

Health system functionality in a low-income country in the midst of conflict: the case of Yemen

Naseeb Qirbi^{1,†} and Sharif A Ismail^{2,*,†}

¹Department of Community Medicine, Faculty of Medicine and Health Science, Sana'a University, Sana'a, Yemen and ²Department of Primary Care and Public Health, Imperial College London, Reynolds Building, St. Dunstan's Road, London, UK

*Corresponding author. Department of Primary Care and Public Health, Imperial College London, Reynolds Building, St Dunstan's Road, London W6 6RP, UK. E-mail: sharif.ismail15@imperial.ac.uk

[†]These authors contributed equally to this work.

Accepted on 27 February 2017

Abstract

Background Although the literature on effects of armed conflict on population health is extensive, detailed assessments of effects on public health 'systems' are few. This article aims to help address this deficit through the medium of a case study on Yemen, describing health system and health outcome performance prior to the internationalisation of the conflict there in March 2015, before assessing the impact of war on health system functionality since that time.

Method Review of peer- and non-peer reviewed literature from 2005 to 2016 from academic sources, multilateral organizations, donors and governmental and non-governmental organizations, augmented by secondary data analysis.

Results Despite significant health system weaknesses and structural vulnerabilities pre-conflict, there were important improvements in selected health outcome measures in Yemen up to early 2015 (life expectancy, and infant and maternal mortality, e.g.), partly driven by a fragile health sector that was heavily reliant on out-of-pocket expenditure, and hampered by weak service penetration especially in rural areas. High intensity conflict has resulted in rising mortality and injury rates since March 2015, the first decline in life expectancy and increase in child and maternal mortality in Yemen for some years, and worsening levels of malnutrition. Service delivery has become increasingly challenging in the context of a funding crisis, destruction of health facilities, widespread shortages of essential medicines and equipment across the country, and governance fragmentation.

Conclusion Conflict in Yemen has resulted in humanitarian disaster on a wide scale in a short period of time, and crippled an already weak health system. Important areas of uncertainty remain, however, including the scale of health worker flight, and the extent to which alternative providers have stepped in to fill widening service gaps as the conflict has unfolded. Planning for longer-term health system reconstruction should begin as soon as possible.

Keywords: Conflict, health system, health financing, health workforce, health intelligence, public health, Yemen

Key Messages

- The public health impacts of conflict are well-recognized but effects on health system functionality have received less attention because of challenges to data collection in unstable environments and a focus on immediate health needs. This article seeks to help address this shortfall through a case study analysis of the unfolding conflict in Yemen since March 2015.
- Despite significant health system weaknesses and structural vulnerabilities pre-conflict, there were important improvements in selected health outcome measures in Yemen to early 2015.
- High intensity conflict has led to a marked deterioration in health system functionality over a short period, resulting from a combination of direct and indirect damage to health facilities, weakening governance and oversight, funding shortfalls and worsening access to preventive and curative care. There is emerging evidence of a reduction in life expectancy and rising child and maternal mortality in Yemen.
- Health information gathering remains extremely challenging however, and important areas of uncertainty include the scale of health worker flight, and the extent to which alternative providers have stepped in to deliver widening service gaps as the conflict has unfolded. Planning for reconstruction should begin now.

Introduction

Around 1.2 billion people live in fragile and conflict-affected states (FCAS) worldwide (OECD 2015). Although the public health and human security effects of armed conflict are well-recognized (Murray *et al.* 2002; Iqbal 2006; Haar and Rubenstein 2012; Leaning and Guha-Sapir 2013), little is known about the ways in which conflict attenuates established health system activities, or mechanisms for health system adaptation and resilience in the face of chronic instability and insecurity (Woodward *et al.* 2016). This is partly because of challenges to conducting robust systems research in dynamic and unstable environments where reliable data may be in short supply, and because of an understandable focus among actors on the ground on prioritizing immediate population health needs (Alliance for Health Policy and Systems Research 2008). The shortage of health systems analysis work during and immediately after conflict means that—despite significant interest among policy-makers—the evidence base to inform health sector rehabilitation and reconstruction work remains small (Newbrander *et al.* 2011; Rubenstein 2011).

These challenges are amplified in the context of Yemen, a country, which has historically received very little attention in the health literature. Prior to the internationalization of the conflict there in March 2015, Yemen was a low-income country with significant political, economic, structural and health sector vulnerabilities, including widespread food insecurity, energy and water supply shortages. Situated in the southern corner of the Arabian Peninsula, some 50% of Yemen's population of around 26 million in early 2015 lived below the poverty line, with a GDP per capita of US\$1408 (World Bank 2015) and a Human Development Index rank of 160 (UNDP 2015). The health system, in turn, could best be described as fragile and was heavily reliant on private, out-of-pocket financing. Despite these vulnerabilities, important strides were made against key health indicators including the Millennium Development Goals up to the beginning of 2015, including increased life expectancy, reduced infant-, under-5 child- and maternal mortality.

Since March 2015, historical health gains have been put at risk by a conflict of rapidly broadening scope and intensity in which there has been persistent disregard for civilian life and preservation of essential services by warring parties. Overall, 20 of Yemen's 22 Governorates¹ have been affected with civilians bearing the brunt of the violence. The scale of the resulting humanitarian emergency now places Yemen on a par with Syria in regional terms: an early 2016 regional overview from the United Nations Office for the

Coordination of Humanitarian Affairs (UN OCHA) found that Yemen was home to 37% of all those classified as in humanitarian need regionally (21.2 million or 82% of the Yemeni population). Some 54% of the population lack access to health care, second regionally only to Syria (UN OCHA 2016a).

The purpose of the analysis presented in this article is several-fold. First, we assess health system performance in Yemen prior to the internationalization of the conflict, to construct a 'baseline' for analysis. Second, we describe the impact of the conflict on the health sector in Yemen to date, drawing on a variety of literature sources. Although a multitude of agency reports and local assessments have been produced, no comprehensive overview of the state of the health system in Yemen—set against the baseline situation before the internationalization of the conflict—yet exists. This article seeks to address that deficit, and in so doing, inform both near-term health system support activities, and longer-term reconstruction efforts when the conflict eventually subsides.

Methodology

Literature review approach

This literature review is based on a comprehensive data search comprising a combination of peer and non-peer reviewed literature searches, and secondary data analysis from authoritative sources. Literature searches incorporated peer-reviewed, academic articles published in English and Arabic between 1 January 2005 and 25 December 2016, identified through keyword database searches (PubMed and Medline, WHO databases), and non-peer reviewed papers and reports from a range of relevant sources including multi-lateral bodies, major international aid donors and organizations either delivering large vertical programmes in Yemen, or with long-standing health sector programming activities in-country. Literature searches were carried out initially between 4 and 15 January 2016, with a revised set of searches conducted between 12 and 16 September 2016, and again between 20 and 25 December. A list of keywords used to structure these searches is provided in Box 1 below. A formal systematic review approach was not considered appropriate for this analysis because of the rapidity with which circumstances on the ground have changed over the past year—necessitating a broad approach to evidence inclusion and synthesis, and we did not conduct formal critical appraisal of sources used.

A 'before and after' study approach is used in this analysis, taking March 2015 as the threshold in time between 'before' and 'after'

Box 1. Search terms and inclusion criteria**Search terms (not necessarily MeSH terms given application to organizational publication lists)**

health; health system; health policy; governance; health care worker; health workforce; health financing; maternal health; child health; infectious disease; communicable disease; chronic disease; non-communicable disease; NCD; malnutrition; conflict

AND Yemen OR Republic of Yemen OR Yemeni

Inclusion criteria

- Peer reviewed journal articles and non-peer reviewed grey literature reports
- Published in English or Arabic
- Published between 1 January 2005 and 25 December 2016
- Article or report fully accessible to the authors

Exclusion criteria

- Journal correspondence or editorial articles

with respect to the conflict in Yemen. Although there was localized fighting in Yemen before this cut-off point, the escalation in its scale, scope and intensity from March 2015 marked a fundamental shift in the dynamic of the conflict.

Conceptual framework for the review

The research literature on health systems is large and a multitude of frameworks exist for health system analysis in different contexts (e.g. Shakaraishvili *et al.* 2010; Berman and Bitran 2011; Van Olmen *et al.* 2012), or addressing specific aspects of health system functionality (e.g. Barbazza and Tello 2014), though few explicitly considering conflict and post-conflict settings. The conceptual framework employed in this review draws on work by De Savigny and Adam (2009) in developing the WHO's basic 'Building Blocks' approach to health systems analysis, providing greater recognition to interconnections between the building blocks of a functioning health system than the original WHO framework, and—crucially—recognizing the central importance of people (as citizens, civil society organizations and networks of interested parties) in influencing health system activities. This framework was used to guide the way in which results were reported below, by providing a series of health system domains against which to evaluate health performance in Yemen both before and during the conflict. These domains are outlined in Figure 1 below.

Results

In the following section, results from the literature review are presented thematically according to the building blocks identified in Figure 1, starting with a baseline analysis prior to the internationalization of the conflict in Yemen in March 2015. This is followed by a summary of available data on health system effects of the conflict, and health outcomes since March 2015.

Health system development in Yemen to March 2015**Leadership and governance**

Health care is guaranteed by the state as a right to all citizens under the Yemeni constitution. Historically, the Ministry of Public Health and Population (MoPHP) was responsible for delivery of health care and overall health system governance. However, the MoPHP assumed a more supervisory role after the Yemeni parliament adopted a local administration law in 2000 giving the 22 Governorates in the country the autonomy to manage some services on a local level (UN DPADM 2004). Accordingly, the Governorate

health offices (GHOs) became the body responsible for health at Governorate level. Health care in Yemen prior to the conflict was therefore governed at three levels: centrally by the MoPHP, at governorate level by the GHOs, and locally by District Health Offices. Centrally the MoPHP's governance remit extended across four sectors: primary health care, population health, curative care and planning and development.

Governance assessments for what was a very heterogeneous health sector in Yemen prior to the conflict, suggest both governance weaknesses, and that corruption was a significant problem down to facility level, especially with respect to costs and procurement of consumables (USAID 2006; World Bank 2010). Global governance assessments persistently ranked Yemen near the bottom among 168 countries measured on public sector corruption (Transparency International 2015). There were also governance shortfalls in important domains—mental health and psychosocial support services, e.g. Weak policy commitment was evident in the fact that although national mental health plans did exist, they had been unchanged since the early 1980s and there was no formal legislation governing mental health in Yemen (Okasha *et al.* 2012).

Health financing

An examination of financing for health in Yemen prior to the conflict reveals a fragmented system heavily reliant on private, out-of-pocket spending. Public expenditure on health as a proportion of GDP hovered at around 4% in the years leading up to the conflict. However, there was a gradual shift over the 2000s in the balance of expenditure from different sources: the proportion of total expenditure on health contributed by the state fell to around 23% in 2014 from 54% in 2000, while private, out-of-pocket expenditure contributed over 75% of total expenditure on health by 2014 (WHO 2016a) compared with 43% in 2000. As elsewhere, most out-of-pocket contributions in Yemen before the conflict were in the form of flat-rate user charges for inpatient and outpatient services, and while small-scale employment-based or informal health financing schemes did emerge during the 2000s these were limited in scope (Holst and Gericke 2012). Rising treatment fees combined with high transport costs for patients (especially from rural areas), created significant access barriers (Anderson de Cuevas *et al.* 2014). Changes in the balance of expenditure on health in Yemen between public and private sources in the run-up to the conflict were exacerbated by a precipitous decline in external resources for health to <50% of levels for 2012 (Table 1), probably due to a combination of ongoing unrest, instability and insecurity that was witnessed following the

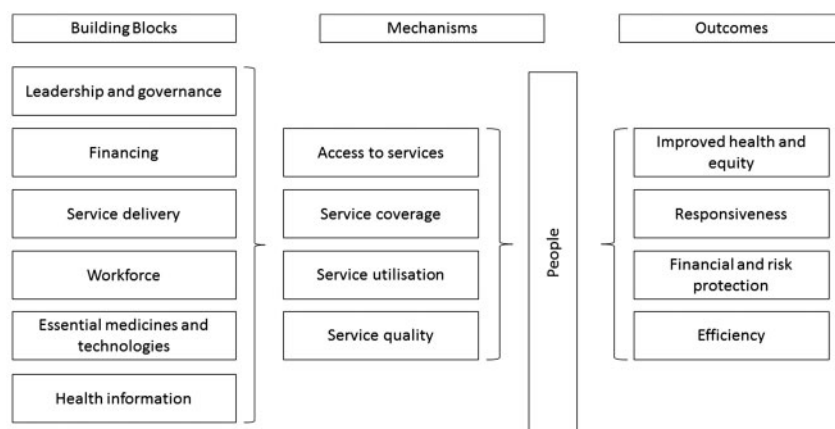


Figure 1. The WHO's health system building blocks framework as visualized by de Savigny [source: adapted from de Savigny (2009)]

Table 1. Expenditure on health in Yemen by source, 2005–16 compared with the WHO Eastern Mediterranean Region (EMR) and World Bank lower middle-income country comparators

Domain	Yemen		WHO EMR ^a average		World Bank lower-middle-income group ^b	
	2005	2014	2005	2014	2005	2014
Total expenditure on health as percentage of GDP (%)	4.58	5.64	3.90	4.80	4.20	4.50
General Government expenditure on health as percentage of total expenditure on health (%)	33.86	22.56	51.20	56.80	33.20	36.20
Out-of-pocket expenditure on health as percentage of total health expenditure (%)	64.78	76.42	41.55	35.09	59.21	55.86
General Government expenditure on health as percentage of total Government expenditure (%)	4.79	3.93	7.30	7.90	6.10	6.70
External resources for health as percentage of expenditure (%)	2.03	6.38	0.90	1.20	3.10	3.30

Source: WHO (2016a).

^aEMR, Eastern Mediterranean Region.

^bWorld Bank lower middle-income group countries are defined as those with a Gross National Income (GNI) per capita of between \$1026 and \$4035 (at Purchasing Power Parity) in 2017; the last recorded GNI per capita for Yemen—on which this classification is based—was \$3660 for the year 2013, i.e. prior to the outbreak of fighting.

‘Arab Spring’ uprisings, and the gradual withdrawal of international donors as a result.

Service delivery and quality of care

Health services in Yemen before the start of the conflict were organized at primary, secondary and tertiary health care levels with a small number of specialized centres in urban areas. Yemen's district health system (across 334 districts) was complemented by vertical programmes that focused on the prevention and control of diseases nationwide, with technical and financial support from international organizations and donors including WHO, the Global Alliance for Vaccines and Immunizations and the Food and Agriculture Organization (FAO). These included the expanded programme on immunization, national roll-back malaria programme and nutrition programmes. Besides MoPHP-run centres, curative health services were also provided by third parties such as the Military, Police and Aden Refinery. Importantly, there was a significant presence for unregulated private sector curative care providers in urban areas (Aulaqi 2014) with low levels of public satisfaction with services (WHO EMRO 2014).

Service delivery was characterized by significant inequalities in availability and access between urban and rural areas, partly reflected in weak indicator performance for access to reproductive health

services and immunization compared with regional neighbours (Table 2). Challenges to service provision particularly in rural areas included sporadic access to essential medicines, shortages of equipment—notably for emergency obstetric care, where some facilities lacked basic newborn resuscitation equipment in studies conducted in the years before 2015 (Al Serouri *et al.* 2009)—and lack of access to basic utilities including electricity especially in rural areas. For patients, distance to facilities was a significant problem; 59% of women surveyed in two studies in 2013 cited this as a barrier to accessing reproductive care (Bawazir *et al.* 2013; Republic of Yemen 2013). Although there has been an essential service package for Yemen—focused on maternal and child health—since 2004, the extent to which this was implemented in the pre-conflict period is uncertain (Wright 2015). Finally, although the literature on quality of care in Yemen is sparse, available evidence suggests that curative care services were of generally poor quality (Anbori *et al.* 2010; Webair *et al.* 2015)—particularly with respect to patient perceptions of care—and were neither readily available nor accessible across the country, especially in rural areas (Bawazir *et al.* 2013; Republic of Yemen 2013).

Medicines and medical technologies

Issues in delivery and quality of care may have been partly attributable to long-standing problems of medicines supply, regulation and quality

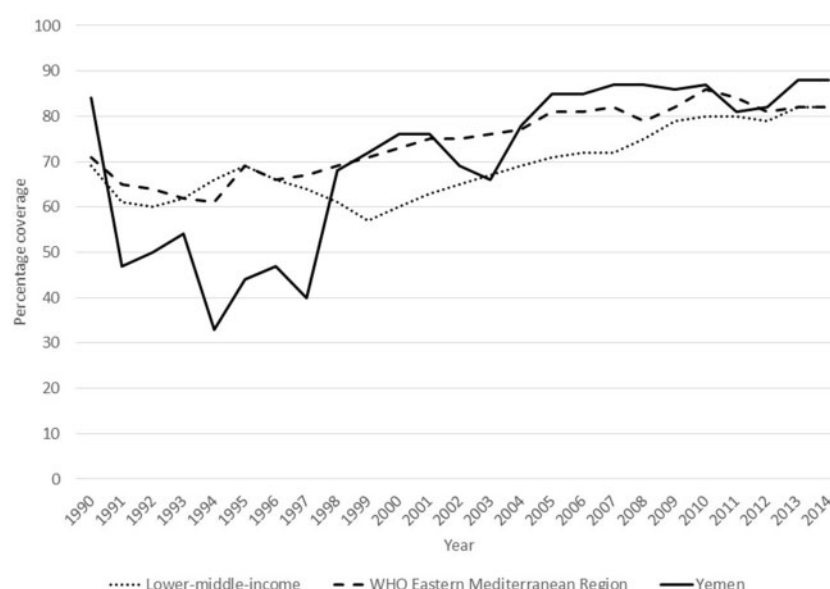
Table 2. Selection of key health outcome indicators for Yemen from 2005 to 2014; a column listing relevant figures across the WHO EMR is provided for comparison

Domain	Indicator	Yemen		WHO EMR
		2005 (unless otherwise stated)	2014 (unless otherwise stated)	2014 (unless otherwise stated)
Global indicators	Life expectancy at birth ^a	64.6	67.1	68.8
	Literacy rate among adults aged 15 and over (%) ^b		65 (2012)	69 (2012)
	Stunting among children aged 5 and under (%) ^c		46.6 (2011)	28.2 (2010)
	GNI per capita ^b	\$3460	\$3820 (2013)	\$10 968 (2013)
Child health	Infant mortality (per 1000 live births) ^b	54.5	35.1	41.6
	Under-5 mortality (per 100 000) ^a	1428.29	929.91	1136.67 (2010)
	Percentage of children under 12 months immunized against measles—MCV1 (MCV2), ^c	76 (25)	75 (53)	76 (N/A)
Maternal and reproductive health	Maternal mortality ratio (per 100 000 births) ^a	346.93	299.23	241.55
	Deliveries attended by qualified medical staff (%) ^b		43 (2013)	67 (2013)
	Women receiving antenatal care (four or more visits) (%) ^b		25.1 (2013)	56 (2013)
	Delivery in a health facility (%) ^b		30 (2013)	
	Family planning (modern method) (%) ^b		47 (2013)	58.4 (2015 estimate)
	Fertility rate ^b	6.2 (2003)	4.1 (2013)	3.3 (2013)
Communicable disease	Malaria incidence rate (per 100 000) ^a	715.65	619.52 (2010)	1076.08 (2010)
	Lower respiratory tract infection mortality rate (per 100 000) ^a	46.37	30.08	35.36 (2010)
Non-communicable disease	Prevalence of cardiovascular disease ^a	3.97	3.93 (2010)	5.04 (2010)
	Prevalence of cerebrovascular disease ^a	0.36	0.37 (2010)	0.44 (2010)
	Prevalence of chronic respiratory disease ^a	8.70	8.23 (2010)	7.17 (2010)

Sources:

^aInstitute for Health Metrics and Evaluation (2016).^bWHO (2016a).^cWHO vaccine-preventable disease monitoring system (2016).

EMR, Eastern Mediterranean Region; MCV1, measles containing vaccine 1 (first dose); MCV2, measles containing vaccine 2 (second dose).

**Figure 2.** Diphtheria, tetanus toxoid and pertussis immunization coverage among 1-year-olds (%)—a standard marker of health service delivery—for Yemen compared with the WHO EMR and World Bank lower-middle income country group averages [source: WHO (2016a)]

control prior to the internationalization of the conflict. Although WHO data indicate that pricing for generic medicines in Yemen was generally competitive by international standards during this period (as indicated by the median consumer price ratio) (WHO 2016a), problems of irregular drug supply, weak regulation and quality control in the pharmaceutical sector, and a rising challenge of counterfeiting were widely acknowledged up to early 2015 (Yemen MoPHP/WHO 2012).

Human resources for health

Workforce concerns in Yemen pre-conflict included inequitable distribution of healthcare workers (HCWs) nationwide, but particularly in rural areas. Physician density in Yemen in 2013 was 2 per 10 000 population, with 3 hospitals per 100 000 population—figures that are broadly consistent with other low-income countries (WHO 2015). However, shortages of female HCWs in particular were

identified as a major barrier to access for women, possibly accounting for a markedly low Caesarian section rate in Yemen at 0.5% (Al Serouri *et al.* 2012). Mental health service provision was also limited: there were 0.5 psychiatrists and 0.09 psychiatric nurses per 100 000 people in Yemen in 2007, two of the lowest ratios in the Arab World (Okasha *et al.* 2012). Public sector HCW pay and retention were, as in many other low-income countries, significant problems; dual job-holding in public and private sector clinics was common (Aulaqi 2014).

Health information and intelligence

Tracking the effect of health system activity on health outcomes in Yemen prior to the conflict is complicated by limitations to health information gathering. Although key statistics were routinely collected by the state-funded Central Statistical Organization and a developing Health Management Information System (HMIS), and the vertical programmes gathered quite detailed monitoring information, health intelligence gathering was hampered by weak capacity in respect of data management and dissemination, and in particular challenges with information relay especially from rural areas (Republic of Yemen/Health Metrics Network 2009). A new electronic Disease Early Warning System (eDEWS) was introduced with support from international organizations to provide improved case report data and support communicable disease surveillance using mobile phone technology—with generally good sentinel site coverage (90% or more) (Ahmed *et al.* 2014).

Health outcomes in Yemen to March 2015

Significant improvements were achieved in Yemen from 2005 to 2013 against a number of key indicators in maternal and child health, and communicable diseases such as Malaria (Table 2). There were marked improvements in life expectancy and, in particular, a reduction in child mortality rates at national level, and Yemen performed well even by comparison with other low-income countries and regional neighbours on some measures (Figure 2 and Table 2).

Data from the Global Burden of Disease study show that the most important causes of years of life lost in Yemen before the internationalization of the conflict continued to be lower respiratory tract infections, diarrhoeal disease and other communicable diseases, and birth complications (Mokdad 2016a). Cardiovascular and cerebrovascular disease were emerging health issues in Yemen (with population prevalence rates of 3.93 and 0.37%, respectively in 2010), but prevalence rates for many non-communicable diseases were well below regional average for the Eastern Mediterranean—with the exception of chronic respiratory conditions (Table 2). Chronic food insecurity was also a major challenge before the beginning of the conflict, and nutritional deficiencies were among the primary causes of years lived with disability in Yemen in 2013 (Mokdad *et al.* 2016). A World Food Programme survey in November 2014—4 months before the conflict began—found that some 10.6 m people (around 41%) of the population were food insecure, with important disparities in degrees of food insecurity between urban (26% of the population) and rural (48%) areas (World Food Programme 2014). However, important strides were made in addressing severe acute malnutrition (SAM) among children especially over 2014, where the estimated number affected fell from 280 000 to 160 000 (UN OCHA 2015a).

In summary, key population health challenges facing the health sector in Yemen prior to the onset of fighting included a lower than regional average life expectancy, enduring problems of malnutrition and endemic poverty. In health system terms, political commitment

to health sector development was low and public funding in decline with evidence of weak service penetration nationwide. Challenges included a need to cater for 4171 health facilities dispersed unevenly across the country (and with some two-thirds of the population living in rural areas), limited health governance capacity especially at the periphery, and weak human resource development policies.

The impact of conflict on health system functionality in Yemen since March 2015

Leadership and governance

Core health system governance functions in Yemen have deteriorated significantly since the onset of fighting. Coordination of the health response within Yemen, formally led by the MoPHP in partnership with the WHO regional office, incorporates some 20 partner organizations including the International Committee of the Red Cross and *Médecins Sans Frontières* (MSF) as part of a health cluster (Gavlak 2015). However, the effectiveness of this response mechanism has been questioned; the decision by many international actors in Yemen to evacuate a majority of their staff as the conflict escalated in March 2015 may have undermined both the coordination and the timeliness of the response to emerging population health needs (Cunningham 2016).

Health financing

In funding terms, the health system in Yemen is experiencing a crisis on two fronts. On one hand, public expenditure has fallen as public administration functions have deteriorated and the economy has contracted. The annual GDP growth rate for Yemen in 2015 was -32.9% , and is predicted to be -12.8% in 2016 (Yemen MoPIC 2016a,b). Prior to the conflict, staff salaries accounted for 30–40% of all expenditure by the MoPHP. On the other hand, international aid funding has also fallen precipitously as an increasing number of organizations have either scaled back their activities in Yemen or withdrawn from the country altogether (Yemen MoPIC 2015). Total external loan and grant funding disbursement to the Yemeni health sector fell from \$51.3 m in 2014 to \$1 m in 2015, in line with the suspension of support from all but a handful of donors following the internationalization of the conflict (Yemen MoPIC 2016a). Persistent under-funding of the humanitarian response plan has—in common with other countries in conflict worldwide—been a significant challenge in Yemen; the WHO's own response plan for 2016 received 24% of total requested funding (WHO EMRO 2016d). Taken together, these funding reductions have contributed to major challenges for public health service delivery since March 2015.

Service delivery and quality of care

Services in public health facilities have been subject to reductions due to direct attack and damage to infrastructure on which delivery depends (e.g. roads, electricity and water supplies), in addition to workforce and supply shortages. According to WHO-conducted Health Resources and Services Availability Mapping System (HeRAMS) survey conducted in February–June 2016 (Yemen MoPHP/WHO EMRO 2016b), 17% of 3507 health facilities assessed were 'non-functional' (i.e. no services currently offered either as a result of critical infrastructure damage, absence of staff, lack of equipment, or physical inaccessibility) and a further 38% 'partially functional' (some, but not all services currently offered) (WHO EMRO 2015a). Direct or indirect attacks on health facilities have been a prominent feature of the conflict from the start, with around 8% of facilities in the 2016 HeRAMS survey being either partially or completely destroyed at the point of assessment. Attacks on

Table 3. Selection of key health outcome indicators for Yemen since the escalation of the conflict, by comparison with baseline, where data are currently available; a column listing relevant figures across the WHO EMR is provided for comparison

Domain	Indicator	Yemen		WHO EMR	
		2014 (unless otherwise stated)	2015	2014 (unless otherwise stated)	2015
Global indicators	Life expectancy at birth ^a	67.10	66.00	68.80	68.80
Child health	Infant mortality (per 1000 live births) ^b	35.10	33.80	41.60	40.50
	Under-5 mortality (per 100 000) ^a	929.91	1135.39	1136.67 (2010)	941.76
	Percentage of children under 12 months immunized against measles—MCV1 (MCV2), ^c	75 (53)	75 (49)	76 (N/A)	76 (N/A)
	Maternal mortality ratio (per 100 000 births) ^a	299.23	307.42	241.55	238.35
Maternal and reproductive health					
Communicable disease	Malaria incidence rate (per 100 000) ^a	619.52 (2010)	571.24	1076.08 (2010)	1018.69
	Lower respiratory tract infection mortality rate (per 100 000) ^a	30.08	29.80	35.36 (2010)	29.47
Non-communicable disease	Prevalence of cardiovascular disease ^a	3.93 (2010)	4.02	5.04 (2010)	5.18
	Prevalence of cerebrovascular disease ^a	0.37 (2010)	0.37	0.44 (2010)	0.45
	Prevalence of chronic respiratory disease ^a	8.23 (2010)	8.14	7.17 (2010)	7.48

Sources:

^aInstitute for Health Metrics and Evaluation (2016).^bWHO 2016a.^cWHO vaccine-preventable disease monitoring system (2016).

EMR, Eastern Mediterranean Region; MCV1, measles containing vaccine 1 (first dose); MCV2, measles containing vaccine 2 (second dose).

international health organizations have also occurred on a regular basis, including four on health facilities operated by MSF prompting that organization's withdrawal from all hospitals in Northern Yemen in August 2016 (*Médecins Sans Frontières* 2016). There is disparity in damage by governorate with Taiz, Aden, Sa'adah and Sana'a worst affected (*Yemen MoPHP/WHO EMRO* 2016b).

Direct targeting of health facilities, combined with reduced functionality because of damage to vital infrastructure, impaired fuel and electricity supplies, lack of supplies, HCW shortages, financing problems and restrictions on population movement have created a situation in which access to basic health services is becoming increasingly challenging (*Safeguarding Health in Conflict Coalition* 2016). The 2016 HeRAMS survey noted large shortfalls in service availability by domain even within those health facilities still operational, with trauma management (of any form) available at 34% of those surveyed, and maternal and new-born health at 35%. Other key service areas were also badly affected in the initial phases of the conflict, particularly Therapeutic Feeding Centres for malnutrition: closures were common during 2015 because of fuel shortages and access difficulties, although there has been some recovery since this time (*UN OCHA* 2015b). The proportion of the population without access to basic healthcare in August 2015 was estimated at 58%, and although this has since improved to 54%, over half of the Yemeni population remain without access (*UN OCHA* 2016a). A crude indication of access restrictions is given by the total number of consultations reported through eDEWS, which dropped by >50% in the first 3 months of the conflict before steadily returning to pre-conflict levels by the end of 2015 (*Yemen MoPHP/WHO EMRO* 2016a).

Core public health prevention work has also been adversely affected. Data suggest a precipitous decline in the extent of vaccination coverage in the initial phases of the conflict—notably for measles. Pre-crisis measles and rubella coverage ranged between 75 and 80% on average between 2004 and 2014, despite significant barriers to vaccination arising partly from the physical inaccessibility of some rural communities (*Al-Taïar et al.* 2010). There is some discrepancy in stated year-end estimates for 2015, with some data

showing a decline nationwide to just over 40% (across all age groups) (*Yemen MoPHP/WHO EMRO* 2015), but other sources indicating an upswing to 75% coverage for first-dose measles and rubella vaccination (MR1 only) among children aged under 1, largely as a result of intensive campaigns towards the end of the year (*WHO EMRO* 2016a; *WHO EMRO* 2016b).

Medicines and medical technologies

Medical supply shortages have proven a major impediment to health service delivery since the internationalization of the conflict, but particular challenges have arisen in provision of secondary or tertiary care interventions that depend on specialized equipment and drugs—notably renal dialysis, oncological care, and to a lesser degree, diabetes mellitus (*WHO EMRO* 2015d).

Human resources for health

Although it is not possible using available data to quantify precisely the toll on HCWs arising from the conflict in Yemen, a recently released WHO report based on secondary data analysis identified 31 deaths resulting directly from attacks on health facilities in the country in 2015 (although this figure does not distinguish between patients and HCWs and is likely to be a conservative estimate) (*WHO* 2016b), and evidence from other countries suggests that HCW deaths, injuries and flight are likely to be significant determinants of health service access to the wider population (*Roome et al.* 2014). Specialized services including renal dialysis have been badly affected because of their reliance on costly equipment, reliable power supplies and trained personnel (*WHO EMRO* 2015b).

Health information and intelligence

From a health information perspective, reporting rates eDEWS have steadily recovered over the course of the conflict to 95% in the first week of 2016, but rates fell as low as 51% in 2015 (*Yemen MoPHP/WHO EMRO* 2016a). Data on HMIS reporting rates in Yemen are not publicly available at present.

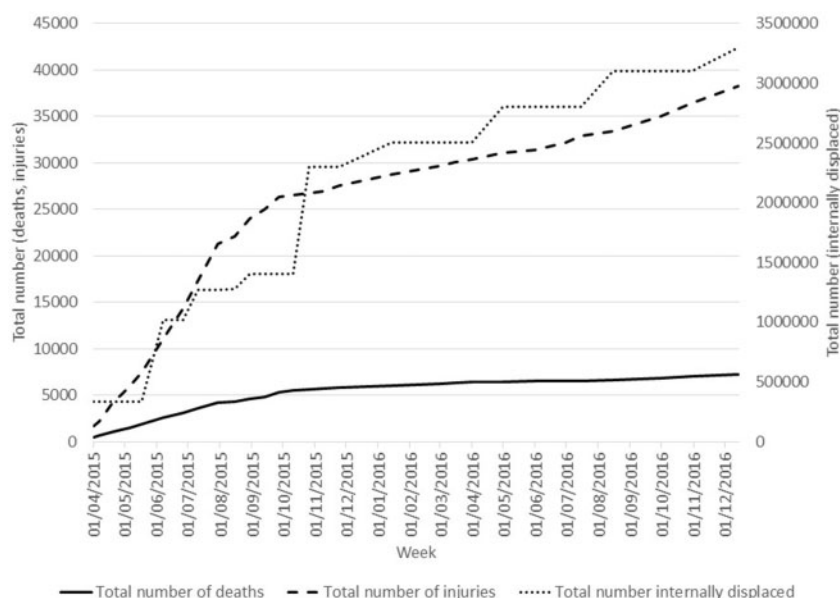


Figure 3. Secular trends in the number of deaths and injuries, and degree of internal displacement in Yemen from April 2015 to September 2016 [source: WHO EMRO Situation Reports for Yemen]

The impact of conflict on population health indicators and outcomes in Yemen since March 2015: a snapshot

At least 7200 individuals have died as a result of the conflict (50% of whom are civilians), and some 38 200 have been injured Figure 3 (UN OCHA 2016c). These figures are likely to underestimate the true burden of mortality and injuries because they include health-facility reported events only. The majority of deaths have occurred in densely populated civilian areas, mainly in the cities of Taiz, Aden, Sana'a and Sa'adah. UN agencies and various NGOs have repeatedly raised concerns about human rights violations and urged the coalition to stop indiscriminate bombing and use of cluster munitions in civilian areas (e.g. Human Rights Watch 2016). Around 3.3 million Yemenis are internally displaced (13.5% of the Yemeni population)—representing a >900% increase since the internationalization of the conflict. Many of those with the resources and capacity to leave Yemen have already done so (mainly the highly educated and wealthy), but the level of external displacement has been low overall (UN OCHA 2016c), particularly by comparison with the crisis in Syria (UN OCHA 2016a).

Wider population health impacts arising as a result of the conflict are now becoming increasingly apparent. Life expectancy in Yemen fell in 2015, and increases were also seen in under-5 child mortality and maternal mortality—the first setbacks to positive trends for these indicators for many years (Table 3). The effect on nutritional status population-wide has been profound, particularly among children. Around 462 000 children are affected by SAM (WHO EMRO 2016d), compared with an immediate pre-conflict figure of 160 000 (UN OCHA 2016d). Notably high pre-conflict rates of anaemia (86% among children under 5 in the 2013 Demographic and Health Survey (Republic of Yemen 2013)) increased to over 95% by the end of 2015 (Mokdad 2016b). The percentage of women of childbearing age who are malnourished rose from 11.6% in 2013 to 18.6% in 2015 (Mokdad 2016b). This worsening food security and malnutrition trajectory may be attributed to the combined effects of movement restrictions on goods imposed by all warring parties, reducing food supplies in many parts of the country (FAO 2016); and declining household incomes as the

cost of basic foodstuffs has risen (Yemen MoPIC 2016b). Nationally, data from the beginning of 2016 suggested that >60% of households were limiting meal sizes to help cope with worsening food security (UN OCHA 2016c). Governorate-level surveys in 2015 indicated increasing reliance at household level on unsustainable coping strategies including meal-skipping even at that early stage in the conflict (Yemen MoPHP/UNICEF 2015).

From a communicable disease perspective, the conflict has exposed vulnerabilities in terms of both prevention and outbreak response. Variable vaccination coverage noted above has not yet translated into a rising case burden, but current immunization coverage falls well below the 90% herd immunity threshold for measles (Orenstein *et al.* 2000). Outbreak control has also become increasingly challenging—as evidenced by a large Dengue Fever outbreak across a number of governorates in 2015. Although past outbreaks of Dengue Fever have been localized in geographical spread, and time-limited in duration (Bin Ghouth *et al.* 2012), in 2015 there was an outbreak of much larger magnitude with a reported caseload ranging from 13 846 to 14 509, across a much wider range of governorates. Although cases presented predominantly in urban areas (as in the past) where access has been easier than in remoter rural areas, implementation of basic Dengue control measures including bednet distribution and fumigation are challenging (Al Yousefi *et al.* 2016) and have been made immeasurably more difficult by ongoing insecurity.

Describing the impact of the conflict on non-communicable disease (NCD) burden with clarity is far more challenging—in part because communicable diseases accounted for the majority of years of life lost in Yemen before the conflict, but also because of long-standing weaknesses in data collection systems. The limited data available show a steady increase in the prevalence of cardiovascular and cerebrovascular disease in Yemen between 2010 and 2015 (Table 3). There is anecdotal evidence to suggest that vulnerable groups such as the elderly have suffered disproportionately as a result of indiscriminate attacks, population displacement and lack of access to routine healthcare including NCD medications, but robust data are in short supply (WHO EMRO 2015c).

Discussion

This analysis has shown that despite profound structural and health sector vulnerabilities in the years leading up to 2015 important health gains were achieved in Yemen in certain domains (notably increases in overall life expectancy, and reductions in infant and under-5 child mortality rates). Following the internationalization of the conflict in the country in March 2015, there is mounting evidence that the Yemeni health system is disintegrating as a result of weakening national oversight, worsening access to health services in the context of severe financing restrictions and—in particular—ongoing threats to the safety of citizens, HCWs and health facilities. These have translated, for the first time in recent years in Yemen, into worsening performance against key health outcomes including life expectancy, under-5 child mortality and maternal mortality. There is particularly concerning evidence of a rapid increase in the number of children affected by SAM, an indication of worsening food insecurity and weakening access to supportive healthcare services in many parts of the country.

Drawing clear parallels between the situation in Yemen and other FCAS settings presents significant methodological challenges. At first glance the Yemeni case shares important features in common with other recent conflicts, especially in the Middle East, where HCWs and health facilities have been subject to direct and indirect attack (e.g. Burnham *et al.* 2012). However, trends in morbidity and mortality in Yemen are at marked variance to the ongoing conflict in Iraq or indeed Syria, a middle-income country where war-related injuries and poorly controlled NCD account for the bulk of years of life lost (Ben Taleb *et al.* 2015; Mokdad *et al.* 2016). Data from Yemen bear closer similarities to evidence from conflicts in sub-Saharan Africa in the 1990s and 2000s, where malnutrition, diarrhoeal diseases, respiratory tract infections and measles made major contributions to case fatality rates (Toole and Waldman 1997; Spiegel *et al.* 2010). A striking feature of the Yemeni conflict has been the low volume of external relative to internal displacement compared with other recent conflicts (IDMC 2016), a factor that has likely compounded the scale of the shock to the health system (Figure 3).

There are important limitations to the analysis presented here—most relating to the low volume and quality of data from Yemen, in common with many other FCAS. First, robust assessment of the population health impact of conflict is difficult, and estimates of mortality and morbidity are overwhelmingly based on health facility-reported data, likely capturing only a proportion of the overall burden of disease in Yemen. A comprehensive assessment of the population health impact of the conflict in Yemen was, however, beyond the scope of this paper given our primary focus on the health system. Second, the exclusion of certain sources (in particular media sources and personal testimony from key informants) may have resulted in important, emerging evidence on health system impacts arising from the conflict being overlooked. A fuller assessment of health system activity since the internationalization of the conflict would include evidence from these additional sources, with appropriate weighting to reflect the nature of the material.

Further, important questions about health system functionality remain unanswered and provide the outlines of a research agenda for Yemen. In particular, there is a need to build a clearer understanding of variations in the intensity of the conflict across the country and how these have been experienced by local health actors. Second, the extent of HCW flight is unclear. Since there is evidence from other settings that human resources for health should be priority for reconstruction efforts in the post-conflict period (WHO

2005), and that this often depends on the degree of protection offered to HCWs during the fighting (Namakula and Witter 2014), building a clearer picture of the scale and scope of HCW flight, and where deficits in expertise may now lie, should be a priority for agencies involved in the response and for academic researchers. Thirdly, there is very little evidence from Yemen on coping strategies in the health sector, including citizens' means for managing health-care costs, and the degree to which non-state actors have been able to fill widening gaps in public sector service provision since the beginning of the conflict. Non-state actors have often adopted key roles in health service provision during conflict in other settings (e.g. Ab Barnabas and Zwi 1997; Howard *et al.* 2014), and may assume important functions in the post-conflict period (Hill *et al.* 2014). Finally, very little can be said of perceptions of healthcare (both public and private) among Yemenis. All of the above point to wider shortfalls in data collection both before and during the conflict.

Identifying suitable health system priorities in the context of a dynamic and ongoing conflict is challenging, but evidence from other FCAS suggests limited health system strengthening work is possible (Newbrander *et al.* 2011; Jones *et al.* 2015). In the near term, firm guarantees regarding the safety of civilians and the preservation of health facilities and health workers are required from the warring parties, which thus far have not been forthcoming. From a health service perspective, evidence exists on the kinds of health service packages that are likely to deliver improvements in health outcomes for displaced people in conflict settings (Spiegel *et al.* 2010), and work is urgently needed to redefine service packages for Yemen that prioritize basic services while recognizing variations in local circumstances across the country. In the medium-term, planning for health system rehabilitation and reconstruction must begin as soon as possible. Ensuring access to reliable and detailed health information will be critical to this effort, and plans should be put in place forthwith to ensure that a robust, national assessment of health needs can be carried out as soon as a reduction in the intensity of the conflict permits.

Conclusion

This review has described significant and wide-ranging impacts of escalating conflict on health system functionality and health outcomes in Yemen, including worsening life expectancy, child and maternal mortality rates and rising rates of SAM. Important areas of uncertainty remain, however, including the scale of health worker flight, and the extent to which alternative providers have stepped in to deliver widening service gaps as the conflict has unfolded. Strengthening health information and monitoring systems is an urgent priority as the conflict continues, and planning for reconstruction should begin as soon as possible.

Acknowledgements

We would like to thank the Public Health in Humanitarian Crises Group at London School of Hygiene and Tropical Medicine for the opportunity to deliver a seminar at which some of the material included in this review article was first presented.

Conflict of interest statement. S.A.I. was co-investigator on a project that was part-funded by Saferworld, for the purposes of diaspora engagement work on the conflict in Yemen. The research leading to this manuscript was separate from that project, however. The authors have no other conflicts of interest.

Note

1. The governorates are the highest administrative divisions in Yemen at sub-national level. Of the 22 governorates in Yemen before the start of the conflict, one (Sana'a City) was a municipality. Each governorate is in turn divided into districts, of which there were 333 nationwide before the conflict.

References

- Ahmed K, Altaf MD, Dureab F. 2014. Electronic Infectious Disease Surveillance System during Humanitarian Crises in Yemen. *Online Journal of Public Health Informatics* 6: e134.
- Al Serouri AW, Al Rabee A, Bin Afif M, Al Rukeimi A. 2009. Reducing maternal mortality in Yemen: challenges and lessons learned from baseline assessment. *International Journal of Gynaecology and Obstetrics* 105: 86–91.
- Al Serouri AW, Al Rukeimi A, Bin Afif M *et al.* 2012. Findings from a needs assessment of public sector emergency obstetric and neonatal care in four governorates in Yemen: a human resources crisis. *Reproductive Health Matters* 20: 122–8.
- Al-Taiar A, Clark A, Longenecker JC, Whitty CJ. 2010. Physical accessibility and utilization of health services in Yemen. *International Journal of Health Geographics* 9: 38.
- Al Yousefi TA, Abdul-Ghani R, Mahdy MA *et al.* 2016. A household-based survey of knowledge, attitudes and practices towards dengue fever among local urban communities in Taiz Governorate, Yemen. *BMC Infectious Diseases* 16: 543.
- Alliance for Health Policy and Systems Research. (2008). Neglected Health Systems Research: Health Policy and Systems Research in Conflict-Affected Fragile States. Research Issues paper number 1. http://www.who.int/alliance-hpsr/AllianceHPSR_ResearchIssue_FragileStates.pdf, accessed 18 March 2016.
- Anburi A, Ghani SN, Yadav H *et al.* (2010). Patient satisfaction and loyalty to the private hospitals in Sana'a, Yemen. *International Journal for Quality in Health Care*. <http://dx.doi.org/10.1093/intqhc/mzq029>
- Anderson de Cuevas RM, Al-Sonboli N, Al-Aghbari N *et al.* 2014. Barriers to completing TB diagnosis in Yemen: services should respond to patients' needs. *PLoS One* 9: e105194.
- Aulaqi A. (2014). On the Edge: the challenges of Yemen's healthcare system. Chapter 12. In: Lackner H (ed). *Why Yemen Matters*. London: SAQI books
- Barbazzia E, Tello JE. 2014. A review of health governance: definitions, dimensions and tools to govern. *Health Policy* 116: 1–11.
- Ab Barnabas G, Zwi A. 1997. Health policy development in wartime: establishing the Baito health system in Tigray, Ethiopia. *Health Policy and Planning* 12: 38–49.
- Bawazir AA, Bin Hawaii TS, Al-Sakkaf KA *et al.* 2013. Distribution and utilization of curative primary healthcare services in Lahej, Yemen. *Public Health* 127: 867–71.
- Ben Taleb Z, Bahelah R, Fouad FM *et al.* 2015. Syria: health in a country undergoing tragic transition. *International Journal of Public Health* 60: 63–72.
- Berman P, Bitran R. (2011). *Health systems analysis for better health system strengthening*. World Bank Health, Nutrition and Population Discussion Paper. Washington: World Bank. <http://siteresources.worldbank.org/HEALTHNUTRITIONANDPOPULATION/Resources/281627-1095698140167/HealthSystemsAnalysisForBetterHealthSysStrengthening.pdf>, accessed 29 December 2016.
- Bin Ghouth AS, Amarasinghe A, Letson GW. 2012. Dengue outbreak in Hadramout, Yemen, 2010: an epidemiological perspective. *The American Journal of Tropical Medicine and Hygiene* 86: 1072–6.
- Burnham G, Malik S, Dhari Al-Shibli AS *et al.* 2012. Understanding the impact of conflict on health services in Iraq: information from 401 Iraqi refugee doctors in Jordan. *The International Journal of Health Planning and Management* 27: e51–64.
- Cunningham A. (2016). To stay and deliver? The Yemen humanitarian crisis 2015. Medecins Sans Frontieres Emergency Gap Series, No 2. https://emergencygap.msf.es/sites/default/files/Emergency%20Gap%20Series_2_Stay%20and%20Deliver_Yemen%20Crisis%202015_April%202016.pdf, accessed 28 December 2016.
- De Savigny D, Adam T. (2009). *Systems Thinking for Health Systems Strengthening*. Geneva: World Health Organization.
- FAO. (2016). Integrated Food Security Phase Classification: Republic of Yemen. June 2016. http://www.ipcinfo.org/fileadmin/user_upload/ipcinfo/docs/1_IPC_Yemen_June2016_AcuteFoodInsecurityAnalysis_CommunicationBrief.pdf, accessed 30 December 2016.
- Gavlak D. 2015. Health system in Yemen close to collapse. *Bulletin of the World Health Organization* 93: 670–1.
- Haar RJ, Rubenstein LS. 2012. Health in fragile and post-conflict states: a review of current understanding and challenges ahead. *Medicine, Conflict and Survival* 28: 289–316.
- Hill PS, Pavignani E, Michael M *et al.* 2014. The “empty void” is a crowded space: health service provision at the margins of fragile and conflict affected states. *Conflict and Health* 8: 1.
- Holst J, Gericke CA. 2012. Healthcare financing in Yemen. *International Journal of Health Planning and Management* 27: 198–225.
- Howard N, Woodward A, Patel D *et al.* 2014. Perspectives on reproductive healthcare delivered through a basic package of health services in Afghanistan: a qualitative study. *BMC Health Services Research* 14: 1.
- Human Rights Watch. (2016). Yemen: coalition drops cluster bombs in capital. 7 January 2016. <https://www.hrw.org/news/2016/01/07/yemen-coalition-drops-cluster-bombs-capital-0>, accessed 24 February 2016.
- IDMC. (2016). *Global Report on Internal Displacement* 2016. Geneva: IDMC. <http://reliefweb.int/sites/reliefweb.int/files/resources/2016-global-report-internal-displacement-IDMC.pdf>, accessed 30 December 2016.
- Institute of Health Metrics and Evaluation. (2016). Global Health Data Exchange: Global Burden of Disease Study Results Tool. <http://ghdx.healthdata.org/gbd-results-tool>, accessed 16 December 2016.
- Iqbal Z. 2006. Health and human security: the public health impact of violent conflict. *International Studies Quarterly* 50: 631–49.
- Jones A, Howard N, Legido-Quigley H. 2015. Feasibility of health systems strengthening in South Sudan: a qualitative study of international practitioner perspectives. *BMJ Open* 5: e009296.
- Leaning J, Guha-Sapir D. 2013. Natural disasters, armed conflict, and public health. *New England Journal of Medicine* 369: 1836–42.
- Médecins Sans Frontières. (2016). Yemen: MSF withdraws its teams from six hospitals in north Yemen. <http://www.msf.org.uk/article/yemen-msf-withdraws-its-teams-from-six-hospitals-in-north-yemen>, accessed 22 September 2016.
- Mokdad AH. 2016a. The Global Burden of Disease: A critical resource for informed policy making in the Gulf region. *Journal of Health Specification* 4: 162–72.
- Mokdad AH. (2016b). *Health in Yemen: Losing Ground in a Time of Crisis*. Seattle: Institute for Health Metrics and Evaluation.
- Mokdad AH, Forouzanfar MH, Daoud F *et al.* 2016. Health in Times of Uncertainty: a systematic analysis for the Global Burden of Disease Study 2013 in the Eastern Mediterranean Region, 1990–2013. *The Lancet Global Health* 4: e704–13.
- Murray CJL, King G, Lopez AD, Tomijima N, Krug EG. 2002. Armed conflict as a public health problem. *BMJ* 324: 346–9.
- Namakula J, Witter S. 2014. Living through conflict and post-conflict: experiences of health workers in northern Uganda and lessons for people-centred health systems. *Health Policy and Planning* 29: ii6–14.
- Newbrander W, Waldman R, Shepherd-Banigan M. 2011. Rebuilding and strengthening health systems and providing basic health services in fragile states. *Disasters* 35: 639–60.
- OECD. (2015). *States of Fragility 2015: Meeting Post-2015 Ambitions*. Paris: OECD.

- Okasha A, Karam E, Okasha T. 2012. Mental health services in the Arab world. *World Psychiatry* 11: 52–4.
- Orenstein WA, Strebel PM, Papania M, Sutter RW, Bellini WJ, Cochi SL. 2000. Measles eradication: is it in our future? *American Journal of Public Health* 90: 1521–5.
- Republic of Yemen/Health Metrics Network. (2009). Health Information Systems Assessment Report. http://www.who.int/healthmetrics/library/countries/HMN_YEM_Assess_Final_2009_07_en.pdf, accessed 24 February 2016.
- Republic of Yemen. (2013). National Health and Demographic Survey for Yemen 2013. <http://dhsprogram.com/pubs/pdf/FR296/FR296.pdf>, accessed 24 February 2016.
- Roome E, Raven J, Martineau T. 2014. Human resource management in post-conflict health systems: review of research and knowledge gaps. *Conflict and Health* 8: 1.
- Rubenstein L. 2011. Post-conflict health reconstruction: search for a policy. *Disasters* 35: 680–700.
- Safeguarding Health in Conflict Coalition. (2016). No protection, no respect: health workers and health facilities under attack, 2015 and early 2016. <https://www.safeguardinghealth.org/sites/shcc/files/SHCC2016final.pdf>, accessed 7 September 2016.
- Shakarishvili G, Atun R, Berman P *et al.* 2010. Converging health systems frameworks: towards a concepts-to-actions roadmap for health systems strengthening in low and middle income countries. *Global Health Governance* 3:1–17.
- Spiegel PB, Checchi F, Colombo S, Paik E. 2010. Health-care needs of people affected by conflict: future trends and changing frameworks. *The Lancet* 375: 341–5.
- Transparency International. (2015). Corruption Perceptions Index 2015. <http://www.transparency.org/cpi2015>, accessed 24 February 2016.
- Toole MJ, Waldman RJ. 1997. The public health aspects of complex emergencies and refugee situations 1. *Annual Review of Public Health* 18: 283–312.
- Transparency International. (2015). Corruption Perceptions Index 2015. <http://www.transparency.org/cpi2015>, accessed 24 February 2016.
- UNDP. (2015). Human Development Report for Yemen 2015. <http://hdr.undp.org/en/countries/profiles/YEM>, accessed 24 February 2016.
- UN DPADM. (2004). Republic of Yemen: Public Administration Country Profile. United Nations Division for Public Administration and Development Management (DPADM) and Department of Economic and Social Affairs (DESA). <http://unpan1.un.org/intradoc/groups/public/documents/un/unpan023187.pdf>, accessed 29 December 2016.
- UN OCHA. (2015a). Yemen: Humanitarian Needs Overview 2015. https://www.humanitarianresponse.info/system/files/documents/files/2015_HNO_Yemen_Final_0.pdf, accessed 29 February 2016.
- UN OCHA. (2015b). Yemen Humanitarian Bulletin Issue 4–15 October 2015. https://www.humanitarianresponse.info/en/system/files/documents/files/yemen_humanitarian_bulletin_15_october_2015_1.pdf, accessed 29 December 2016.
- UN OCHA. (2016a). Middle East and North Africa: Crises in Focus - an overview of humanitarian needs in the region. https://gallery.mailchimp.com/8cf3bdfdba0a875ff6dd19093/files/MENA_HNO_Overview_ENGLISH_01.pdf, accessed 24 February 2016.
- UN OCHA. (2016b). Yemen Humanitarian Bulletin Issue 8— 1 February 2016. http://reliefweb.int/sites/reliefweb.int/files/resources/OCHA_Yemen_Hum_Bulletin_Jan_2016.pdf, accessed 24 February 2016.
- UN OCHA. (2016c). Yemen Humanitarian Bulletin Issue 18 – 14 December 2016. http://reliefweb.int/sites/reliefweb.int/files/resources/november_hb_issue_18.pdf, accessed 29 December 2016.
- UN OCHA. (2016d). Facts and figures on the humanitarian situation in Yemen. https://www.sheltercluster.org/sites/default/files/docs/yemen_crisis_fact_sheet_20160218.pdf, accessed 29 February 2016.
- USAID. (2006). Yemen Corruption Assessment. <https://yemen.usembassy.gov/root/pdfs/reports/yemen-corruption-assessment.pdf>, accessed 24 February 2016.
- van Olmen J, Marchal B, Van Damme W *et al.* 2012. Health systems frameworks in their political context: framing divergent agendas. *BMC Public Health* 12: 774.
- Webair HH, Al-Assani SS, Al-Haddad RH *et al.* 2015. Assessment of patient safety culture in primary care setting, Al-Mukala, Yemen. *BMC Family Practice* 16: 1.
- World Bank. (2010). *Yemen - Governance and Anti-Corruption Diagnostic Survey*. Washington, DC: World Bank. <http://documents.worldbank.org/curated/en/2010/03/16620607/yemen-governance-anti-corruption-diagnostic-survey>, accessed 24 February 2016.
- World Bank. (2015). GDP per capita (US dollars) 2015. <http://data.worldbank.org/indicator/NY.GDP.PCAP.CD>, accessed 24 February 2016.
- World Food Program(2014). Comprehensive Food Security Survey – Yemen. <http://documents.wfp.org/stellent/groups/public/documents/ena/wfp269771.pdf>, accessed 24 February 2016.
- WHO. (2005). *Guide to Health Workforce Development in Post-Conflict Environments*. Geneva: WHO. <http://www.who.int/hac/techguidance/tools/guide%20to%20health%20workforce%20development.pdf>, accessed 29 December 2016.
- WHO. (2015). *World Health Statistics*. Geneva: WHO
- WHO. (2016a). Global Health Observatory data repository. <http://apps.who.int/gho/data/node.main>, accessed 29 February 2016.
- WHO. (2016b). *Attacks on Health Care: Report on Attacks on Health Care in Emergencies*. Geneva: WHO. <http://www.who.int/hac/techguidance/attacksreport.pdf?ua=1>, accessed 7 September 2016.
- WHO EMRO. (2014). *Assessing the Regulation of the Private Health Sector in the Eastern Mediterranean Region: Yemen*. Cairo: WHO Regional Office for the Eastern Mediterranean.
- WHO EMRO. (2015a). Yemen crisis: tele-assessment of public health facilities, May–June 2015. <http://www.emro.who.int/images/stories/yemen/info-graphics-YEM-teleassessment-0715-final.pdf>, accessed 7 September 2016.
- WHO EMRO. (2015b). Yemen conflict: situation report number 13. <http://reliefweb.int/sites/reliefweb.int/files/resources/WHO%20Yemen%20sitrep%20Issue%2013.pdf>, accessed 24 February 2016.
- WHO EMRO. (2015c). Yemen conflict: situation report number 19. http://reliefweb.int/sites/reliefweb.int/files/resources/WHO_Yemen_situation_report_Issue19_10-24_Nov.pdf, accessed 24 February 2016.
- WHO EMRO. (2015d). Yemen conflict: situation report number 21. http://reliefweb.int/sites/reliefweb.int/files/resources/WHO_Yemen_situation_report_Issue21_8_-22_December_2015_rev.pdf, accessed 28 December 2016.
- WHO EMRO. (2016a). Yemen conflict: situation report number 22. http://www.emro.who.int/images/stories/yemen/WHO_Yemen_situation_report_Issue_1_2016.pdf?ua=1, accessed 24 February 2016.
- WHO EMRO. (2016b). *Factsheet: Routine Immunisation Coverage – Yemen 2015*. Sana'a: WHO EMRO.
- WHO EMRO. (2016c). Health facilities functionality and service availability: presentation based on preliminary findings of HeRAMS in 16 governorates, February–June 2016. Sana'a, 5th September.
- WHO EMRO. (2016d). Health in emergencies update: September–October 2016. http://reliefweb.int/sites/reliefweb.int/files/resources/WHO_in_emergencies_October_2016.pdf, accessed 28 December 2016.
- Woodward A, Sondorp E, Witter S, Martineau T. 2016. Health systems research in fragile and conflict-affected states: a research agenda-setting exercise. *Health Research Policy and Systems* 14: 51.
- Wright J. (2015). *Essential Package of Health Services Country Snapshot: Yemen*. Bethesda, MD: Health Finance & Governance Project, Abt Associates Inc
- Yemen MoPHP/UNICEF. (2015). SMART Survey: Hodeidah Governorate. August 2015.
- Yemen MoPHP/WHO (2012). Yemen Pharmaceutical Country Profile. Sana'a: MoPHP. http://www.who.int/medicines/areas/coordination/YemenPSCP_Narrative2012-12-16Final.pdf, accessed 22 September 2016.
- Yemen MoPHP/WHO EMRO. (2015). Measles/Rubella Surveillance Bulletin Week 52, 28 December 2015.
- Yemen MoPHP/WHO EMRO (2016a). *Weekly Epidemiological Bulletin* 3: 28 December 2015–3 January 2016. http://reliefweb.int/sites/reliefweb.int/files/resources/Weekly%20Epidemiological%20Bulletin%20Volume%2003b%20Issue%2053%20Epi%20week%2053%2028%20Dec%202015_3%20Jan%202016.pdf, accessed 24 February 2016.

- Yemen MoPHP/WHO EMRO (2016b). *Service Availability and Health Facilities Functionality in 16 Governorates*: final report, using HeRAMS. Sana'a: Yemen MoPHP/WHO EMRO. Online at: <http://www.moh.gov.ye/arabic/docs/Reports/HeRAMS%2016%20Govn%20final%20report.pdf>, accessed 31 January 2017.
- Yemen MoPIC. (2015). Yemen Socio-Economic Update No 7, September.
- Yemen MoPIC. (2016a). Yemen Socio-Economic Update No 16, July. http://eosc-yemen.org/images/DownloadCenter/Other/3rdSocio-EconomicUpdate/USEU-16th_En.pdf, accessed 28 December 2016.
- Yemen MoPIC. (2016b). Yemen Socio-Economic Update No 20, October. http://reliefweb.int/sites/reliefweb.int/files/resources/yseu20_english_v8_final.pdf, accessed 30 December 2016.