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Economic development and road traffic fatalities in two neighbouring African nations



Développement économique et décès occasionnés par les accidents de la route dans deux pays africains voisins

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Introduction: The rapid growth of Botswana's economy since independence in 1966 has brought more tarred roads and vehicles, accompanied by an escalating road crash fatality rate. We tested the hypothesis that motor vehicle crash fatality increases resulted from, rather than just corresponded with, annual gross domestic product (GDP) increases. Data from Zambia, adjacent to Botswana, were used for comparison.

Methods: Annual social and economic indicators and motor vehicle crash fatality rates in Botswana and Zambia were accessed from 1960 to 2012 and analysed using vector autoregressive analysis and Granger causality tests.

Results: In Botswana, annual changes in per capita GDP predicted annual changes in motor vehicle crash fatality rates ($p = 0.042$). The opposite was not observed; annual changes in motor vehicle crash fatality rates did not predict annual GDP changes. These findings suggest that GDP growth in a given year caused additional road traffic fatalities in Botswana and that, on average, every billion dollar increase in GDP produced an increase in the rate of road traffic fatalities. In Zambia, annual GDP changes predicted annual fatality rate changes three years later ($p = 0.029$), but annual changes in road crash fatality rates also predicted annual increases in per capita GDP ($p = 0.026$) three years later, suggesting a correlation between trends, but not a causal effect of GDP.

Conclusion: Road crash fatalities increased in recent decades in both Zambia and Botswana. But the rapid economic development in Botswana over this time period appears to have driven proportionate road traffic fatality increases. There are opportunities for newly emerging economies such as Zambia, Angola, and others to learn from the Botswana experience. Evidence-based investments in road safety interventions should be concomitant with economic development.

Introduction: La croissance rapide de l'économie du Botswana depuis l'indépendance en 1966 s'est traduite par le développement du nombre de routes goudronnées et de véhicules, accompagnés d'un taux de mortalité due aux accidents de la route qui va s'accroître. Nous avons testé l'hypothèse selon laquelle les hausses de la mortalité due aux accidents de véhicules motorisés seraient attribuables aux augmentations du produit intérieur brut (PIB), plutôt que d'en être un simple reflet. Des données provenant de Zambie, pays adjacent au Botswana, ont été utilisées pour établir une comparaison.

Méthodes: Des indicateurs économiques et sociaux annuels et les taux de mortalité due aux accidents de la route au Botswana et en Zambie ont été examinés sur la période 1960–2012 et analysés en utilisant une analyse vectorielle autorégressive et des tests de causalité au sens de Granger.

Résultats: Au Botswana, les variations annuelles de PIB par habitant ont prédit les variations annuelles des taux de mortalité due aux accidents de véhicule motorisés ($p = 0,042$). L'inverse n'a pas été observé; les variations annuelles de taux de mortalité due aux accidents de véhicules motorisés ne permettent pas de prédire les variations annuelles de PIB. Ces résultats suggèrent que la croissance du PIB pour une année donnée a causé des décès occasionnés par des accidents de la route au Botswana et qu'en moyenne, chaque augmentation d'un milliard de dollars du PIB a produit une augmentation du taux de décès occasionnés par des accidents de la route. En Zambie, les variations annuelles de PIB ont prédit les variations annuelles du taux de mortalité trois ans plus tard ($p = 0,029$), mais les variations annuelles des taux de mortalité des accidents de la route ont également prédit les augmentations annuelles de PIB par habitant ($p = 0,026$) trois ans plus tard, ce qui suggère une corrélation entre les tendances mais pas un effet de causalité du PIB.

Conclusion: Les décès occasionnés par les accidents de la route ont augmenté au cours des dernières décennies en Zambie comme au Botswana. Mais le développement économique rapide au Botswana au cours de cette période semble avoir entraîné des augmentations proportionnelles des décès dus aux accidents de la route. Il est possible, pour les nouvelles économies émergentes comme la Zambie, l'Angola, et d'autres, de tirer des leçons de l'expérience du Botswana. Des investissements dans des interventions en matière de sécurité routière, fondés sur des données concrètes, doivent être concomitants au développement économique.

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African relevance

- Road traffic crash is a major cause of morbidity and mortality in Africa.
- There may be a relationship between rapid economic growth in African countries and frequency of road traffic crashes.
- Road safety interventions, especially in African countries with rapidly growing economies, are likely to be beneficial.

Introduction

Low- and middle-income (LMIC) countries carry a disproportionate burden of the death and disability caused by road traffic crashes (RTCs).^{1–3} RTCs kill 1.2 million people worldwide each year and are expected to increase by 65% over the next 20 years if left unabated.¹ The World Health Organisation (WHO) predicts that by 2030, RTC injury will become the fifth leading cause of death worldwide, up from ninth in 2004.⁴ It is important to determine whether RTC fatalities are an unfortunate unintended consequence, inevitable in a country with a rapidly developing economy. If RTC fatalities are directly due to aspects of economic development, then traffic safety programmes can prioritise modifying risk factors and expanding programmes in developing nations alongside their economies and roadway systems.

The relationship between economic development and traffic fatalities is complex. Studies in 41 out of 88 countries comparing RTC fatality trends with measures of economic development found positive associations.^{5–9} In absolute terms, middle-income countries had the highest fatality rates, but when adjusted for the number of motor vehicles, the poorest countries showed the highest road traffic fatality rates.⁶ Kopits et al. found that once countries experienced higher gross domestic product (GDP) levels, fatalities per capita declined.⁷ However, during the early stages of these countries' economic growths, sharp increases in fatalities per capita were evident as GDP increased. Such a relationship was reported by Winston et al. who found that the sudden economic change resulting from the reunification of Germany led to a dramatic increase in fatalities for car occupants in East Germany.¹⁰

The WHO and other organisations have emphasised the important contribution of economic development to mobility, increased motorisation and vehicle ownership, increased vehicle miles driven, and therefore increased exposure to risk.^{1,7,10,11} In many lower and middle income countries, new high-speed roadways were built to accommodate expanding commerce. Rapid urbanisation and increased travel between urban and rural areas, especially at holiday times, have contributed to increased traffic without proportionately resourced traffic safety systems.^{1,7,10,11} Countries with higher economic development, in contrast, tend to have new and existing roadways equipped with traffic safety systems, better public transport, more efficient regulation, higher accountability to public authorities for enforcement, and public education campaigns on road safety; this ultimately has the potential to confer a protective benefit.⁷

There has been a need to intensify research efforts about RTCs in Africa, in particular, improving data quality, increasing surveillance, and implementing actions based on evidence

from African countries.¹² New road traffic safety measures are needed in most of sub-Saharan Africa, including Botswana¹³ and Zambia.¹⁴ This study tested the hypothesis that annual GDP increases directly cause increases in RTC rates. To test this, this study examined these trends in Botswana and compared them with those in Zambia, a neighbouring country. Both countries gained independence from Britain at similar times: 1966 and 1964, respectively. The World Bank has described Botswana as one of the fastest growing economies in the world until recently,¹⁵ and Zambia, with rapid economic growth for the last decade.¹⁶ By 2007, Zambia had 222,188 registered vehicles. That year, of Zambia's population of 11.9 million people, 10,524 were injured or killed in road traffic crashes.⁴ Botswana, with a considerably smaller population of 1.8 million, had 293,755 registered vehicles and 7639 people injured or killed road traffic crashes.⁴

Methods

This study accessed data from the World Bank, WHO, and Botswana Motor Vehicle Accident Fund for socio-economic indicators and annual RTC fatality rates in Botswana and Zambia for the period 1960–2012.^{17,18} Data on socio-economic indicators were available for this time period, however data on RTC deaths in Botswana were available only for 1981–2012. This study used the 31-year period for hypothesis testing in Botswana. Similarly for Zambia, this study used data from the period 1981 to 2007 (the most recent year available) for analyses. Data on vehicles per 1000 population were available for most years between 1990 and 2012 for Botswana but for only a few years for Zambia.

The annual data on GDP and RTC deaths were plotted, with changes over time measured as percent changes and average percent changes per year.^{4,17} To test the presence of a causal relationship between GDP and RTC deaths, this study then analysed the annual time series of RTC death rates and GDP per capita with vector autoregressive analysis and Granger causality tests. The notion of Granger causality follows: if lagged values of X help predict current values of Y in a time series (i.e., Y regressed against values of X that occurred one year earlier, two years earlier, and so on), and lagged values of Y do not help predict current values of X, then X is said to “Granger-cause” Y.¹⁹ The analysis then tested the relationship between the two time series using up to three annual lags. Consistent with conventional time series methodology, each time series was detrended (i.e., differenced, where from the value of a given year had the value of the previous year subtracted) prior to analysis and evaluated for stationarity using the Dickey–Fuller test. Residuals of the regression analyses were evaluated using normality test, plots of the autocorrelation function, and the Q statistic.

The study was approved by the University of Pennsylvania Institutional Review Board.

Results

The populations of Botswana and Zambia were 531,555 and 3,044,262 respectively in 1960, and 1.90 million and 12.6 million respectively in 2008. Population growth over that time was linear in Botswana but exponential in Zambia. In 2008, GDP in Botswana increased to \$8.46 billion and in Zambia,

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