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Abstract

Background: Road traffic injuries (RTIs) and deaths constitute a serious preventable global public health problem.

Aims: To analyse time trends of age-standardized mortality rates and disability-adjusted life years (DALYs) caused by RTIs in 23 Middle East and North Africa (MENA) countries; and to assess the correlation between national implementation of best practice for road safety recommended by the World Health Organization, national income level, and RTI burden.

Methods: Time trend analysis over 17 years (2000–2016) was conducted using Joinpoint regression. An overall score was calculated for each country to assess implementation of best practice for road safety.

Results: Mortality decreased significantly (P

Conclusion: Countries in the MENA region had varying levels of success in reducing the burden from RTIs. During the Decade of Action for Road Safety 2021–2030, MENA countries can achieve optimal road safety by implementing measures that are customized for the local context, such as law enforcement and public education. Other focus areas for improving road safety are building capacity in sustainable safety management and leadership, improving vehicle standards, and addressing gaps in areas such as use of child restraint.

Keywords: road safety, Middle East and North Africa, road traffic injuries, road traffic crashes,

road safety measures

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Introduction

Injury and death from road traffic crashes, which are preventable, constitute a serious global health problem. All-cause mortality rates have stabilized worldwide in recent years; however, deaths from road traffic crashes have increased since 2000, reaching 1.35 million annually in 2016 (1). The highest burden from road traffic injuries (RTIs) is disproportionately observed in low- and middle-income countries. RTIs are a leading cause of premature death in children and young adults (1), including in the Middle East and North Africa (MENA) region (2,3). Interventions that prevent road traffic crashes, such as, effective policies, law enforcement, smart road design, and public awareness campaigns, can save millions of lives when implemented in compliance with evidence-based best practices recommended by the World Health Organization (WHO) (1).

We have passed the endpoint for the United Nations (UN) Decade of Action for Road Safety 2011–2020 and the deadline for Sustainable Development Goal target 3.6 to halve the number of deaths and injuries from road traffic crashes by 2020 (4). The new Decade of Action for Road Safety 2021–2030 aims to prevent at least 50% of road traffic deaths and injuries by 2030 (5). However, a recent bibliometric study identified a substantial research gap caused by an insufficient quantity and quality of published research on RTIs in the MENA region (6). To address this gap, we aim to: (1) describe the time trends of mortality rates and disability-adjusted life years (DALYs) caused by RTIs in the MENA region; (2) identify the MENA countries applying best practices congruent with institutional management, road safety

legislation, vehicle standards, and access to post-crash care; (3) assess the correlation between the efforts made by the MENA countries, their income level, and burden of RTIs as measured by death rates and DALYs; and (4) evaluate how MENA countries are progressing to prevent at least 50% of road traffic deaths and injuries by 2030.

Methods

Population of interest

The population of interest was the road users of the 23 MENA countries (7), which include low-income countries (Afghanistan, Somalia, Sudan, Syrian Arab Republic, and Yemen); middle-income countries (Algeria, Djibouti, Egypt, Islamic Republic of Iran, Iraq, Jordan, Lebanon, Libya, Mauritania, Morocco, Pakistan, and Tunisia), and high-income countries [Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates (UAE)] (8). Even though Palestine is part of the MENA region, it was not included in this study because mortality and DALY data were unavailable.

Time trends analysis of age-standardized mortality rates and DALYs

Mortality due to RTIs is defined as the number of deaths divided by population size (4). DALYs are “the sum of years of potential life lost due to premature mortality and the years of productive life lost due to disability” (no unit) (9). Time-trend analyses of national-level age-standardized mortality rates and DALYs were conducted to evaluate RTI burden over time in MENA countries. Age-standardized mortality rates allow comparison of several populations with various age structures because age can have a critical influence on the risk of RTI and death (10).

Age-standardized mortality rates (per 100 000 persons, standardized using the indirect method with the world standard population) (11) and DALYs caused by RTIs were retrieved from the publicly available WHO Global Health Observatory (11) for 2000, 2010, 2015, and 2016. Mortality time trend analysis over 17 years was conducted to evaluate whether MENA countries were able to reduce the number of deaths caused by RTIs, as recommended in Sustainable Development Goal target 3.6. We also investigated DALY time trends to comprehensively assess the burden of RTIs in MENA countries.

We assessed annual age-standardized mortality rate and DALY time trends by modelling the observed data using Joinpoint regression (Joinpoint trend analysis software version 4.9) (12). From the 4 mortality and DALY estimates available for 2000, 2010, 2015, and 2016, we modelled yearly mortality and DALY trends using the Joinpoint model to study time trends. The mathematical model for the Joinpoint regression was a log-linear regression model that determined joinpoints in the trends. Joinpoints were breakpoints in time for which significant

changes in the linear trends were identified. Annual percentage changes for 2000–2016 were estimated to measure the magnitude of the trend change and its statistical significance (13). When a trend was neither increasing nor decreasing significantly, it was considered as constant. The significance of the change in mortality trends was tested using the Monte Carlo Permutation method (P = 0.05).

Implementation of best practice for road safety

To understand mortality and DALY time trends, we assessed implementation of best practice recommended by the WHO related to institutional management, road safety legislation, road standards, vehicle standards, and access to post-crash care.

Similar to previously used scoring to assess best practices in road safety (14), we assessed the level of implementation of the WHO best practices for each MENA country, using a calculated overall score. This overall score was estimated based on the following 11 road safety assessment categories as defined by WHO (2): an agency (score = 0–5); strategy and target (score = 0–4); speed (score = 0–15); drink and drug driving (score = 0–15); seatbelt (score = 0–14); helmet

(score = 0–17); child restraint (score = 0–14); mobile phone use (score = 0–4); safe road (score = 0–6), safe vehicle (score = 0–8); and post-crash response (score = 0–10). A maximum score in each category was given when the laws and standards of a country and their enforcement were enacted in accordance with the WHO best practice for road safety (1). We calculated the overall score by summing the scores for the 11 categories (overall score = 0–112). The procedure for overall score calculation is outlined in Supplementary Material 1.

Country-level data relevant to the assessment of implementation of road safety best practice were retrieved from the Global Status Reports on Road Safety 2015 (15) or 2018 (1). Data on Algeria, Bahrain, Djibouti, and Yemen were available only in the 2015 report, which reported data available up to 2014 (15). Data for the remaining MENA countries were retrieved from the 2018 report, which reported data up to 2017 (1).

Correlation analysis between overall score on the one hand and mortality (2016) and DALYs (2016) on the other hand was not feasible because visual inspection of the corresponding graphs did not show any association between the overall score and these 2 variables. Consequently, to assess country-level mortality and DALYs in 2016 according to overall score, we categorized MENA countries based on their high (> median) or low (**Results**

In the MENA region, Bahrain had the lowest age-standardized mortality rate (8.2 per 100 000 persons) caused by RTIs in 2016, followed by Qatar, UAE, Egypt, and Pakistan (Table 1). The highest mortality rates caused by RTIs in 2016 were observed in Somalia, Saudi Arabia, Mauritania, Djibouti, and Islamic Republic of Iran.

There was a significant decrease in mortality due to RTIs between 2000 and 2016 (annual percent change

P Figure 1) in Qatar (-5.3%), Oman (-2.5%), Kuwait (-2.4%), Islamic Republic of Iran (-1.3%), Lebanon (-1.1%), Tunisia (-0.8%), and Jordan (-0.4%). Saudi Arabia was the only country with a significant increase in mortality due to RTIs (annual percent change +1.1% P

The lowest DALYs caused by RTIs in 2016 were observed in Bahrain (DALYs= 7), Djibouti (DALYs = 15), Qatar (DALYs = 21), Kuwait (DALYs = 43), and Lebanon (DALYs =54). The highest DALYs in 2016 were observed in Pakistan (DALYs = 2045), Islamic Republic of Iran (DALYs = 1220), Egypt (DALYs = 767), and Sudan (DALYs = 663). Only the Islamic Republic of Iran showed a significant decrease in DALYs between 2000 and 2016 (annual percentage change = -0.2%, P Figure 2). DALYs significantly increased between 2000 and 2016 in 12 of 23 (52.2%) MENA countries: Algeria, Afghanistan, Iraq, Jordan, Kuwait, Mauritania, Oman, Pakistan, Somalia, Sudan, Saudi Arabia, and Yemen.

MENA countries are at different stages of implementing WHO best practices for road safety. Implementation of these best practices was not significantly associated with national income level (Figure 3). The 5 MENA countries with the highest overall scores for implementation of road safety best practices were UAE (95/112), Oman (93/112), Qatar (79/112), Islamic Republic of Iran (73/112), and Egypt (73/112). The 5 MENA countries with the lowest overall scores were Mauritania (46/112), Djibouti (31/112), Afghanistan (28/112), Yemen (23/112), and Somalia (13/112). Of the 6 high-income MENA countries (8), only Oman, Qatar, UAE, and Saudi Arabia were ranked among the top 10 countries for overall score; Bahrain ranked 14 (score = 53/112) and Kuwait 18 (score = 47/112). Detailed assessment of the implementation of the 11 WHO road safety assessment categories in the 23 MENA countries is reported in Supplementary Material 2.

In 2016, no significant difference was observed between the age-standardized mortality rates in any of the MENA countries based on national income. No correlation was identified between the overall score for implementation of best practice for road safety and mortality and DALYs.

Among the MENA countries, low overall scores (lower than the median of 58) and high mortality rates (age-standardized mortality higher than the median of 24) were observed in Djibouti, Jordan, Libya, Mauritania, Somalia, and Yemen (Figure 4). The countries with high overall scores and low mortality rates were Egypt, Lebanon, Morocco, Qatar, and UAE. Despite high overall scores, Algeria, Islamic Republic of Iran, Oman, Saudi Arabia, Syrian Arab Republic, and Sudan had high mortality rates. Although Afghanistan, Bahrain, Iraq, Kuwait, Pakistan, and Tunisia had low overall scores, they also had low mortality rates. A decrease in mortality was observed in countries with low overall score (e.g. Tunisia, Kuwait, and Jordan), whereas an increase in mortality was observed in Saudi Arabia, which had a high overall score. Similarly, in 2016, the highest DALYs were observed in Pakistan, which had a low overall score, and in the Islamic Republic of Iran, which had a high overall score.

Discussion

We synthesized mortality and DALY data over 17 years (2000–2016) from 23 MENA countries, and analysed their implementation of WHO best practices for road safety. MENA countries were at varying stages of implementing best practices (e.g. partial, recent, or long-term implementation), and had differing levels in addressing the RTI burden (mortality and DALYs). Implementation of road safety best practices appeared not to be related to national income level, except in Afghanistan, Somalia, and Yemen. Greater political will is required in several MENA countries to implement the best practices and help reduce RTIs and deaths (18). Our analysis showed no association between RTIs and mortality and national income level. There was no significant association between the implementation of WHO best practices for road safety measured with the calculated overall score and mortality and DALYs. However, countries with the highest overall score for implementing WHO best practices for road safety had the lowest mortality rates (e.g. Bahrain, Qatar, and UAE) or demonstrated a significant decrease in mortality (e.g. Qatar, Oman, and Lebanon). However, not all countries with a high overall score reported low mortality rates. For example, Egypt, Saudi Arabia, and Sudan had a high overall score for implementing WHO best practices for road safety but did not show a decrease in mortality rate due to road traffic crashes. This can be explained by the low level of enforcement of existing laws related to seatbelt and helmet use. This suggests that the best practices for road safety that are not yet implemented in these countries (e.g. speed limit of 50 km/h in urban areas and requirement for child restraints) could contribute most to reducing road traffic crash mortality, or simply that additional time is needed to achieve a reduction in mortality.

In parallel, DALYs were increasing in most countries where mortality was decreasing. This suggests that while fewer people were dying on the roads, they were losing years of optimal health, likely because of disabilities resulting from RTIs. Decreases in mortality and DALYs were significant only in the Islamic Republic of Iran, which was one of the countries implementing most of the WHO best practices for road safety (overall score = 73/112). However, despite substantial efforts and reduction in mortality and DALYs, the Islamic Republic of Iran continues to have a higher than median mortality rate and DALYs because of road traffic crashes (19). One study identified that the most common cause of injury in the country was road traffic

crashes (51%) (20). DALYs were also high in Algeria and Yemen, with concomitant mortality among the highest in the region.

The proportion of MENA countries (17.3%) with a national road safety strategy was lower than the global proportion (109/175, 62.3%) reported in the 2018 Global Status Reports on Road Safety (2). Similarly, the proportion of MENA countries (39.1%) reporting an established funded lead agency assuming all 3 responsibilities of coordination, legislation and monitoring, and evaluation, was lower than the global proportion (73.7%) (1). Most MENA countries appeared to be deficient in management capacity according to the WHO recommendations (1). Lack of data systems probably affected the recording of deaths due to RTIs and may explain why some MENA countries had low mortality despite implementing WHO best practices (1). Oman, Qatar, and UAE demonstrated optimum management capacity, inclusive of responsible agencies, multisectoral coordination arrangements, sustainable funding, and data systems to measure, target, and monitor progress (1). To address the RTI burden in the region, a step in the right direction would be to develop a road safety management framework (2). More specifically, all MENA countries should establish funded lead agencies and develop national strategies and targets to reduce fatalities due to RTIs (21).

Vehicle safety regulations were neglected in the MENA region. Only Egypt had implemented 7 of the 8 priority UN vehicle safety standards, while all the other MENA countries reported no implementation (1). Globally, the proportion of countries that have implemented 7 or 8 of these standards was low (40/175, 22.8%); however, this figure was higher than in the MENA region. Uptake of the 8 priority UN vehicle standards is probably an essential step for most MENA countries to help reduce mortality from RTIs. In addition to vehicle safety, national efforts towards making roads safer should be reinforced through adequate planning, design, building, and maintenance of high safety performance standards of road networks (21).

An evidence-based solution to address the burden of RTIs in the MENA countries is to develop and implement effective road safety laws that affect road user behaviour (21). To achieve this, MENA countries should align their road safety laws with the WHO best practices (1). This would be possible by improving existing laws, adding new laws, and enforcing them. Improving current road safety legislation and adding new road safety laws in low- and middle-income countries has been effective in reducing the RTI burden (22). Globally, a small proportion of the population (7%) has adequate laws addressing the behavioural risk factors for RTI prevention; that is, child restraint, motorcycle helmet use, seatbelt use, speeding, and drink driving (21). In the MENA countries, implementation of the child restraint law was the most neglected. The proportion of MENA countries reporting a national child restraint law (5/23, 21.7%) was lower than the global proportion (83/175, 45%). Children also had RTIs as a result of noncompliance with laws for other behavioural risk factors. For instance, in Saudi Arabia, the most common cause of children’s RTIs was the absence of seatbelt use or safety seats and children driving

prior to the licensing age (23). In Lebanon, a country with an existing child restraint law, the most common cause of child RTIs was noncompliance with speed limits (24).

A substantial proportion of RTIs in the MENA countries involved motorbikes. For instance, in Pakistan, two thirds of the RTIs involved motorbikes and 70% involved children and young adults (11–40 years) (25). Helmets, when properly used, can reduce the risk of fatal injuries by 42% (26). Failure to wear helmets remains a critical cause of RTIs in the MENA region (1). Globally, the proportion of countries that have mandatory helmet laws for motorcyclists was higher than in the MENA region (28% vs 8.7%). A national motorcycle helmet law that was applied to both driver and passengers, to all roads and engines, and required fastening a helmet, and reference to standards was missing in most of the MENA countries (21/23, 91.3%). These MENA countries should improve their current legislation related to helmet use by adding the requirement of fastening the helmet and a reference to standards.

Noncompliance with seatbelts and mobile phone use while driving were additional risk factors for RTIs in the MENA region (27). Despite laws addressing seatbelt noncompliance and mobile phone use, these violations were common among drivers in Kuwait (28), Qatar (29–32), Saudi Arabia (33), and Islamic Republic of Iran (34). There was no difference between male and female drivers for these factors in Qatar (29), while in Saudi Arabia, female drivers were less likely to wear seatbelts (33). Seatbelt noncompliance has been associated with more severe RTIs (31). In Kuwait, people who were noncompliant with seatbelt use were significantly less aware of the law surrounding mandatory seatbelt use (28). They believed significantly more often that wearing a seatbelt did not protect them from RTIs and they were significantly less likely ever to have been fined for noncompliance with seatbelt use (28).

Distracted driving was another risk factor for RTIs in the MENA region. In the Islamic Republic of Iran, sending text messages and smoking while driving had the highest risk for motorcycle crashes (34). In Qatar, other traffic violations (e.g. exceeding the speed limit) were significantly associated with road traffic crashes (30). Further awareness campaigns to enhance people's understanding of the consequences of road users' behaviour-related risk factors for RTIs (e.g. distracted driving, noncompliance with seatbelt use, and speeding), and law enforcement (e.g. installation of speed cameras, increases in fines for traffic violations, and increased police vigilance) are necessary to enhance road safety for all road users in MENA countries.

There were some limitations to our study. Mortality and DALY time trends were modelled over 17 years based on estimations for 2000, 2010, 2015, and 2016. Any change in trends that may have occurred between the years during which the WHO estimations were performed, especially between 2000 and 2010, may have been missed. However, an overall increase

and/or decrease in mortality and DALYs between 2000 and 2016 was probably identified by this study. The effects of implementation of the recommended WHO best practices likely occurred over several years, and changes from one year to another may have been artifacts. A lack of data meant that we were not able to describe mortality and DALY time trends for Palestine, which is included in the MENA region.

The Decade of Action for Road Safety 2011–2020 has led to road safety improvement in several MENA countries that have implemented best practices. However, additional efforts are required to achieve the Decade of Action for Road Safety 2021–2030 target (5). The action plan currently developed by WHO and the UN Regional Commissions (5) recommends that most MENA countries should build capacity for sustainable safety management and leadership (i.e. developing national road traffic strategies and establishing a funded agency), and address neglected topics (e.g. child restraint use and vehicle standards). MENA countries are at varying stages with regard to achieving the UN target of decreasing mortality from RTIs, and additional progress is achievable. Political will at the national level to commit to and implement the required actions (e.g. enforcement of existing laws) is critical. In low- and middle-income MENA countries, governments are encouraged to adopt their own RTI reduction targets that should be ambitious, achievable, and supported by performance indicators based on the identified gaps (35).

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Étude écologique de la charge des accidents de la circulation au Moyen-Orient et en Afrique du Nord

Résumé

Contexte : Les traumatismes et les décès dus aux accidents de la circulation constituent un

problème de santé publique mondial grave et évitable.

Objectifs : Analyser les tendances dans le temps des taux de mortalité standardisés selon l'âge et des années de vie ajustées sur l'incapacité (DALY) causés par les traumatismes dus aux accidents de la circulation dans 23 pays du Moyen-Orient et d'Afrique du Nord ; et évaluer la corrélation entre la mise en œuvre au niveau national des meilleures pratiques en matière de sécurité routière recommandées par l'Organisation mondiale de la Santé, le niveau de revenu national et la charge des traumatismes dus aux accidents de la circulation.

Méthodes : Une analyse des tendances temporelles sur une période de 17 ans (2000-2016) a été réalisée à l'aide de la régression Joinpoint. Un score global a été calculé pour chaque pays afin d'évaluer la mise en œuvre des meilleures pratiques en matière de sécurité routière.

Résultats : La mortalité a considérablement diminué (p