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Review Article

Quickest Way to Reduce Road Deaths: To Implement Traffic Rules

Tianze Xu*, Binghua Wu

Department of Physics, Henan University of Urban Construction, Pingdingshan, China

ABSTRACT

In this study, firstly we compared the 13 interventions presented by UN to cut traffic accident in each country and found that high-income countries do not necessarily have Low Road Death Rate (LRDR) and low-income countries can achieve LRDR, and that being strict of any one of the 13 interventions does not guarantee LRDR while being lax of any one of the 13 interventions does not necessarily mean High Road Death Rate (HRDR). This means none of the interventions is a decisive factor in influencing a country's road death rate. Furthermore, we compared the difference in traffic management between what is common in LRDR countries and what is common in HRDR countries. Through analysis, we argue that decisive factors are traffic rules and its enforcement. Specifically, we drew the following conclusions for safe traffic: 1) Government being strict in issuing driver's license, 2) traffic rules must be scientific and in detail and well obeyed by human, and 3) traffic management precautions must be seamlessly consistent with infrastructure and environment and traffic condition. The key value of our study and conclusions is road death rate of a HRDR country can reach the lowest level in a reasonably short time by enacting traffic rules and enforcement of them, without need for upgrading its level in economy, infrastructure and vehicles, which needs at least decades of time.

Keywords: Traffic accident; Road death rate; Intervention; Decisive factor; Traffic rule

INTRODUCTION

According to our calculation based on data included in UN Global status report on road safety 2018, there is big difference in road death rates among countries from as high as 81.56 in Congo to as low as 0.34 in Norway in terms of per 10 thousand vehicles registered. If all countries have road death rate as low as Norway's 0.34, the total global road fatality will be 67,205 or 5% of the current fatality of 1.3 million. Finding the decisive factors influencing a country's road death rate can help countries with high road death rate to take effective measures to cut down their road death rates. A decisive factor in traffic safety is defined as the factor that the road death rate of a country will be greatly higher if a country fails to do good work in [1].

According to UN Global status report on road safety 2018, countries have been taking the following interventions to cut down road death rate1: low BAC limit, low speed limit, strict helmet law, strict seat-belt law, strict child restraint law, strict vehicle standard, investments to upgrade high risk locations, audits or star rating of new road infrastructure projects, strict inspections/ star ratings of existing road infrastructure projects, strict design standards for the safety of pedestrians and cyclists, strict policies and investment in urban public transport, strict national or subnational policies promoting walking and cycling, more emergency medicine and trauma surgery, strict prohibition of using mobile phones while driving, strict drug-driving prohibition law, etc. It is vital to know whether they are decisive factors or not, for if they are then interventions adopted by countries with low death rates can afford successful experience to other countries with high road death rates [2].

In this study, firstly we analyzed whether the thirteen interventions are decisive factors through comparison. Secondly, we presented and analyzed some decisive factors. The rest of the paper is organized as follows: section 2 introduced methods, section 3 compared the 13 interventions, section 4 presented some decisive factors, and section 5 concluded the paper.

Correspondence to: Tianze Xu, Henan University of Urban Construction, Pingdingshan, China, E-mail: selecxtz@126.com

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LITERATURE REVIEW

To find whether the thirteen interventions are decisive factors or not, we need to compare how the 13 interventions are executed in different countries. To do the comparison, we calculate road death rate per 10 thousand vehicles registered for each member country based on the total death number and total vehicles registered for each member country. We then order the road death rates ascendingly. We find there is large difference on road death rates among 162 countries which data are available, with the highest being 81.56 for Congo and the lowest being 0.34 for Norway The next step is to compare each of interventions among countries in the same order shown in so as to find statistically what difference there is on the intervention among the countries. After comparison of each intervention among different countries we can find whether they are decisive factors.

To do the comparison, the countries for which data on an intervention are available are broken into three groups based on road deaths per 10 thousand vehicles registered, with LRDR countries being with death rates from 0.00 to 1.99, MRDR from 2.00 to 5.99, and HRDR from 6.00 to 89.99. The means of each intervention of three groups are statistically compared using Brown-Forsythe Variance Analysis. Without causing confusion, the means of each intervention are denoted as Ψ_{lowest}, Ψ_{middle}, and $\Psi_{highest}$ for the LRDR, MRDR, and HRDR, respectively. The degree of freedom between treatments in this study is m=2, intra group degree of freedom n is dependent on the sample size. Brown F is calculated and denoted as BF (m,n). The significance level for Brown F is 0.01. All the Confidence Intervals (CI) are at significance level 0.05. The result of the analysis for each intervention is explained. Furthermore, the exceptions and contradictions of each intervention are found and discussed (Figure 1).

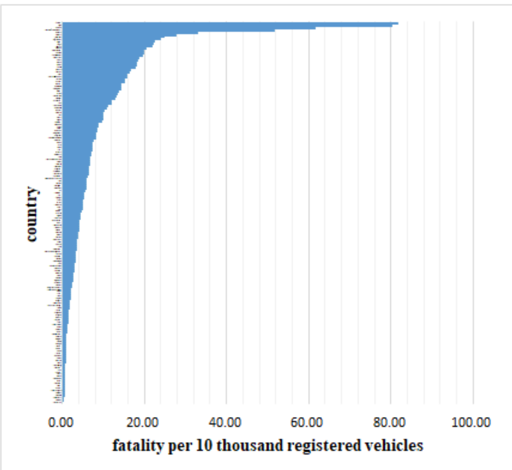

Figure 1: Fatalities per 10 thousand registered vehicles. Data reported for total registered vehicles for 2016 and reported number of road traffic deaths are from the Global status report on road safety 2018.

COMPARISONS

Income level of countries

Gross National income (GN) per capita for the year 2016 came from World Bank estimated. Where no data were available for 2016, published data for the latest year were used. The World Bank Atlas method was used to categorize GNl into bands thus： Low-income=US$ 1005 or less, Middle-income =US$ 1006 to US $ 12235, and High-income=US$ 12236 more. For Brown-Forsythe Variance Analysis (BFVA) of income, BF (2, 155.232) =99.778, p=0.000. The 95% CI are (1.66 ± 0.54) for high death rate group (n=65), (2.10 ± 0.36) low death rate group (n=50), and (2.85 ± 0.42) low death rate group (n=47), respectively. At significance level 0.05, it holds statistically that $\Psi_{lowest}>\Psi_{middle}>\Psi_{highest}$, which means generally wealthier countries have lower road death rate. However, five middle-income countries Maldives, Belarus, Croatia, Bulgaria and China have LRDR 0.43, 1.40, 1.54, 1.76 and 1.97, respectively, and one low-income country Liberia has LRDR 1.61. Two high-income countries Seychelles and Saudi Arabia have HRDR 6.5 and 13.10, respectively. This phenomenon indicates that income level is not a decisive factor on a country's road death rate and being wealthy does not guarantee a high-income country to have LRDR while being poor should not be excuse for a low-income country to have HRDR [3,4].

BAC/BrAC restriction

A country presents a national drink-driving law with BAC (Blood Alcohol Concentration) limit for the general population not exceeding a threshold such as 0, 0.01, 0.02, 0.05, 0.08, 0.12, 0.15g/dl, etc. For Brown-Forsythe Variance Analysis (BFVA) of national maximum legal BAC levels, BF (2, 122.768) =5.082, p= 0.008. The 95% CI are (0.06 ± 0.03) for high death rate group n=43), (0.05 ± 0.02) middle death rate group (n=38), and (0.05± 0.03) low death rate group (n=45), respectively. At significance level 0.05, it holds statistically that $\Psi_{lowest}<\Psi_{middle}<\Psi_{highest}$, which means generally countries with stricter BAC limit have lower road death rate. Enforcement of BAC restriction law is evaluated on a scale of 0 to 10, with 0 being "not effective" and 10" highly effective". For Brown-Forsythe Variance Analysis (BFVA) of the enforcement of BAC restriction law, BF (2, 119.682) = 10.190, p=0.000. The 95% CI are (4.74 ± 2.25) for high death rate group (n=43), (5.45 ± 2.13) middle death rate group (n=38), and (6.76 ± 1.98) low death rate group (n=45), respectively. At significance level 0.05, it holds statistically that $\Psi_{lowest}>\Psi_{middle}$ and $\Psi_{lowest}>\Psi_{highest}$, which means generally countries with stricter BAC enforcement have lower road death rate. However, six LRDR countries United Kingdom, Barbados, United States, Singapore, Liberia, and Trinidad and Tobago have lax BAC limit 0.08 to 0.15 yet low road death rate 0.47 to 1.62. Likewise, four LRDR countries Malta, Barbados, Greece and Liberia have lax BAC enforcement 0 to 4 yet low road death rate 0.61 to 1.61. Four HRDR countries Paraguay, Morocco, Cuba and Vietnam have strict BAC limit 0 to 0.02 yet high road death rate 6.42 to 16.61. These are contradictory to general cases where strict BAC limit and enforcement correspond to low road death rates and vice versa, which indicates that BAC is not a decisive factor on a country's road death rate and strict BAC limit does not guarantee LRDR while lax BAC limit does not necessarily mean HRDR [5].

Managing speed

Speed limits reported here are the default speed limits for private passenger cars. "Default speed limit" was interpreted as the maximum speed limit applying in normal circumstances (regardless of weather, roadworks, special events, etc.) on the road type considered. Enforcement is on a scale of 0 to 10, with 0 being "not effective" and 10" highly effective". For Brown-Forsythe Variance Analysis (BFVA) of the national speed limits on urban roads, rural roads and motorways, BF (2, 123.574) = 4.526, p=0.013. The 95% CI are (298.74 ± 84.25) for high death rate group (n=57), (262.58 ± 53.06) middle death rate group (n=45), and (276.48 ± 42.06) low death rate group (n=46), respectively. At significance level 0.05, it holds statistically that $\mu_{lowest}>\mu_{middle}$ and $\mu_{lowest}>\mu_{highest}$, which means generally countries with stricter speed limit have lower road death rate. For Brown-Forsythe Variance Analysis (BFVA) of the enforcement of national speed limits, BF (2, 141.563)=7.204, p=0.001. The 95% CI are (4.91 ± 2.09) for high death rate group (n=57), (5.31 ± 2.08) middle death rate group (n=45), and (6.39± 1.84) low death rate group (n=46), respectively. At significance level 0.05, it holds statistically that $\mu_{lowest}>\mu_{middle}$ and $\mu_{lowest}>\mu_{highest}$, which means generally countries with stricter speed limit enforcement have lower road death rate. However, LRDR countries Maldives, Malta, Estonia, Trinidad and Tobago, and Latvia have lax motorway speed limit 200 km/h, Cyprus has lax rural speed limit 200 km/h, and Qatar has lax urban speed limit 100 km/h, while the above eight LRDR countries have road death rate ranging from 0.43 to 1.97. HRDR countries Kiribati, Bhutan and Tonga have strict motorway speed limit 50 to 70 km/h, rural speed limit 30 to 50 km/h, and urban speed limit 50 to 70 km/h, while their road death rate is from 13.49 to 22.08. This indicates that speed limit is not a decisive factor on a country's road death rate and strict speed limit does not guarantee LRDR while lax speed limit does not necessarily mean HRDR.

Helmet law

The data collected were based on the following seven variables: National motorcycle helmet law, applies to driver, applies to adult passengers, applies to all roads, applies to all engines, helmet fastening required, standard referred to and/or specified. Each variable is scored 1, or 0, respectively, if the data is "Yes", or "No". A score of 7 is assigned to a country where all seven variables are scored 1. A score of 6 is assigned to a country where six out seven variables are scored 1, etc. For Brown-Forsythe Variance Analysis (BFVA) of national helmet law, BF (2, 133.869) =2.503, p=0.086. The 95% CI are (5.68 ± 1.24) for high death rate group (n=59), (5.87 ± 0.82) middle death rate group (n=47), and (6.16 ± 1.15) low death rate group (n=43), respectively. No statistical difference on the means is observed at significance level 0.05. Helmet law enforcement of each country is evaluated on a scale of 0 to 10, with 0 being "not effective" and 10" highly effective". For Brown-Forsythe Variance Analysis of national helmet law enforcement, BF (2, 137.214) =19.616, p=0.000. The 95% CI are (5.14 ± 2.32) for high death rate group (n=59), (6.06 ± 2.51) middle death rate group (n=47), and (7.93± 1.84) low death rate group (n=43), respectively. At significance level 0.05, it holds statistically that $\mu_{lowest}>\mu_{middle}>\mu_{highest}$, which means countries with stricter helmet law enforcement have lower road death rate. However, LRDR countries Maldives and United States have helmet law evaluated as 2, and enforcement evaluated as 5 and 6, while their road death rates are 0.43 and 1.25, respectively. HRDR countries Samoa and Rwanda have helmet law evaluated as 6, and enforcement evaluated as 10, while their road death rates are 6.74 and 32.92, respectively. This indicates that helmet law is not a decisive factor on a country's road death rate and strict helmet law does not guarantee LRDR while lax helmet law does not necessarily mean HRDR [6].

Seat-belt law

The data are collected based on the occupant seat belt applies to: drivers, front seat passengers, or rear-seat passengers. Data on seat-belt for each category of occupant is reported as "Yes" or "No", and is scored 1 or 0, respectively. "3" means seat-belt law applies to drivers, front seat passengers and rear-seat passengers. "2" means seat-belt law applies to two of them. "1" means seat-belt law only applies to one of them. For Brown-Forsythe Variance Analysis of seat-belt law, BF (2, 138.668) = 7.644, p=0.001. The 95% CI are (2.45 ± 0.53) for high death rate group (n=65), (2.60 ± 0.61) middle death rate group (n=50), and (2.83 ± 0.38) low death rate group (n=47), respectively. At significance level 0.05, it holds statistically that $\mu_{lowest}>\mu_{middle}$ and $\mu_{lowest}>\mu_{highest}$, which means generally countries with stricter seat-belt law have lower road death rate. Seat-belt law enforcement of each country is evaluated on a scale of 0 to 10, with 0 being "not effective" and 10" highly effective". For Brown-Forsythe Variance Analysis of seat-belt law enforcement, BF (2, 150.935) =12.832, p=0.000. The 95% CI are (5.26 ± 2.08) for high death rate group (n=65),(6.00 ± 1.99) middle death rate group (n=50), and (7.04 ± 1.41) low death rate group (n=47), respectively. At significance level 0.05, it holds statistically that $\mu_{lowest}>\mu_{middle}>\mu_{highest}$, which means generally countries with stricter seat-belt law enforcement have lower road death rate. However, LRDR countries Maldives, Spain, Malta, United States, Qatar, and Trinidad and Tobago have seat-belt law scored 2 while their road death rates are from 0.43 to 1.62. LRDR country Greece has seat-belt law enforcement scored 4 while its road death rate is 0.87. HRDR countries Samoa and Eritrea have seat-belt law enforcement scored 10 and 8 while their road death rates are 6.74 and 17.95. This indicates that seat-belt law is not a decisive factor on a country's road death rate and strict seat-belt law does not guarantee LRDR while lax seat-belt law does not necessarily mean HRDR [7].

DISCUSSION

Child restraint

A country is interpreted as having a child restraint law where the country requires the mandatory use of child restraint systems for an identified group of children based on either their height and/ or their age and/or their weight. “1” means a country has child restraint while “0” means a country has no child restraint. For Brown-Forsythe Variance Analysis of national child restraint law, BF (2, 140.312) = 28.915, p= 0.000. The 95% CI are (0.25 ± 0.43) for high death rate group (n=65), (0.50 ± 0.51) middle death rate group (n=50), and (0.87 ± 0.34) low death rate group (n=47), respectively. At significance level 0.05, it holds statistically that $\mu_{lowest}>\mu_{middle}>\mu_{highest}$, which means generally countries with stricter child restraint have lower road death rate. National child restraint law enforcement of each country is evaluated on a scale of 0 to 10, with 0 being “not effective” and 10” highly effective”. For Brown-Forsythe Variance Analysis of national child restraint law enforcement, BF (2, 108.155) =53.629, p=0.000. The 95% CI are (0.48 ± 1.31) for high death rate group (n=65), (2.32 ± 3.01) middle death rate group (n=50), and (5.79 ± 3.18) low death rate group (n=47), respectively. At significance level 0.05, it holds statistically that $\mu_{lowest}>\mu_{middle}>\mu_{highest}$, which means generally countries with stricter child restraint enforcement have lower road death rate. However, LRDR countries Maldives, Qatar, Croatia, Liberia, South Korea and China have no child restraint while their road death rates are from 0.43 to 1.97. Sixteen HRDR countries have child restraint while their road death rates range from 6.42 to 81.56. This indicates that seat-belt law is not a decisive factor on a country’s road death rate and strict child restraint law does not guarantee LRDR while lax child restraint law does not necessarily mean HRDR.

Vehicle standard

Data on vehicle standards were collected using information from the UN World Forum for Harmonization of Vehicle Regulations. Technical support on analyzing and interpreting this data was provided by Global NCAP 71. The data collected were based on the following eight variables: Frontal impact, Side impact, Electronic Stability Control, Pedestrian protection, Seat-belts, Seat-belt anchorages, Child restraints, Motorcycle antilock braking system. Each variable is scored 1, or 0, respectively, where the data is “Yes”, or “No”. A score of 8 is assigned to a country where all eight variables are scored 1. A score of 7 is assigned to a country where seven out eight variables are scored 1, etc. For Brown-Forsythe Variance Analysis of national vehicle standard, BF (2, 101.520) = 108.914, p=0.000. The 95% CI are (0.28 ± 1.28) for high death rate group (n=65), (0.86 ± 2.19) middle death rate group (n=50), and (6.37 ± 2.92) low death rate group (n=47), respectively. At significance level 0.05, it holds statistically that $\mu_{lowest}>\mu_{middle}$ and $\mu_{lowest}>\mu_{highest}$, which means generally countries with stricter vehicle standards have lower road death rate. However, LRDR countries Maldives, Barbados, Qatar, Belarus, Singapore, Liberia, and Trinidad and Tobago have no vehicle standards while their road death rates are from 0.43 to 1.62. HRDR countries India, Egypt and Ecuador have vehicle standard 6, 7 and 5, respectively, and have road death rates ranging from 7.17 to 15.03. This indicates that vehicle standard is not a decisive factor on a country’s road death rate and strict vehicle standard does not guarantee LRDR while lax vehicle standard does not necessarily mean HRDR.

Audits or star rating of new road infrastructure projects

Information on audits or star rating of new road infrastructure projects is reported as “Yes”, “No”, or “Partial”, and is scored 2, 0, or 1, respectively. For Brown-Forsythe Variance Analysis (BFVA) of audits or star rating of new road infrastructure projects, BF (2, 149.842) =0.396, p=0.674. The 95% CI are 1.38 ± 0.72] for high death rate group (n=65), (1.29 ± 0.76) middle death rate group (n=50), and (1.40 ± 0.65) low death rate group (n=47), respectively. No statistical difference on the means is observed at significance level 0.05. However, LRDR countries Maldives, Barbados, United States and Uruguay have no audits or star rating of new road infrastructure projects while their road death rates are from 0.43 to 1.90. Thirty-four HRDR countries have audits or star rating of new road infrastructure projects scored 2 while their road death rates are from 6.31 to 81.56. This indicates that audits or star rating of new road infrastructure projects is not a decisive factor on a country’s road death rate and strict audits or star rating of new road infrastructure projects does not guarantee LRDR while lax audits or star rating of new road infrastructure projects does not necessarily mean HRDR.

Inspections/star ratings of existing road infrastructure projects

Information on inspections/star ratings of existing road infrastructure projects is reported as “Yes” or “No”, and is scored 2 or 0, respectively. For Brown-Forsythe Variance Analysis of inspections/star ratings of existing road infrastructure projects, BF (2, 129.216) = 7.476, p=0.001. The 95% CI are (1.21± 0.99) for high death rate group (n=65), (1.29 ± 0.97) middle death rate group (n=50), and (1.83 ± 0.57) low death rate group (n=47), respectively. At significance level 0.05, it holds statistically that $\mu_{lowest}>\mu_{middle}$ and $\mu_{lowest}>\mu_{highest}$, which means generally countries with stricter inspections/star ratings of existing road infrastructure projects have lower road death rate. However, LRDR countries Trinidad and Tobago, Bulgaria and Uruguay have no inspections/star ratings of existing road infrastructure projects while their road death rates are from 1.62 to 1.90. Thirty-seven HRDR countries have inspections/star ratings of existing road infrastructure projects scored 2 while their road death rates are from 6.31 to 51.50. This indicates that inspections/star ratings of existing road infrastructure projects are not a decisive factor on a country’s road death rate and strict inspections/star ratings of existing road infrastructure projects do not guarantee LRDR while lax inspections/star ratings of existing road infrastructure projects do not necessarily mean HRDR.

Design standards for the safety of pedestrians and cyclists

Design standards for the safety of pedestrians and cyclists is reported as “Yes”, “No”, or “Partial”, and is scored 2, 0, or 1, respectively. “Yes” responses included the provision of the following Managing speed to safe system outcomes (e.g. 20 mph or 30 km/h); Safe crossings for pedestrians and cyclists; and Separation of pedestrians and cyclists from vehicular traffic. If 1-2 of the provisions were met, responses are reflected as “Partial”. For Brown-Forsythe Variance Analysis of design standards for the safety of pedestrians and cyclists, BF (2, 145.773)=14.018, p=0.000. The 95% CI are (1.12 ± 0.57) for high death rate group (n=65), (1.20 ± 0.67) middle (n=50), and (1.70 ± 0.55) low death rate group (n=47), respectively. At significance level 0.05, it holds statistically that $\mu_{lowest}>\mu_{middle}$ and $\mu_{lowest}>\mu_{highest}$, which means generally countries with stricter design standards for the safety of pedestrians and cyclists have lower road death rate. However, LRDR countries Switzerland and United States have no design standards for the safety of pedestrians and cyclists while their road death rates are 0.36 to 1.25, respectively. Fifteen HRDR countries have design standards for the safety of pedestrians and cyclists scored 2 while their road death rates are from 6.50 to 32.92. This indicates that design standards for the safety of pedestrians and cyclists is not a decisive factor on a country’s road death rate and strict design standards for the safety of pedestrians and cyclists does not guarantee LRDR while lax design standards for the safety of pedestrians and cyclists does not necessarily mean HRDR.

Investments to upgrade high risk locations of each country

Investments to upgrade high risk locations is reported as “Yes” or “No”, and is scored 2 or 0, respectively. For Brown-Forsythe Variance Analysis (BFVA) of investments to upgrade high risk location, BF (2, 153.116)=0.856, p=0.427. The 95% CI are (1.26 ± 0.97) for high death rate group (n=65), (1.31 ± 0.96) middle death rate group (n=50), and (1.49 ± 0.88) low death rate group (n=47), respectively. No statistical difference on the means is observed at significance level 0.05. However, twelve LRDR countries have no investments to upgrade high risk locations while their road death rates are from 0.43 to 1.91. Forty-one HRDR countries have investments to upgrade high risk locations scored 2 while their road death rates are from 6.31 to 81.56. This indicates that investments to upgrade high risk locations is not a decisive factor on a country’s road death rate and strict investments to upgrade high risk locations does not guarantee LRDR while lax investments to upgrade high risk locations does not necessarily mean HRDR.

Policies & investment in urban public transport

Policies & investment in urban public transport is reported as “Yes” or “No”, and is scored 2 or 0, respectively. For Brown-Forsythe Variance Analysis of policies & investment in urban public transport, BF (2,146.807)=4.354, p=0.015. The 95% CI are (1.35 ± 0.94) for high death rate group (n=65), (1.36 ± 0.94) middle death rate group (n=50), and (1.79 ± 0.62) low death rate group (n=47), respectively. At significance level 0.05, it holds statistically that $\mu_{lowest}>\mu_{middle}$ and $\mu_{lowest}>\mu_{highest}$, which means generally countries with stricter policies & investment in urban public transport have lower road death rate. However, five LRDR countries Germany, Australia, Estonia, Hungary and Latvia have no policies & investment in urban public transport while their road death rates are from 0.57 to 1.97. Forty-five HRDR countries have policies & investment in urban public transport scored 2 and their road death rates range from 6.31 to 80.16. This indicates that policies & investment in urban public transport is not a decisive factor on a country’s road death rate and strict policies & investment in urban public transport does not guarantee LRDR while lax policies & investment in urban public transport does not necessarily mean HRDR [8].

Policies promoting walking and cycling of each country

Policies promoting walking and cycling is reported as “Yes”, “No”, or “Subnational”, and is scored 2, 0, or 1, respectively. For Brown-Forsythe Variance Analysis of policies promoting walking & cycling, BF (2, 150.179)=23.352, p= 0.000. The 95% CI are (0.60 ± 0.83) for high death rate group (n=65), (0.96 ± 0.88) middle death rate group (n=50), and (1.66 ± 0.70) low death rate group (n=47), respectively. At significance level 0.05, it holds statistically that $\mu_{lowest}>\mu_{middle}>\mu_{highest}$, which means generally countries with stricter policies promoting walking and cycling have lower road death rate. However, five LRDR countries Maldives, Germany, Barbados, Trinidad and Tobago, and Latvia have no policies promoting walking and cycling while their road death rates are from 0.43 to 1.97. Fourteen HRDR countries have policies promoting walking and cycling scored 2 while their road death rates are from 7.00 to 32.92. This indicates that policies promoting walking and cycling is not a decisive factor on a country’s road death rate and strict policies promoting walking and cycling does not guarantee LRDR while lax policies promoting walking and cycling does not necessarily mean HRDR.

Emergency medicine and trauma surgery

Emergency medicine and trauma surgery is reported as “Yes”, or “No”, and is scored 1, or 0, respectively. “2” means a country has both of them, “1” means a country has either of them, “0” means a country has none of them. For Brown-Forsythe Variance Analysis of emergency medicine and trauma surgery, BF (2, 152.510)=4.106, p=0.018. The 95% CI are (0.14 ± 0.87) for high death rate group (n=64), (1.53 ± 0.72 middle death rate group (n=48), and (1.48 ± 0.78) low death rate group (n=46), respectively. At significance level 0.05, it holds statistically that $\mu_{middle}>\mu_{highest}$ and $\mu_{lowest}>\mu_{highest}$, which means generally countries with stricter emergency medicine and trauma surgery have lower road death rate. However, eight LRDR countries have no emergency medicine and fourteen LRDR countries have no trauma surgery while their road death rates are from 0.43 to 1.97. Thirty-nine HRDR countries have emergency medicine and thirty-one countries have trauma surgery while their road death rates are from 6.33 to 81.56. This indicates that emergency medicine and trauma surgery is not a decisive factor on a country's road death rate and strict emergency medicine and trauma surgery does not guarantee LRDR while lax emergency medicine and trauma surgery does not necessarily mean HRDR. So far we have compared the 13 interventions and found that none of the interventions are a decisive factor that influences a country's road death rate.

Analysis of decisive factors

To find the decisive factors, we need to compare and analyze the difference between what is common in LRDR countries and what is common in HRDR countries from five aspects inclusive of human, vehicle, road, environment and management. The comparison and analysis should be based on survey as well as on theory. The best way to get the data needed for comparison is to do survey in each country in the five aspects but the cost will be too large and beyond the reach of us. An alternative method is to take the privilege of the internet and collect what is wanted through search engine such as Baidu or Google. Considering population of China is large and there are many Chinese living and working in most countries globally, we collect through Baidu the posted Chinese texts and answers to traffic-related questions in different countries and extracted information from them and analyzed the information. Though not all countries are covered by the posted Chinese texts and answers, most countries are. Some clear and unanimous differences between what is happening in HRDR countries and in LRDR countries in traffic were found, which can be reference for finding the decisive factors.

The biggest difference lies in how to get a driver's license. In all HRDR countries, issuing driver's license is not strict, usually with lax driving test. One can even buy a driver's license without taking driving test in all HRDR countries. While in all LRDR countries, issuing driver's license is very strict, all with strict driving test. People have to pass strict driving test to get a driver's license. No one can buy a driver's license without taking driving test. According to the analysis of the causes of road traffic accidents in various countries, more than 85% of traffic accidents are caused by drivers (According to the research results of American Indian University, 90.3% of accidents are related to drivers; according to the research results of Britain, nearly 95%of accidents are related to road users; according to the research of Finnish Insurance Information Center, 89% of accidents are attributable to drivers; Belarus analyzes the causes of accidents and believes that 92% of accidents are attributable to drivers). Moreover, the shortcomings of road and automobile can be compensated by human subjective initiative. If the driver is skillful, responsive and cautious, traffic accidents may be avoided even if the road is in bad condition and the vehicle has faults. Therefore, the key to road traffic safety is the reliability of drivers. People often call those low-quality drivers without formal training and strict examination "road killers" they account for 70% of the total traffic accidents in the province each year due to their poor awareness of traffic laws and regulations, their poor driving skills, or their improper emergency treatment measures. With such big difference in getting a driver's license between HRDR countries and LRDR countries, it is not surprising that the difference in road death rates between them is large.

The second biggest difference lies in the setting of traffic signs and markings. In all HRDR countries, there are no stop or yield signs at un-signalized intersections, which account for the vast majority of rural intersections. While in all LRDR countries, there are stop or yield signs at un-signalized intersections. This means parties of traffic participants in HRDR countries are more likely to conflict at un-signalized intersections and lead to accident compared against in LRDR countries.

The third biggest difference lies in human's traffic behavior. In all HRDR countries, it is an ordinary phenomenon that pedestrians may cross a road at any point and pedestrians and non-motor vehicles and motor vehicles often share the same road. While in all LRDR countries, it is normal phenomenon that pedestrians cross a road on crosswalk and pedestrians and non-motor vehicles and motor vehicles are separated in most cases.

For each of the three differences, we have solutions on traffic rules to solve the problems in HRDR countries. For the first difference, in order to effectively prevent the occurrence of traffic accidents, it is necessary to strictly control the access threshold of drivers and nip in the cradle the adverse factors affecting traffic safety. This can only be done by government enacting detailed rules on issuing driver's license and conducting strict enforcement of them. For the second difference, the reason for not setting traffic signs and markings in HRDR countries is that there are no governmental traffic rules regulating the setting of them. Considering setting traffic signs and markings or crosswalk needs money and may not be applicable in some low-income countries, a replaceable method is to regulating through traffic rule that vehicles must stop or yield signs at un-signalized intersections. For the third difference, considering paving crosswalk or constructing separated roads needs money and may not be applicable in some low-income countries, a replaceable method is to regulating through traffic rule that vehicles must slow down to a certain speed limit to avoid hurting people when they are getting closer to each other. This speed limit should be much lower than the general speed limit for the road to ensure safety of all traffic participants. It also must be exact, say 20 km/hour, so as to be executed in reality. The rule must also regulate that pedestrian should cross road through crosswalk if there is or watch carefully and cross only if there are no vehicles coming closer in the case of no crosswalk. Thus, we argue that all the problems for HRDR countries associated with the difference can be solved by government enacting traffic rules and enforcing them strictly and that decisive factors influencing a country's road death rate are traffic rules and its enforcement.

Theoretically speaking, as long as there is no problem (such as a hole) with a road and a vehicle functions well, a qualified driver will drive the vehicle on the road normally. If the speed is reasonable then the traffic will be safe. The speed limit for a road section must be consistent with the condition of the road section and environment on both sides of it. High level road corresponds to high speed limit and vice versa. A safe speed must consider the facility level as well as surrounding traffic.

Different speed limit may be considered for different road section to take into consideration the difference of environment and traffic composition and traffic condition in different road section for the same road. Domestic or local traffic rules must regulate the speed limit for different road section in detail and enforce them strictly. This means the lowest condition to achieve safe traffic should include: 1) well-trained and skillful drivers, 2) vehicles that may not be advanced but must function well, 3) infrastructure that may not be at high level but should not have problems with it, 4) traffic management precautions that are seamlessly consistent with infrastructure and environment and traffic condition, and 5) Traffic participants' abidance by traffic rules. Since these conditions do not include any of the following time-consuming and expensive items: constructing high level infrastructure, making advanced vehicles, and highly developed economy, they are the quickest and most economical method to lower road death rate and achieve safe traffic for a HRDR country. All that is needed for them is government enacting traffic rules and enforce them strictly.

CONCLUSION

In this study, we have found that high-income countries do not necessarily have low road death rate LRDR and low-income countries can achieve LRDR, and that none of the 13 interventions presented by UN is a decisive factor in influencing a country's road death rate strict rules and enforcement on them do not necessarily lower the road death rate of a country though they may have positive effect on lowering it. Through theoretical analysis and comparison between what is common in LRDR countries and what is common in HRDR countries, we argue that decisive factors are traffic rules and its enforcement. Specifically, we drew the following conclusions on safe traffic: 1) being strict in issuing driver's license, 2) traffic rules must be scientific and in detail and well obeyed by human, and 3) traffic management precautions must be seamlessly consistent with infrastructure and environment and traffic condition. All that is needed for reaching these conditions is government enacting traffic rules and enforce them strictly, implying they are the quickest and most economical method to lower road death rate and achieve safe traffic for a HRDR country.

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CONFLICT OF INTEREST

The author declares no competing interests.

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