Civilian Road-Traffic Injuries in the aftermath of conflict and disaster:

Should we be making it a priority? The case of Iraq

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Abstract:

Background:

There is increased awareness and research into the importance of Road-Traffic Injuries (RTIs), particularly in low and middle-income countries, where 90% of the global burden of RTIs are concentrated. RTIs in the context of conflict and disaster are less well explored. The aim is to establish whether civilian RTIs should be among one of the many health priorities in such settings.

Methods:

Literature review and analysis of annual Iraq Ministry of Health reports from 2001 to 2007.

Results:

RTIs are common in military and humanitarian aid workers but there is little published regarding civilian RTIs in various phases of conflict. Civilian road use falls during ongoing conflict, though case-fatality in the event of a road-traffic crash is significantly higher than during peace-time. Limited data suggest that the turbulent post-conflict and recovery phases represent a time with rapid increases in civilian road-use with a persistently high case-fatality rate. This is particularly the case in middle-income countries which were highly-motorised pre-conflict.

Discussion

Despite limited civilian data, evidence suggests that RTIs are an important cause of morbidity and mortality in post-conflict settings in general and in Iraq in particular, where multiple risk factors exist before, during and after the 2003 conflict. Aspects of primary, secondary and tertiary RTI prevention in Iraq using the Haddon Matrix as a template are discussed.

While RTIs are one of many health-priorities in Iraq, measures that will reduce their impact have the potential to complement existing initiatives toward health systems strengthening as well as contribute to overall reconstruction and development.

Introduction

There has been increasing recognition in the arena of global public health of the importance of Road Traffic Injuries (RTIs) as a cause of significant mortality and morbidity in low- and middle-income countries. An estimated 1.2 million people die as a result of RTIs each year and they are predominantly a disease of the young: the economically active and children. 70% of RTC deaths occur in those under 40 years of age.

There are major inequities in the global and local distribution of RTIs, as well as their subsequent health and socioeconomic costs. The poor and disadvantaged are worst affected on both the global and local scale. 90% of the global burden of RTI is in Low &Middle-Income Countries (LMICs). This is in contrast to the sustained reductions in mortality from RTIs in highly-industrialised countries, despite ever-increasing vehicle numbers and distances travelled, i.e. increased exposure to risk of RTIs.

The poor and more vulnerable groups within society are disproportionately affected by RTIs by several mechanisms. Firstly, they suffer increased exposure to RTCs as either vulnerable road users (pedestrians, cyclists) or as drivers/passengers in less safe vehicles. As such, they are more likely to sustain severe or life-threatening injuries. Secondly, the subsequent social and economic burden is greater from potentially catastrophic healthcare costs[6] as well as loss of income from previously economically active household members.

The rise in numbers of RTIs in LMICs seems inevitable with increasing urbanisation and motorisation, and prompts the question of whether RTIs are a necessary evil of economic growth and development, similar to the epidemics of RTI seen in High-Income Countries (HICs) earlier in the 20th century. However, the massive strides HICs that have been able to achieve in significantly reducing RTI number and severity in the face of ever increasing motorisation rates provides further evidence that RTIs are preventable and not simply 'accidents'. The evidence for effectiveness of many of the interventions which have proved successful in HIC settings, for example increased seatbelt usage, does not need to be re-established in LMICs settings, however the means by which these are achieved may differ and implementation research may be more appropriate in LMIC settings.

The direct and indirect costs of RTIs on individuals and on societies are considerable and have a major negative effect on economic growth. With respect to the monetary costs of RTCs, it has been estimated that this constitutes between 1-2% of GDP according to the level of development. For LMICs this is more than is received in external development assistance. For this reason, if economic development is to truly take place in these countries, road safety needs to be tackled in order for LMICs to capitalise on any economic benefits increases in motorised transportation may bring.

Iraq has been through various phases of turbulent and violent change: politically, economically and socially in the aftermath of recent conflict that was preceded by prolonged economic sanctions and more conflict. The impact of this on both the magnitude and nature of RTIs in Iraq, as an already urbanised and motorised population within a region with high burden of death and disability from RTIs, will be considered, with the aim of creating a framework for further research and policy strategies that could be appropriate for Iraq in both the short and longer term.

There is little published evidence on the effect of conflict, economic sanctions or complex emergency situations on RTIs in civilian populations. However, RTIs have long been recognised as an important cause of morbidity and mortality in both military populations and aid workers.

It is proposed that the lack of security associated with acute phases of conflict and military activity leads to a fall in road use and a subsequent reduction in the incidence of Road Traffic Crashes (RTCs). However, as either security improves or conflict becomes more chronic, and people attempt to return to more normal routines during the more turbulent recovery phases, road use may increase with a resultant increase in incidence of road traffic crashes and thereof exposure to RTIs. In addition to increased (and perhaps different patterns of) road use, there are other factors which are likely to increase the risk of death and disability from RTCs. This proposed sequence would be particularly evident in environments highly motorised pre-conflict. Some of the causative factors at play may be common with developing countries not engaged in recent conflict; and some may be more unique to a conflict/post-conflict situation.

The aim of this study is to begin to examine the extent and impact of RTIs in Iraq. Is it an important public health issue at the present time? If so, where should it lie on the long and complex list of Iraq's current health needs? Are the causes of RTCs in post-conflict settings fundamentally different from those in peacetime? What would need to be done in order to minimise the number and impact of RTIs in Iraq? Are solutions known to be effective in other countries feasibly applicable to Iraq today or in the near future?

Methods

Review of literature

- Multiple literature searches on various aspects of RTCs. Databases used were: Medline, Web of Science and Global Health. Highly relevant articles were cross-referenced and this yielded a significant number of further citations. Key words and search terms included but were not limited to:
    - Road traffic crashes, road traffic injuries, road traffic deaths, motor vehicle crashes
    - Conflict, war, sanctions, military, humanitarian, aid, development
    - Iraq, Middle east, Eastern Mediterranean region, Gulf
    - Fatalism, driving behaviour, driving style
- **Search of relevant websites: WHO, WB, TRL, Government of Iraq ministerial websites**
- **Analysis of data on RTIs Iraqi MoH annual reports between years 2001-2007.**

Results

Civilian RTCs during conflict and economic sanctions

Only two studies were found examining RTCs in civilians during times of conflict and/or economic sanctions. One examined civilian RTCs in Israel during the 1990 Persian Gulf War. The second studied the effect of economic sanctions and military activity on RTCs in the autonomous province of Vojvodina, Serbia between 1996-2005. Rates of RTCs were lowest during periods of both sanctions & military activity reflecting a period of lowest civilian road-use. Numbers of RTCs rose with the end of military activity (but when sanctions were still in place) and they peaked once both sanctions and military activity ceased. In contrast, Case Fatality Rates (CFRs) of RTCs were

highest during the period of combined sanctions & military activity, peaking just before cessation of military activity.

Economic sanctions reduce road use and therefore RTC rates, but probably by different mechanisms to times of military activity. Reduced availability and affordability of vehicles and fuel as well as indirect damage to infrastructure are most.

CFR is likely to be increased, by two broad mechanisms. Older vehicles, deteriorating road infrastructure lead to increased risk of sustaining injury in the event of RTC. If injury is sustained, it is more likely to be severe or fatal, namely due to reduced access to, and perhaps quality of, adequate pre-hospital and hospital emergency medical care.

There was no real change in crash characteristics during the whole time period with respect to:

- Proportion of RTCs in urban versus rural areas
- Timing of RTCs during the day
- Percentage of RTCs where speeding or alcohol were cited as factors
- Road user type involved

These suggest that although road use overall fell during military activity and sanctions, patterns of road use did not really change.

In trying to infer the impact of conflict and sanctions on RTIs in Iraq, there are parallels with Serbia as well as differences. In the case of Iraq, it seems that indirect damage to infrastructure as a result of economic sanctions was more substantial than direct damage during the relatively short military campaign. This is in contrast to circumstances in Serbia where direct damage deliberately targeted at infrastructure during military activity was a predominant factor.

The lack of published data in this field may reflect a lack of recognition of RTIs as a major contributor to civilian morbidity and mortality during conflict, particularly in areas already significantly motorised pre-conflict. It is also a difficult area to study as it requires pre-existing methods of data collection on RTIs which can be maintained to some degree during and after conflict- circumstances that do not exist in many LMICs.

Due to the lack of data directly examining civilian RTIs, the area of RTIs in military and humanitarian workers during conflict were examined to see if any information could be extrapolated to the civilian population.

The Military & RTCs:

Disease and Non-Battle Injuries (DNBI) often contribute more to military casualties during wartime compared with combat injuries [11]. The majority of evidence around conflict and RTCs in the published literature comes from US and UK Army soldier populations.

52% of US army deaths in the Persian Gulf War were from non-combat injury, with motor vehicle and motorcycle accidents representing 71% of these deaths. RTCs still remain the leading cause of death and hospitalisation in the US army, though significant reductions in mortality rate have been achieved. Army soldiers are a high-risk group for RTIs. The vast majority are young, male and educated to high-school level only, all of which are significant risk

factors for RTCs in this population. Army soldiers also participate in risky driving behaviour and that such behaviour is not confined to deployment in combat operations but persists persist even after soldiers return home. Deployments in active combat operations and symptoms of Post-traumatic Stress Disorder have been associated with risky driving behaviour.

The young, predominantly male demographic in the Army population reflects that of most drivers in developing countries. In addition, civilian populations exposed to violent conflict may also have an increased risk of involvement in RTCs by similar mechanisms as army soldiers, which may also persist into peacetime.

Studies conducted by the military following the 2003 Iraq war point to some factors which increase RTC risk in Iraq at that time. A cross-sectional questionnaire study of UK military personnel[19] during active deployment southern Iraq in 2007 asked about risks to driving during deployment. Main factors cited by respondents were:

- Iraqi drivers: driving on the wrong side of road, using donkeys and carts as well as disregarding of available signage and speed limits
- Variable law enforcement
- Security dangers
- Bad roads: potholes & inadequate street lighting
- Speeding

This suggests that at least a proportion, if not the majority, of RTCs involving British military vehicles also involved Iraqi civilians in some way or another.

A retrospective case series of RTC admissions to a British military hospital in Shaibah, southern Iraq over 6 months in 2005 also cited similar reasons for RTCs problem. Although not explicitly stated, it appears that all admissions were army personnel i.e. no civilians. During the study period 315 RTCs were reported in the area of responsibility, namely Al-Basrah province. This is likely to only refer to RTCs involving military vehicles, though this is unclear. 85% of admissions were not wearing a seatbelt, which increased risk of ejection from the vehicle and risk of severe injury.

Outside Iraq, a retrospective study of trauma admissions during peace-keeping operations in Kosovo in 2004 to a level-3 hospital facility with capacity to manage major trauma sheds more light on civilian trauma rates post-conflict. Patients treated were predominantly civilians. 46% of trauma admissions were secondary to RTCs and represented 72% of blunt trauma. As the study was looking at all causes of trauma rather than RTCs in particular, data was not presented regarding classification of RTC trauma patients by age, gender or road-user type. The authors cite the following as contributory factors to RTIs in Kosovo at that time:

- Absence of a vehicle licensing authority
- Small and poorly maintained roads
- Lack of traffic control
- Virtually non-existent use of seatbelts

The study represents patients requiring high-level trauma facility admissions, therefore information on RTC rates in the wider population at that time cannot be inferred, though it clearly demonstrates that civilian RTCs were a

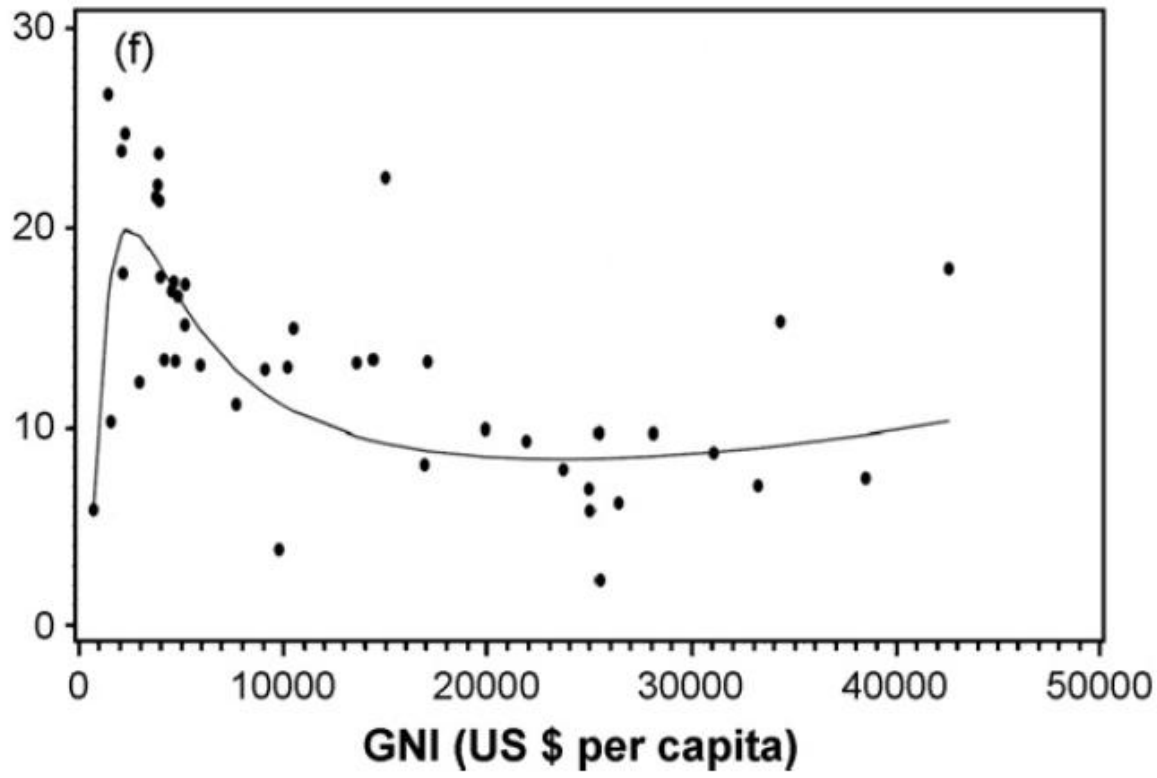
problem at that time and identifies some of the environmental factors adversely affecting road safety in a post-conflict environment which also apply to Iraq.

Humanitarian workers & RTCs

It has long been recognised within the community of humanitarian workers that RTCs are significant cause of death during deployment abroad. There are fewer published studies compared with military populations. Deaths of national staff while off-duty are often not taken into account in analyses. The issue of whether aid workers face higher risk RTC following return from deployment has not been explored in published literature.

A retrospective analysis of deaths in humanitarian workers showed that RTCs are more likely in UN peacekeepers (accounting for one third of deaths between 1985 and 1998), drivers and office staff. Drivers having to swerve to avoid other vehicles, animals, pedestrians was cited as a predisposing factor for RTCs. Another study of Dutch development workers between 1984-1994 showed RTCs were a more common cause than violence or other injury. Another analysis of medical evacuations & deaths in UNHCR field employees, RTCs accounted for one of 37 deaths and 8.3% of medical evacuations. Causative factors for RTCs that are cited include: Deployment to areas with higher RTI rates than home countries, with poor road infrastructure, lack of law enforcement, driving in unfamiliar surroundings with very different vehicle mix and lack of separation of different types of vehicle and road user. Aid workers may also engage in a different, and riskier, driving style compared with when at home e.g. less likely to wear seatbelt (if available), more likely to drink and drive.

National income, economic growth and RTCs



The Kuznet's curve demonstrates the observed relationship between GDP per capita and RTI fatalities. RTI mortality rates peak during 'low-middle income stage' then gradually fall. This is based on cross-sectional and ecological data between countries rather than a demonstration of progress with time in individual countries or regions.

Some data exists that suggests economic turbulence and upheaval is also associated with significant changes in RTI rates in developing countries, which is also relevant to Iraq. Data on RTI fatalities in the former East Germany showed that over four years following reunification in 1989 RTI rates increased by four times. This increase was reflected by an increase in deaths per 100,000 population. This observation was independent, and in excess of, increases in distances travelled, as measured by fatalities per billion km.

The brunt of this surge in RTIs occurred in the young, with death rates among 18-20 year olds rising by 11 times during this period. The authors describe the sudden economic changes that took place in the former East Germany following reunification with sudden increases in affluence with concomitant rises in vehicle ownership, predominantly by young and inexperienced drivers on the roads. Numbers of motor vehicles increased by 41% between 1989 and 1991 and this increase was not matched by similar improvements to road infrastructure.

A second study from Thail demonstrates the sensitivity of RTI rates to economic changes, where RTI rates increased during economic boom in SE Asia and promptly reduced during the 1990 economic crisis, only to rise again with increased economic growth folloandwing the economic recession.

Not only are developing countries more vulnerable to changes in macroeconomic circumstances, but the rate at which such change occurs is also relevant, perhaps contributing to the lack of overall planning in land use and transportation seen in many LMICs. This leads to the suggestion that increased injury rates can be reasonably anticipated during times of economic change and modernisation allowing appropriate preventative countermeasures to be considered and implemented in a timely manner.

Increasing income does not passively lead to the changes necessary to reduce national burdens of RTIs as demonstrated by the HIC gulf countries of the EMRO region. Despite gaps in published data, RTI death rates in these countries far exceed what may be expected by their economic standing i.e. they are significant outliers on the curve.

What may passively change with increasing income is the distribution of RTI deaths by road user type, i.e. predominance of drivers & passengers over VRUs, but RTI rates will not inevitably decline unless significant action is taken at a government and policy level.

The graph perhaps demonstrates that it takes a certain degree of economic development for RTIs to become a public health problem, and then further economic development for it to be feasibly tackled. RTIs could be described as another manifestation of the epidemiological transition. It is likely that other determinants of development are at play. A major determinant is that of political structures, process and culture.

The interplay between conflict, economic turbulence and growth and RTI rates has not been greatly explored. Economic sanctions lead to reductions in numbers of RTCs due to rises in the cost of transportation costs and

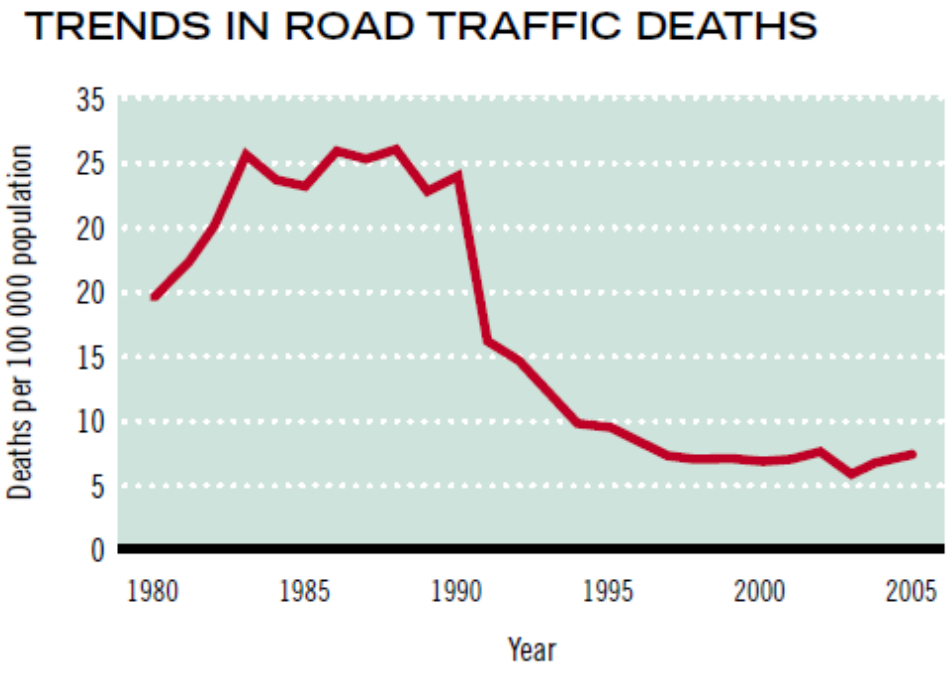
reduced vehicle numbers or capacity for maintenance. Acute phases of violent conflict lead to reduced road use due to reduced safety and security. What happens after acute violence ceases will depend on pre-existing infrastructure, levels of motorisation, the availability of motorised transport post-conflict, and the circumstances under which violence declines if at all. For example, in Iraq, although the formal duration of conflict by coalition forces was relatively short, this was soon followed by protracted period of collective violence, it is expected that road use at this time would be low, particularly by VRUs. However, as this situation became more chronic, combined with massive increase in vehicle availability and attempts at reconstruction of physical infrastructure, it would be expected that RTI rates would rise. The extent of such an increase, and whether RTIs sustained in such circumstances are inherently different from those during peacetime, is effectively unknown. From the limited evidence of RTIs is circumstances conflict, it could be supposed that the case fatality rate of RTIs would be higher, and may be more likely to involve drivers and passengers of 4-wheel vehicles.

Are RTIs a significant public health problem in Iraq?

The WHO global status report data on demonstrates clearly the transitions in RTI death rates in Iraq (even if accounting for limitations in the quantity and quality of data) over recent years.

Prior to the 1990 Persian Gulf War, sanctions and the events since 2003, Iraq was already a highly motorised country with a predominantly urban population and extensive road infrastructure. There is some evidence to demonstrate that this high regional baseline of RTI death rates existed in Iraq prior to 1990 and were comparable if not exceeding those of neighbouring countries.

Post 1990-1991, there is a dramatic fall from the relatively steady and high RTC death rate of around 25 deaths/100,000 population to a sustained low of 7-8/100,000. This drop coincides with the aftermath of the Persian Gulf War and subsequent stringent economic sanctions. This is most likely due to reduced road use, as



Source: Central Organization for Statistics and Information Technology, data since 1990 exclude Kurdistan region

there were dramatic falls in vehicle rates, which occurred for several reasons. Firstly, It was extremely difficult to import vehicles or spare parts for maintenance during this time. The only available vehicles would be based on the existing, and ageing, vehicle pool prior to the imposition of sanctions. Secondly, while Iraqis became particularly adept at maintaining, modifying and recycling most things (including vehicles) during this time, the cost of owning a car would increase greatly relative to falling incomes, making it beyond the means of most Iraqis to continue to own a vehicle. Thirdly, in addition to the deterioration that took place in the health sector during this time there was an increased total burden of disease and dramatic changes in the nature of disease burden in Iraq (such as the re-emergence of communicable diseases, rises in maternal and infant mortality) that would predictably reduce the priority of measuring and managing injury rates in general and RTIs in particular, though CFRs from RTIs would probably rise.

Overall, there probably was a genuine decline in RTI death rates due to reduced road use, but case-fatality rate (CFR) in the event of a RTC would be greater. However, the following need to be considered:

- The case definitions RTIs and death from RTIs can vary greatly between countries and can change. If, as in some countries, only deaths on the day of injury are counted, this under-represents the true number. There are no case definitions for any health parameters within Iraqi MoH annual reports.
- Local variations in reporting RTCs to the police and how reporting procedure is organised will influence the measured rates locally
- Under-reporting is especially a feature of RTCs involving VRUs or vehicles other than cars.
- The level of under-reporting is not necessarily constant over time, meaning it cannot be treated as a systematic error when conducting analyses over time.

Despite these considerations however, it would be easy to suggest from the visual trend that RTI deaths should not be a priority issue in Iraq. As the graph ends in 2005, the question arises of what could be happening to RTI death rates after this point?

Examination of data from Iraqi MoH annual reports may provide some clues to this. Note this is a different source from that used in Global status report (based on police data). Table 2 summarises annual RTI rates by governate, together with population estimates used in reports. Crude RTI rates per 1000 population were then calculated for each governate as well as the mean calculated across Iraq. As some years did not include data for Kurdistan region, averages excluding this data for all years were also calculated to allow greater comparison.

- Although not explicitly stated in any of the reports, it is assumed that the numbers given are for RTIs that required or received hospital attention (this is by far the main form of public healthcare facility in Iraq). They are not death rates as they would be in the order of several hundred per 100,000 population.
- Therefore death rates from RTIs are unknown from this data. Mortuary data does not classify deaths according to cause but rather by mechanism of injury, namely types of penetrating injury, burns and so on. RTC or RTI is not a measured subgroup within these data.
- Great caution needs to be exercised in drawing any conclusions from this data:
  - How RTCs are defined in these data is unknown

- Injuries reported could range from the fatal to the very trivial. However there may be a significant proportion of RTIs in Iraq which never reach medical attention due to lack of necessity or access to healthcare. This will be particularly relevant for the poor who are affected by RTIS.
- Hospital data cannot provide an idea of total burden of RTIs, but it does provide an idea of the proportion of healthcare resources are taken up by this problem,
- There is probably under-reporting of pre-hospital RTI deaths
- It is not clear if data pertain to rates hospital admissions, or all visits to healthcare facilities. It is difficult to correct the latter for multiple visits being recorded for the same patient or injury[40,41].
- Data are probably only based on the public sector of health system. The proportion of RTIs managed within Iraq's significant private sector is therefore unlikely to be accounted for.

All of these threaten the validity of the numerator of RTIs provided. The denominator of population data is also potentially unreliable. All population data are likely estimates rather than census data, and such estimates would be particularly difficult to measure during the turbulent and violent conflict and post-conflict phases, fluxes in population movement.

Reports from 2001 & 2002 include no data on RTIs at all, and it is only from 2003 onwards that RTCs are again specified as a cause of injury. This could be because rates of RTIs increased following 2003 war making them more prominent and therefore measured with increased frequency. This is not necessarily the case, it is equally possible that RTIs were a significant problem prior to 2003 but were just not measured.

It is difficult to know from the MoH data if and how RTI rates are changing in Iraq and whether it is a problem which needs addressing at the present time. However, there is some evidence to suggest that RTIs would be a greater problem post-2003 compared with period of economic sanctions as there were significant changes in motorisation rates and increased road usage: the main exposures to risk from RTIs. The rate of increase in road use during the post-conflict phase may have been particularly rapid in Iraq for several reasons:

- Although in need of major rebuilding and rehabilitation, there was an existing road infrastructure 'ready and waiting' to be used
- A major factor in this was the extremely rapid increases in vehicle numbers due to relaxation of import restrictions (table 3), equivalent to 40% increase of imported vehicles in 2003-2004, namely of used vehicles imported from neighbouring countries, in particular Jordan and Kuwait.

Table 3

Year	Number of registered vehicles within Iraq
1970	122,000
1980	463,000
1989	1 million
1990s	Very slow growth during sanctions
2003-2004	500,000 to 800,000 used-vehicles imported into Iraq
2006	2,242,269

Substantial resources have been allocated to post-conflict reconstruction projects in Iraq in order to rebuild infrastructure. Rebuilding of road infrastructure has been regarded a key part of facilitating necessary increases in economic growth. Also, when reconstruction of other sectors of infrastructure have suffered considerable setbacks, road (re)construction is perhaps relatively easier than other projects such as electricity, water and sanitation projects and therefore has continued despite setbacks suffered in other sectors. Transport and telecommunications needs were assessed at US$3.41 billion by the WB & UN Joint needs assessment in 2003, compared with $US1.6bn for health. This difference has subsequently been translated in sectoral distribution of funds for reconstruction in Iraq, with 14% allocated to transport and 5% to health.

Part of the World Bank Emergency Road Rehabilitation Project ($135m) set up to finance rehabilitation of highways & village access roads in central & southern Iraq included emergency improvements to major 2-lane carriageway (Erbil to Perdi) that is part of Erbil-Baghdad highway. For this 42km section of road alone:

- 22,000 vehicles/day
- Approx 12 'serious' (not defined) road crashes per day. Does not state number of injuries/fatalities. This does imply there is a greater total number of RTCs (to include non-serious RTCs). Also, possible high number of 'near-misses'. Works out as 1 serious accident per 3 km per day on this stretch of road alone.
- Cites deterioration of pavement & frequent overtaking as reasons for RTCs.
- One of USAID's Iraq road reconstruction projects included the Al Mat highway between Baghdad & Jordan (2004) is used by 3000 trucks per day, in addition to other vehicles. Another example is the repair of a floating bridge at Al-Kut to improve traffic flow for 50,000 travellers per day.

These all point to significant and rapid increases in road-use within Iraq. In terms of the vehicle mix within Iraq, the majority of registered vehicles are cars. However, laws introduced in Iraq post-2003 (appendix I) suggest that motorcycles may be a significant issue and representing a greater proportion of vehicle mix than expected from earlier trends in Iraq or compared with neighbouring countries. Also, unregistered vehicles have been a problem. Apart from being an unmeasured addition to vehicle numbers per capita, are also more likely to disproportionately represent vehicles involved in RTCs.

Other traffic legislation introduced post-2003 suggest some of the particular challenges government agencies may face in trying to tackle road safety in Iraq, with some laws clearly reactionary to road user behaviour.
Speed limits are stratified according to vehicle type, as well as lower speed limits for night-driving (reduction of 10km/hr). There is some evidence from other countries that such a system is beneficial in reducing RTC rates. However, the system does place significant responsibility on drivers to exercise their discretion in deciding which speed limits to apply. This is particularly the case with urban roads where speed limits of up to 60km/hr are allowed with this speed to be halved if the road crowded.
The cost of RTIs to a nation's economic growth can be substantial and has been shown to be between 1-2% of national GDP depending on the country's economic level. These costs include the direct cost of managing victims of RTIs as well as the indirect costs related to loss of income due to death and disability from RTIs. For developing and economically emergent countries, this represents more than the total received in external donor aid. The question that would need to be asked is whether Iraq can afford to lose 1-2% of its GDP each year to RTIs in its

current circumstances in addition to the wider social and psychological costs paid by victims of RTIs and their families or indeed the financial costs faced by individual families. Those most often killed in RTCs are either young, potentially economically active men or children. It is unlikely that Iraq in particular can afford to lose more of their young population to death and disability following the demographic changes it has undergone due to multiple conflicts and migration.

The Haddon Matrix

The Haddon matrix can be used to systematically categorise risk factors that increase risk of RTIs so that public health interventions can be prioritised according to effect. Tackling only one aspect of the matrix cannot effectively tackle the problem. It also broadens the perspective used in tackling road safety. As human error is a major and inevitable factor in RTI incidence, and modifiable to an extent, all possible measures should be taken to minimise this, rather than simply placing increased responsibility on individual road users, which has often been the approach in the past. In addition, human error can equally be applied to stakeholders higher up the road-safety chain such as policy makers and law enforcement agencies.

The effect of conflict on civilians' hazard perception and attitudes to road safety has not been studied, but they could have significant implications for the feasibility and effectiveness of interventions that rely on changes in human behaviour to reduce RTIs. Research into this area could inform strategies on how to tackle these human variables. Therefore, strategies which modifying other aspects of road safety may be even more important in settings unaffected by conflict.

The Haddon Matrix applied to RTIs in Iraq

	Pre-crash factors (Requiring primary prevention methods)	Crash factors (Requiring secondary prevention)	Post-crash factors (Requiring tertiary prevention)

Human variables	• Decision to use vehicle or road in the first place
	  ○ Perceived level of security
	  ○ Necessity
	• Demographics: young & male
	  • Licensing of drivers
	  • Inexperienced drivers
	• Risk perception & Attitude to risk
	  ○ 'Baseline' attitudes (i.e. in Iraq and similar countries), fatalism
	  ○ 'Driving style'
	• Alcohol/drugs/use of mobile phone (these apply mainly drivers but also to other road users
	• Law enforcement by traffic police
	  • Barriers to effective traffic law enforcement for individuals working in police forces including fear and intimidation from population
		Decision to use safety devices where available e.g. seatbelt, child restraint, cycle helmet
		
		Overcrowding/inappropriate loading of vehicles
			• EMS not called post-RTC
			• Inadequate numbers of pre-hospital and hospital staff with adequate training in management of major trauma.

	Pre-crash	Crash	Post-crash
Vehicle	Number of vehicles per capita and rate of increase Vehicle mix on the roads	•Asymmetry of size/power of vehicles involved in RTC inc. presence of military vehicles •Vehicle type and age •absence of safety features •Modifications to vehicles (e.g. changing fuel source of car to household gas)	•Inadequate numbers of ambulance vehicle for provision pre-hospital care •Other vehicles not making way for emergency vehicles en route to scene or medical facility
Environment	•General security environment •Economic development (and rate of change) •Socioeconomic variations and inequalities in distribution of accidents •Political environment •Road: Design/type/quality/maintenance •Layout of roads and effect on perception of appropriate speed of drivers (independent of actual speed limit) •Quality of road signage and road users' comprehension of these •Lack of separation of VRUs from high-speed traffic •Rapid urban growth with poor planning of public spaces	•Design of roads and existence of safety barriers or hazards •Quality of building & maintenance of roads	•Urban vs. Rural environment •Rural areas: Possibly higher risk of underreporting of RTCs & RTIs and increased injury severity & CFR due to risk of delay to definitive emergency care •Availability of infrastructure & resources for provision of emergency care to victims

Discussion

There is a complex interplay of factors which all act to increase Iraq's risk of a high burden of road-traffic injury. As a previously highly motorised country prior to period of economic sanctions, there was a significant baseline mortality from RTIs. This is in common with neighbouring countries, all with significant mortality rates of RTI. Economic sanctions were associated with a significant fall in RTI deaths. Even accounting for under-reporting during this time, this is likely a genuine decrease for the reasons already discussed. Following the 2003 war and its aftermath, actual RTI mortality rates are effectively unknown. It would be expected that following the 2003 , road usage would increase substantially with subsequent increases in RTIs. Very rapid increases in number of motor vehicles, many of them older vehicles, would have significantly contributed to this.

The economic growth Iraq is aiming for in this period of reconstruction and development will not on its own alone provide reductions in RTI mortality now existing in highly-industrialised countries. High-income countries of the region experience very high, yet under-reported, RTI mortality. RTI rates have been shown to be very sensitive to economic changes, and my act as a risk factor in itself to RTI rates. The mechanisms of this are undoubtedly complex. The relationship of economic growth and RTIs is further compounded by the socio-economic impact of RTIs, mostly affecting the young and economically active and significantly affecting GDP.

RTI rates in groups military not only show that RTIS are a feature of deployment, but risky driving behaviours may persist long after the conflict. How driving behaviour may be affected for civilians Iraq after their own exposure to insecurity and violence has not been examined. Understanding the role the environment plays on attitudes to road safety and driving behaviour is likely to be key to effective implementation of any initiatives on primary and secondary prevention of RTIs.

The world is becoming increasingly urbanised and motorised. The nature of conflict has also been changing in recent times. It is becoming more-frequent, more chronic and with increasing exposure of civilians and taking place in urban areas. RTI in civilians has previously not been considered as a significant cause of mortality during conflict, and it may not be so. Though the turbulent post-conflict phase may represent a period where increases in RTI rates should be anticipated and accounted for when planning delivery of health-care during this time.

This study has been based purely on secondary data and a review of relevant literature. It therefore is a more a theoretical framework on which to base more specific work in this area, founded upon a study of the contextual factors at play In Iraq with regard to its burden of road traffic injuries. As such, it has been beyond the scope of this study to go into great depth regarding the evidence base for specific road safety policies in developing countries, but it is hoped that what is lacking in depth and primary data has been made up for in the breadth of what has been covered.

Although Iraq has many public health and social problems in need of urgent action, and prioritising these is always challenging, it is felt that sufficient evidence has been provided to make the argument that tackling road safety should be a public health priority in Iraq.

The Haddon matrix classifies what is required in terms of data and what needs to be done to effectively tackle RTI. It clearly demonstrates that the focus should be on primary and secondary prevention, which the health sector has little control over. In terms of what is required of the health sector in terms of tackling RTIs, the need is twofold. First, improved data collection is essential to assess the nature and extent of RTIs in Iraq. This applies to hospital and pre-hospital data as well as police data. Such evidence will act as a powerful incentive to generate the political will required. Second, the effective delivery and organisation of pre-hospital services, strengthening emergency medical services particularly with trauma care, and provision of adequate rehabilitation services are what is required. All these only act to strengthen Iraq's health system as whole.

The lack of primary data is a significant limitation of this study. It has not been possible to elucidate the distribution of RTIs among different groups of road users which is essential in order to develop an effective road safety strategy in Iraq. However this does not mean steps cannot be taken in tandem with further research. A long-term national road safety strategy is needed for Iraq. Ideally, this would be overseen by a dedicated agency with genuine multi-sectoral representation and collaboration, as recommended by UN call for action on road safety. Such a move would be challenging with the multitude of stakeholders involved. Despite these challenges, Iraq is even more vulnerable to the high toll RTIs impose on individuals and societies. It could be argued this price is simply too high for action not to be taken. For this reason, despite the challenges posed, this public health issue cannot be ignored.

Appendix I: Examples of recent traffic legislation in Iraq post-2003

Year	Traffic Law	Possible reasons behind legislation & Implications
2004	Cars produced before 1990 and imported before 31st December 2003 needed to be taken to directorate of traffic police of relevant governate within 30 days	Issues with formal registration of imported vehicles Significant numbers of old vehicles being imported (>12 years)
	Driving right-hand drive cars was prohibited	Significant numbers of imported vehicles were right-hand drive (where left hand drive is required)
	Small motorcycles (<125cc engine capacity) prohibited from use on roads	Stated reason is due to RTCs Suggests increasing number of motorcycles (would not be necessarily expected compared with neighbouring countries where motorcycles are not significant part of vehicle mix. Motorcyclists constitute proportion of VRUs and RTI victims where such vehicles are used
2005	Prohibition of importation of cars produced later than 2004, i.e. only new cars to be imported	This may or may not have been for road safety reasons. Implies continued import of old cars. Increase cost of purchasing a vehicle, with effects of reducing or limiting vehicle ownership
	Specific locations in Baghdad set up to allow increases in vehicle registration of imported cars	Suggests significant numbers of vehicles not registered
2006	Repeated call for registration of legally imported vehicles	Suggests persistent problem
	Prohibition of use of mobile phones while driving	Possible evidence or perception that mobile phone use while driving significant contributor to RTCs Possibly implemented for security reasons
2008	Modification of speed limits by vehicle type and road type (amendments/additional to laws in 2002 & 2004). See later	Possibly for road safety purposes How previous laws had been amended unclear. Potentially some speed limits increased on certain roads.
2008 Regional laws	Prohibition of vehicles/buses carrying greater than 14 passengers and lorries weighing more than 4 tons within 3 specified areas of city of Mosul.	Stated reason is to reduce traffic accidents and improve traffic flow. Possible evidence of traffic congestion and/or RTC 'hotspots' or areas of chaotic traffic flow. May also reflect security concerns rather than road safety per se.
	In Al'Amarah province, prohibition of lorries > 4 tons within city centre No stopping of vehicles on certain city centre routes	
2009	Prohibition of installation of a DVD player or television on the car dashboard or on the front of the car.	With stated intention of reducing RTCs. Clearly reactionary to modifications to vehicles. Unclear how widespread such modifications need to be in order to change legislation

Appendix II: Speed limits in Iraq (as of 2008)

Road Type	Vehicle Type		
	Cars	**Passenger buses**	**Goods Vehicles**
Major external highways	80-120 km/h	80-100 km/h	70-90 km/h
Internal highways	60-100 km/h	60-90 km/h	60-80 km/h
Dual carriageway with lanes separated by central reservation or trees	Daytime: 100 km/h Night: 90 km/h	Daytime: 70 km/h Night: 60 km/h	
Single carriageway	Daytime: 80 km/h Night: 70 km/h		
Urban Roads	60km/hr 'normal circumstances' 30km/hr if approaching built up areas, schools or rail crossings		

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