

# Adverse health consequences of the Iraq War

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The adverse health consequences of the Iraq War (2003–11) were profound. We conclude that at least 116 903 Iraqi non-combatants and more than 4800 coalition military personnel died over the 8-year course. Many Iraqi civilians were injured or became ill because of damage to the health-supporting infrastructure of the country, and about 5 million were displaced. More than 31 000 US military personnel were injured and a substantial percentage of those deployed suffered post-traumatic stress disorder, traumatic brain injury, and other neuropsychological disorders and their concomitant psychosocial problems. Many family members of military personnel had psychological problems. Further review of the adverse health consequences of this war could help to minimise the adverse health consequences of, and help to prevent, future wars.

## Introduction

The USA and its coalition partners initiated the Iraq War in March, 2003, because of unfounded perceptions that the Saddam Hussein regime was capable of developing nuclear, biological, and chemical weapons, and that it had ties with Al Qaeda terrorists. The war began with intensive aerial bombing, intended to create so-called shock and awe that would lead to a quick surrender by the regime. Instead, the war, which spawned an insurgency campaign, continued for 8 years. Although the USA withdrew its troops in 2011, sporadic incidents of extreme violence in Iraq have continued.

## War-related mortality

### Iraqi non-combatants

The number of war-related deaths among Iraqi non-combatants is uncertain, but we conclude from our review of studies that it was at least 116 903. However, studies by research groups using different methodologies arrived at widely different estimates.

In a systematic review published in 2008, Tapp and colleagues<sup>1</sup> identified 13 primary research studies that estimated Iraqi deaths during the period from March 20, 2003, to January, 2008. Three of these studies<sup>2–4</sup> were population-based, reported in peer-reviewed journals, and had estimated both the excess number of deaths attributable to all causes since the start of the war and the number of deaths caused by violence. In these studies,

the estimated number of excess Iraqi deaths as a consequence of the war ranged from 98 000 during the first 18 months of the war<sup>2</sup> to about 655 000 in the first 40 months.<sup>3</sup>

In the discussion section of their systematic review, Tapp and colleagues<sup>1</sup> stated that among the population-based studies that they had reviewed, reports by Roberts and coworkers<sup>2</sup> and Burnham and colleagues<sup>3</sup> provided “the most rigorous methodology as their primary outcome was mortality.” The study by Burnham and colleagues,<sup>3</sup> which had by far the highest estimate of Iraqi deaths attributed to the war, was criticised for the small number of clusters studied, lack of randomness of household sampling within clusters, possible over-reporting of mortality, and other alleged inadequacies;<sup>5–9</sup> however, the authors responded to

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See [Editorial](#) page 875

See [Comment](#) page 877

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## Search strategy and selection criteria

We searched PubMed for “Iraq” with the terms “health”, “mortality”, “morbidity”, “environment”, “refugees”, and “human rights”. These searches resulted in more than 100 articles, from which we selected those in English relevant to the focus of this Review. We reviewed lists of references cited in these articles to identify additional publications. We monitored and reviewed printed and online articles in major news media and reports of governmental agencies, international organisations, and non-governmental organisations. By writing articles and editing multicontributor books on the public health effects of war, including the Iraq War, and by attending professional conferences, we have frequently communicated with other health professionals about relevant health issues. We relied mainly on information from peer-reviewed journals, reports of government agencies and international organisations, and major news media outlets. However, we did not do a systematic assessment of the quality of research studies that we cited, and therefore are not making judgments on the quality of these studies. We recognise that, because most of the published work on the adverse health consequences of the Iraq War has focused on US and other coalition military personnel, this Review focuses disproportionately on them, compared with Iraqi combatants and non-combatants, who in the aggregate have had far greater morbidity and mortality.

## Key messages

- The Iraq War caused much mortality, mainly among non-combatant Iraqi civilians
- The war also caused much morbidity, including many cases of mental health disorders, among coalition military personnel and their family members
- The war also led to substantial environmental damage, displacement of millions of Iraqis, many violations of human rights, and diversion of substantial human and financial resources—all of which adversely affected health
- If the issues that provoked the war had been resolved non-violently, all its adverse health consequences could have been prevented

these criticisms,<sup>10</sup> and others supported their methods and stated that “indirect deaths, from loss of public health infrastructure” add to the death toll among Iraqis.<sup>11</sup> Subsequently, this study was criticised for its methodology and ethical and data-integrity problems.<sup>12–14</sup>

The Iraq Body Count, administered by Conflict Casualties Monitor, maintains and updates a database of war-related violent non-combatant civilian deaths in Iraq, with media reports of deaths being crosschecked to at least one other source (eg, hospital or morgue information) before being added to the database. It documented, by March 5, 2013, at least 116 903 deaths of civilian non-combatants.<sup>15</sup> A study based on this database which examined 92 614 Iraqi civilian deaths attributed to armed violence during the first 5 years of the war showed that unknown perpetrators caused 68 396 (74%) of these deaths, coalition forces 11 516 (12%), and anti-coalition forces 9954 (11%).<sup>16</sup> Analysis of a subset of 60 481 civilian deaths attributed to 14 196 lethally violent short-duration events showed that a third were attributable to extra-judicial executions by unknown perpetrators.<sup>16</sup> Of the events in which civilians died, the largest average number of civilians killed were in suicide bombings by unknown perpetrators that targeted civilians (19 per lethal event) and in coalition aerial bombings (17 per lethal event).<sup>16</sup> The most indiscriminate effects on women and children, as measured using a so-called Dirty War Index, were from unknown perpetrators using mortar fire and non-suicide vehicle bombs, and from coalition air attacks.<sup>16</sup>

The US National Counterterrorism Center also reported that many Iraqi deaths occurred because of terrorist attacks by (anti-coalition) insurgents. During 2005 and 2006, 21 602 terrorist incidents occurred, accounting for 10 098 deaths.<sup>17</sup> Another report of 60 481 Iraqi civilian deaths during the first 5 years of the war showed that 19 706 (33%) were caused by extra-judicial executions, 11 877 (20%) by small-arms gunfire, 8708 (14%) by suicide bombs, 5360 (9%) by vehicle bombs, 2854 (5%) by roadside bombs, 2079 (3%) by mortar fire, and 3050 (5%) by air attacks.<sup>18</sup>

One study documented 1003 suicide-bomb events in Iraq between 2003 and 2010, which caused 12 284 (11%) civilian deaths and injured 30 644 (26%) civilians.<sup>20</sup> Suicide bombers on foot caused 43% of deaths and those who used cars caused 40% of injuries. A higher proportion of demographically identifiable deaths in children were caused by suicide bombings (14%) than were caused by general armed violence (9%). For each lethal suicide-bomb event, on average more Iraqi civilians were killed (12) than coalition soldiers (three).<sup>19</sup>

#### Coalition military personnel

As of Jan 14, 2013, the US Department of Defense reported that 4409 US military personnel died in Iraq and nearby areas between March, 2003, and January, 2013<sup>20</sup>—3480 killed in action and 929 deaths attributed to non-hostile causes, such as diseases and self-inflicted

wounds.<sup>20</sup> 4804 coalition military fatalities occurred, including 179 among UK military personnel.<sup>21</sup>

#### War-related morbidity

##### Iraqi civilians

The numbers of cases of war-related illnesses and non-fatal war-related injuries among Iraqis has not been established, although many resulted from extensive damage to the health-supporting infrastructure, including medical care and public health services, food production and supply systems, water treatment and supply systems, and sewage treatment and sanitation facilities. Medical care facilities—which were challenged to serve the many people who were injured or became ill because of violence—urgently needed generators, drugs, and laboratories.<sup>22</sup> As a result of widespread looting at the start of the war, public health offices, clinics, and laboratories were damaged; equipment was stolen; and records were ruined. Core public health services—such as vaccination programmes, control of vector-borne disease, and tuberculosis treatment—were disrupted.<sup>23</sup> In 2008, 401 Iraqi refugee doctors who were interviewed in Jordan stated that there was a progressive decline in health services in Iraq from 2003 to 2006.<sup>24</sup> However, a national survey of 1256 Iraqi households in May, 2010, recorded widespread satisfaction with primary health-care services.<sup>25</sup>

Many health workers were displaced within Iraq or left the country. A study<sup>26</sup> of 1243 physician specialists who were based at 12 tertiary hospitals located in Baghdad, Basrah, Erbil, and Mosul on Jan 1, 2004, reported that, by late 2007, the total number of physician specialists decreased by 76 (6%) in Iraq, and by 193 (22%) in Baghdad. Of the latter group, many fled from Baghdad, but remained within Iraq.

Many injuries to Iraqis, such as injuries from electric shock, unintentional explosions, unintentional gunshot wounds, and falls, resulted from breakdown of the infrastructure in Iraq, as was shown by a 2009 survey that established the injury rate to be 54·9 per 1000 person-years.<sup>27</sup> Only 8·4% of these injuries were from intentional causes and only 4% were due to intentional explosions.<sup>27</sup> Injury incidence was highest in men, displaced individuals, and illiterate people.<sup>27</sup>

##### Coalition military personnel

For the remainder of this Review, the terms “service members,” “military personnel,” and “veterans” represent participants in studies of US service members in the wars in both Iraq and Afghanistan, unless otherwise specified. With regard to non-fatal injuries, as of Jan 14, 2013, the US Department of Defense reported that 31 926 US military personnel had been wounded in action in the Iraq War.<sup>20</sup> Explosions have caused a greater percentage of injuries in the wars in Iraq (and Afghanistan) than in other large-scale conflicts.<sup>28</sup> Between March, 2004, and December, 2007, 4623 combat explosion episodes occurred in Iraq, causing an average of 3·8 injuries or disorders per

episode; the most frequent were mild traumatic brain injury (TBI, 10·8%), open leg wounds (8·8%), and open face wounds (8·2%, including tympanic membrane rupture).<sup>28</sup> Body parts most often injured were arms and legs (41·3%), and head and neck (37·4%).<sup>28</sup>

As of 2010, more than 950 military personnel had a combat-related amputation.<sup>29</sup> Military personnel with major traumatic limb loss had significantly worse quality of life when they had a combat-associated head injury, had a combat-associated injury to the non-amputated limb, or required assistance in activities of daily living.<sup>30</sup>

War-related mental health disorders are highly prevalent among veterans. According to data obtained from routine postdeployment health assessments, of 222 620 military personnel who returned from Iraq between May, 2003, and April, 2004, 42 506 (19%) reported mental health problems and 68 923 (31%) used mental health services during the first year after returning home.<sup>31</sup> A study reported that 151 (17%) of 882 US Army personnel and 127 (16%) of 813 US Marines met screening criteria for major depression, generalised anxiety, or post-traumatic stress disorder (PTSD).<sup>32</sup> Among 9990 UK Iraq and Afghanistan veterans, prevalence of probable PTSD was 4·0% and prevalence of symptoms of common mental disorders was 19·7%.<sup>33</sup> Among 552 UK Reservists who had been deployed to Iraq in 2003, deployment was associated, 16 months after their return, with common mental disorders, PTSD, and poor general health.<sup>34</sup>

Risk factors for PTSD after combat deployment include: (1) combat exposures, especially the threat of death, serious injury, and witnessing injury or death;<sup>35</sup> (2) killing or being responsible for killing;<sup>36</sup> (3) previous assault;<sup>37</sup> (4) low mental or physical health status before combat;<sup>38</sup> and (5) adverse childhood experiences, such as physical neglect.<sup>39,40</sup> Military sexual trauma, defined as exposure to sexual assault or sexual harassment during service, was reported by 15·1% of 17 580 women and 0·7% of 108 149 men surveyed; it was associated with having a mental health disorder, including PTSD, other anxiety disorders, depression, and substance use disorders.<sup>41</sup>

Mild TBI, defined as "an injury with loss of consciousness or altered mental status (eg, dazed or confused),"<sup>42</sup> is common among soldiers returning from Iraq.<sup>42-59</sup> A study of 327 388 veterans using US Veterans Health Administration services in 2009 showed that 6·7% were diagnosed with TBI; much comorbidity existed, with 89% of those with TBI having had a diagnosed mental health disorder during fiscal year 2009, most commonly PTSD.<sup>55</sup> A survey of 2525 US Army infantry soldiers 3-4 months after returning from a 1-year deployment in Iraq showed that 124 (4·9%) reported injuries with loss of consciousness (43·9% of whom met criteria for PTSD) and 260 (10·3%) reported injuries with altered mental status (27·3% of whom met criteria for PTSD).<sup>42</sup> In a study of 760 US Army soldiers assessed before and after deployment to Iraq, 9% reported TBI (predominantly mild TBI), 17·6% of whom screened positive for PTSD

and 31·3% of whom screened positive for depression.<sup>43</sup> Among 2235 military personnel surveyed after deployment, 12% reported a history consistent with mild TBI and 11% screened positive for PTSD;<sup>44</sup> mild TBI was common among veterans injured by bullets or shrapnel, blasts, motor vehicle crashes, air or water transport incidents, and falls.<sup>44</sup> Among 781 men injured during military combat between September, 2004, and February, 2005, 15·8% met criteria for TBI.<sup>45</sup> A study based on data from the Combat Trauma Registry of the US Navy-Marine Corps who had served in Iraq identified 115 who had received about 200 TBI-related diagnoses; compared with individuals not injured in battle, those injured in battle were more likely to have had two or more TBI diagnoses and more severe TBI, and to have been medically evacuated.<sup>46</sup> Among 4620 UK military personnel returning from deployment in Iraq and Afghanistan, the prevalence of mild TBI was 4·4%, but among those who had had a combat role it was 9·5%.<sup>47</sup> Psychological distress and alcohol misuse before deployment were also associated with subsequent mild TBI.<sup>47</sup>

Symptoms of PTSD are common among service members with TBI. So-called re-experiencing symptoms of PTSD, such as flashbacks and nightmares, have been strongly associated with blast-related mild TBI.<sup>48</sup> Post-concussive symptoms (headache, dizziness, balance problems, irritability, and memory problems) have been associated with mild TBI alone and PTSD alone, and strongly associated with the combined presence of mild TBI and PTSD.<sup>49</sup>

A reduction in cognitive function occurs frequently among service members with TBI. A study of 502 service members showed that 31% of those reporting TBI had a decline in cognitive performance over time, as measured by a battery of neuropsychological tests.<sup>50</sup>

Some evidence suggests that some military personnel with mild TBI have axonal injury to the brain, even without intracranial injury detectable on CT. A study of 63 US military personnel with mild TBI who did not have detectable intracranial injury on CT, who were studied with diffusion tensor imaging (a form of MRI sensitive to axonal injury), showed that 18 (29%) had brain abnormalities that were consistent with multifocal traumatic axonal injury.<sup>59</sup>

TBI has been associated with self-reported hearing and self-reported visual impairment. Among 12 521 Iraq and Afghanistan veterans, 34·6% self-reported dual sensory impairment, 31·3% auditory impairment only, and 9·9% visual impairment only.<sup>51</sup> Veterans with both TBI and a history of blast exposure had the highest rate of dual sensory impairment.<sup>51</sup> Studies have documented not only noise-induced hearing loss, but also tinnitus, eardrum perforation, and dizziness among military personnel sustaining blast injuries.<sup>60,61</sup>

Many veterans with TBI have had infectious complications. These infections have been associated with blast injuries and burns; retained bullet or shrapnel fragments;

and lung injury, intubation, or tracheostomy;<sup>52</sup> and include hospital-acquired infections and infections from implanted prosthetic devices.<sup>52</sup>

Sex differences have been identified in the prevalence of psychiatric diagnoses and neurobehavioral symptoms. Among 12 605 veterans with TBI, PTSD was more common among men than women, but women were twice as likely to be diagnosed with depression. Women reported more severe symptoms than men in several neurobehavioural domains.<sup>53</sup>

Alcohol and drug abuse occur frequently among military personnel returning from Iraq. Among 12 092 Veterans Administration outpatients, 22% of male veterans returning from Iraq (and Afghanistan) screened positive for alcohol misuse, compared with 11% of veterans who did not serve in either country.<sup>62</sup> Among 6527 US Army soldiers surveyed 3–4 months after returning from Iraq, 27% screened positive for alcohol misuse, which was frequently associated with serious alcohol-related behaviours, such as drinking and driving, being convicted of driving under the influence, using illicit drugs, and riding with a driver who had been drinking.<sup>63</sup> These findings are much the same as from another study of 1120 veterans 3–4 months after their return from Iraq, of whom 25% screened positive for alcohol misuse and 12% exhibited alcohol-related behaviour problems; alcohol misuse was associated with exposure to threat of injury or death; alcohol-related behaviour problems were associated with exposure to atrocities.<sup>64</sup> Among 48 481 Reserve and National Guard personnel, new-onset heavy weekly alcohol consumption was significantly associated with combat exposure.<sup>65</sup> Among 1382 service members, 941 of whom were followed up after 3 years, increased alcohol consumption was especially great among those who thought they might be killed and those who experienced hostility from civilians during deployment.<sup>66</sup>

Many veterans have had both mental health disorders and substance abuse disorders. A study of more than 1 million veterans showed that, among those with a diagnosed mental health disorder, 21% had a comorbid substance abuse diagnosis; especially high rates of comorbid substance use disorder occurred among those with bipolar disorder or schizophrenia.<sup>67</sup> Among 287 veterans studied, those who screened positive for PTSD or depression were twice as likely to report alcohol misuse compared with others.<sup>68</sup> Among 678 382 veterans, increased diagnoses of major depression and substance use disorders were associated with deployment.<sup>69</sup> Among 456 502 veterans, 11% had received a diagnosis of substance abuse disorder; use of alcohol, drugs, or both was between 3·08 and 4·68 times more likely in veterans with either PTSD or depression.<sup>70</sup>

The total number of deaths by suicide among military personnel who served in Iraq is not known. However, a report stated that there were, in fiscal year 2008, 96 deaths by suicide among US veterans of the Iraq and Afghanistan

Wars; and that having a diagnosed mental health disorder was associated with an increased risk of suicide.<sup>71</sup> Suicidal ideation has been frequently described among service members returning from Iraq. Among 2854 US soldiers returning from deployment there, 67 (2·3%) reported suicidal thinking, 16 (0·6%) reported a desire for self-harm, and four (0·14%) reported both; significant predictors for self-harm after deployment were a previous suicide attempt and PTSD after deployment.<sup>72</sup> Among 1740 veterans, 113 (6·5%) reported suicidal ideation at time of interview; major risk factors were female sex, a previous suicide attempt, and a diagnosis of a depressive disorder.<sup>73</sup>

On return from deployment, service members have had problems in social functioning and mental health, affecting reintegration.<sup>74,75</sup> A study of 754 veterans estimated that 25–56% of combat veterans who use Veterans Administration health services report some degree of difficulty in social functioning, productivity, community involvement, or self-care.<sup>76</sup> National Guard troops studied after deployment frequently had readjustment problems (45% reported financial or family problems); those who reported the most readjustment stressors were 5·5 times more likely to have suicidal ideation.<sup>77</sup> Among 4991 UK veterans studied after deployment to Iraq (or Afghanistan), reservists, as compared with regular personnel, were more likely to feel unsupported by the military and to have difficulties with social functioning.<sup>78</sup>

A study<sup>79</sup> of infections complicating the care of trauma patients in Iraq (and Afghanistan) showed that among 16742 patients in the Joint Theater Trauma Registry, 921 patients (5·5%) had codes indicating one or more infections with only 16 recorded deaths attributable to infections. Most common were skin or wound infections (286, 26·7%) and lung infections (156, 14·6%).

With regard to respiratory disorders, a prospective study<sup>80</sup> of 46 077 military personnel deployed to Iraq and Afghanistan between 2001 and 2006 showed increased rates of newly reported respiratory symptoms among those who were deployed, but rates of chronic bronchitis, emphysema, and asthma were not associated with deployment. Open-air exposure to burning of rubbish and other waste in so-called burn pits had been thought a possible cause of respiratory symptoms among military personnel, but a study<sup>81</sup> of 22 844 military personnel did not find an association between exposure to burn pits and respiratory outcomes. A study<sup>82</sup> of 1·2 million military personnel deployed as of the end of 2005 showed that rates of respiratory symptoms and medical encounters for obstructive pulmonary disease increased after deployment. Another study<sup>83</sup> showed no significant associations between exposure to particulate matter less than 2·5 µm and cardiorespiratory outcomes in deployed military personnel, who were young and relatively healthy. A study<sup>84</sup> of military personnel exposed to a sulphur plant fire in 2003 showed that they had increased symptoms of, but no increase in, clinical encounters for chronic respiratory disorders.



### Family members of coalition military personnel

Mental health and related problems have been frequently reported among spouses and partners of military personnel deployed to Iraq.<sup>85</sup> Among 250 626 wives of active-duty US Army soldiers who received outpatient care between 2003 and 2006, those whose husbands had been deployed for 1–11 months received more diagnoses of depressive disorders (2·7% excess), sleep disorders (1·2% excess), anxiety (1·6% excess), and acute stress reaction and adjustment disorders (1·2% excess) than did wives of non-deployed military personnel.<sup>86</sup> Deployment of husbands for more than 11 months was associated with even greater excesses: depressive disorders (3·9%), sleep disorders (2·4%), anxiety (1·9%), and acute stress reaction and adjustment disorders (1·6%).<sup>86</sup> A study of 940 spouses of military personnel deployed in Iraq or Afghanistan showed that spouses had much the same rates of mental health problems as did soldiers, but they were more likely to seek care for their mental health problems and were less concerned with the stigma of mental health care than were soldiers.<sup>87</sup> Among 5928 married male enlisted soldiers deployed to Iraq or Afghanistan, marital quality decreased and reports of past-year infidelity and separation or intent to divorce increased; however, the rate of marital dissolution did not increase.<sup>88</sup>

Mental health disorders and related problems have also been reported among children of deployed military personnel.<sup>89</sup> A study of 307 520 children between the ages of 5 and 17 years who had at least one parent in active duty in the US Army in Iraq (or Afghanistan) showed that these children had an excess of 6579 mental health diagnoses during a 4-year period compared with children whose parents had not been deployed; there was an association between length of parental deployment and increased mental health diagnoses in these children.<sup>90</sup> A review of nine US-based studies of the effect on children of parental deployment identified an increase in emotional and behavioural problems in children when a parent was deployed; psychopathology among parents was most consistently identified as a risk factor for childhood emotional and behavioural disorders.<sup>91</sup>

Mothers of military personnel have also been affected. Mothers of sons serving in the US Marines reported significantly higher levels of emotional distress and more health risk behaviours compared with mothers of sons not deployed.<sup>92</sup>

Caring for injured or ill veterans places a major burden on family members. A study of families caring for US service members with TBI and multiple traumatic injuries established that 25% of the caregivers were providing more than 40 h a week of care;<sup>93</sup> many of them might need additional resources to meet the long-term needs of their family members.

### Beyond statistics

This Review has provided many statistics concerning morbidity and mortality of non-combatants and military

personnel and their families. However, as we have noted before, statistics are people with the tears washed off. Many personalised accounts of suffering due to the Iraq War have been published.<sup>93–95</sup>

### Population health status

In the two decades before the Iraq War, the health of the population of Iraq had been adversely affected by the Iran–Iraq War (1980–88), the Persian Gulf War (1990–91), and economic sanctions (1990–2003). Analysis of data from two parallel studies done by UNICEF showed that, as a result of the Persian Gulf War and economic sanctions, between 1991 and 1998 an estimated 400 000–500 000 excess deaths occurred in children in Iraq.<sup>96</sup>

During the war, the rate of childhood malnutrition was high, but not as high as it had been during much of the 1990s, when it increased mainly because of economic sanctions. Data from the World Bank suggest that the prevalence of malnutrition (low weight-for-age among children younger than 5 years) increased from 10·4% to 12·9% between 1991 and 2000, but then decreased to 10·1% in 2003, 8·0% in 2004, and 7·1% in 2006.<sup>97</sup> Other sources of data often showed higher rates of malnutrition. For example, a survey in 2004, done by the Iraq Ministry of Planning and Development Cooperation in partnership with the UNDP, showed that among Iraqi children between 6 months and 5 years of age, 23% had chronic malnutrition (low height-for-age), 12% had general malnutrition (low weight-for-age), and 8% had acute malnutrition (low weight-for-height).<sup>98</sup> In 2006, another survey showed that about 25% of Iraqi children were chronically malnourished and many more were underweight.<sup>99</sup> Another report from UNICEF stated that, between 2003 and 2009, an estimated 6% of children younger than 5 years were moderately or severely underweight, and 26% had moderate or severe stunting.<sup>100</sup>

The war, a general economic slowdown in Iraq, and economic sanctions adversely affected Iraq's food security, although the situation has improved in recent years—mainly due to improved availability of food and reduction in violence. A 2007 World Food Programme survey<sup>101</sup> estimated that 933 000 people (3·1% of households sampled) were food insecure, compared with 4 million (15·4%) 2 years before. During the same period, the proportion of people dependent on a monthly food ration decreased from 31·8% (8·3 million) to 9·4% (2·8 million).<sup>101</sup> The table<sup>97</sup> shows recent health status data for Iraq, now with a population of about 33 million.

### Environmental health

As far as we are aware, there has been no systematic analysis of environmental health problems related to the Iraq war. Available data are scarce and are neither comprehensive nor necessarily representative.

Data from the World Bank provide an overview of sanitation and of access to safe drinking water. Between 1991 and 2010, a progressive increase occurred, from 67%

	Data (year)
Infant mortality rate (per 1000 livebirths)	30.9 (2011)
Under-5 mortality rate (per 1000 livebirths)	37.9 (2011)
Maternal mortality ratio (per 100 000 livebirths)	63 (2010)
Percentage of births attended by skilled health staff	79.7% (2007)
Percentage of pregnant women receiving prenatal care	83.8% (2006)
Contraceptive prevalence (women, age 15–49 years)	49.8% (2006)
Adolescent fertility rate (births per 1000 females, age 15–19 years)	88.3 (2011)
Percentage of children age 12–23 months immunised against measles	76% (2011)
Health expenditures per person (current US\$)	\$247 (2010)
Health expenditures (as percentage of gross domestic product)	8.4% (2010)

**Table: Health status in Iraq<sup>97</sup>**

to 73%, in the proportion of the population with access to improved sanitation facilities.<sup>97</sup> Between 1990 and 2010, there was a progressive increase, from 44% to 56%, in the proportion of the rural population with access to an adequate amount of water from improved water sources; however, among the urban population, this proportion progressively decreased from 97% in 1990, to 91% in 2010.<sup>97</sup> By contrast, UN agencies have reported that more than 7.6 million Iraqis did not have access to safe drinking water at some point during the war,<sup>102</sup> and that, at the start of the war, millions of tons of raw sewage were dumped into rivers in Iraq.<sup>103</sup>

In 2005, the UNEP published a report on so-called environmental hot spots in Iraq, which had been selected by the Iraq Ministry of Environment.<sup>104</sup> These sites included: a metal plating facility, which had been bombed, looted, and demolished, that had hazardous wastes, including several tons of cyanide compounds, scattered over a publicly accessible site; a pesticides warehouse, which had been looted; a petrochemicals warehouse, which had been looted and partially burnt down; a large sulphur mining complex, which had been damaged by fire; and a military scrapyard site.<sup>104</sup>

At and around US military bases, contamination with depleted uranium has occurred, in addition to oil spillages, contaminated ash, and unexploded ordnance.<sup>105</sup> Depleted uranium, which has been used in antitank munitions, is both chemically toxic and radioactive,<sup>106</sup> although its health effects are unclear. In people, the most sensitive target organ after ingestion or inhalation of soluble uranium is the kidney; another important target organ is the lung after inhalation of small particles of insoluble uranium.<sup>107</sup> The surveillance programme for long-term health consequences attributable to exposure to depleted uranium and retained embedded fragments of depleted uranium in US veterans of the 1991 Persian Gulf War or the Iraq War has, thus far, not identified clinically significant health effects related to depleted uranium, but it has shown that fragments of depleted uranium embedded in muscle continuously release soluble uranium.<sup>108</sup> Because of its long half-life (4.5 billion years for <sup>238</sup>uranium, 700 million years for <sup>235</sup>uranium) depleted uranium potentially

represents a long-lasting hazard to those exposed. However, no adequate studies have documented adverse health effects of depleted uranium on human populations.

### Forced migration

In the first 4.5 years after the onset of the Iraq War, an estimated 2.2 million refugees fled the country.<sup>109,110</sup> An estimated 2.7 million people were internally displaced,<sup>111</sup> many of whom have faced greater health risks, because of problems such as inadequate shelter and lack of security, than refugees who left Iraq. Prior to the Iraq War, almost 1 million Iraqis became internally displaced because of repression, draining of marshland, and human-rights abuses under the Saddam Hussein regime.<sup>112</sup>

During the first 2 years of the Iraq War (2003–05), more than 400 000 people were displaced.<sup>113</sup> Most Iraqi refugees fled to Jordan and Syria. For these refugees, food insecurity was a major problem. Among 1200 households of Iraqi refugees in Jordan surveyed in 2008, 18% had received food aid and 10% cash assistance.<sup>114</sup> A similar survey of 813 households of Iraqi refugees in Syria a year later reported that 90% had received food aid and 25% cash assistance.<sup>114</sup>

A study of adult Iraqi refugees showed that their prevalence of chronic diseases, mainly hypertension and musculoskeletal disorders, was 51.5% among 2342 in Syria and 41.0% among 3414 in Jordan, with 7.1% of those in Syria and 3.4% in Jordan identified as disabled, mainly because of conflict.<sup>115</sup> Among 7642 Iraqi refugees and asylum-seekers in Jordan, 17% of those who sought health assistance had conditions classified as neurological disorders, mainly back pain, headache, and epilepsy.<sup>116</sup>

As of January, 2013, UNHCR: the UN Refugee Agency estimated that there were 1.4 million refugees who had left Iraq (with an estimated 480 000 living in Syria and 450 500 in Jordan) and 1.3 million internally displaced people within Iraq.<sup>117</sup> Even though an estimated 67089 Iraqi refugees had returned to Iraq and an estimated 193 610 internally displaced people had returned to their homes, many of these people face continuing challenges, such as inadequate security, unemployment (including getting back their former jobs), inadequate basic services, and scarcity of personal documentation.

### Violations of human rights and their health consequences

We have summarised the health consequences of the violations of human rights that occurred before and during the Iraq (and Afghanistan) wars previously,<sup>118</sup> although the full effects of these violations have not been adequately documented.

Briefly, before the war, human rights were violated by the Saddam Hussein regime;<sup>119</sup> during the war, both insurgents and coalition forces violated the rights of Iraqi civilians. The US administration of George W. Bush reportedly authorised so-called

enhanced interrogation—deemed by many experts to be torture under international law—of prisoners of war whom it suspected were aiding or abetting terrorism.<sup>120</sup> Health workers helped to design enhanced interrogation techniques, and participated in such interrogations.<sup>121–123</sup> These methods occasionally led to death and frequently led to health problems among detainees, including mental health problems.<sup>123</sup> Human rights of more than 1000 detainees deemed by the US Government to be enemy combatants and held at the US military base at Guantanamo Bay, Cuba, have likewise been violated.<sup>124,125</sup> Further interrogations in countries with poor human-rights records, such as Syria, were carried out on prisoners detained by the USA and transferred by rendition.<sup>126</sup> Other human rights abuses in the Iraq War included the use of cluster munitions<sup>127,128</sup> and weapons containing depleted uranium by coalition forces.

### Diversion of human and financial resources

As of Jan 15, 2013, the Iraq War had cost the USA about US\$810 billion (not including interest on debt).<sup>129</sup> The ultimate cost of the war to the USA could be \$3 trillion.<sup>130</sup> Clearly, this money could have been spent instead on domestic and global programmes to improve health.<sup>131</sup> The diversion of human resources was also substantial, in Iraq, the USA, and other coalition countries.

### Conclusion

The Iraq War caused a huge amount of morbidity and mortality among non-combatants and military personnel and their families. What are the main lessons from reviewing the adverse health consequences of this war? First, the health consequences of a specific war are likely to be much more extensive than envisioned before the war began. Second, government and military leaders should resort to war only as a last resort when all other measures to resolve conflict have failed—and then only if the goals of war are clear, the use of military force is proportionate to the threat, and non-combatants and the health-supporting infrastructure of society are protected. And third, the only way to prevent morbidity and mortality of non-combatants and military personnel during war is to prevent war itself. If the issues that provoked the Iraq War had been resolved non-violently, all the adverse health consequences described in this Review could have been prevented.

#### Contributors

BSL and VWS collaborated in the design of this Review. BSL did most of the research and writing. BSL and VWS reviewed the final draft of this Review.

#### Conflicts of interest

BSL and VWS have both received honoraria to give lectures on topics relevant to this Review. They also receive royalties for books that they have edited on terrorism, war, and social injustice and their relation to public health.

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