

# Road traffic injuries in Baghdad from 2003 to 2014: results of a randomised household cluster survey

Barclay T Stewart,<sup>1,2,3,17</sup> Riyadh Lafta,<sup>4,5</sup> Megan Cherewick,<sup>6</sup> Sahar A Esa Al Shatari,<sup>7</sup> Abraham D Flaxman,<sup>5,8</sup> Amy Hagopian,<sup>5,9</sup> Lindsay P Galway,<sup>10</sup> Tim K Takaro,<sup>11,12</sup> Gilbert Burnham,<sup>13</sup> Adam L Kushner,<sup>6,14,15</sup> Charles Mock<sup>1,16</sup>

► Additional material is published online only. To view please visit the journal online (<http://dx.doi.org/10.1136/injuryprev-2015-041707>).

For numbered affiliations see end of article.

## Correspondence to

Dr Barclay T Stewart,  
Department of Surgery,  
University of Washington,  
1959 NE Pacific St., Suite  
BB-487, P. O. Box 356410,  
Seattle, WA 98195-6410, USA;  
[stewartb@uw.edu](mailto:stewartb@uw.edu)

Received 2 June 2015

Revised 18 November 2015

Accepted 14 January 2016

Published Online First

5 February 2016

## ABSTRACT

**Introduction** Around 50 million people are killed or left disabled on the world's roads each year; most are in middle-income cities. In addition to this background risk, Baghdad has been plagued by decades of insecurity that undermine injury prevention strategies. This study aimed to determine death and disability and household consequences of road traffic injuries (RTIs) in postinvasion Baghdad.

**Methods** A two-stage, cluster-randomised, community-based household survey was performed in May 2014 to determine the civilian burden of injury from 2003 to 2014 in Baghdad. In addition to questions about household member death, households were interviewed regarding crash specifics, healthcare required, disability, relatedness to conflict and resultant financial hardship.

**Results** Nine hundred households, totalling 5148 individuals, were interviewed. There were 86 RTIs (16% of all reported injuries) that resulted in 8 deaths (9% of RTIs). Serious RTIs increased in the decade postinvasion and were estimated to be 26 341 in 2013 (350 per 100 000 persons). 53% of RTIs involved pedestrians, motorcyclists or bicyclists. 51% of families directly affected by a RTI reported a significant decline in household income or suffered food insecurity.

**Conclusions** RTIs were extremely common and have increased in Baghdad. Young adults, pedestrians, motorcyclists and bicyclists were the most frequently injured or killed by RTCs. There is a large burden of road injury, and the families of road injury victims suffered considerably from lost wages, often resulting in household food insecurity. Ongoing conflict may worsen RTI risk and undermine efforts to reduce road traffic death and disability.

## INTRODUCTION

Each year, more than 1.2 million people die and another 50 million are disabled on the world's roads.<sup>1 2</sup> Road traffic injuries (RTIs) are the leading cause of death of young people aged 15–29 years and cost societies more than US\$160 billion annually.<sup>3–5</sup> In addition, these deaths and disabilities significantly affect the communities where victims once worked and lived.<sup>1 6</sup> This burden falls disproportionately on middle-income countries where RTIs are more than twice as common as in high-income countries, and harbour 80% of all road deaths.<sup>1</sup>

Baghdad is a large, urbanised, middle-income city. In 2010, Iraq had a road traffic death rate of 32 per 100 000 persons, almost twice the global average road traffic fatality rate of 18 per 100 000

and three times the number of deaths from acts of terrorism.<sup>7</sup> The road traffic death rate in Iraq is considerably higher than that in nearby countries that have been politically stable (10 per 100 000 persons in United Arab Emirates (UAE), 14 in Qatar and 6 in Bahrain).<sup>1 8</sup> In response, Iraq launched the 'Decade for Road Safety' in 2011 that aimed to reduce the road traffic fatality rate by 10%.<sup>1 8</sup> However, prolonged insecurity has undermined traditional injury prevention strategies, law enforcement and the maintenance of a culture of safety.<sup>9</sup>

Despite a growing need to prevent and treat injury among civilians living amid conflict globally, few community-based studies have characterised the epidemiology of these coexisting problems, and none have described both mortality and morbidity over time.<sup>9 10</sup> Moreover, details of RTI mechanisms during insecurity have not been previously reported. Our goal was to describe RTI epidemiology in Baghdad to inform prevention initiatives, health policy and humanitarian assistance planning. In addition, the findings might contribute to the understanding of the road injury burden in low-income and middle-income countries (LMIC) cities affected by conflict and prolonged insecurity more broadly. We conducted a cluster-randomised community-based survey of injuries and disabilities to characterise the epidemiology of civilian conflict-related and non-conflict-related RTIs in Baghdad in May 2014, just before the security situation worsened.

## METHODS

### Study design

A team of international and Iraqi public health and trauma experts with experience from previous two-stage cluster study designs in Iraq, Rwanda and Sierra Leone developed the survey strategy.<sup>11–13</sup> A survey instrument was adapted from the WHO's community injury survey guidelines and the Surgeons OverSeas Assessment of Surgical Need.<sup>12–14</sup> The instrument was translated into Arabic, back translated to assure accuracy and piloted for utility and validity. The final version was designated the Surgeons OverSeas Injury Survey (SOSINJ).

A two-stage randomised 30 cluster by 30 households sample was performed. Baghdad was divided into 14 administrative districts and sectors and 30 random clusters were chosen using Google Earth. Clusters were delineated based on the 2011 population estimates for administrative units in Baghdad. Data were obtained from the Iraqi Central



**To cite:** Stewart BT, Lafta R, Cherewick M, et al. *Inj Prev* 2016;**22**:321–327.

Organization for Statistics and Information Technology and Ministry of Health.<sup>15</sup> Five clusters were randomly replaced due to security concerns or being located proximate sensitive military facilities a priori.

### Definitions

A household was defined as a group of persons living together in a dwelling with a separate outer door and a separate kitchen. Most clusters had no household refusal. However, five clusters had a single refusal each. An injury was defined as an intentional or unintentional physical event that required medical care and/or intervention and resulted in a loss or reduction in normal activities for a period of time. Given potential barriers to care, we did not exclude individuals who might have required care but were not able to access the care required.<sup>16–18</sup> In keeping with other population-based studies from LMICs that rely on recall, we did not ask respondents to consider deaths within a specific time period (ie, 30 days after RTC); we asked to attribute a person's death to a cause.<sup>9 19–22</sup>

### Data collection

The starting household and a backup starting household were selected using satellite imagery and grids in Google Earth.<sup>23</sup> If teams deemed the starting household unsafe they proceeded to the backup starting household. After the starting household, every other household was interviewed until 30 households were completed.

Two teams of four trained Iraqi physicians worked with a supervisor and sampled households in May 2014. Heads of household were identified and explained the survey procedure. After obtaining verbal informed consent, heads of the household were interviewed with regard to household demographics. Questions on injuries, mechanism, relation to conflict, care required, disabilities (eg, ability to care for self, climb stairs, walk or suffering of pain, stigma or anxiety/depression), financial hardship, suspected responsible party for intentional injuries and others were asked. Subsequently, all available household members were interviewed. The head of household provided information about injuries and disabilities for household members who were unable to answer questions (eg, children, head injured) or not present.

### Data management and analysis

Data were collected on paper forms and doubly entered into a database. Discrepancies were immediately clarified with collection teams. We described the relationships between demographic factors and RTIs and compared injuries between pedestrians struck and other RTCs with counts and relative proportions. The latter was performed given the frequency of vulnerable road user injuries in middle-income countries and potential for markedly different injury patterns and death and disability rates in a fragile healthcare system.<sup>1 24</sup> Simple bivariate logistic regression was used to model the effect of each covariate on having suffered a road traffic death or injury after 2002. ORs, adjusted for gender, age and marital status (ie, variables with evidence for an association with RTI from bivariate analysis), were calculated by using a three-level mixed-effects logit link function to control for intraclass correlation among clusters and within households using the equation:

$$\text{RTI} \approx \beta_0 + \beta_{\text{sex}(i)} + \beta_{\text{age group}(i)} + \beta_{\text{marital status}(i)} + \mu_{\text{cluster}(i)} + \mu_{\text{household}(i)}$$

Using national census data from 1997, 2003 and 2011 performed by the Iraqi Central Organisation for Statistics and

Information Technology, incidence rates were calculated.<sup>15</sup> For years between censuses, the population of Baghdad was estimated using second-degree parabolic extrapolation.<sup>25</sup> All analyses were performed using Stata (College Station, Texas, USA).

### Sensitivity analysis

To minimise reporting recall biased results, incidence rates were calculated using only serious injuries. Serious injuries were defined as those resulting in death, hospitalisation or surgery or more than 1 month of selected disabilities (ie, inability to care for self or walk as before the injury, suffering chronic pain or being unable to work due to anxiety or depression after injury). Further, a sensitivity analysis was performed to examine the proportion of reported injuries that resulted in death or ongoing disability. Non-fatal injuries with ongoing disability that occurred in 2014 were excluded in the sensitivity analysis given their potentially short duration. By comparing reported RTIs and serious RTIs per year, conclusions can be drawn about the potential for recall bias.

### Ethics and funding

Al Mustansiriyah University and Baghdad Provincial Council approved the study. Approvals for secondary analysis of the de-identified database were obtained through Johns Hopkins Bloomberg School of Public Health and the University of Washington institutional review boards. Verbal informed consent was obtained from each head of household prior to interview and payment was not given to participants. No names or other identifying information were collected. Funding for logistics in Baghdad was provided by the US-based non-governmental organisation, Surgeons OverSeas.

## RESULTS

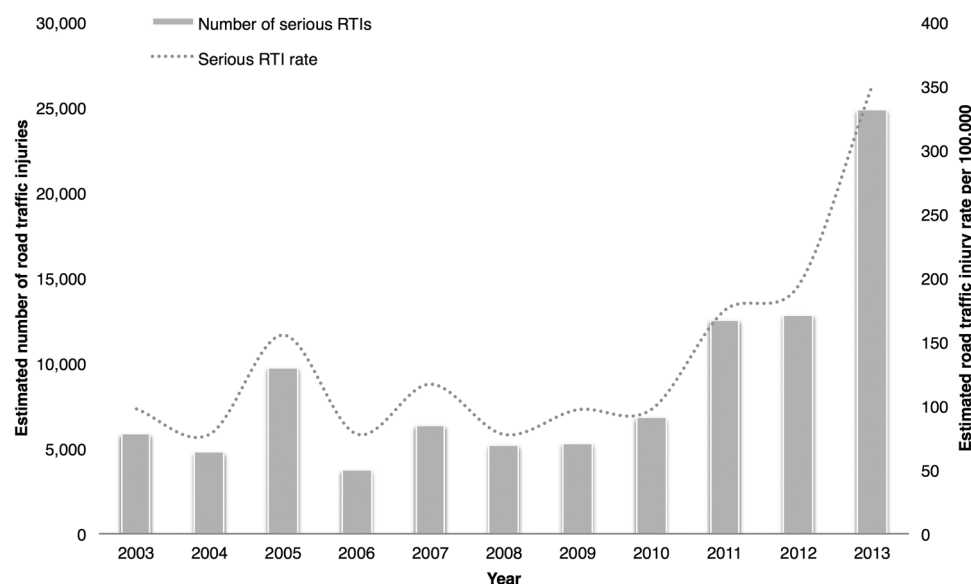
### Serious RTI incidence rate

Thirty randomly selected households from each of 30 clusters were surveyed, totalling 900 households and 5148 individuals. Households reported 86 RTIs, which were 16% of all injuries reported. In 2003, households reported an estimated 5851 serious RTIs in the surveyed population (97 per 100 000 persons). The annual rate of serious road injury increased post-invasion, particularly since 2011. There were 26 341 serious RTIs in 2013 (350 per 100 000 persons) (figure 1).

### RTI epidemiology

The majority of RTIs occurred among males (74% of RTIs). In bivariate analysis, males had almost three times the odds of suffering an RTI than females (OR 2.95; 95% CI 1.81 to 4.80). However, this association was not as strong in the multivariable model (adjusted OR 1.95; 95% CI 0.94 to 4.07) (table 1). While respondents aged 16–64 years were more likely to have sustained an RTI compared with younger persons in bivariate analysis, this was not evident in the multivariable mixed-effects model. Currently, married respondents had lower odds of having had an RTI compared with those who were never married (adjusted OR 0.35; 95% CI 0.14 to 0.86). There were no other significant associations between other demographic characteristics (eg, education, occupation) and odds of injury.

Ninety-two per cent of RTIs were characterised as unintentional (table 2). Pedestrians were the most frequently injured (49%), followed by those in a private car (18%), bus (10%), riding a motorcycle or bicycle (9%) and in a taxi (8%). Respondents reported that crashes resulting from criminal or military intent occurred while in private cars or taxis. The responsible parties in intentional vehicular assaults



**Figure 1** Estimated numbers and rates of serious road traffic injuries (RTIs) in Baghdad, Iraq from 2003 to 2013. Serious injuries were defined as those resulting in death, hospitalisation or surgery or more than 1 month of selected disabilities (ie, inability to care for self or walk outside of the home, suffering chronic pain or being unable to work due to anxiety or depression after injury).

reportedly included criminals, militias, coalition forces and others (not tabled).

### RTIs, death and disability

Forty-five road traffic injured persons suffered a fracture, dislocation or amputation (52%) and another 24 had more than one serious injury (28%) (table 3). In addition, 12% of RTIs resulted in traumatic brain injury or spinal cord injury. Two-thirds of road injured initially presented to a hospital (54 injured; 63%) and nearly half were hospitalised (41; 47%). Eight households reported a road traffic death (9%) and 60% of the injured were left with disability (table 3). Seventy-five per cent of the disabled remained incapable of caring for themselves at the time of survey and 58% suffered from social stigma. One-quarter of the disabled was unable to leave home (22 injured; 26%), suffered from chronic pain (17; 20%) or had significant anxiety, depression or stress responses after injury (17; 20%).

There was no evidence for a difference in the odds of specific injuries, death or disability between pedestrians struck and non-pedestrians struck (not tabled). To examine the potential for recall bias, we examined the reporting of all RTIs compared with serious RTIs, assuming that serious RTIs would be less likely forgotten. Despite an increase in number, the proportion of any RTI or serious RTI reported per year did not change significantly across the decade ( $p=0.18$  and  $p=0.13$ , respectively) (see online supplementary material). Similarly, there was no evidence for a difference in the proportion of deaths and injuries with ongoing disability reported per year over the decade ( $p=0.42$ ).

### Household consequences of RTI

Seventy-five households reported at least one RTI. Of these, 38 households (51%) reported an RTI resulting in a decline in household income or food insecurity (table 4). Families often borrowed money to pay healthcare costs or recoup the injured or dead's lost wages (25 households; 33%). More than half of the households of RTI victims borrowed between 20% and  $\geq 100\%$  of their annual income requirements to recover losses

(15 households; 20% of households with RTIs). In Iraq, the per capita income is US\$4272 per year.<sup>26</sup>

### DISCUSSION

The goal of this study was to describe the morbidity and mortality associated with civilian RTIs in the postinvasion decade in Baghdad to better understand road safety during insecurity. Our findings showed that the rate of serious RTIs increased more than threefold between 2003 and 2013 (97–330 per 100 000 persons in 2003 and 2013, respectively). As in other LMICs, pedestrians, motorcyclists and bicyclists were the most vulnerable, accounting for more than half of RTIs.<sup>24</sup> In addition to healthy life-years lost, affected families suffered considerably as a result of healthcare costs and lost wages of the dead or injured, often causing food insecurity.

Middle-income countries like Iraq harbour 80% of the world's road traffic deaths, despite accounting for only 72% of the global population and 52% of the world's vehicles.<sup>1</sup> In 2010, Iraq had one highest road traffic death rates (31.5 per 100 000) in the world.<sup>1</sup> With a goal to reduce road injury burden by 10%, Iraq developed a national road safety strategy to create safer roads, set national speed limits, enforce laws related to use of mobile phones while driving and requiring motorcycle driver helmet and front seat-belt use.<sup>1</sup> However, Iraq does not have policies mandating routine road inspections, the protection of vulnerable road users, vehicle standardisation, rear seat-belts, helmet standardisation, motorcycle passenger helmets or child restraints.<sup>1</sup> Limited funding, inconsistent enforcement and sustained insecurity have hindered Iraq's ability to reach this goal. Other countries, 41 middle-income and 5 low-income, have reduced road deaths through sustained national commitment to road safety policies aforementioned in the past decade.<sup>1</sup> Addressing these policy deficiencies, particularly those associated with the protection of vulnerable road users, may reduce the road injury burden in Baghdad. Such policies include those that separate motorised and non-motorised traffic or create traffic calming, road crossing facilities or street lighting.<sup>27</sup>

**Table 1** Demographic characteristics of household members and road traffic injury victims in Baghdad, Iraq from 2003 to 2014

	Total N=5148	Road traffic injuries n (%)	ORs OR (95% CI)	aORs aOR (95% CI)
Injured	553	86 (16)		
Sex				
Female	2569	22 (1)	Referent	Referent
Male	2579	64 (3)	2.95 (1.81 to 4.80)	1.95 (0.94 to 4.07)
Age				
≤15 years	1789	17 (1)	Referent	Referent
16–64 years	3131	64 (2)	2.18 (1.27 to 3.72)	1.46 (0.55 to 3.85)
≥65 years	228	5 (2)	2.34 (0.85 to 6.40)	0.92 (0.16 to 5.21)
Education among injured				
None	102	14 (14)	Referent	–
Any primary	261	45 (17)	1.31 (0.68 to 2.51)	–
Completed at least secondary	190	27 (14)	1.04 (0.51 to 2.09)	–
Marital status of injured				
Never married	238	46 (19)	Referent	Referent
Married	292	36 (12)	0.59 (0.37 to 0.94)	0.35 (0.14 to 0.86)
Divorced, separated, widowed	23	4 (17)	0.88 (0.29 to 2.71)	1.06 (0.20 to 5.64)
Occupation of injured				
Student	106	11 (10)	Referent	–
Employed	157	14 (9)	0.53 (0.27 to 1.03)	–
Farmer	97	15 (16)	0.99 (0.50 to 1.96)	–
Unemployed, retired, homemaker	139	8 (6)	0.53 (0.26 to 1.06)	–
Other	54	6 (11)	0.66 (0.27 to 1.61)	–

ORs were adjusted for gender, age and marital status (ie, variables with evidence for a relationship with RTI from bivariate analysis) using a two-level mixed-effects logit link function to control for intraclass correlation among clusters and within households.

aOR, adjusted OR.

In addition to RTI prevention strategies, postcrash care is also important in limiting death and disability.<sup>28</sup> More than half of the injured required orthopaedic care (eg, management of fracture, dislocation or amputation) and 28% required advanced trauma care for multiple injuries. All of these injuries place a significant burden on the Iraqi health system, already undermined by the ongoing conflict. Only 11% to 49% of seriously injured people are transported by ambulance to a hospital in Iraq.<sup>1</sup> Once they arrive, they become part of a very busy system. Emergency physicians see more than seven patients per hour, with RTIs among the most common conditions.<sup>29</sup> Despite the volume of trauma, only 19% of Iraq's emergency departments have a standard triage system, fewer than a quarter of physicians in emergency departments have undergone advanced trauma life support training, and only 3% of physicians have specialised emergency training.<sup>29</sup> Increasing the coverage and skill of pre-hospital services and training clinicians who care for the injured

have all been shown to reduce trauma-related morbidity and mortality.<sup>30–32</sup>

A similarly performed population-based study of civilian injury over a 3-month period in Baghdad in 2009 reported that RTIs comprised 10% of all injuries reported.<sup>9</sup> We report that RTCs were responsible for 16% of injuries overall, and were increasing in recent years (ie, 2010–2013). Complicating national efforts to reduce RTIs is the ongoing conflict, which undermines the rule of law, alters safe behaviour, diminishes efforts to support injury prevention and erodes road infrastructure.<sup>9 33</sup> The conflict has resulted in more than 3.2 million internally displaced persons and refugees in Iraq, many of whom have fled to Baghdad.<sup>34 35</sup> This influx has further strained infrastructure and emergency services. As a result, Iraq has among the highest road traffic fatality rates in the eastern Mediterranean region (18 per 100 000 persons). Neighbouring countries without recent conflict have markedly lower road traffic fatality rates (10 per 100 000 persons in UAE, 14 in Qatar, 9 in Egypt and 6 in Bahrain).<sup>1</sup> Further, UAE, Qatar and Bahrain have decreasing road traffic fatality rates, while Egypt, which has suffered from a significant but lesser degree of unrest than Iraq, has not been able to reduce its road traffic fatality rate in recent years.<sup>1</sup> As the hot war ended, the RTI rate increased. The increase might be the reality of a population returning to normal activity on a road system that is unsafe and/or a change in safe behaviour. In addition to having a higher rate, the pattern of RTIs in Baghdad may be different than neighbouring countries without insecurity. Respondents reported 38% of deaths to be pedestrians struck compared with only 28% of road traffic deaths in the Eastern Mediterranean Region as a whole.<sup>1</sup> Further, no deaths were reported after motorcycle or bicycle crash, which differs from other Eastern

**Table 2** Description of types of unintentional and intentional RTCs in Baghdad, Iraq from 2003 to 2014

	Unintentional n (%)	Intentional n (%)
Cause		
Private car	14 (18)	4 (57)
Taxi	6 (8)	3 (43)
Public bus	8 (10)	0
Motorcycle or bicycle	7 (9)	0
Pedestrian	39 (49)	0
Other	5 (6)	0

**Table 3** Types of and care required for road traffic injuries in Baghdad, Iraq from 2003 to 2014

	Total n (%)	Non-pedestrian road injury n (%)	Pedestrians struck n (%)
Injury			
Amputation	2 (2)	2 (5)	0
Fracture or dislocation	43 (50)	26 (59)	17 (44)
TBI or SCI	10 (12)	3 (8)	7 (18)
Burn	1 (1)	1 (2)	0
Polytrauma	24 (28)	11 (25)	13 (33)
Unknown	3 (3)	1 (2)	2 (5)
Initial site of care			
Hospital	54 (63)	29 (66)	25 (66)
Clinic	28 (33)	15 (34)	13 (34)
Surgical care			
Procedure(s) with anaesthesia	22 (26)	14 (33)	8 (22)
Procedure(s) without anaesthesia	33 (38)	19 (45)	14 (38)
No procedure required	24 (28)	9 (22)	15 (41)
Hospitalisation			
Not hospitalised	35 (41)	15 (36)	20 (58)
<2 weeks	27 (31)	19 (45)	8 (24)
≥2 weeks	14 (16)	8 (19)	6 (18)
Death and disability			
Died	8 (9)	5 (11)	3 (8)
Alive without disability	26 (30)	14 (30)	12 (31)
Alive with disability	52 (60)	28 (59)	24 (61)
Needs assistance with self-care	46 (53)	26 (53)	20 (53)
Unable to walk out of house	22 (26)	13 (29)	9 (23)
Deafness	19 (22)	10 (22)	9 (23)
Chronic pain	17 (20)	11 (24)	6 (15)
Suffers social stigma	50 (58)	32 (71)	18 (46)
Anxiety, emotional changes	17 (20)	10 (22)	7 (18)
Emotional changes preventing activity	13 (15)	6 (13)	7 (18)
Total	86	47	39

SCI, spinal cord injury; TBI, traumatic brain injury.

Mediterranean Region countries where these crashes result in 17% of road traffic deaths.<sup>1</sup> Our findings are similar to data from West Bank and Gaza, which report high pedestrian struck deaths (53%), but low motorcycle or bicycle deaths (1%).<sup>1</sup> RTI

**Table 4** Financial consequences of road traffic injury in Baghdad, Iraq from 2003 to 2014

	Households with RTI n (%)
Financial consequences	
Decline in household income	38 (51)
Decline in household food availability	38 (51)
Borrowed money: US\$	
<250	31 (41)
250–999	1 (1)
1000–4999	12 (16)
≥5000	3 (4)

75 households reported at least one RTI.  
RTI, road traffic injury.

pattern data are not available from other insecure countries in the region such as Syria, Libya, Afghanistan, South Sudan or Somalia. Improvements in road safety in Iraq and other insecure environments will be challenging until the security situation improves.

This study is a large, comprehensive, community-based assessment of injury in postinvasion Baghdad. However, there are several limitations that deserve discussion prior to interpreting the data. First, the incidence rates reported likely underestimate road injuries for several reasons. Although Iraq has a vital registration and emergency department-based injury surveillance system, under-reporting of fatalities and poor documentation of non-fatal injuries is common worldwide, especially in LMICs strained by conflict.<sup>1 36</sup> Thus, this community-based survey underscores the need to supplement routine data sources. Second, five insecure clusters were replaced with more secure ones for the safety of study members. These areas may have had higher injury rates compared with clusters with greater security. However, these clusters were replaced a priori and at random to minimise potential selection bias. Third, surveys depend on recall of respondents. The recall period used in this study was over 10 years. One would anticipate significant memory decay during this period. However, despite an increase in the number of RTIs, the proportion of serious RTIs and RTIs that resulted in death or ongoing disability did not vary considerably across the decade (see online supplementary material). Therefore, recall bias did not account for this trend alone. Next, the survey was conducted just prior to 'Islamic State' insurgent penetration deep into Iraqi territory, including Baghdad. It is possible that RTI rates have changed as a result of the worsened security situation. Next, we did not have vehicle-kilometres travelled data for Baghdad during the study period; thus, we were unable to control for this important variable. Therefore, the increase in RTIs could be due to an increase in vehicle-kilometres travelled over the decade and not a decline in road safety. No matter the underlying reason, the number of RTIs increased, which signals a need for a more comprehensive road safety strategy. Lastly, SOSINJ was developed to characterise the epidemiology of a number of injuries and was not designed specially for road injury. Therefore, information on the road environment, crash details and postcrash care was not collected in granular detail, limiting the analysis. Despite these limitations, these data allow useful conclusions to be drawn about the burden of RTIs on the individual and their families in Baghdad and the epidemiology of RTIs in insecure LMICs more generally.

## CONCLUSION

RTIs are extremely common and increasing in Baghdad. Young adults, pedestrians, motorcyclists and bicyclists are the most frequently injured or killed by RTCs. The burden of injury for victims of road injury is large, and the communities and families of road injury victims suffer considerably because of lost wages, often resulting in household food insecurity. Though Iraq has a national strategy to improve road safety, its effectiveness has been limited and its policy approaches have not been comprehensive. Moreover, ongoing conflict may alter usual RTI patterns among LMICs and undermine efforts to reduce road traffic death and disability. Given the current situation, potential recommendations for improving road safety might include:

1. Promote public education through popular media (eg, television, radio, social media, print) regarding the benefits of the use of seatbelts for motorists and occupants, and the use of helmets for motorcyclists and bicyclists and passengers.

2. Advocate for policies and infrastructure that separate vulnerable road users and vehicles.
3. Improve enforcement of laws, particularly those aimed to reduce speed, minimise distracted driving and encourage seat belt and helmet use.
4. Strengthen prehospital and trauma care and rehabilitation, particularly in areas that are prone to RTCs.
5. Perform more detailed studies to determine the specific risks and causes of RTIs to better inform specific prevention initiatives.
6. Evaluate and respond to the mechanisms that lead to higher rates of RTI and deaths during conflict and prolonged insecurity.

### What is already known on the subject

- ▶ Road traffic deaths are most common in middle-income countries and occur disproportionately among vulnerable road users; road safety strategies can reduce this burden.
- ▶ Data on road safety in insecure environments have not been previously reported.

### What this study adds

- ▶ Despite a national road safety strategy, the burden of road traffic injury in Baghdad is very high, increasing and affects the injured's family significantly.
- ▶ The usual pattern of road traffic injuries may be different during insecurity with more pedestrians struck and less motorcycle and bicycle crash deaths.
- ▶ Insecurity may undermine initiatives to reduce road traffic death and disability.

### Author affiliations

- <sup>1</sup>Department of Surgery, University of Washington, Seattle, Washington, USA  
<sup>2</sup>School of Public Health, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana  
<sup>3</sup>Department of Surgery, Komfo Anokye Teaching Hospital, Kumasi, Ghana  
<sup>4</sup>Department of Community Medicine, Al Mustansiriya University, Baghdad, Iraq  
<sup>5</sup>Department of Global Health, University of Washington, Seattle, Washington, USA  
<sup>6</sup>Department of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA  
<sup>7</sup>Human Resources Development and Training Center, Iraq Ministry of Health, Baghdad, Iraq  
<sup>8</sup>Institute for Health Metrics and Evaluation, Seattle, Washington, USA  
<sup>9</sup>Department of Health Services, University of Washington, Seattle, Washington, USA  
<sup>10</sup>Department of Health Sciences, Lakehead University, Thunder Bay, Ontario, Canada  
<sup>11</sup>Faculty of Health Sciences, Simon Fraser University, Burnaby, British Columbia, Canada  
<sup>12</sup>Department of Environmental and Occupational Health Sciences, University of Washington, Seattle, Washington, USA  
<sup>13</sup>Department of International Health, Center for Refugee and Disaster Response, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA  
<sup>14</sup>Surgeons OverSeas (SOS), New York, New York, USA  
<sup>15</sup>Department of Surgery, Columbia University, New York, New York, USA  
<sup>16</sup>Department of Global Health, University of Washington, Seattle, Washington, USA  
<sup>17</sup>Surgeons OverSeas (SOS) and Fogarty International Center (R25-TW009345; D43-TW007267)

**Acknowledgements** We thank the dedicated supervisors and enumerators for their contribution in understanding injury in Baghdad and helping to plan a response. Funding for logistics in Baghdad was provided by the US-based

non-governmental organisation, Surgeons OverSeas. Data analysis and manuscript preparation were done with funding from the Fogarty International Center, US National Institutes of Health, through the Northern Pacific Global Health Research Fellows Training Consortium under grant R25-TW009345. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

**Contributors** The study was designed by ALK, SAEAS, ADF, AH, RL, GB and CM. Data collection, or supervision thereof, was done by ALK, SAEAS, RL and GB. The data were analysed and interpreted by BTS, MC, ADF, AH, LPG, TT and CM. Manuscript preparation was done by BTS, MC, ALK, LPG, TT and CM. All authors contributed critically and significantly in drafting a final manuscript. All authors approved the final version.

**Funding** Surgeons OverSeas (SOS) and Fogarty International Center (R25-TW009345; D43-TW007267)

**Competing interests** None declared.

**Ethics approval** Al Mustansiriya University and Baghdad Provincial Council approved the study. Approvals for secondary analysis of the de-identified database were obtained through Johns Hopkins Bloomberg School of Public Health and the University of Washington institutional review boards.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data sharing statement** The dataset from the survey is available to the investigators. The team is working on other manuscripts.

### REFERENCES

- 1 Toroyan T, Iaych K, Peden M. *Global status report on road safety: 2013 supporting a decade of action*. Geneva, World Health Organization: Department of Violence and Injury Prevention and Disability, 2013.
- 2 World\_Health\_Organization. *The facts violence and injury prevention*. Geneva, 2010.
- 3 Lozano R, Naghavi M, Foreman K, *et al*. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012;380:2095–128.
- 4 Dalal K, Lin Z, Gifford M, *et al*. Economics of global burden of road traffic injuries and their relationship with health system variables. *Int J Prev Med* 2013;4:1442–50.
- 5 Bishai D, Quresh A, James P, *et al*. National road casualties and economic development. *Health Econ* 2006;15:65–81.
- 6 Rodriguez-Hernandez JM, Campuzano-Rincon JC. [Primary prevention measures for controlling pedestrian injuries and deaths and improving road safety]. *Rev Salud Publica (Bogota)* 2010;12:497–509.
- 7 USNCTC. *Number of deaths in Iraq due to terrorism between 2006 and 2013*. Washington DC: United States National Counterterrorism Center, 2012.
- 8 World Health Organization. *Iraq Committed to Improving Road Safety*. 2011. Available from: <http://www.emro.who.int/irq/iraq-news/iraq-committed-to-improving-road-safety.html>. Accessed July 2, 2015
- 9 Donaldson RI, Hung YW, Shanovich P, *et al*. Injury burden during an insurgency: the untold trauma of infrastructure breakdown in Baghdad, Iraq. *J Trauma* 2010;69:1379–85.
- 10 Aboutanos MB, Baker SP. Wartime civilian injuries: epidemiology and intervention strategies. *J Trauma* 1997;43:719–26.
- 11 Hagopian A, Flaxman AD, Takaro TK, *et al*. Mortality in Iraq associated with the 2003–2011 war and occupation: findings from a national cluster sample survey by the university collaborative Iraq Mortality Study. *PLoS Med* 2013;10:e1001533.
- 12 Stewart KA, Groen RS, Kamara TB, *et al*. Traumatic injuries in developing countries: report from a nationwide cross-sectional survey of Sierra Leone. *JAMA Surg* 2013;148:463–9.
- 13 Petroze RT, Joharifard S, Groen RS, *et al*. Injury, disability and access to care in Rwanda: results of a nationwide cross-sectional population study. *World J Surg* 2015;39:62–9.
- 14 World\_Health\_Organization. *Guidelines for conducting community surveys on injuries and violence*. Geneva, 2004.
- 15 Central Statistical Organization. *General Census, Iraq, Republic of Iraq, Ministry of Planning*, 2014.
- 16 Al Hilfi TK, Lafta R, Burnham G. Health services in Iraq. *Lancet* 2013;381:939–48.
- 17 Burnham G, Hoe C, Hung YW, *et al*. Perceptions and utilization of primary health care services in Iraq: findings from a national household survey. *BMC Int Health Hum Rights* 2011;11:15.
- 18 Burnham GM, Lafta R, Doocy S. Doctors leaving 12 tertiary hospitals in Iraq, 2004–2007. *Soc Sci Med* 2009;69:172–7.
- 19 Groen RS, Samai M, Stewart KA, *et al*. Untreated surgical conditions in Sierra Leone: a cluster randomised, cross-sectional, countrywide survey. *Lancet* 2012;380:1082–7.

- 20 Mock CN, Abantanga F, Cummings P, *et al.* Incidence and outcome of injury in Ghana: a community-based survey. *Bull World Health Organ* 1999;77:955–64.
- 21 Gupta S, Ranjit A, Shrestha R, *et al.* Surgical needs of Nepal: pilot study of population based survey in Pokhara, Nepal. *World J Surg* 2014;38:3041–6.
- 22 Petroze RT, Groen RS, Niyonkuru F, *et al.* Estimating operative disease prevalence in a low-income country: results of a nationwide population survey in Rwanda. *Surgery* 2013;153:457–64.
- 23 Galway L, Bell N, Sae AS, *et al.* A two-stage cluster sampling method using gridded population data, a GIS, and Google Earth(TM) imagery in a population-based mortality survey in Iraq. *Int J Health Geogr* 2012;11:12.
- 24 Naci H, Chisholm D, Baker TD. Distribution of road traffic deaths by road user group: a global comparison. *Inj Prev* 2009;15:55–9.
- 25 United Nations Estimates derived by extrapolation of census results. *Methods requiring three or more previous censuses*. Geneva, The United Nations.
- 26 UN Development Programme Country programme action plan: 2011–2014 Country report: Iraq, 2013.
- 27 Constant A, Lagarde E. Protecting vulnerable road users from injury. *PLoS Med* 2010;7:e1000228.
- 28 Peden M. Road safety in 10 countries. *Inj Prev* 2010;16:433.
- 29 Donaldson RI, Shanovich P, Shetty P, *et al.* A survey of national physicians working in an active conflict zone: the challenges of emergency medical care in Iraq. *Prehosp Disaster Med* 2012;27:153–61.
- 30 Roudsari BS, Nathens AB, Arreola-Risa C, *et al.* Emergency Medical Service (EMS) systems in developed and developing countries. *Injury* 2007;38:1001–13.
- 31 Diehl P, Mauer D, Schneider T, *et al.* [The emergency telephone number—the essential weak link in an emergency system. Prospective studies involving cardiac arrests observed by bystanders]. *Anaesthesist* 1992;41:348–53.
- 32 Ali J, Adam R, Stedman M, *et al.* Advanced trauma life support program increases emergency room application of trauma resuscitative procedures in a developing country. *J Trauma* 1994;36:391–4.
- 33 Devakumar D, Birch M, Osrin D, *et al.* The intergenerational effects of war on the health of children. *BMC Med* 2014;12:57.
- 34 Iraq, Geneva, Internal Displacement Monitoring Center.
- 35 Conflict and violence-induced displacement: IDP and refugee numbers, 1989 to present Global figures, Geneva, Internal displacement monitoring centre, 2015.
- 36 Jacobs G, Aeron-Thomas A, Astrop A. *Estimating global road fatalities*, Crowthorne, Transport Research Laboratory 2000;445.

### Tristar Worldwide wins triple gold for safety

The UK Royal Society for the Prevention of Accidents (RoSPA) has awarded a chauffeuring service, Tristar Worldwide (TW), three gold awards in the Occupational Health and Safety Awards category. One was earned for fleet safety, and one for technology. The Health and Safety award was TW's fourth successive such award. (This year is the diamond anniversary of these RoSPA Awards.)

### Fatal falls: London building firm fined

Two friends who had been drinking fell 4 m (13 ft) through a building site's hoarding (wall). The firm pleaded guilty to two counts of corporate manslaughter. The judge stated the fall was an 'accident waiting to happen' and 'wholly preventable'. The site's perimeter wall gave way leading to the fall down an uncovered light well. Comment: The fine was impressively large.

### IKEA recalls tip-over chests

IKEA will recall 180 models of chests and dressers that do not meet safety standards—a total of 29 million pieces of furniture. All have the potential to tip over and crush a child. One has already killed three children when it tipped. It should be noted that the industry standard is entirely voluntary. Previously, IKEA resisted a recall arguing that buyers could use a free wall-anchoring kit. However, many consumers are not aware of the tip-over risks.