Safety of young children on motorized two-wheelers around the world: A review of the global epidemiological evidence

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ABSTRACT

The safety of children younger than 10 years on motorized two-wheeled vehicles (MTWs) in low- and middle-income countries receives substantial attention from global road safety advocates. However, there is little empirical evidence available to describe the magnitude of the problem. Therefore, we constructed a population-level database of road traffic injury statistics disaggregated by age (<5, 5–9, 10+ years) and mode of transport. Our database included mortality data from 44 countries and 5 Indian cities, and hospital admissions from 17 countries. The MTW fleet in these settings ranged from 2% to 70% of all registered vehicles. We find that children under 5 years averaged 0.05% (SD 0.13%) of all road traffic deaths, and 5–9 year olds averaged 0.11% (SD 0.25%). Even in regions with high prevalence of MTWs, young children comprised at most 1.5% of all road traffic deaths and 5.8% of all MTW deaths. Young children were a slightly larger proportion of all road traffic deaths in countries where MTWs were more common. However, after adjusting for population age structure, this effect was no longer evident. The percentage of child road traffic injuries that are due to MTWs increased with increasing MTW use, but at a much lower rate. Our findings suggest that children may be at lower risk from MTW crashes than previously assumed, and certainly at a lower risk than as pedestrians. Further studies are needed to explain the underlying mechanisms that regulate risk of road users.

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1. Introduction

There appears to be near unanimous consensus among global road safety advocates that the safety of young children on motorcycles in low- and middle-income countries is of grave concern. Thus, a recent World Health Organization (WHO) report to the Ministry of Transport of Vietnam advises, “WHO encourages adults not to transport children on motorcycles unless absolutely necessary. If this is the case, then both WHO and UNICEF promote the use of standardized, correctly fitted, helmets for children as a harm reduction strategy.” [1] (Bold in original) Similarly, a report from the WHO South East Asia Regional Office recommends, “Governments at the national, provincial and municipal levels should consider policies . . . that would obviate the need for transporting children on motorcycles” [2].

These policy statements are primarily referring to infants and children younger than 10 years (hereafter referred to as “young children”) who are often transported as passengers on motorized two-wheeled vehicles (MTWs) in many parts of the world. Anecdotal mentions of such use of MTWs have been reported from South, East, and Southeast Asia [1,2] (including Malaysia [3] and Vietnam [4]), sub-Saharan Africa (including Cameroon [5] and Uganda [6]), North Africa and the Middle East (including Iran [7]), Latin America (including Brazil [8]), among others. MTW riders are inherently vulnerable in crashes because, unlike most motor vehicles, MTWs do not have a steel protective shell. Head injuries are the most common cause of death in MTW crashes. Therefore, the promotion of helmet use has been a primary thrust of MTW safety policy worldwide [9]. Unfortunately, providing protective head gear for infants is difficult for several reasons, including the fact that the size and shape of the human head evolve rapidly during the first four years of life [10]. Although helmets exist for older children (aged 5–10) for different purposes, helmet use in this age group of MTW riders is relatively rare in most of the world [2,11]. Therefore, it is natural that road safety advocates worry about the vulnerability of young children in MTW crashes.

However, despite the apparent importance of the issue and the strong public positions taken by international agencies, there is surprisingly little empirical evidence supporting the urgency of addressing the safety of children on MTWs. Public debates related to the health of children usually inspire strong emotions and a tendency to view issues as a matter of values that are so fundamental that they are beyond rational debate [12]. Thus, advocates for the safety of children on MTWs have
had a tendency to frame facts as "everybody knows" without supporting empirical evidence.

The goal of our study is to review the empirical evidence on the safety of young children on MTWs globally. In particular, we focus on a cluster of questions that affect public policy:

- Are young children more vulnerable than adults in MTW crashes and do children require additional safety considerations?
- Are MTW crashes an important risk factor for child health around the world? Should public health professionals focus special attention on the issue?
- Are child MTW passengers a large proportion of road traffic deaths around the world? Does the road safety community need to focus special attention on the issue?
- Do countries with more MTWs have higher child road traffic death rates? Should transport planners steer societies away from developmental trajectories that involve large MTW fleets?

In this paper, we summarize the literature on what is known about the biomechanical tolerance of young children to impact forces, and briefly review the global burden of road traffic injuries among young children. We develop a database of population-level MTW and road traffic injury statistics and explore the epidemiological evidence related with MTW injuries among young children in countries across global regions.

1.1. Biomechanics of injuries in young children

Despite large advances in knowledge about human injury tolerance, the vulnerability of children relative to adults remains poorly understood. Over the last century, substantial efforts have been directed at studying the capability of the human body to withstand external forces and accelerations. The body regions most vulnerable in MTW crashes (head, torso, and extremities) are commonly involved in many other types of injury events and have been a central focus of many biomechanical investigations. Studies have focused on analyzing real-world injury incidents, conducting experiments on human volunteers, animals, and cadavers, and developing and validating mechanical and computational models. Among these, cadaver experiments have been particularly important because they can be subjected to injury-inducing forces and have proven especially useful for understanding the response of adult hard tissue. However, child cadavers have been rarely used for biomechanical research due to ethical and logistical constraints [13].

Children are not miniature adults from a biomechanical standpoint. Human body segments grow at different rates during childhood leading to large differences between the relative geometric and inertial properties of children and adults [14]. For instance, the infant head is 25% of its standing height but the adult head is only 11% [15]. The infant head reaches 90% of the size of the adult head by the age of four [10]. Similarly, the mechanical properties of human tissue evolve considerably during childhood [16–18]. Experiments on human tissue suggest that the elastic and viscous components of the complex shear modulus (a measure of how much the tissue distorts during impact) of frontal brain tissue increases significantly with age affecting the mechanical response of the brain to impact forces [17]. Furthermore, the frontal bone of the skull in infants consists of two halves that are connected by a dense connective tissue (suture) that fuses by the age of six. Since sutures have a much lower elastic modulus, the pediatric skull case surely requires similar tests with peak accelerations limited to 300 g [20].

### Table 1
Global vehicle and motorized two-wheeler (MTW) fleet in 2010.

<table>
<thead>
<tr>
<th>Global region</th>
<th>Population (1000s)</th>
<th>Fleet Vehicles (1000s)</th>
<th>MTWs (1000s)</th>
<th>MTWs (% of veh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southeast Asia</td>
<td>612,705</td>
<td>171,133</td>
<td>129,224</td>
<td>76</td>
</tr>
<tr>
<td>South Asia</td>
<td>1,628,745</td>
<td>126,398</td>
<td>88,869</td>
<td>70</td>
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<tr>
<td>East Asia</td>
<td>1,363,753</td>
<td>211,958</td>
<td>104,412</td>
<td>49</td>
</tr>
<tr>
<td>Western Sub-Saharan Africa</td>
<td>339,896</td>
<td>18,118</td>
<td>6746</td>
<td>37</td>
</tr>
<tr>
<td>Caribbean</td>
<td>27,962</td>
<td>7425</td>
<td>2674</td>
<td>36</td>
</tr>
<tr>
<td>Andean Latin America</td>
<td>53,078</td>
<td>5105</td>
<td>1546</td>
<td>30</td>
</tr>
<tr>
<td>Tropical Latin America</td>
<td>207,069</td>
<td>65,737</td>
<td>16,746</td>
<td>25</td>
</tr>
<tr>
<td>Southern Latin America</td>
<td>62,103</td>
<td>18,826</td>
<td>4716</td>
<td>25</td>
</tr>
<tr>
<td>North Africa &amp; Middle East</td>
<td>402,319</td>
<td>74,426</td>
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<tr>
<td>Eastern Sub-Saharan Africa</td>
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<td>929</td>
<td>2752</td>
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<tr>
<td>Central Latin America</td>
<td>231,953</td>
<td>47,985</td>
<td>6781</td>
<td>14</td>
</tr>
<tr>
<td>Western Europe</td>
<td>425,264</td>
<td>271,574</td>
<td>28,615</td>
<td>11</td>
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<tr>
<td>Eastern Europe</td>
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<td>65,604</td>
<td>4845</td>
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<td>Central Europe</td>
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<tr>
<td>High Income Asia Pacific</td>
<td>186,282</td>
<td>110,877</td>
<td>6906</td>
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</tr>
<tr>
<td>Australasia</td>
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<td>773</td>
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<tr>
<td>Southern Sub-Saharan Africa</td>
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<tr>
<td>High Income North America</td>
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<tr>
<td>Central Sub-Saharan Africa</td>
<td>93,636</td>
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<tr>
<td>Central Asia</td>
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<td>1</td>
</tr>
<tr>
<td>Oceania</td>
<td>2041</td>
<td>552</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Grand total</td>
<td>6,804,247</td>
<td>1,574,198</td>
<td>433,719</td>
<td>28</td>
</tr>
</tbody>
</table>

Countries are grouped into GBD-2010 regions [25]. Regions are sorted by proportion of vehicle fleet that is MTWs.
The free fall drop height in helmet tests (1.8 m) is similar to the vertical elevation above ground level of the head of a standing MTW rider. This is because the trajectory of the head and body in an MTW crash can be roughly approximated as a projectile that has been imparted a horizontal velocity. The laws of Newtonian mechanics dictate that the head will hit the ground with a vertical velocity that is equal to that produced by free fall (i.e., under acceleration due to gravity) from the original height. Falls from a height of 2 m have been shown to cause serious head injuries to children [22].

In summary, it remains unclear if children are more vulnerable to injuries than adults in MTW crashes. However, crash forces generated in MTW crashes are expected to exceed injury thresholds for both adults and children. Therefore, all MTW riders are vulnerable in crashes.

1.2. Global burden of MTW injuries among young children

Road traffic injuries are a large global public health problem for all ages after the first year of life [23,24]. Overall, road traffic injuries are the 8th leading cause of death and 10th leading cause of health loss (measured in disability adjusted life years lost, DALYs), killing 1.3 million and injuring 78 million people annually [23,25]. Among infants under 1 year, infectious diseases dominate global mortality and morbidity and road traffic injuries are relatively rare even in settings where MTWs are prevalent. Thus, among infants aged 1 month to 1 year, road traffic deaths rank relatively low — 19th leading cause of death globally, 19th in Southeast Asia, and 26th in South Asia. Road traffic injuries emerge as a health issue among children 1–4 years old for whom they are the 9th leading cause of death and 10th leading cause of health loss [24]. They become more prominent among 5–9 year olds, rising to the 5th leading cause of death with only 28% fewer deaths than diarrheal disease, which is the leading cause of death [23]. Therefore, addressing road safety is important globally for the health of young children after the first year of life.

While MTW crashes are a large proportion of road traffic crashes in all ages, they constitute a substantially smaller proportion among children (Fig. 1). Overall, MTW crashes resulted in an estimated 206,435 deaths globally in 2010, 15% of all road traffic deaths [23]. Among young children, MTW crashes resulted in an estimated 4514 deaths in children under 5 years, and 2616 deaths in children aged 5–9 years [23]. MTW deaths amount to 6% and 8% of road traffic deaths in these age groups, which is substantially lower than the proportion for all age groups. Notably, substantially more young children die as pedestrians (45,972 deaths among 0–9 years) than as MTW riders even in settings where MTW use is high. Therefore, while addressing MTW safety is important for road safety overall, MTW safety for young children is a comparatively smaller problem.

MTW use varies dramatically globally. Therefore, it is important to consider the issue at the regional, national and city level. Estimated MTW death rates are highest in Western sub-Saharan Africa (6.0 per 100,000 people) and South East Asia (5.7) [23]. These rates are about twice the global average (3.0), and ten times the rate in Central Asia (0.6), where MTW death rates are lowest [23]. Understanding the impacts on the safety of young children requires characterizing the age-distribution of MTW injuries in countries with varying amounts of MTW use.

Mohan [26] conducted a review of epidemiological studies that reported the age distribution of MTW victims in regions where MTWs are prevalent. Although the review found very few studies with such data, a consistent finding was that young children were a relatively small proportion of MTW victims. In a hospital in Chennai (India), 67% of 2748 patients admitted between 1999 and 2005 with maxillofacial injuries were MTW riders but only 3% were child MTW passengers under 10 years [27]. Similarly, in Delhi (India), only 3% of MTW injuries seen at a major hospital were children 0–14 years [28]. In Taipei (Taiwan), in a study of 1160 MTW victims with craniofacial injuries, only 2% were children aged 0–15 years [29]. In Northeast Thailand, children under 10 years comprised 2.1% to 3.8% of MTW injuries before and after enforcement of a helmet law [30]. Finally, in a similar study in Taiwan, children under 10 comprised 1.0% to 1.2% of fatalities before and after a helmet law was implemented [31]. Although the reason for the increase in percentage of children after the introduction of the helmet law in these two studies is unknown, it is clear that the percentages are always small.

Unfortunately, existing global databases that report country-level road traffic deaths do not allow cross-country comparisons of MTW injuries among young children. The WHO Global Status Reports on Road Safety (GSRRS) [32,33] present country-reported and modeled estimates of MTW deaths in all-countries but do not report deaths disaggregated by age. The 2010 Global Burden of Disease (GBD-2010) project provided estimates of MTW injuries disaggregated by age in all regions. However, the underlying mortality data used for GBD-2010 estimates included relatively little information on age and transport-mode of road injuries in the regions where MTWs are most common. As a result, GBD-2010 estimates of childhood deaths and injuries on MTWs are unlikely to be reliable for such investigation.

Therefore, we compiled statistics on MTW crashes from databases that included reliable statistics on road traffic injuries disaggregated by age and mode of transport and compared the incidence of child MTW injuries across countries and cities. We discuss how risk to

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**Fig. 1.** Distribution of global road traffic deaths in 2010 by mode of transport among young children and people of all-ages.
children varies across settings with varying amounts of MTWs in their transport fleet.

2. Data sources and methods

2.1. Estimating the global MTW fleet

We obtained vehicle registration data from official statistics provided by country governments to WHO as reported in the 2013 WHO GSRRS [33]. This included data from 161 of 185 countries. The years for which vehicle registration data were available ranged from 2007–2011 (2010 or 2011 in 87% of these countries). For selected missing countries that are known to have large MTW fleets, we obtained statistics from alternate sources. These included Argentina [34], China [35], Japan [36], and Uganda [37]. No estimates of registered vehicles and registered MTWs were available from countries that together comprised 2.2% and 6.2% of the global population, respectively. For these countries with missing data, we assumed regional vehicle and MTW ownership levels.

2.2. Estimating age-specific MTW crashes

We constructed a population-level database containing age-disaggregated MTW injury statistics using information from the following sources:

1. WHO Mortality Database: ICD-coded cause of death tabulations disaggregated by age were obtained from the WHO Mortality Database, which reports the underlying causes of deaths reported by national civil registration systems [38]. We classified injury deaths by road user according to ICD-based definitions developed by the GBD-2010 Injury Expert Group. We audited the data for coverage, completeness, and quality of cause-of-death coding using a method developed previously [39]. The method for the quality audit primarily assesses the proportion of deaths that area assigned to less-specific causes of death (such as unspecified road user; unspecified accidents, unspecified injury, and unspecified causes of death) that are commonly used on death certificates. If the most recent data did not pass audit, we used the most recent year for which the quality threshold was met. For selected countries with small populations, we aggregated data for multiple years. Finally, we restricted analysis to countries that had more than 100 MTW deaths.

2. IRTAD: We acquired data from the International Road Traffic Accident Database [40] for the year 2005 and retained data for 17 countries that reported fatalities disaggregated by age and had more than 100 MTW deaths in 2005. IRTAD reports road traffic deaths standardized to a 30-day definition. For several countries, where we also had data from the WHO mortality database, we used IRTAD data because it is expected to be of higher quality [39].

3. UNECE Data: We obtained road traffic deaths from UNECE Transport Statistics [41] disaggregated by road user and age groups for 5 European countries that were not included in IRTAD. The UNECE reports deaths standardized to a 30-day definition.

4. Indian Cities: Age distribution of MTW deaths is not readily available in most of urban South Asia [42]. We obtained data from traffic police in five Indian cities for deaths caused by a road traffic crash. Traffic police reports in India include road traffic deaths regardless of when the death occurs after the crash — i.e. there is no time restriction when the death occurs as an admitted ‘accident’ patient in a hospital. In four of these cities, we assessed the text-based first information reports for the period 2007–2012 [43]. We identified MTW crashes where the victim was identified as “boy” or “girl”, which we assumed to be a child under 10.

5. Hospital Admissions: We extracted data on MTW victims from the GBD-2010 Injury Expert Group’s hospital data collection [44] for the 17 countries where the database contained more than 100 MTW injury admissions.

6. Other Data Sources: In addition to the above, we included the following sources that provided MTW injuries disaggregated by age: national death registration data from Iran [45], police data from Malaysia [34,46], and mortuary data from a city (Ibadan) in Nigeria [47].

We grouped ages into <5 years, 5–9 years, and older, except for the data from Indian cities where a single child age group 0–9 years was used. The two childhood age groups were chosen because these groups have different implications for helmet policy. In order to compute per capita injury rates, we used population data from the UN population division [47].

While the IRTAD and UNECE data exclude deaths that happen more than 30 days after the crash, data from the WHO mortality database and Indian cities have no time restriction. However, according to the 2013 WHO Global Status Report on Road Safety, only 3% of deaths occur more than 30 days after a crash.

Throughout, by MTWs we mean two-wheeled motorized vehicles, which include mopeds, scooters and motorcycles. In principle, this also includes bicycles with electric motors (e-bikes) that are becoming increasingly popular in many regions. While we expect that our MTW injury data include e-bike passengers, it is likely that the vehicle fleet statistics only include e-bikes if the local government requires registration of these vehicles. In China, for instance, there are about 100 million e-bikes that are not included in the fleet statistics [48].

In all, the database contained mortality statistics for 44 countries and 5 Indian cities, and hospital admissions from 17 countries. The MTW fleet in these countries ranged from 2% to 70% of all registered vehicles. We classified the countries and cities into Low MTW Use, where MTWs comprised less than 5% of the vehicle fleet (12 countries), Medium MTW Use, 5–20% of vehicle fleet (21 countries), and High MTW Use, >20% of vehicle fleet (11 countries and 5 Indian cities).

3. Results

We estimate that there are approximately 434 million MTWs comprising 28% of the vehicle fleet in the world (see Table 1). Approximately 74% of the global MTW fleet is in East, South, and Southeast Asia. The proportion of vehicles that is MTWs varies dramatically by region, reaching 70% or more of the vehicle fleet in South and Southeast Asia. In 8 of 21 global regions, MTWs comprise more than one-fourth of the vehicle fleet. In addition to the aforementioned regions, these include the Caribbean, Western Sub-Saharan Africa, and Andean, Tropical and Southern Latin America. These 8 regions together have 63% of the global population implying that most of the global population lives in regions where MTWs comprise a substantial proportion of the vehicle fleet.

Per capita MTW ownership levels are high in some regions where MTWs comprise a relatively small portion of the vehicle fleet. For instance, although MTWs only comprise 11% of the vehicle fleet in Western Europe, ownership levels in the region (67 MTWs per 1000 people) are higher than that in South Asia [55].

MTW deaths among young children (under 10) comprised at most 1.5% of all road traffic deaths in the countries in the database (Fig. 2). India-Amritsar (1.50%), Paraguay (0.99%), and India-New Delhi (0.87%) had the highest percentages. On average, 0.16% (SD 0.29%) of all road traffic deaths were young children on MTWs in these countries. Children under 5 years averaged 0.05% (SD 0.13%), and 5–9 years averaged 0.11% (SD 0.25%) of all road traffic deaths. As expected, settings with High MTW Use had a higher percentage of child MTW deaths. However, even in these settings, the average percentage of child MTW deaths was only 0.41% (SD 0.41%), with children under 5 years averaging 0.19% (SD 0.20%) and 5–9 year olds 0.28% (SD 0.39%).

Restricting attention to only MTW deaths (Fig. 3a), young children comprised less than 6.0% (mean 0.74%, SD 1.13%) in all countries.
Egypt (5.8%), India-Amritsar (3.8%), and India-New Delhi (2.8%) had the highest percentages. In general, this percentage was higher in settings with higher MTW use. However, even in the High MTW Use settings, the percentage of MTW deaths that were young children averaged only 1.52% (SD 1.50%). Among children under 5 years, this percentage averaged at 0.82% (SD 0.79%) and among 5–9 year olds, averaged at 0.95% (SD 1.16%).

In contrast, the percentage of all road traffic deaths that are young children is much higher (Fig. 3b). This percentage ranges from 1.0% to 12.1% and has an average of 2.81%, SD 1.94%. With three exceptions (Latvia, Poland, and India-Amritsar), the percentage of all road traffic deaths that are young children was always higher than the percentage of MTW deaths that are young children. In two-thirds of these countries, it was more than 5 times higher. Among children under 5 years, this percentage averaged 1.53% (SD 1.15%), about six times higher than the corresponding percentage of MTW deaths in this age group. Similarly, among 5–9 year old children, this percentage averaged 1.4% (SD 1.09%), more than twice the corresponding percentage of MTW deaths in this age group. The percentage of road traffic deaths that are young children is slightly higher in settings with more MTW use, increasing from an average of 2.66% (SD 1.44%) in Low MTW Use settings and 1.90% (SD 0.8%) in Medium MTW Use settings, to 4.08% (SD 2.43%) in High MTW Use settings.

The population age-structure varies substantially across the countries in the database. While young children (under 10 years) are only 8% of the population in Germany and Japan, they are over 30% in Nigeria. Therefore, we adjusted for the age structure by estimating the child-to-population rate ratio — i.e. the ratio of injury rates among children to injury rates among the general population (Fig. 4). The child-to-population rate ratio for all road traffic deaths averaged 1.53% (SD 1.15%), about six times higher than the corresponding percentage of MTW deaths in this age group. The percentage of road traffic deaths that are young children is slightly higher in settings with more MTW use, increasing from an average of 2.66% (SD 1.44%) in Low MTW Use settings and 1.90% (SD 0.8%) in Medium MTW Use settings, to 4.08% (SD 2.43%) in High MTW Use settings.

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The child-to-population rate ratio for road traffic deaths varied from 0.23 (SD 0.08) in Low MTW Use countries, 0.18 (SD 0.03) in Medium MTW Use countries, to 0.21 (SD 0.11) in High MTW Use countries.

Thus far we have presented results related with fatalities. If we consider non-fatal hospital admissions (Fig. 5), the percentage of non-fatal MTW injuries that are young children is substantially higher than the corresponding percentage for fatalities. On average, young children comprised 1.89% (SD 1.61%) of non-fatal hospital admissions for MTW crashes, compared with 0.74% of fatalities. This was also true for both age sub-groups. Children under 5 years comprised 0.64% of non-fatal hospital admissions for MTW crashes, compared with 0.26% of fatalities. Similarly, children 5–9 years old comprised 1.25% of non-fatal admissions, compared with 0.51% of fatalities. We had both non-fatal admissions statistics and fatality statistics for 9 countries. In each of these countries, the percentage of non-fatal MTW admissions that are young children was higher than the corresponding percentage for fatalities. Notably, in Argentina, where the difference was largest, 5.0% of non-fatal MTW admissions were young children compared with 0.4% of fatalities.

Fig. 6 illustrates the relationship between the percentage of road traffic deaths among young children that are MTW riders and the extent of MTW use in each country. Also shown is a 45-degree line, which corresponds to the two growing at the same rate. In settings where MTW are a small proportion of the vehicle fleet, there was substantial scatter in the percentage of child road traffic deaths that were MTW riders. MTW comprised less than 10% of the vehicle fleet in four of the five countries that were above the 45-degree line (UK, Latvia, France, and Spain). India-Amritsar was an outlier with an unusually high percentage of deaths (80%). In general, the percent of child road deaths that were on MTWs grew linearly in countries with higher MTW use but at a much slower rate than the growth in MTWs.

### Discussion

Our analysis shows that young children rarely die in MTW crashes even in settings where MTWs are a common mode of transportation.
Reasons for using MTWs vary across the globe. Our database included several countries where MTWs are commonly used to transport children, notably including Brazil, Iran, five cities in India, Thailand, and Uganda. However, even in these settings, young children comprised at most 1.5% of all road deaths and 5.8% of all MTW deaths. These findings are broadly consistent with several previous studies that have presented MTW injuries disaggregated by age [27–31].
Children were a larger proportion of road traffic deaths in countries where MTWs were more common. However, countries with more MTWs tend to also have a larger proportion of children in their population. Therefore, we adjusted for population age structure by estimating child-to-population rate ratios. These rate ratios for MTW deaths did not show an increase with increasing MTW use.

It is surprising that children do not comprise a larger proportion of road traffic and MTW fatalities. The reasons for this finding deserve to
be systematically investigated. First, it is possible that the exposure of young children to MTWs may be lower than people perceive. Humans may have a higher tendency to remember unusually risky events and hence overestimate their prevalence. In our literature review, most references to the common use of MTWs to transport children were anecdotal [1–8] and we found no objective measurements of the prevalence of children on MTWs. Observation studies of MTWs are conducted frequently, usually for measuring prevalence of helmet use [49–51]. Such studies could be easily extended to provide estimates of the prevalence of young children on MTWs.

Second, it is possible that MTWs carrying child passengers have lower risk of crash involvement. It is possible that MTW drivers with children on board may drive at lower speeds than when alone and other drivers may become more careful in the vicinity of MTWs with children. An accompanying paper in this issue (Why do Three-Wheelers Carrying School Children Suffer Very Low Fatal Crashes?) documents the fact that three-wheeled scooter taxis with child occupants had very low crash rates.

Third, several studies have documented a “safety in numbers” effect for bicyclists, where the risk of crashes to individual bicyclists is lower in settings where bicycling is more common [52,53]. It is reasonable to expect that such an effect would apply also to larger two-wheelers, such as mopeds and low powered MTWs that are common in many parts of the world. In our analysis, child MTW deaths were disproportionately high in settings with relatively few MTWs but disproportionately low in settings with high prevalence of MTWs (Fig. 4), suggesting the possibility of a safety in numbers effect for MTWs. Simulator studies show that car drivers detect MTWs quicker in settings with a high prevalence of MTWs. Such studies build on a large body of work that shows that humans are not systematically investigated. First, it is possible that the exposure of young children to MTWs may be lower than people perceive. Humans may have a higher tendency to remember unusually risky events and hence overestimate their prevalence. In our literature review, most references to the common use of MTWs to transport children were anecdotal [1–8] and we found no objective measurements of the prevalence of children on MTWs. Observation studies of MTWs are conducted frequently, usually for measuring prevalence of helmet use [49–51]. Such studies could be easily extended to provide estimates of the prevalence of young children on MTWs.

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Finally, our analysis suggests that young children may be more commonly injured than killed in MTW crashes, although the percentages are small. This may be due to the fact that MTWs with child passengers may be driven at lower speeds than those without children. On the other hand, it is also possible that children are more likely to be hospitalized in relatively minor crashes where the accompanying adult did not require admission. We had relatively few countries from High MTW Use settings where such a comparison was possible, and systematic investigations with more data would likely provide insights.

It is important to note the limitations of the data that we have analyzed. While national death registration systems in Latin America provide reliable information on age and mode of transport for national road traffic deaths, such data were sparse in other regions where MTW are prevalent and commonly used to transport young children. We had comparatively little information from South and Southeast Asia, and none from East Asia. Systematically collecting data from these settings would help build confidence in our findings as well as help explain their underlying mechanisms.

Although we have shown that MTWs are not a major threat to young children, road safety is nevertheless an important issue for children after the first year of life [25,33]. Globally and regionally, about three-fourths of all road traffic deaths among young children are either pedestrians or vehicle occupants. It is interesting to note that bicycle use is being promoted globally for health and environmental reasons but carrying children on bicycles does not evoke the same policy debates as carrying them on MTWs. Child pedestrian fatalities were also substantially higher in the locations studied. An argument could be made that if all child pedestrians and bicyclists wore helmets, more lives would be saved than MTWs only.

The WHO World Reports on Road Traffic Injury Prevention [9] and Child Injury Prevention [56] provide a wide range of strategies ranging from increasing adult supervision of children on streets, to engineering approaches, such as safer infrastructure around schools and playgrounds. These recommendations are grounded in a comprehensive public health approach of systematically identifying risk factors and appropriately prioritizing interventions. Children hold a special place in most societies, making it particularly important that we are guided by evidence when planning for their health and safety.

References


