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Supplementary appendix

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Annex

The Effects of Armed Conflict on the Health of Women and Children

This Annex provides details and references for the methods used in the estimations of displacement, populations affected, and mortality the primary manuscript. We also distinguish where the data we provide represents new analyses or a reference to previously published data.

Contents:

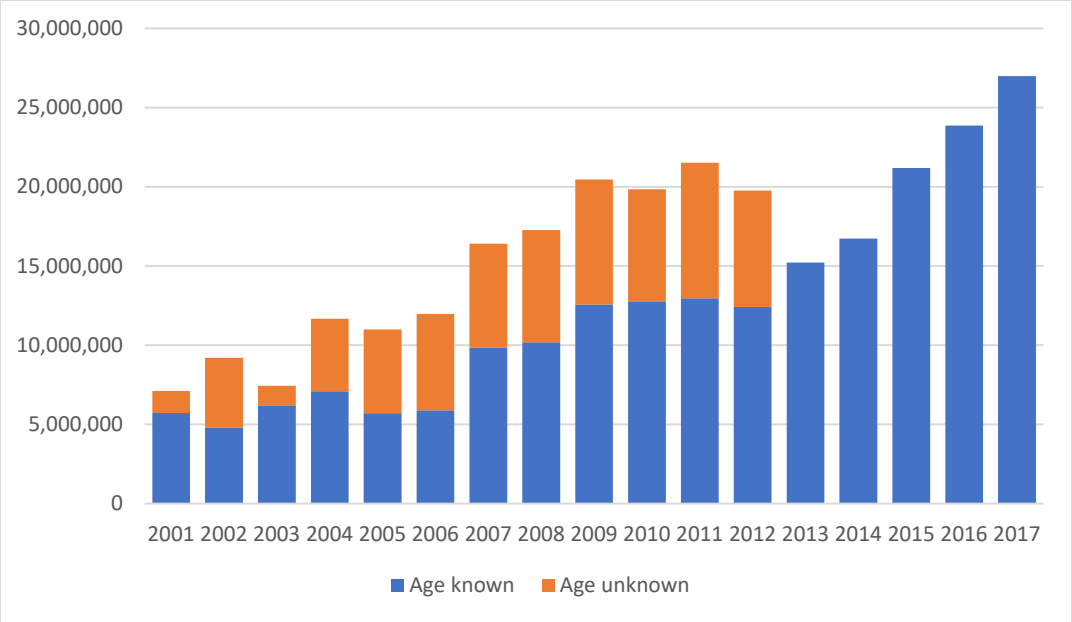
1: Estimation of the displacement of women and children

UNHCR, IDMC and others publish annual data on numbers of refugees, people in refugee-like situations (people who have been forced to leave their homes and crossed an international border due to armed conflict), internally displaced persons (IDPs) (as refugees but not crossing an international border) and asylum-seekers (have sought international protection but not (yet) having refugee status). Most sources, however, do not publish age-sex disaggregated data.

In addition, the United Nations Relief and Works Agency website from their yearly publication UNRWA in

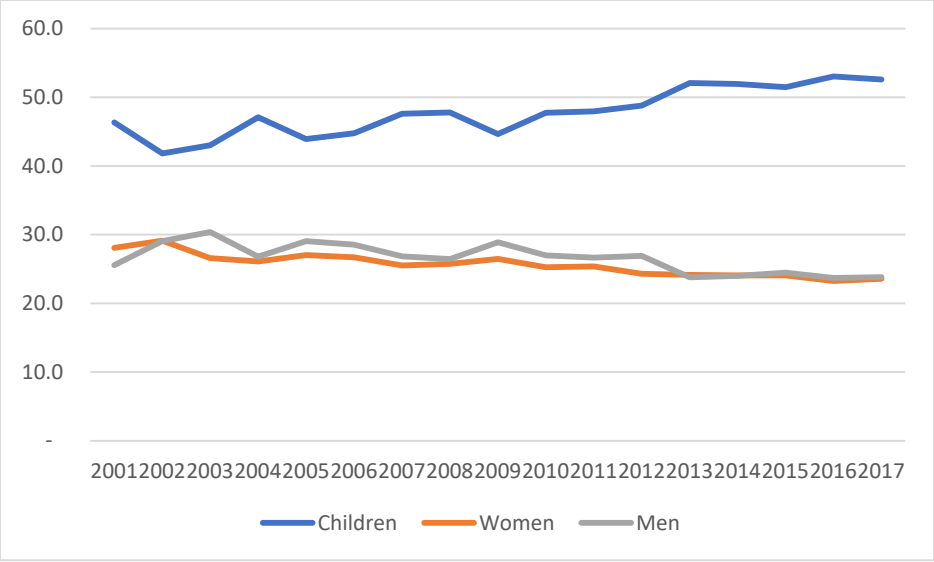
UNHCR is the only large-scale source of published data on the age and sex distribution of persons who were displaced and seeking residence, either internally or as refugees. This includes refugees in host countries as well as an unknown proportion of internally displaced persons (IDPs). It is likely that the age-sex status is better known for refugees than for IDPs. Therefore, we assume that the dataset is dominated by refugee data. Importantly, UNHCR stopped recording individuals with unknown age and sex from 2013. From 2001 to 2017, the number of individuals with known age and sex in the dataset increased more than 3-fold globally from an approximate 5.7 to 27.0 million (Figure A1).

Figure A1: Total number of displaced persons with known and unknown age and sex, UNHCR age-sex database



The proportion of displaced persons who are children has increased gradually since 2009 and was 52.6% in 2017 (Figure A2). The proportion who are women 18 years and over declined gradually to 23.6% in 2017 and was very similar to men 18 years and over (23.8%).

Figure A2: Proportion of displaced person who are children under 18, adult women and adult men (Source: UNHCR)



We estimate the number of women and children displaced by armed conflicts by assuming that the age-sex distribution among those with data in the UNHCR database is the same as for those without age-sex breakdown. This is reasonable because the missingness of age-sex data is more likely a result of idiosyncratic differences in data collection systems rather than systematic differences that may be related

to the demographic structure of the displaced. The following steps were used to estimate the number of women and children who were displaced by calendar tear during the period 2009-2017.

- Country estimates for asylum seekers were obtained from the UNHCR population statistics database (http://popstats.unhcr.org/en/asylum_seekers). Data were aggregated to the level of annual global and regional estimates.
- Estimates for refugees by country of origin were downloaded from the World Bank Open Data database (https://data.worldbank.org/). Data were again aggregated to the level of annual global and regional estimates.
- Country estimates for internally displaced persons (IDPs) resulting from conflict and violence were obtained from the Internal Displacement Monitoring Centre (http://www.internal-displacement.org/database/displacement-data). Data were aggregated to the level of annual global and regional estimates, and regions were defined to match the UNHCR regions, principally Africa, Americas, Asia Pacific, Europe and Middle East and North Africa (https://www.unhcr.org/where-we-work.html).
- Age and sex proportions were calculated:
    - Data with gender and age breakdown were downloaded from UNHCR population statistics database (http://popstats.unhcr.org/en/demographics).
    - Proportions of women, children 0-17, children 0-4, and children 5-17 were calculated by year, globally and regionally.
- The number of IDPs, asylum seekers, and refugees were added, and proportions of women, children 0-17, children 0-4, and children 5-17 were applied to global and regional estimates.
- Data on the number of Palestinian refugees were obtained from the United Nations Relief and Works Agency website. Annual estimates are available in the Figures from https://www.unrwa.org/sites/default/files/content/resources/unrwa_in_figures_2018_eng_v1_31_1_2019_final.pdf
    - Population distribution for Palestinian people was obtained from the United Nations Population Division website (https://population.un.org/wpp/DataQuery/), and proportions of women, children 0-4, children 5-17, and children 0-17 were calculated.
    - Proportions were applied to the total yearly estimates.
- The total number of displaced people globally was added to the total number of Palestinian people to obtain a global total of displaced people, and then broken down for women and children.

2: Estimation of non-displaced populations affected

The populations affected because they are living in the proximity of a conflict can be estimated using data on the location of armed conflict events. One way to approximate the number of women (18 years old and over), adolescents, and children (0-17 years old) affected by conflict is to assess the population sizes in the vicinity of armed conflicts. Elsewhere, we demonstrated that armed conflicts have a strong relationship with adverse outcomes for children and women living within 50km from the location of the conflict.[1] We use that boundary to estimate the number of women, adolescents, and children affected by conflict, by which we mean those groups who are at a measurably elevated risk of morbidity and mortality compared to a world without the nearby conflict. We use the following procedure to estimate the number of non-displaced women, adolescents, and children affected by conflict:

1. We start with a 1km x 1km gridded surface of gender- and age-structured population for each year between 2000 and 2017.[2] [3] [4](The original data is available for 2000, '05, '10, and '15, and we linearly interpolate each grid cell from 2000 to 2015, and extend to 2017.)
2. For each grid cell, we estimate whether or not the cell was within 50km of an armed conflict event as recorded in UCDP in the same calendar year as the population estimate.[5]
3. We then total the number of women, adolescents, and children that live in conflict-affected grid cells in each year to arrive at the totals. The conflict in Syria precludes geospatial representation in UCDP to date, and we assume, following CRED, that, since 2011, 70% of the national population is affected by conflict.[5] We therefore add 70% of Syria's women, adolescents, and children to the annual totals since 2011.
4. The underlying population data contains data on children 0-14 and women of childbearing age at 15-49. We modify the estimates by applying, in each country and year, the ratio of the under-18 population to under-15 population, and the ratio of all women to women 15-49 years old. This results in estimates of non-displaced, conflict-affected children 0-17 and women 18 and older.
5. Because the gridded population datasets may include both non-displaced and displaced populations, we subtract the country totals of women and children who have been displaced by conflict (refugees, asylum seekers, IDPs, estimated in Section 1 of this Annex) in any year from the country total number of children and women. This gives us a conservative lower bound on the number of affected non-displaced women and children.

Two important caveats should be noted. First, our population measures are derived from satellite images calibrated to census data and may overestimate the true resident population where displacement is poorly reflected in the population estimates. This is the primary reason for estimating the affected population size

[1] Wagner Z, Heft-Neal S, Bhutta ZA, Black RE, Burke M, Bendavid E. Armed conflict and child mortality in Africa: a geospatial analysis. The Lancet 2018;392(10150):857–65

[2] Alegana VA, Atkinson PM, Pezzulo C, et al. Fine resolution mapping of population age-structures for health and development applications. Journal of The Royal Society Interface 2015;12(105):20150073.

[3] Lloyd CT, Sorichetta A, Tatem AJ. High resolution global gridded data for use in population studies. Scientific Data [Internet] 2017 [accessed 2019 Mar 19];4:170001. Available from: https://www.nature.com/articles/sdata20171

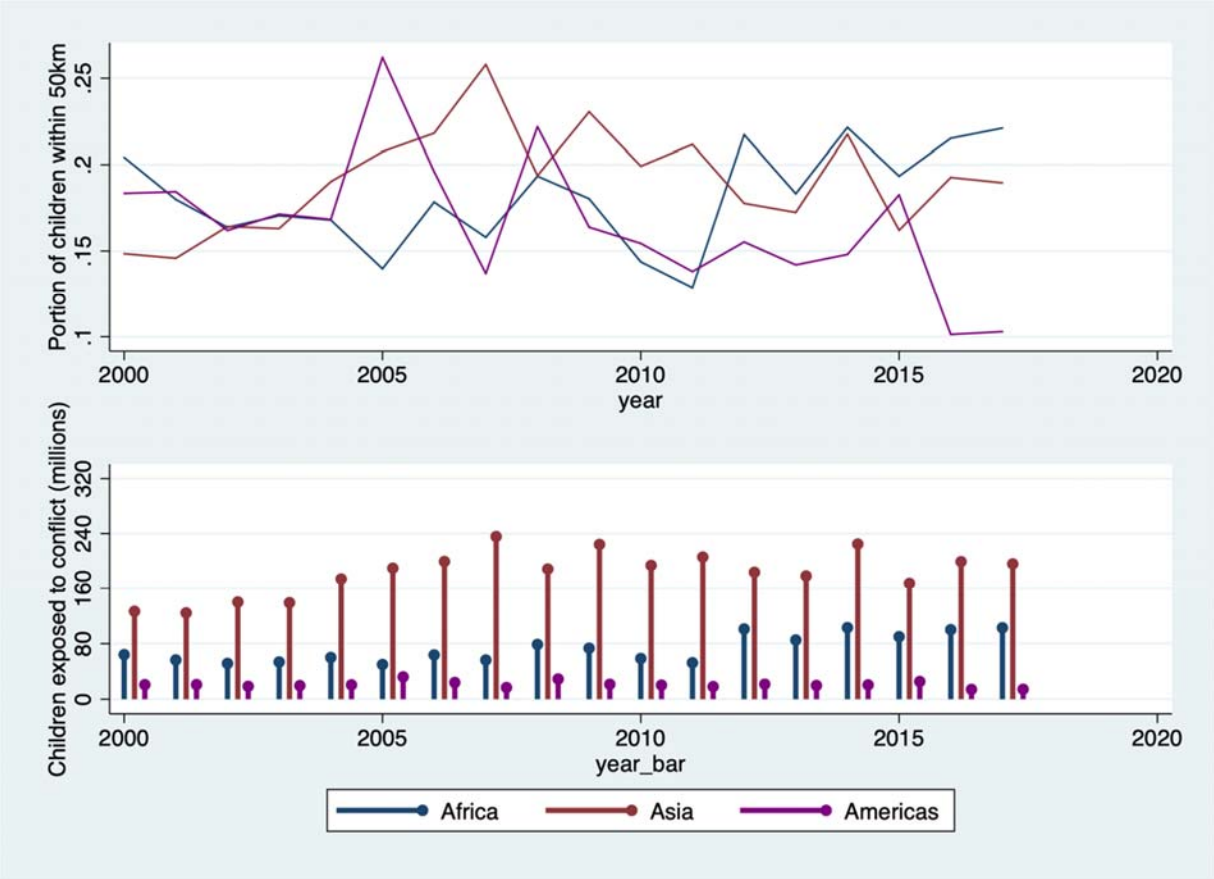
[4] WorldPop [Internet]. [accessed 2019 Mar 19];Available from: https://www.worldpop.org/

[5] Sundberg R, Melander E. Introducing the UCDP georeferenced event dataset. Journal of Peace Research 2013;50(4):523–32

by subtracting the total numbers of displaced populations. Second, we use a 50km boundary which we identified as meaningfully capturing conflict impacts, but the true range of conflict effects varies by conflict and may be smaller or bigger (our previous work suggests 50km may be, on average, a conservative estimate of the affected region).[1]

Figure A3 provides further detail for children under 18 years in addition to Figure 3 in the main text, showing the trends in the proportion and number of children exposed to conflict for the three primary conflict-affected regions of the world: Africa, Asia and the Americas.

Figure A3: Population affected by conflict by world region. Top panel: portion of children in the region; bottom panel: number of children affected



3: Estimation of mortality impact on infants and children under 5 years of age

The methods used to quantify the mortality effect of armed conflicts on infants and children under 5 years of age were first developed in a paper by Wagner and colleagues that focused on Africa.[6] In that analysis, the authors matched child survival records to nearby armed conflict events using the geocoded information on the place of residence of households in DHS, and information on the location and intensity of armed conflict events in the Uppsala Conflict Data Program (UCDP) Georeferenced Events Dataset. The primary outcome, survival of infants to age 1-year-old, was available from surveys in 35 African countries between 1995 and 2015. In that analysis, the increase in mortality risk for infants in response to armed conflict was assessed as a function of distance from the armed conflicts and conflict intensity. The primary analysis examined the mortality rise in response to armed conflicts within 50 km in the year of birth. The number and portion of deaths of infants younger than 1 year related to conflict were estimated. The results were based on 15,441 armed conflict events that led to 968,444 combat-related deaths, matched these data with 1·99 million births and 133,361 infant deaths (average infant mortality of 67 deaths per 1,000 births) between 1995 and 2015.

This paper repeats the primary analysis of Wagner and colleagues, extended to an additional 18 countries in Asia and 11 countries in the Americas with georeferenced child survival data. The additional countries include: Afghanistan, Armenia, Bangladesh, Cambodia, India, Indonesia, Jordan, Kazakhstan, Kyrgyz Republic, Maldives, Myanmar, Nepal, Pakistan, Philippines, Tajikistan, Timor, Uzbekistan, Vietnam, and Yemen (in Asia); and Bolivia, Brazil, Colombia, Dominican Republic, Guatemala, Guyana, Haiti, Honduras, Nicaragua, Paraguay, and Peru (in the Americas). Additional details on the estimation procedures, including the equations for estimating the attributable deaths from conflict is in the Supplement to "Armed Conflict and Child Mortality in Africa" (Wagner et al), section S3. Broadly, the process for estimating the number of attributable deaths follows the following steps:

1. In each year, estimate the number of births within 50km of each conflict noted in UCDP.
2. Obtain the estimated infant mortality rate (or under-5 mortality rate for estimating deaths among children under 5) for each conflict area.
3. Use the regional (Africa, Asia, or the Americas) effect size of armed conflict to estimate what the local infant mortality rate would have been absent conflict. For example, the regional effect size of conflict on infant mortality in Africa is 9.4%. In a conflict area with infant mortality rate of 50 deaths per 1,000 births, the infant mortality rate would be expected to be 45.7 per 1,000 births absent conflict.
4. Estimate the number of deaths in the conflict area in the year given the actual infant mortality rate (or under-5 mortality rate for estimating deaths among children under 5), and the number of deaths expected absent conflict. The difference between these two numbers is the number of deaths attributed to conflict.
5. Aggregate the number of deaths across all conflicts in each year.

[6]Wagner Z, Heft-Neal S, Bhutta ZA, Black RE, Burke M, Bendavid E. Armed conflict and child mortality in Africa: a geospatial analysis. The Lancet 2018;392(10150):857–65.

Syria is not included in the calculations of attributable deaths from conflict, as the UCDP does not have geospatially-explicit location of conflicts during the period of interest. Given the large extent of the conflict in Syria, however, we took additional steps to add data from these countries to the total estimates of conflict-related deaths of children. For Syria, as noted in section S2 above, it is estimated that 70% of the population is exposed to conflict. Therefore, we take 70% of all estimated births in Syria as the population affected, and we apply the conflict effect of Asia to Syria's estimated national infant mortality rate to estimate the number of deaths that would be expected to not occur absent conflict. We add this to the total.

4: Estimation of impact on mortality among women of childbearing age

The methods for estimating the effects of conflict on mortality among women of childbearing age (15–49 years) are described in a paper by Wagner and colleagues (2020).[7] In a scheme similar to the analysis of mortality among children, data on location, timing, and intensity of armed conflicts were obtained from the Uppsala Conflict Data Program, and data on the location, timing, and outcomes of women of childbearing age from Demographic and Health Surveys conducted in 35 African countries between 1990 and 2016. Mortality among women was obtained from sibling survival data. Regression models were used to compare survival of women during periods of nearby conflict (within 50 km) to survival of women in the same area during times without conflict. The effects of varying conflict intensity were assessed using number of direct battle deaths and duration of consecutive conflict exposure. In that analysis, data were obtained on 1,629,352 women (19,286,387 women-years), among whom 103,011 (6·3%) died (534·1 deaths per 100 000 women-years).

[7] Wagner Z, Heft-Neal S, Wise PH, et al. Women and children living in areas of armed conflict in Africa: a geospatial analysis of mortality and orphanhood. Lancet Global Health 2019, 7(12): e1622-e1631.