Country level economic disparities in child injury mortality

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ABSTRACT

Background Injuries are a neglected cause of child mortality globally and the burden is unequally distributed in resource poor settings. The aim of this study is to explore the share and distribution of child injury mortality across country economic levels and the correlation between country economic level and injuries.

Methods All-cause and injury mortality rates per 100 000 were extracted for 187 countries for the 1–4 age group and under 5s from the Global Burden of Disease Study 2010. Countries were grouped into four economic levels. Gross domestic product (GDP) per capita was used to determine correlation with injury mortality.

Results For all regions and country economic levels, the share of injuries in all-cause mortality was greater when considering the 1–4 age group than under 5s, ranging from 36.6% in Organization for Economic Cooperation and Development countries to 10.6% in Sub-Saharan Africa. Except for Sub-Saharan Africa, there is a graded association between country economic level and 1–4 injury mortality across regions, with all low-income countries having the highest rates. Except for the two regions with the highest overall injury mortality rates, there is a significant negative correlation between GDP and injury mortality in Latin America and the Caribbean, Eastern Europe/Central Asia, Asia East/South-East and Pacific and North Africa/ Middle East.

Conclusions Child injury mortality is unevenly distributed across regions and country economic level to the detriment of poorer countries. A significant negative correlation exists between GDP and injury in all regions, exception for the most resource poor where the burden of injuries is highest.

INTRODUCTION

As neonatal mortality is a main cause of under 5 deaths, the Millennium Development Goals (MDG) have targeted 4 initiatives largely focused on infant survival efforts1–3 in order to reduce the overall under 5 mortality rate by two-thirds by 2015.2 Now, millions of lives have been saved and child health improved due to investments in multi-sectoral approaches, community-based interventions, sanitation and hygiene, water supply and quality and the provision of medical equipment to detect symptoms of child infectious diseases.2–4–7 While this remains essential, attention also needs to be placed on the mortality causes beyond the first year of life, among which injuries are estimated to account for about 1 in 10 deaths globally.8–9

Injuries are one of the major causes of premature death and disability globally in the 1–4 age group and drain health and societal resources now and in the future.9–11 A previous study showed that drowning followed by road traffic injury, fire and falls are the top causes of deaths from unintentional injuries in this age group.11 However, other phenomena such as conflicts, wars and national disasters also contribute. Earlier studies indicate the burden of injury on children is unequally distributed in resource poor settings.9–12–14 Yet, to the best of our knowledge, country economic differences in injury have been investigated in few global countries/specif regions only or have focused on other ages than the 1–4 age group.13–16 The capacity of the Organization for Economic Cooperation and Development (OECD) countries to halve the number of unintentional injury deaths under the age of 15 demonstrates their high preventability.17 Also, neglecting to address injuries jeopardises the lives of vulnerable children and the positive outcomes of early investment in immunisation, nutrition and neonatal healthcare.11 The aim of this study is to assess the proportion and distribution of injury mortality in children 1–4 years within regions and across country income levels. We also measure within regions the correlation between country gross domestic product (GDP) and injury mortality.

METHODS

This was an ecological level study including 187 countries as classified by the Global Burden of Disease study.18 The country level data on outcomes and population estimates for under 5 and 1–4 age group were extracted from the Global Burden of Disease for the year 2010.18 Data on GDP per capita using purchasing power parity exchange rates and gross national income (GNI) per capita for the year 2010 were extracted from the World Bank data base.19 The key outcome variable was injury mortality rates per 100 000 for the 1–4 age group. Injury mortality included deaths caused by transport and unintentional causes of injuries other than transport-related ones, intentional causes such as self-harm and interpersonal violence, and injuries due to forces of nature, war and legal interventions.18

Countries were stratified according to the seven global burden of disease (GBD) regions and grouped according to four economic categories based on GNI per capita: high income ($12 196 or more); upper-middle income ($3946–$12 195); lower-middle income ($996–$3945) and low income ($995 or less).20 Average rates of injury mortality were compiled by region and country economic level for the age group 1–4 for the year 2010. The proportion of injury in all-cause mortality was


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also calculated. Furthermore, we explored the relationship between GDP and injury mortality for the countries in each GBD region through scatterplots using Spearman coefficient correlations (r). The log transformation of GDP was undertaken to make the data less skewed. All data treatments were performed using Microsoft Excel 2010 and SPSS V19.21

RESULTS
Table 1 presents the percentage of injuries in all-cause mortality by region and country economic level (year 2010) and two groups of under 5 children. In all instances, the percentage was far greater in children 1–4 years than in under 5 years (0–4 years). Globally, an average of 13.5% of all deaths was due to injuries in the 1–4 age group. The highest proportion of injuries was in the high-income OECD countries (36.6%) and the lowest share in the low-income countries of Sub-Saharan Africa (SSA) (10.6%).

Thus, the proportion of injury mortality in all-cause mortality varied considerably between country economic levels in the 1–4 age group with a tendency to be higher in high-income countries (HICs), with the exception of Eastern Europe/Central Asia and Latin America and the Caribbean. In the former, the percentage was higher in upper-middle income compared with HICs (36.9% vs 29.5%) and in the latter, it was highest in the low-income countries such as South Asia.

Figure 1 reveals that, except for SSA, there is a graded association between country economic level in the 1–4 injury mortality rates across regions, with the highest rates observed in low-income countries and the lowest in the high-income group. SSA differs in that respect as the highest rate was in the only HIC in that region.

Figure 2A–F presents six regions-based scatterplots showing the correlation between country level GDP and injury mortality rate. There is a significant negative correlation in the four regions where the rates of injuries are not as high: Latin America and the Caribbean (r=−0.52, p=0.004), Eastern Europe/Central Asia (r=−0.65, p<0.001), Asia East, South-East and Pacific (r=−0.52, p=0.05) and North Africa/Middle East (r=−0.057, p=0.02).

DISCUSSION
Main findings
Our study found that the proportion of injuries in all-cause mortality is two to four times higher in 1–4 than 0–4 as there is a substantial share of infant mortality among all-cause under 5 deaths.23 Except for two regions, this 1–4 injury proportion in

| Table 1 Number of countries, percentage of children under 5 years and percentage of injury in all-cause mortality according to region and country economic category, 2010 |
|---|---|---|---|
| Regions | Number of countries | Under 5 population (%) | Percentage of injury in all-cause mortality (under 5 years) |
| | | | 0–4 | 1–4 |
| Sub-Saharan Africa | 46 | 140.4 million | 5.5 | 10.6 |
| HICs | 1 | 0.1 | 11.3 | 20.9 |
| UMICs | 4 | 4.2 | 3.8 | 7.6 |
| LMICs | 12 | 33.2 | 6.9 | 13.2 |
| LICs | 29 | 62.6 | 4.8 | 8.9 |
| South Asia | 6 | 174.5 million | 4.2 | 13.4 |
| LMICs | 3 | 86 | 3.9 | 12.0 |
| LICs | 3 | 14 | 6.2 | 22.4 |
| Latin America and the Caribbean | 29 | 49.1 million | 13.3 | 31.0 |
| HICs | 3 | 0.3 | 6.4 | 23.3 |
| UMICs | 16 | 80.8 | 8.3 | 25.8 |
| LMICs | 9 | 16.4 | 6.9 | 16.8 |
| LICs | 1 | 2.5 | 46.5 | 60.8 |
| Eastern Europe/Central Asia | 29 | 25.5 million | 8.9 | 30.0 |
| HICs | 8 | 14.6 | 6.4 | 29.5 |
| UMICs | 12 | 53.5 | 10.3 | 36.9 |
| LMICs | 7 | 26 | 8.5 | 26.8 |
| LICs | 2 | 5.8 | 6.3 | 21.0 |
| Asia East, South East and Pacific | 26 | 144.4 million | 9.1 | 25.4 |
| HICs | 2 | 2.3 | 15.1 | 39.0 |
| UMICs | 4 | 2.1 | 8.6 | 20.3 |
| LMICs | 15 | 90 | 9.7 | 27.1 |
| LICs | 5 | 5.5 | 5.3 | 14.0 |
| North Africa/Middle East | 19 | 46.7 million | 5.8 | 21.7 |
| HICs | 6 | 8.3 | 8.0 | 34.1 |
| UMICs | 5 | 36.4 | 6.9 | 28.3 |
| LMICs | 8 | 55.3 | 5.1 | 18.2 |
| OECD | 32 | 57.4 million | 9.6 | 36.6 |
| HICs | 29 | 91.5 | 9.7 | 37.5 |
| UMICs | 3 | 8.5 | 9.2 | 31.9 |

HICs, high-income countries; LICs, low-income countries; LMICs, lower- and middle-income countries; OECD, Organization for Economic Cooperation and Development; UMICs, upper- and middle-income countries.
all-cause mortality is higher for high- or upper-middle-income countries compared with low- or lower-middle-income countries. Those regions are Latin American and the Caribbean, where the 2010 earthquake in the low-income country Haiti may have skewed the distribution, and South Asia where there are no high- or upper-middle-income countries. However, in contrast to our finding, an earlier study from 1999 including 51 countries from around the world added that the proportion of injury in all deaths was high in lower-middle-income countries compared with high income countries.15 It is comprehensible that over the 15 years in HICs the child deaths from other causes have declined even more rapidly than injury. This makes the injury share as the principal cause of child death for developed nations.15 A potential explanation is that the HICs have transitioned from child deaths due to infectious diseases and malnutrition towards chronic diseases in which injuries play an important role.17

We also found that four regions demonstrate a strong tendency for a graded relationship between country economic level and injury mortality as compared with higher injury rates in poorer countries. This does not apply to the two poorest regions, which also are the ones with the highest rates of injury mortality, SSA and South Asia. In SSA, there is only one HIC (Equatorial Guinea) which skews the distribution and, as mentioned above, South Asia has only two country economic levels (but these are not the same as in the OECD group). This finding of imbalance between regions is in line with the results from the MDG report 2013 that child deaths in general are much higher in resource poor regions2 as well as an injury specification within the resource poor countries under study. This remains a critical ongoing concern for investigating progress towards MDG targets.

Furthermore, except for the two regions with the highest overall injury mortality rates, a significant negative correlation existed between GDP and injury mortality in the remaining four regions: Latin America and the Caribbean, Eastern Europe/ Central Asia, Asia East/South-East and Pacific and North Africa/ Middle East. In the European context alone, a study based on an aggregated 26 countries also revealed a statistically significant relationship between country GDP and child injury mortality, with increasing GDP leading to lower rates.16

**Strengths and limitations**

This study contributes to the body of research on country geographic and economic determinants on injury mortality in early childhood with a huge pool of countries (n=187). It sheds light on the share of injuries in child mortality globally, as well as the correlation between a key marker of country development (GDP) and injury mortality in the countries across regions. Although the country level data used were obtained from standardised sources (Global Burden of Disease study and World Bank), information biases across countries and regions may arise, as reported in a previous study that under 5 mortality estimates have large variation in countries with conflict.24 Also, it is recognised that WHO registration coverage has risen in recent years to around 40% of global deaths, but with a very unequal global distribution, as more than 30% of the world’s population live in regions where less than 5% of all deaths are registered.25,26 This may have resulted in an underestimation of the mortality rates in the resource poor countries under study. This remains a critical ongoing concern for investigating progress towards MDG targets.

Furthermore, it was not possible to investigate the role of economic differences within countries as there was no consistent, up-to-date GINI coefficient for all 187 countries included in the study and there was no income inequality ratio available for the countries with the highest mortality burden, such as SSA. In addition, while recognising the extensive efforts in data collection and treatment by the Global Burden of Disease group, research would benefit from having access to more recent injury data seeing as there was a 4-year gap in the latest available data for this analysis. Last, although this study investigates GDP as a driver of children’s well-being, additional measures warrant...
attention when measuring progress towards MDG: technological innovations, adequacy of governance, environmental sustainability, dependency on external finance, perceived levels of corruption/democracy/political stability, forced/voluntary global migration and violence. These parameters are of interest in order to further our understanding of the social determinants of children’s health and safety. Studies demonstrate the potential for high return on investment if countries at low levels of economic development were to specifically target improving outcomes for children.

**Implications for the health and safety agenda**

Integrating injury prevention into multi-sector child survival efforts has the potential to assist in meeting the MDG targets, reduce health inequities and most importantly provide children worldwide with a safe and healthy environment. A wide range of evidence-based measures for unintentional injury control and safety promotion exist globally and by injury cause and countries like Bangladesh are committed to injury prevention and have made substantial progress over time in drowning. Nonetheless, a number of the high-risk countries struggle with global phenomena that challenge traditional injury prevention measures, such as the sudden natural disaster in Haiti and war and conflict in Syria, Nigeria, Iraq, DR Congo, Angola and Afghanistan. Children under the age of 5 are most vulnerable in a crisis situation as they are more likely to be injured, killed, lost, unable to access help or healthcare, or exposed to greater danger through separation from their families or caregivers. Between a third to a half of deaths in disasters are borne by children and 90% of conflicts worldwide since 1990 have occurred in SSA alone. Reducing disaster and conflict risk and increasing resilience to these hazards can accelerate achievement of the MDGs.

The improvement of child safety in and around the home where 1–4 group is mostly injured can be achieved by the implementation of a range of evidence-based measures and history shows that the health system has a key role to play by ensuring that injury and violence prevention are incorporated in the provision of universal primary care and community-based action. In particular, a number of safety measures can be introduced to guardians and parents in the course of home regular visitation programmes. Safety-for-all strategies (including legislation,
regulation, enforcement, community-based programmes and home education and visitation programmes) have been shown to be effective in reducing injuries in all socioeconomic groups and benefit children’s health overall.\textsuperscript{[16-19,40]}

**CONCLUSIONS**

The MDG is a means to stimulate and focus attention on advancing equity as a core marker of achievement regarding global improvements in child outcomes. This study showed that child injury mortality is unevenly distributed across regions and country economic level to the detriment of poorer countries. Furthermore, a significant negative correlation exists between GDP and injury in all regions, except for the most resource poor where the burden of injuries is highest. Closing the child injury gap globally also requires addressing country level disparities as a means to promote safety for all.

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