

REVIEW ARTICLE

GLOBAL HEALTH

Natural Disasters, Armed Conflict, and Public Health

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NATURAL DISASTERS AND ARMED CONFLICT HAVE MARKED HUMAN EXISTENCE throughout history and have always caused peaks in mortality and morbidity. But in recent times, the scale and scope of these events have increased markedly. Since 1990, natural disasters have affected about 217 million people every year,¹ and about 300 million people now live amidst violent insecurity around the world.² The immediate and longer-term effects of these disruptions on large populations constitute humanitarian crises. In recent decades, public health interventions in the humanitarian response have made gains in the equity and quality of emergency assistance.

Natural disasters are broadly classified as biologic, climate-related (hydro-meteorologic), or geophysical (Table 1). (Biologic events are not considered in this article because they require very specific analytic approaches and are often not directly connected to geophysical and climate-related disasters.) There were three times as many natural disasters from 2000 through 2009 as there were from 1980 through 1989 (Fig. 1 and interactive graphic, available with the full text of this article at NEJM.org). Although better communications may play a role in the trend, the growth is mainly in climate-related events, accounting for nearly 80% of the increase, whereas trends in geophysical events have remained stable. During recent decades, the scale of disasters has expanded owing to increased rates of urbanization, deforestation, and environmental degradation and to intensifying climate variables such as higher temperatures, extreme precipitation, and more violent wind and water storms. The effects of disasters on populations include immediate death and disabilities and disease outbreaks caused by ecologic shifts. For example, the 2010 earthquake in Haiti and Cyclone Nargis, which hit Myanmar in 2008, killed 225,000 and 80,000 people, respectively, in a matter of minutes; destroyed health care facilities; and left many homeless.

In contrast, armed conflicts have decreased globally, although some persist, with entrenched internal violence lasting for years, such as in Darfur (in Sudan) and in the eastern Democratic Republic of Congo. Advances in small-arms technology and struggles over natural resources of international value (oil and rare minerals) make conflict resolution challenging. Civilians bear the burden. Families are forced to move from their homes to escape internecine violence. Refugees cross national borders and are legally entitled to assistance in United Nations (UN)-managed camps. But increasingly since the mid-1980s, people have been unable to cross international frontiers and so remain internally displaced (Fig. 2). They are often at higher risk for malnutrition and disease than residents or refugees.³

ADVANCES IN HUMANITARIAN PUBLIC HEALTH RESPONSE SINCE 1970

The early 1970s were watershed years for public health in emergencies. The Biafran War (in Nigeria), the 1970 cyclone in Bangladesh, and the sweeping famines in Africa


An interactive
graphic showing
natural disasters
from 1950 through
2012 is available
at NEJM.org

deeply engaged the public health community in trying to meet the need for impartial and effective medical aid. The use of epidemiologic methods to reduce civilian morbidity and mortality in mass emergencies began in earnest at this time.^{4,5} This period also saw the engagement of health care practitioners in the elaboration of international norms on ethics, human rights, and humanitarian law in emergency settings.⁶⁻⁸

Public health is a major component of the larger operational framework of international relief. It includes disease control, reproductive health and maternal care, psychosocial support, short-term or emergency medical and surgical interventions, and sanitation and nutritional services. Although the health needs during and after natural disasters and armed conflicts are similar, the differences arise from the political complexities of the latter, in which civilian populations serve as targets of war and human rights abuses aggravate health and protection needs.

The main health consequences of internal armed conflicts are not combat-related injuries and deaths. Mortality is driven by many direct and indirect factors (Fig. 3); severe malnutrition, malaria, and other common childhood diseases are the main factors.¹⁰ Typically, health status deteriorates as violence and insecurity lead to population displacements and the breakdown of health care systems and supply chains; this breakdown, in turn, degrades essential services such as vaccination programs, maternal care, and therapeutic feeding.

The main relief needs in natural disasters are water, food, sanitation, and shelter. Poor countries require more extensive assistance than wealthier ones, although severe natural disasters in wealthy regions, such as the 2011 tsunami in Japan, create needs that challenge nation-based responses. In disasters, unlike armed conflicts, the need for emergency relief is comparatively short-lived. However, in some underresourced regions hit by recurrent natural disasters, such as South Asia and Haiti, there is now increasing evidence of longer-term health effects, such as chronic malnutrition, mediated through intensifying food insecurity.^{11,12}

In acute disasters, such as earthquakes and cyclones, physical trauma may require specialized interventions. The probability of survival from serious injury decreases substantially 12 to 24 hours after the disaster strikes, and good outcomes in most cases are thus highly dependent on

Table 1. Classification of Natural Disasters.*

Biologic

Epidemic infectious disease: viral, bacterial, parasitic, fungal, prion
Insect infestation
Animal stampede

Geophysical

Earthquake
Volcano
Mass movement (dry): rockfall, landslide, avalanche, subsidence

Climate-related

Hydrologic

Flood: general flood, flash flood, storm surge or coastal flood
Mass movement (wet): rockfall, landslide, avalanche, subsidence

Meteorologic

Storm: tropical cyclone, extratropical cyclone, local storm
Extreme temperature: heat wave, cold wave, extreme winter condition
Drought
Wildfire: forest fire, land fire

* The classification is from the Center for Research on the Epidemiology of Disasters, University of Louvain.

the rapidity of appropriate medical and surgical responses.¹³ Advance preparedness of local health care personnel in search-and-rescue capacities and immediate emergency care are crucial for improving victim survival. An additional requirement that is less widely recognized is for adequate local follow-up nursing care and infection control in postoperative settings and rehabilitation services.

EXPANDING USE OF EPIDEMIOLOGIC METHODS IN CRISES

The critical role of epidemiologic methods in natural disasters was recognized in the 1970s and 1980s in studies after a series of massive catastrophes,^{14,15} including the Bangladesh cyclone,¹⁶ Guatemala¹⁷ and Naples¹⁸ earthquakes, and African Sahel famines.¹⁹ These population-based quantitative assessments identified determinants of mortality that helped improve future preparedness and the response of medical teams. Innovative approaches for rapid medical assessment among refugees from the Pol Pot mass killings in the Thai border camps in 1979 and 1980 also drew attention to the importance of conducting an early and accurate evaluation of needs.²⁰

During humanitarian responses to the subsequent wave of African famines and postcolonial civil wars in the 1980s, these epidemiologic methods were widely applied. Health analysts were

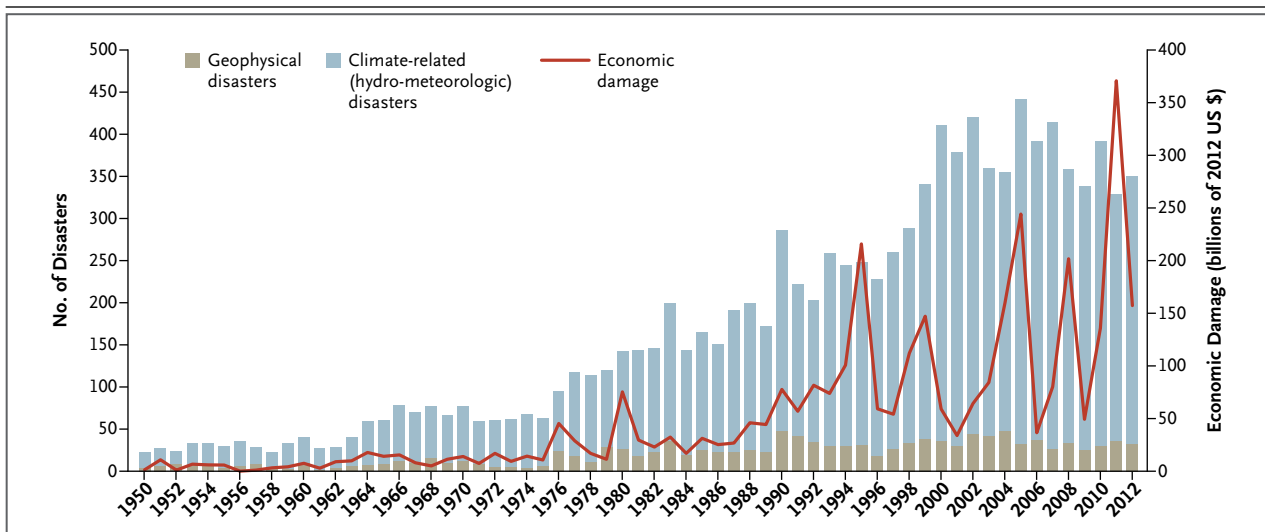


Figure 1. Numbers and Types of Natural Disasters, 1950–2012.

The effect of a disaster on the local economy usually consists of direct consequences (e.g., damage to infrastructure, crops, and housing) and indirect consequences (e.g., loss of revenues, unemployment, and market destabilization). The estimated economic damage is for the year in which the disasters occurred and is given in billions of 2012 U.S. dollars. Data are from the EM-DAT International Disaster Database, Center for Research on the Epidemiology of Disasters, University of Louvain (www.emdat.be/). Although this database tracks biologic events, such events are not shown here because they require very specific analytic approaches and are often not directly connected to geophysical and climate-related disasters.

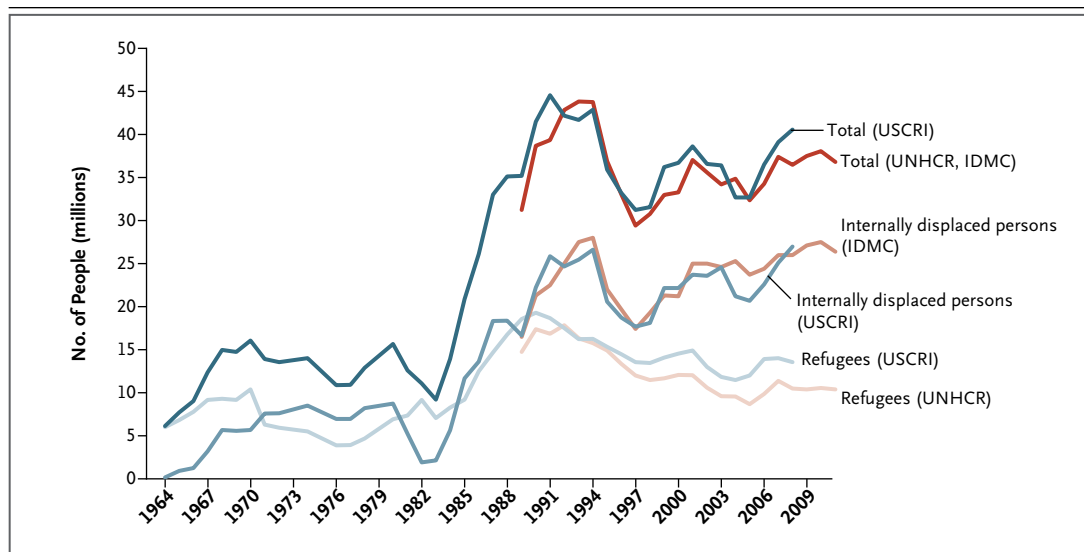
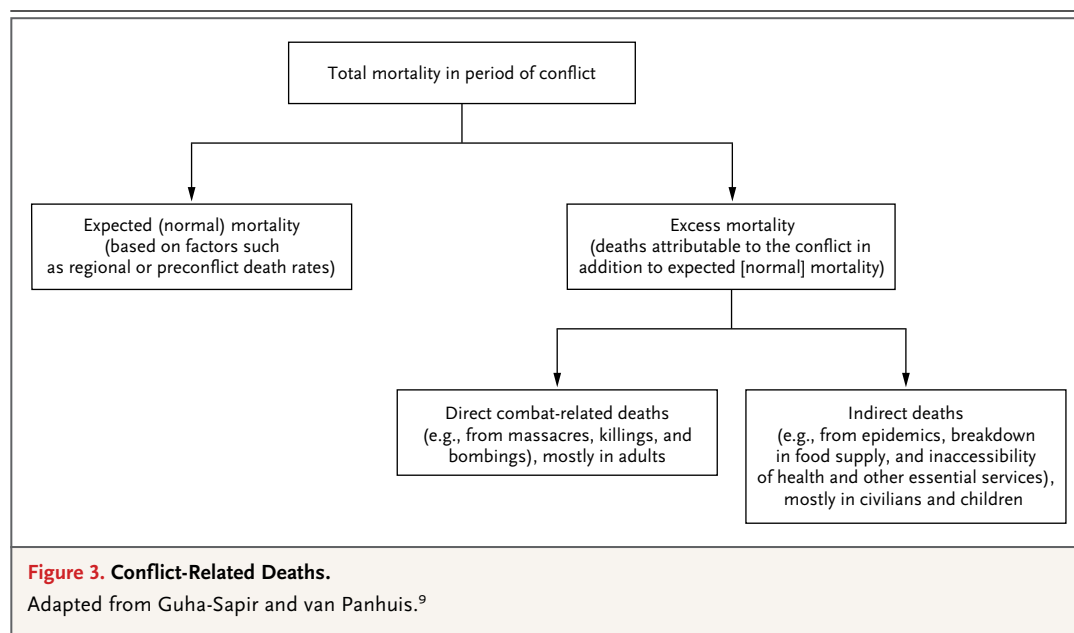


Figure 2. Refugees and Displaced Populations, 1964–2011.

Estimates are from the Office of the United Nations High Commissioner for Refugees (UNHCR), the U.S. Committee for Refugees and Immigrants (USCRI), and the Internal Displacement Monitoring Centre (IDMC).

thus able to describe how mortality and morbidity differed across population groups and over time, providing crucial insights for improving response and preparedness.²¹ But high population

mobility, the breakdown of vital registration or surveillance systems, homelessness, and insecurity posed serious methodologic barriers to generalizing from epidemiologic or risk analyses



conducted with small samples. Emergency health assessments also suffered from the lack of baselines against which to calculate excess deaths (Fig. 3) and calibrate the criticality of a situation.²²

In response to growing concerns regarding equity and needs-based response, public health analysts within the humanitarian aid community worked to identify thresholds of key indicators of mortality and malnutrition in order to classify situations as critical and establish triggers for the provision of emergency relief.²³ Recognizing the major implications of using such thresholds,²⁴ a group of academics, nongovernmental organizations, and UN agencies developed Standardized Monitoring and Assessment of Relief and Transitions (SMART), a rapid cluster-sampling method that divides the population into groups, or clusters, and randomly selects a sample among these clusters for data collection, in order to provide statistically sound estimates of mortality and malnutrition.²⁵ Now widely used by relief agencies,²⁶ this method generates comparable epidemiologic data to quantify crisis thresholds and monitor the effectiveness of the relief,²⁷ strengthening the evidence-based response.

Collecting reliable epidemiologic information still presents unique challenges in these disrupted field contexts.²⁸ Because the SMART method does not require household listing, it has advantages

over random sampling.²⁹ However, the relative uncertainties of cluster sampling (lower levels of precision and constraints on extrapolation of key variables such as mortality) can prove problematic, because risks are highly variable across small areas.³⁰ Given the importance of correctly measuring malnutrition and mortality, on the one hand, and the shortcomings of cluster sampling in transient settings, on the other, alternative methods, such as lot quality assurance sampling (which involves taking a large number of unusually small random samples from each set in the population to determine whether they meet an established standard) or collection of data from key informants, are increasingly used.³¹ For insecure settings (e.g., in a zone of conflict), these alternatives show promising advantages because of ease of implementation and the provision of nearly real-time estimates of mortality.

Although these advances have contributed to a greatly improved understanding of the determinants of mortality and morbidity and the effectiveness of aid, the Haiti earthquake response (2010) revealed persistent weaknesses in international emergency relief, particularly with regard to initial assessment and coordination. An authoritative evaluation has noted the long delay in obtaining a “rapid” health assessment (reported on day 45 vs. day 12, which is the standard³²), owing to the widespread initial chaos but also explicitly to the bureaucratic complexity of the

UN Health Cluster system.³³ Trauma response by foreign field hospitals in a recent review was found to be completely uncoordinated and poorly documented. The field units arrived in unprecedented numbers (44 total vs. 41 for the 2005 Pakistan earthquake) but much later than recommended for clinical efficacy (a mean of 10.2 days after the earthquake rather than the standard of 1 to 5 days) and left scant and scattered information on surgical outcomes and patient follow-up.³⁴

EVOLVING NORMS AND PRACTICE GUIDELINES FOR PUBLIC HEALTH RESPONSE

Much of the progress described above has been driven by the ethical imperatives of medical and public health interventions in humanitarian emergencies. Ensuring unimpeded access to all victims of a disaster or conflict, providing relief according to need rather than political expediency, and documenting or sounding the alert on grave human rights abuses are central to the engagement of health care professionals in responding to humanitarian emergencies. The global health community has made major advances on these issues by working within the international humanitarian framework of law and practice.^{35,36} Normative and operational guidance for health care responders within the humanitarian community has been codified in a number of key publications (see the Supplementary Appendix, available at NEJM.org).

Medical responders³⁷ in disaster or conflict zones face stressful situations that demand experience and seasoned judgment beyond medical skills. For example, impartial provision of medical care to victims requires negotiating humanitarian space to prevent hostile interference from local authorities and armed combatants who are the perpetrators of the violence. Delivering food or medical aid to vulnerable or high-risk persons or groups may require population-based triage decisions that can be technically complex and morally challenging.³⁸

The collection of data on sensitive topics such as mortality estimates, combat injuries, or witnessed human rights violations requires adherence to standards of informed consent, confidentiality, and informant protection. In oppressive and hostile settings, these standards are difficult to maintain because of risks to those who provide information and to those who collect it.³⁹

Norms of equity, particularly in areas of severe need, dictate that the provision of emergency health care cannot be restricted to the survivors but must extend to the surrounding poor communities that help take them in.⁴⁰ Broader societal issues related to humanitarian response are often neglected, such as the need to maintain respect for cultural practices regarding death and grief.⁴¹ On occasion, mass emergency interventions may still violate human rights norms of mutual respect and cause discontent in local communities whose cooperation with external assistance is vital. Experiences from massive earthquakes have shown that the longer-term, social consequences of such oversights can be severe.⁴² For instance, the citizens of Soviet Armenia (sensitive to the historical echoes of genocide) were incensed at the Soviet Union for offering to take orphans in the immediate aftermath of the December 1988 earthquake that killed at least 25,000 people — an affront that lingers to this day⁴³ and that foreshadowed the controversy about post-disaster international child adoption that surfaced with the earthquakes in Haiti⁴⁴ and Japan.⁴⁵

CHALLENGES

Much has been learned in the past few decades, but some important issues need urgent attention. The rapidity of emergency health care intervention has greatly improved, with teams on the ground within days, but coordination of health needs assessments performed by multiple groups is weak. Although coordination of health data has been widely recognized as an ongoing problem through in-depth evaluations of the Rwanda genocide and Haiti earthquake, little progress has been made in addressing this problem.

Bridging the transition from emergency health response to local health systems has not been adequately addressed in most post-conflict or post-disaster settings and especially in poor regions afflicted by recurrent conflicts or natural disasters. Sudden infusions of outside aid and expertise can compromise existing community public health operations by setting up parallel systems with different norms and resources. Abrupt departures of emergency teams may also leave patients without locally viable follow-up nursing care. Resolving such transitional issues by reducing vulnerabilities and strengthening the

resilience of local systems will inform the strategies needed to address root causes of these crises.

Finally, humanitarian health care personnel regularly face political and military barriers to providing humane and appropriate care for those most in need.⁴⁶ These crises often uncover deep fissures in societies. In particular, humanitarian health care providers confront the need to maintain silence about witnessed violations of international humanitarian and human rights law in order to maintain access to stigmatized or oppressed populations.⁴⁷ These ethical dilemmas have provoked sustained controversy and require health care personnel to possess not only medical and public health expertise but also a practical understanding of when to negotiate or speak out on the basis of applicable humanitarian norms and legal principles.⁴⁸ Health care personnel need adequate training in these aspects of the humanitarian response as situations become increasingly politicized and neutral space constricts.⁴⁹

CONCLUSIONS

The effects of armed conflict and natural disasters on global public health are widespread.

Much progress has been made in the technical quality, normative coherence, and efficiency of the health care response. But action after the fact remains insufficient. In the years ahead, the international community must address the root causes of these crises. Natural disasters, particularly floods and storms, will become more frequent and severe because of climate change. Organized deadly onslaughts against civilian populations will continue, fueled by the availability of small arms, persistent social and political inequities, and, increasingly, by a struggle for natural resources. These events affect the mortality, morbidity, and well-being of large populations. Humanitarian relief will always be required, and there is a demonstrable need, as in other areas of global health, to place greater emphasis on prevention and mitigation.

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REFERENCES

- Guha-Sapir D, Vos F, Below R. Annual disaster statistical review 2011: the numbers and trends. Brussels: Center for Research on the Epidemiology of Disasters, 2012.
- Guha-Sapir D, D'aoust O. Demographic and health consequences of civil conflict: background paper. In: World development report 2011: conflict, security, and development. Washington, DC: World Bank, 2011.
- Feikin DR, Adazu K, Obor D, et al. Mortality and health among internally displaced persons in western Kenya following post-election violence, 2008: novel use of demographic surveillance. *Bull World Health Organ* 2010;88:601-8.
- Waldman RJ, Kruk ME. Conflict, health, and health systems: a global perspective. In: Parker R, Sommer M, eds. *Routledge handbook of global public health*. Abingdon, Oxfordshire, United Kingdom: Routledge, 2011:229-35.
- Noji EK, Toole MJ. The historical development of public health responses to disaster. *Disasters* 1997;21:366-76.
- Universal declaration of human rights. United Nations General Assembly resolution 217A (III) on 10 December 1948 (<http://www.un.org/cyberschoolbus/humanrights/resources/universal.asp>).
- The Fourth Geneva Convention of 1949. Geneva: International Committee of the Red Cross, August 1949.
- Brown RE, Mayer J. Famine and disease in Biafra: an assessment. *Trop Geogr Med* 1969;21:348-52.
- Guha-Sapir D, Panhuis WG. Conflict-related mortality: an analysis of 37 datasets. *Disasters* 2004;28:418-28.
- Salama P, Spiegel P, Talley L, Waldman R. Lessons learned from complex emergencies over past decade. *Lancet* 2004;364:1801-13.
- Rodriguez-Llanes JM, Ranjan-Dash S, Degomme O, Mukhopadhyay A, Guha-Sapir D. Child malnutrition and recurrent flooding in rural eastern India: a community-based survey. *BMJ Open* 2011;1(2):e000109.
- Ferris E, Petz D, Stark C. The year of recurring disasters. Washington, DC: Brookings Institution, March 2013 (<http://www.brookings.edu/research/reports/2013/03/natural-disaster-chapter-1-ferris>).
- Roces MC, White ME, Dayrit MM, Durkin ME. Risk factors for injuries due to the 1990 earthquake in Luzon, Philippines. *Bull World Health Organ* 1992;70:509-14.
- Western KA. The epidemiology of natural and man-made disasters: the present state of the art. (DTPH dissertation. London: London School of Hygiene and Tropical Medicine, University of London, June 1, 1972; <http://cidbimena.desastres.hn/docum/crid/Agosto2004/pdf/eng/doc3610.htm>.)
- Lechat MF. The epidemiology of disasters. *Proc R Soc Med* 1976;69:421-6.
- Sommer A, Mosley WH. East Bengal cyclone of November, 1970: epidemiological approach to disaster assessment. *Lancet* 1972;1:1029-36.
- Glass RI, Urrutia JJ, Sibony S, Smith H, Garcia B, Rizzo L. Earthquake injuries related to housing in a Guatemalan village. *Science* 1977;197:638-43.
- De Bruycker M, Greco D, Lechat MF, Annino I, De Ruggiero N, Triassi M. The 1980 earthquake in Southern Italy — morbidity and mortality. *Int J Epidemiol* 1985;14:113-7.
- Rivers JPW, Holt JFJ, Seaman JA, Bowden MR. Lessons for epidemiology from the Ethiopian famines. *Ann Soc Belg Med Trop* 1976;56:345-60.
- Glass RI, Cates W Jr, Nieburg P, et al.

- Rapid assessment of health status and preventive-medicine needs of newly arrived Kampuchean refugees, Sa Kaeo, Thailand. *Lancet* 1980;1:868-72.
21. Famine-affected, refugee, and displaced populations: recommendations for public health issues. *MMWR Recomm Rep* 1992;41(RR-13):1-76.
 22. Byass P. Person, place and time — but who, where, and when? *Scand J Public Health* 2001;29:84-6.
 23. The Sphere handbook: humanitarian charter and minimum standards in humanitarian response. Geneva: Sphere Project, 2011:311.
 24. 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;272:371-6.
 25. Katz J. Sample-size implications for population-based cluster surveys of nutritional status. *Am J Clin Nutr* 1995;61:155-60.
 26. Standard Monitoring and Assessment of Relief and Transitions (SMART). Measuring mortality, nutritional status, and food security in crisis situations, version I. 2006 (http://smartmethodology.org/documents/manual/SMART_Methodology_08-07-2006.pdf).
 27. Reed HE, Keely CB, eds. Forced migration and mortality. National Research Council. Washington, DC: National Academy Press, 2001.
 28. Guha-Sapir D, van Panhuis WG, Degomme O, Teran V. Civil conflicts in four African countries: a five-year review of trends in nutrition and mortality. *Epidemiol Rev* 2005;27:67-77.
 29. Checchi F, Roberts L. Interpreting and using mortality data in humanitarian emergencies: a primer for non-epidemiologists. Humanitarian practice network paper 52. London: Overseas Development Institute, 2005.
 30. Degomme O, Guha-Sapir D. Patterns of mortality rates in Darfur conflict. *Lancet* 2010;375:294-300.
 31. Deitchler M, Deconinck H, Bergeron G. Precision, time, and cost: a comparison of three sampling designs in an emergency setting. *Emerg Themes Epidemiol* 2008;5:6 (<http://www.ete-online.com/content/5/1/6>).
 32. Inter-Agency Standing Committee (IASC). Initial Rapid Assessment (IRA): guidance notes. June 2000:3 (http://www.who.int/hac/network/global_health_cluster/ira_guidance_note_june2009.pdf).
 33. de Ville de Goyet C, Sarmiento JP, Grunewald F. Health response to the earthquake in Haiti January 2010: lessons to be learned for the next massive sudden onset disaster. Washington, DC: Pan American Health Organization, 2011:112-113.
 34. Gerdin M, Wladis A, von Schreeb J. Foreign field hospitals after the 2010 Haiti earthquake: how good were we? *Emerg Med J* 2012;30(1):e8.
 35. Thurer D. Dunant's pyramid: thoughts on the "humanitarian space." *Intl Rev Red Cross* 2007;89:47-61.
 36. The Sphere Project. The Sphere handbook: humanitarian charter and minimum standards in humanitarian response (<http://www.sphereproject.org/handbook/>).
 37. Coupland RM. Epidemiological approach to surgical management of the casualties of war. *BMJ* 1994;308:1693-7.
 38. Iserson KV, Moskop JC. Triage in medicine. I. Concept, history, and types. *Ann Emerg Med* 2007;49:275-81.
 39. Ford N, Mills EJ, Zachariah R, Upshur R. Ethics of conducting research in conflict settings. *Confl Health* 2009;3:7.
 40. United Nations High Commissioner for Refugees. Public health equity in refugee and other displaced persons settings. Public Health and HIV section, DPSM. Policy Development and Evaluation Service. April 2010 (<http://www.unhcr.org/4bdf61699.pdf>).
 41. Management of dead bodies in disaster situations. Disaster manuals and guidelines series. No. 5. Washington, DC: Pan American Health Organization, 2004:85-128.
 42. Batniji R, Van Ommeren M, Saraceno B. Mental and social health in disasters: relating qualitative social science research and the Sphere standard. *Soc Sci Med* 2006;62:1853-64.
 43. Libaridian GJ. Armenian earthquakes and Soviet tremors. *Society* 1989;26:59-63.
 44. Thompson G. After Haiti quake, the chaos of US adoptions. *New York Times*. August 4, 2010:A1 (<http://www.nytimes.com/2010/08/04/world/americas/04adoption.html?pagewanted=all>).
 45. Macedo D. Foreigners looking to adopt Japanese earthquake orphans need not apply. *Fox News Network*. March 22, 2011 (<http://www.foxnews.com/world/2011/03/21/foreigners-looking-adopt-japanese-earthquake-orphans-need-apply/>).
 46. Weissman F. Liberia: can relief organizations cope with the warlords? In: Médecins sans Frontières. *World in crisis: the politics of survival at the end of the twentieth century*. London: Rutledge, 1997: 100-21.
 47. Bruderlein C, Leaning J. New challenges for humanitarian protection. *BMJ* 1999;319:430-5.
 48. Leaning J, Briggs SM, Chen L, eds. *Humanitarian crises: the medical and public health response*. Cambridge, MA: Harvard University Press, 1999.
 49. Leaning J. The dilemma of neutrality. *Prehosp Disaster Med* 2007;22:418-21.

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