19 which examined the impact of armed conflict on CVD risk among refugees (rather than
20 among civilians who remained in conflict-affected settings, including internally displaced
21 persons)⁴⁷. Other potentially eligible studies conducted among refugees were excluded
22 because there was no component of comparison. The lack of studies is concerning given the
23 recent rise in refugee movements worldwide and the need to understand the double burden of
24 armed conflict and forced migration. Future study designs should prioritise the use of control
25 groups, capture outcomes using validated tools, and adequately address confounding, but the

1 need to balance feasibility against robustness and costs is an important consideration in
2 conflict settings. Quasi-experimental approaches such as an interrupted time series should
3 also be considered, especially if routine health data are collected by health services or local
4 organisations. Other methodological advancements could include improved data on specific
5 conflict-related events, linking survey data to local health registries, and propensity score
6 matching on key variables. The complete absence of studies using interrupted time series
7 designs is reflected in the low quality of ecological studies.

8 How to best address the rising prevalence of CVD in LMICs in the context of armed conflict
9 through a combination of whole population and high risk interventions needs greater policy
10 focus. Primary health care is a central tenet to deliver CVD preventative interventions but is
11 under-prioritised in low resource settings and may be especially vulnerable for disruption
12 during armed conflict. The WHO Package of Essential Non-communicable (PEN) Disease
13 Interventions could be usefully adapted to address this vulnerability and identify whether and
14 how primary care-based “best buys” can be delivered in conflict and post-conflict settings.⁵⁰
15 Training healthcare professionals to deliver interventions during and post conflict and
16 ensuring continuity in the supply of common medications are key priorities. The under-
17 diagnosis and under-recording of CVD and their risk factors during times of conflict should
18 also be considered in the health system planning of conflict-affected settings. It is prudent for
19 future studies to examine access to, and effectiveness of, CVD-related services, particularly
20 at the primary care level.

21 To the best of our knowledge, this is the first systematic review to examine the impact of
22 armed conflict on CVD and its risk factors, and highlights clear research gaps that should
23 guide future work. The systematic re-analysis of included studies has enabled the extraction
24 and reporting of associations not adequately presented in the original papers, and ensured
25 both the direction and precision of each effect estimate are captured. This review is limited by

1 the small number of studies that are mainly low quality, the inability to formally assess
2 publication bias, the use of scoring for risk of bias assessments, and that the majority of
3 evidence arises from a handful of conflicts. This may limit the generalisability of this review
4 and the strength of its conclusions. The relationship between armed conflict and health
5 remains complex and multi-factorial, and homogenising armed conflict as a simplistic
6 exposure variable has its limitations. As more studies address CVD and armed conflict, a
7 sensitivity analysis by sex and age may be insightful to determine whether there are
8 differential effects by population sub-groups.

9 To conclude, armed conflict may be associated with increased mortality from stroke and heart
10 disease, increased blood pressure levels, and increased tobacco use in the populations they
11 affect, though the strength of evidence is limited by low study quality. There is an urgent
12 need to expand research in this area to better inform how governments and agencies can best
13 respond to reduce the burden of CVDs in conflict and post-conflict settings.

14 **ACKNOWLEDGEMENTS**

15 MJ is supported by the Medical Research Council Doctoral Training Partnership. The Public
16 Health Policy Evaluation Unit is supported by the National Institute for Health Research
17 School of Public Health Research.

18 **CONFLICTS OF INTEREST**

19 None.

20 **CONTRIBUTORS**

21 Study conception and design: MJ, EV, BR, CM

22 Acquisition of data: MJ, MN

23 Analysis and interpretation of data: MJ, MJ, EV

1 Drafting of manuscript: MJ

2 Critical revision: EV, BR, MN, CM

3 LICENCE

4 The Corresponding Author has the right to grant on behalf of all authors and does grant on
5 behalf of all authors, an exclusive licence (or non exclusive for government employees) on a
6 worldwide basis to the BMJ Publishing Group Ltd and its Licensees to permit this article (if
7 accepted) to be published in HEART editions and any other BMJ PGL products to exploit all
8 subsidiary rights.

9 REFERENCES

- 10 1. Kontis V, Mathers CD, Rehm J, et al. Contribution of six risk factors to achieving the
11 25×25 non-communicable disease mortality reduction target: a modelling study. *Lancet* 2014;
12 **384**(9941): 427-37.
- 13 2. UCDP. Uppsala Conflict Data Program. Department of Peace and Conflict Research
14 [online]. Available at: <https://bit.ly/2L1TBkx> [Date of access 16 May 2018].
- 15 3. Roberts B, Patel P, McKee M. Noncommunicable diseases and post-conflict
16 countries. *Bull World Health Organ* 2012; **90**(1): 2-A.
- 17 4. Spiegel PB, Checchi F, Colombo S, Paik E. Health-care needs of people affected by
18 conflict: future trends and changing frameworks. *Lancet* 2010; **375**(9711): 341-5.
- 19 5. Spiegel PB, Salama P. War and mortality in Kosovo, 1998–99: an epidemiological
20 testimony. *Lancet* 2000; **355**(9222): 2204-9.
- 21 6. Lo J, Patel P, Roberts B. A systematic review on tobacco use among civilian
22 populations affected by armed conflict. *Tob Control* 2015.

- 1 7. Lo J, Patel P, Shultz JM, Ezard N, Roberts B. A Systematic Review on Harmful
2 Alcohol Use Among Civilian Populations Affected by Armed Conflict in Low- and Middle-
3 Income Countries. *Substance Use & Misuse* 2017; **52**(11): 1494-510.
- 4 8. Ogilvie D, Fayter D, Petticrew M, et al. The harvest plot: A method for synthesising
5 evidence about the differential effects of interventions. *BMC Medical Research Methodology*
6 2008; **8**(1): 8.
- 7 9. Koupil I, Shestov DB, Sparén P, Plavinskaja S, Parfenova N, Vågerö D. Blood
8 pressure, hypertension and mortality from circulatory disease in men and women who
9 survived the siege of Leningrad. *European journal of epidemiology* 2007; **22**(4): 223-34.
- 10 10. Sparén P, Vågerö D, Shestov DB, et al. Long term mortality after severe starvation
11 during the siege of Leningrad: prospective cohort study. *BMJ* 2004; **328**(7430): 11.
- 12 11. Vågerö D, Koupil I, Parfenova N, Sparen P. Long term health consequences
13 following the Siege of Leningrad. *Early Life Nutrition and Adult Health and Development*
14 2013: 207-25.
- 15 12. Hagopian A, Flaxman AD, Takaro TK, et al. Mortality in Iraq Associated with the
16 2003-2011 War and Occupation: Findings from a National Cluster Sample Survey by the
17 University Collaborative Iraq Mortality Study. *PLoS Med* 2013; **10**(10).
- 18 13. Sibai AM, Fletcher A, Armenian HK. Variations in the impact of long-term wartime
19 stressors on mortality among the middle-aged and older population in Beirut, Lebanon, 1983–
20 1993. *American journal of epidemiology* 2001; **154**(2): 128-37.
- 21 14. Vaktskjold A, Yaghi M, Balawi U, Iversen B, Venter W. The mortality in Gaza in
22 July-September 2014: a retrospective chart-review study. *Conflict & Health [Electronic*
23 *Resource]* 2016; **10**: 10.
- 24 15. Roberts L, Lafta R, Garfield R, Khudhairi J, Burnham G. Mortality before and after
25 the 2003 invasion of Iraq: Cluster sample survey. *The Lancet* 2004; **364**(9448): 1857-64.

- 1 16. Hult M, Tornhammar P, Ueda P, et al. Hypertension, diabetes and overweight:
2 looming legacies of the Biafran famine. *PLoS ONE [Electronic Resource]* 2010; **5**(10):
3 e13582.
- 4 17. Kulenovic I, Robertson A, Grujic M, Suljevic E, Smajkic A. The impact of war on
5 Sarajevans with non-insulin-dependent diabetes mellitus. *The European Journal of Public*
6 *Health* 1996; **6**(4): 252-6.
- 7 18. Rotar O, Moguchaia E, Boyarinova M, et al. Seventy years after the siege of
8 Leningrad: does early life famine still affect cardiovascular risk and aging? *J Hypertens*
9 2015; **33**(9): 1772-9.
- 10 19. Stanner SA, Yudkin JS. Fetal programming and the Leningrad Siege study. *Twin*
11 *research and human genetics* 2001; **4**(5): 287-92.
- 12 20. Obilom RE, Thacher TD. Posttraumatic stress disorder following ethnoreligious
13 conflict in Jos, Nigeria. *Journal of Interpersonal Violence* 2008; **23**(8): 1108-19.
- 14 21. Babić R, Maslov B, Babić D, Vasilj I. The prevalence of metabolic syndrome in
15 patient with posttraumatic stress disorder. *Psychiatria Danubina* 2013; **25 Suppl 1**: 45-50.
- 16 22. Creson D, Schmitz JM, Arnoutovic A. War-related changes in cigarette smoking: a
17 survey study of health professionals in Sarajevo. *Substance Use & Misuse* 1996; **31**(5): 639-
18 46.
- 19 23. Creson D, Schmitz JM, Smitran M. War related changes in cigarette smoking: A
20 follow-up survey study of health professionals in Sarajevo. *Journal of Substance Use* 2000;
21 **4**(4): 239-41.
- 22 24. Ghazanfari Z, Ghazanfari T, Araghizadeh H, et al. Physical activity of the civilian
23 chemical victims of Sardasht 20 years after sulfur mustard exposure. *Toxin Reviews* 2009;
24 **28**(1): 48-53.

- 1 25. Gomez-Restrepo C, Tamayo-Martinez N, Buitrago G, et al. [Violence due to Armed
2 Conflict and Prevalence of Mood Disorders, Anxiety and Mental Problems in the Colombian
3 Adult Population]. *Revista Colombiana de Psiquiatria* 2016; **45 Suppl 1**: 147-53.
- 4 26. Idris A, Al Saadi T, Turk T, et al. Smoking behaviour and patterns among university
5 students during the Syrian crisis. *East Mediterr Health J* 2018; **24(2)**: 154-60.
- 6 27. Kadojić D, Demarin V, Kadojić M, Mihaljević I, Barac B. Influence of Prolonged
7 Stress on Risk Factors for Cerebrovascular Disease. *Coll Antropol* 1999; **23(1)**: 213-9.
- 8 28. Roberts B, Chikovani I, Makhashvili N, Patel V, McKee M. Tobacco use and nicotine
9 dependence among conflict-affected men in the Republic of Georgia. *International Journal of*
10 *Environmental Research & Public Health [Electronic Resource]* 2013; **10(6)**: 2185-97.
- 11 29. Šantić Ž, Lukić A, Sesar D, Miličević S, Ilakovac V. Long-term follow-up of blood
12 pressure in family members of soldiers killed during the war in Bosnia and Herzegovina.
13 *Croatian medical journal* 2006; **47(3)**: 416-23.
- 14 30. Sokolova-Djokic L, Zizic-Borjanovic S, Igetic R. Cigarette smoking in Serbia. Impact
15 of the 78-day NATO bombing campaign. *Journal of BUOn* 2008; **13(2)**: 285-9.
- 16 31. Farhood LF, Chaaya M, Saab BR. Detainment and health: The case of the Lebanese
17 hostages of war. *International Journal of Mental Health Nursing* 2010; **19(2)**: 83-91.
- 18 32. Alajbegović S, Metelko Ž, Alajbegović A, Suljić E, Resić H, Poljaković D. Cigarette
19 smoking, alcohol consumption, overweight and obesity in diabetic and nondiabetic patients
20 with acute myocardial infarction. *Diabetologia Croatica* 2002; **31(4)**: 223-9.
- 21 33. Bergovec M, Heim I, Vasilj I, Jembrek-Gostovic M, Bergovec M, Strnad M. Acute
22 coronary syndrome and the 1992-1995 war in Bosnia and Herzegovina: A 10-year
23 retrospective study. *Military Medicine* 2005; **170(5)**: 431-4.

- 1 34. Bergovec M, Mihatov S, Prpic H, et al. [The effect of war-induced stress in Croatia
2 on the incidence and mortality of acute ischemic heart disease]. *Wiener Medizinische*
3 *Wochenschrift* 1992; **142**(19): 430-2.
- 4 35. Dumitrascu DL, Hopulele S, Baban A. Cardiovascular complaints following the
5 uprising of December 1989 in Romania. *Medicine and war* 1993; **9**(1): 45-51.
- 6 36. Mihatov S, Bergovec M, Prpic H, et al. Incidence and hospital mortality of acute
7 coronary artery disease among civilians in Zagreb during air-raid alarms. *Acta Medica*
8 *Croatica* 1995; **49**(2): 49-52.
- 9 37. Mirić D, Giunio L, Božić I, Fabijanić D, Martinović D, Čulić V. Trends in myocardial
10 infarction in middle dalmatia during the war in croatia. *Military Medicine* 2001; **166**(5): 419-
11 21.
- 12 38. Rumboldt Z, Miric D, Bozic I, Giunio L, Polic S, Tonkic A. War-stress-induced
13 medical emergencies in South Croatia [18]. *Lancet* 1993; **341**(8850): 965-6.
- 14 39. Sibai AM, ARMENIAN HK, ALAM S. Wartime determinants of arteriographically
15 confirmed coronary artery disease in Beirut. *American journal of epidemiology* 1989; **130**(4):
16 623-31.
- 17 40. Dimitrijević J, Dzirlo K, Bratić M, et al. 10-year analysis of cerebrovascular accidents
18 at the Neurology Clinic in Sarajevo (before, during and after the war). *Medicinski arhiv* 2002;
19 **56**(3): 151-3.
- 20 41. Pibernik-Okanovic M, Roglic G, Prasek M, Metelko Z. War-induced prolonged stress
21 and metabolic control in type 2 diabetic patients. *Psychological Medicine* 1993; **23**(3): 645-
22 51.
- 23 42. Roglic G, Metelko Z. Effect of war on glycemc control in type II diabetic patients.
24 *Diabetes Care* 1993; **16**(5): 806-8.

- 1 43. Grimard F, Laszlo S. Long-Term Effects of Civil Conflict on Women's Health
2 Outcomes in Peru. *World Development* 2014; **54**: 139-55.
- 3 44. McNabb SJN, Welch K, Laumark S, et al. Population-based nutritional risk survey of
4 pensioners in Yerevan, Armenia. *American Journal of Preventive Medicine* 1994; **10**(2): 65-
5 70.
- 6 45. Robertson A, Fronczak N, Jaganjac N, Hailey P, Copeland P, Duprat M. Nutrition and
7 immunization survey of Bosnian women and children during 1993. *Int J Epidemiol* 1995;
8 **24**(6): 1163-70.
- 9 46. Vespa J, Watson F. Who is nutritionally vulnerable in Bosnia-Herzegovina? *BMJ*
10 1995; **311**(7006): 652-4.
- 11 47. Delbiso TD, Rodriguez-Llanes JM, Altare C, Masquelier B, Guha-Sapir D. Health at
12 the borders: Bayesian multilevel analysis of women's malnutrition determinants in Ethiopia.
13 *Global Health Action* 2016; **9**.
- 14 48. Surwit RS, Schneider MS, Feinglos MN. Stress and diabetes mellitus. *Diabetes care*
15 1992; **15**(10): 1413-22.
- 16 49. Rosenzweig S, Reibel DK, Greeson JM, Edman JS. Mindfulness-based stress
17 reduction is associated with improved glycemic control in type 2 diabetes mellitus: a pilot
18 study. *Alternative Therapies in Health and Medicine* 2007; **13**(5): 36.
- 19 50. World Health Organisation. Package of Essential Noncommunicable (PEN) Disease
20 Interventions for Primary Health Care. <http://bit.ly/1R0NegW> [Accessed 06.10.15].

1 TABLES

2 Table 1. Study characteristics and methodological quality of 65 included studies

Characteristic		% (No.)
Year of publication	1999 or earlier	26.2 (17)
	2000-2009	32.3 (21)
	2010 or later	41.5 (27)
Funding source	Reported	40.0 (26)
	None declared	6.2 (4)
	Not reported	53.9 (35)
Ethics approval	Yes	33.9 (22)
	“Not required”	3.1 (2)
	Not reported	63.1 (41)
Study design	Cross-sectional	47.7 (31)
	Ecological	29.2 (19)
	Cohort	18.5 (12)
	Case-control	4.6 (3)
Armed conflict	Croatian War of Independence (1991-1995)	24.6 (16)
	Bosnian War (1992-1995)	18.5 (12)
	Colombian conflict (1975-2015)	9.2 (6)
	Siege of Leningrad (1941-1944)	7.7 (5)
	Lebanese Civil War (1975-1991)	6.2 (4)
	Georgian-Ossetian Conflict (1989-present)	3.1 (2)
	US-led invasion of Iraq (2003-2011)	3.1 (2)
	Sudan Civil War (1983-2015)	3.1 (2)
	Unspecific conflicts in Uganda	3.1 (2)
	Other conflicts	21.5 (14)
Level of jurisdiction	City	41.5 (27)
	Subnational	26.2 (17)
	National	23.1 (15)
	Camp or village	7.7 (5)
	Not reported	1.5 (1)
Setting	Community	56.9 (37)
	Hospital	38.5 (25)
	Educational establishment	1.5 (1)
	Not reported	3.1 (2)
Armed conflict exposure measurement	Uniform exposure to all based on time and place	47.7 (31)
	Exposure to specific armed conflict events	20.0 (13)
	Exposure based on time of birth	12.3 (8)
	Exposure based on internal displacement	9.2 (6)
	Exposure based on war-related PTSD	4.6 (3)
	Other exposure	3.0 (2)
Comparison type	Control group	61.5 (40)
	Time trend	38.5 (25)
Time between conflict and outcome	Less than 5 years	27.7 (18)
	5.0-9.9 years	23.1 (15)
	10.0-39.9 years	27.7 (18)
	40 years or more	21.5 (14)
Newcastle-Ottawa Scale	Low quality (score <5)	66.2 (43)
	Moderate quality (score 5-6)	18.5 (12)
	High quality (score >6)	15.4 (10)

3

1 **Table 2. Study quality domains by study design, mean (standard deviation)**

	Selection (maximum 4)	Comparability (maximum 2)	Outcome (maximum 2)	Total (maximum 8)
Study design				
Cross-sectional	2.1 (1.0)	0.9 (1.0)	0.9 (0.6)	3.9 (1.6)
Ecological	0.4 (1.0)	0.0 (0.0)	0.6 (0.5)	1.1 (1.2)
Cohort	2.7 (0.8)	0.6 (0.9)	1.2 (0.6)	4.4 (1.2)
Case-control	2.3 (0.6)	1.3 (1.2)	2.0 (0.0)*	6.7 (1.5)^
Year of publication				
1999 or earlier	1.2 (1.3)	0.2 (0.7)	0.8 (0.8)	2.3 (2.6)
2000-2009	1.5 (1.5)	0.3 (0.7)	0.9 (0.5)	2.8 (1.9)
2010 or later	2.2 (0.9)	1.1 (1.0)	1.0 (0.6)	4.3 (1.4)

2 *maximum 3; ^maximum 9

FIGURES

Figure 1. Study flow

Figure 2. Exposure to armed conflict and non-communicable disease risk - summary of results by broader-level outcomes

Figure 2 legend: Solid colour: all studies; patterned colour: moderate-to-high quality studies; N=number of studies

Figure 3. Exposure to armed conflict and non-communicable diseases – summary of results by individual-level outcomes

Figure 3 legend: Solid colour: all studies; patterned colour: moderate-to-high quality studies; N=number of studies

Figure 4. Exposure to armed conflict and non-communicable disease clinical factors – summary of results by individual-level outcomes

Figure 4 legend: Solid colour: all studies; patterned colour: moderate-to-high quality studies; N=number of studies

Figure 5. Exposure to armed conflict and non-communicable disease behavioural factors – summary of results by individual-level outcomes

Figure 5 legend: Solid colour: all studies; patterned colour: moderate-to-high quality studies; N=number of studies

Figure 6. Adapted funnel plot assessing publication bias