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Road injuries, labor productivity, and economic growth in Africa: A panel study

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Abstract

Background and Aims: Globally, millions of people suffer from road injuries, with Africa having the highest burden of road injury deaths. This public health problem has the potential to reduce labor productivity and hence hamper economic growth, especially on the African continent. This study, to the best of the authors' knowledge, therefore seeks to provide the first empirical evidence of the interaction or combined effect of road injuries and labor productivity on economic growth in African countries.

Methods: The study uses annual data on 45 African countries over the period, 2002 to 2019. The dynamic panel system generalized method of moments regression is used as the estimation technique.

Results: The findings show that the interaction of road injuries with labor productivity has a negative significant effect on economic growth in both the short-run (coefficient: −1.96, $p < 0.01$) and long-run (coefficient: −1.93, $p < 0.01$) periods.

Conclusion: There is a need to increase investment in road safety to reduce the prevalence of road injuries on the African continent.

KEYWORDS

Africa, economic growth, labor productivity, road injuries

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1 | INTRODUCTION

Road injuries are major public health problems affecting millions of people globally. Each year, between 20 and 50 million people are affected by nonfatal road injuries, while about 1.19 million people die due to road crashes, of which two-thirds occur among individuals within the working-age bracket (18–59 years).[1] In addition, about 92% of all road injury deaths globally occur in low- and middle-income countries, with the World Health Organization (WHO) African Region bearing the greatest brunt of these deaths.[1]

These injuries could be associated with productivity losses due to illnesses, deaths, and disabilities as well as family members/people who have to abandon their works to cater for injured relatives or people.[1,2] This can adversely affect economic growth since human capital (with health being an essential component) is a major determinant of economic growth.[3–6]

Nonetheless, to the best of the authors' knowledge, few empirical studies exist on the effect of road injuries on economic growth in other regions or countries[7–11] and Africa.[12–15] However, although Africa bears the highest brunt of road injury deaths, the studies on the economic growth effect of road injuries in Africa were primarily single-country studies, and hence their findings cannot be generalized to other countries on the continent. Meanwhile, knowing the economic growth effect of road injuries in several African countries will provide a broader picture of the economic effects of road injuries, which could increase attention on the need to enhance road safety initiatives. Moreover, conducting a study on a number of countries over several years (panel data) enhances the precision of inference made from parameters and helps in dealing with omitted variable bias as well as takes into consideration the complex nature of human behavior.[16] In addition, while road injuries are likely to affect economic growth by interacting (or in combination) with factors such as labor productivity and treatment cost, the past studies, especially those on African countries, did not examine these factors.

This study, therefore, examines the combined effect of road injuries and labor productivity on economic growth in 45 African countries, while controlling for endogeneity. To the best of the authors' knowledge, the study contributes to the literature in the following ways: (i) it is the first study to investigate the effect of road injuries on economic growth in many African countries over several time periods and (ii) it is the first study in the African context to examine an important factor (i.e., labor productivity) which road injuries could interact with to affect economic growth. The findings of the study will therefore help in increasing attention toward the need to deal with road injuries. This would greatly help in achieving the Sustainable Development Goal 3.6 (which is focused on reducing road traffic injuries and deaths),[17] as well as reducing the associated losses to economic growth.

2 | SUMMARY OF RELATED LITERATURE

Theoretically, the augmented Solow growth model posits that human capital is a major determinant of economic growth.[6] Thus, since health is an important aspect of human capital, it means changes in health conditions of workers will affect economic growth.[3,4] This is because, healthier workers are more robust and energetic both mentally and physically, making them more productive and vice versa.[3] Since road injuries can cause illnesses, disabilities, and deaths among the working age group, they will lead to presenteeism and absenteeism from work, which would reduce the productivity of the affected persons and their caregivers, hence negatively affecting economic growth.[1,2] Moreover, the cost of treatment and damages to property (such as physical capital and technology) due to road accidents may divert resources from savings and investment, thereby negatively affecting economic growth.[14]

Regarding empirical studies, Connelly and Supangan[9] found that in Australia the annual cost of road traffic crashes in 2003 was 2.3% of gross domestic product (GDP). Bhavan[7] conducted a study in Sri Lanka over the period, 1977–2016 to examine the effect of road fatalities on economic performance, using the Vector Error Correction Model (VECM) as the estimation technique. The study found statistically significant long- and short-run association between economic growth and road fatalities. In another study among 166 countries, Chen et al.,[8] examined the economic burden of road injuries using a macroeconomic model that takes account of how nonfatal and fatal road injuries affect labor supply as well as how expenses on treating road injuries move away funds from savings among others. In 2015–2030, they estimated the global cost of road injuries to be $1.8 trillion (in constant 2010 United States (US) $), an equivalent of a yearly tax of 0.12% of the world GDP. In a related study among 31 European countries, it has been found that the overall cost of road crashes was equal to 0.4%–4.1% of GDP.[11]

Miovsky et al.,[10] over the period, 1990–2016, assessed how fatal injuries, including transport accidents, affected GDP among a sample of Eastern and Central European countries. The study found fatal transport accidents (especially among female adolescents and adults) to have a negative significant effect on GDP. Similarly, it has been found that rising road fatalities negatively affected economic growth in Nigeria, over the period, 1970–2016, using the Autoregressive Distributed Lag (ARDL) model as the estimation technique.[12] In another study conducted in Nigeria, using the ordinary least-squares (OLS) regression over the period, 1990–2013, it was found that a percentage increase in road traffic accidents decreased economic growth by 1.15%.[15] In a related study in Ghana, using the OLS regression, it was found that a 1% increase in road traffic accidents decreased economic growth by 0.21%.[13] Similarly, in Mauritius, Tandrayen-Ragoobur,[14] using the VECM as the estimation technique over the period, 1980–2020, found that a percentage increase in road accidents decreased real GDP by 0.42%.

From the above studies, it is clear that none of the studies devoted to African countries was conducted in more than one country and also these studies did not examine the factors road injuries could interact with to affect economic growth. Given the importance of these gaps as outlined in the introduction, this study attempts at addressing these issues using 45 countries in Africa. Nonetheless, it must be stressed that due to data paucity on the cost of treatment and damages to property due to road accidents, this

study focuses on labor productivity as a factor which road injuries could interact with to affect economic growth.

3 | METHODS

This section presents the methods employed in carrying out the study as outlined in the subsections below.

3.1 | Model specification

This study specifies the economic growth-road injuries nexus model below, based on the literature.[18–22]

$$\Delta EG = f(\mathrm{RI},\ \mathrm{INF},\ \mathrm{FDI},\ \mathrm{RQ},\ \mathrm{EXP},\ \mathrm{NX},\ \mathrm{DI}), \tag{1}$$

where ΔEG is the logarithm (log) difference between the current and previous year's GDP; the measure of economic growth, which is a function of road injuries (RI), inflation (INF), foreign direct investment (FDI), regulatory quality (RQ), consumption expenditure (EXP), net exports (NX), and domestic investment (DI).

For estimation purposes, this study respecifies Equation (1) as an augmented economic growth model as follows:

$$\begin{aligned}\Delta \mathrm{EG}_{it} = {} & \Omega + \varpi \mathrm{EG}_{it-1} + \beta \mathrm{RI}_{it} + \delta \mathrm{INF}_{it} + \phi FDI_{it} + \lambda \mathrm{RQ}_{it} \\ & + \mathit{ш} \mathrm{EXP}_{it} + \vartheta \mathrm{NX}_{it} + \Upsilon \mathrm{DI}_{it} + \varkappa_t + \nu_{it},\end{aligned} \tag{2}$$

where Ω represents the constant term and EG_{it-1} is the first lag of the log of GDP (the dynamic term capturing the persistence of economic growth overtime). The notations ϖ, β, δ, ϕ, λ, $\mathit{ш}$, ϑ, and Υ are coefficients of the associated variables. In addition, time (year), country, time fixed effects, and the error term are represented by t, i, $\varkappa$, and ν, respectively. The meanings of the remaining notations are as already defined. To incorporate the effect of labor productivity, we respecify Equation (2) as follows:

$$\begin{aligned}\Delta \mathrm{EG}_{it} = {} & \Omega + \varpi EG_{it-1} + \beta \mathrm{RI}_{it} + \Xi P_{it} + \delta \mathrm{INF}_{it} + \phi \mathrm{FDI}_{it} + \lambda \mathrm{RQ}_{it} \\ & + \mathit{ш} \mathrm{EXP}_{it} + \vartheta \mathrm{NX}_{it} + \Upsilon \mathrm{DI}_{it} + \varkappa_t + \nu_{it},\end{aligned} \tag{3}$$

where P represents labor productivity and Ξ is its associated coefficient. To examine how road injuries affect economic growth in combination with labor productivity, Equation (3) is respecified as follows:

$$\begin{aligned}\Delta \mathrm{EG}_{it} = {} & \Omega + \varpi \mathrm{EG}_{it-1} + \beta \mathrm{RI}_{it} + \Xi P_{it} + ¥ \mathrm{RP}_{it} + \delta \mathrm{INF}_{it} + \phi \mathrm{FDI}_{it} \\ & + \lambda \mathrm{RQ}_{it} + \mathit{ш} \mathrm{EXP}_{it} + \vartheta \mathrm{NX}_{it} + \Upsilon \mathrm{DI}_{it} + \varkappa_t + \nu_{it},\end{aligned} \tag{4}$$

where RP is the interaction of road injuries with labor productivity (i.e., RP = RI × P) and ¥ is the coefficient of the interaction term. The interaction term is used to assess the combined effect of road injuries and labor productivity on economic growth.

With regard to the expected signs, since road injuries are likely to be associated with a reduction in labor productivity through presenteeism, absenteeism, and even death, they are expected to have a negative effect on economic growth. Thus, while labor productivity is expected to have a positive effect on economic growth because it enhances human capital, the interaction of road injuries with labor productivity is expected to have a negative effect on economic growth.[1–3,5,6] For inflation, it can lead to higher production of goods and services, hence higher economic growth if it is being caused by shortages of goods and services. On the contrary, the ability of firms to purchase inputs for production can be limited by inflation, thereby negatively affecting economic growth. Thus, the sign of inflation can be either positive or negative.[23] Similarly, the sign of FDI can be either positive or negative. Thus, if FDI is associated with technological advancement, it can enhance factor productivity, which would propel economic growth.[24,25] However, if foreign firms repatriate their profits and also drive domestic firms out of business, it will be detrimental to economic growth.[21,26,27]

With regard to regulatory quality, since the private sector is regarded as an important driver of economic growth, and enhanced regulatory quality is expected to increase private sector development, the effect of regulatory quality on economic growth is expected to be positive.[23] Rising domestic investment would lead to the injection of more resources into production, thereby enhancing economic growth.[21] Nonetheless, for consumption expenditure, its effect on economic growth is uncertain because our measure constitutes both household and government expenditure. Thus, while government consumption expenditure may increase leakages of resources away from production (hence reducing domestic investment) (see Immurana et al.[21]), private consumption expenditure could increase the demand for goods and services produced by firms, which can enhance their overall performance leading to higher economic growth. For net exports, it will have a negative effect on economic growth if imports exceed exports but a positive effect on economic growth if exports exceed imports.[23]

3.2 | Data and measurement of variables

In this study, annual data on 45 African countries (Algeria, Central African Republic, Eritrea, Lesotho, Niger, Tanzania, Angola, Chad, Ethiopia, Libya, Nigeria, Togo, Benin, Congo Dem. Rep. (i.e. Democratic Republic of the Congo), Gabon, Madagascar, Rwanda, Tunisia, Botswana, Congo Rep. (i.e. Republic of the Congo), Gambia The, Mali, Senegal, Uganda, Burkina Faso, Cote d'Ivoire, Ghana, Mauritania, Zambia, Burundi, Djibouti, Guinea, Mauritius, Sierra Leone, Zimbabwe, Cabo Verde, Egypt Arab Rep., Guinea-Bissau, Morocco, South Africa, Cameroon, Equatorial Guinea, Kenya, Mozambique, and Sudan) over the period, 2002–2019 are used. The data span and the countries chosen are mainly dictated by the availability of data on all variables. The data on road injuries are obtained from the Global Burden of Diseases Study (GBD).[28] Data on regulatory quality are sourced from the Worldwide Governance Indicators of the World Bank[29] and data on labor productivity are obtained from the website of the International Labor Organization,[30] while data on all the

remaining variables are obtained from the World Development Indicators of the World Bank.[31]

As stated already, economic growth is measured by the log difference of the present year's GDP and the past year's GDP. GDP is measured in constant 2015 US Dollars. This measure of economic growth is used because it captures the growth of overall income or output in an economy while accounting for inflation. Moreover, using this indicator of economic growth is in tandem with some past studies.[18,32,33] Road injuries are measured in percentage point prevalence. Labor productivity is measured as the yearly percentage growth rate in output (GDP) per worker. The GDP deflator is used as the proxy for inflation and it is measured in percentages. FDI is measured by the net inflows of FDI as a percentage of GDP. Regulatory quality is defined as how people perceive governments' ability to initiate effective policies and regulations toward enhancing private sector development, measured on a score ranging from −2.5 to 2.5. Consumption expenditure is measured as a percentage of GDP. Gross fixed capital formation is used as the proxy for domestic investment and it is measured as a percentage of GDP. Net exports are measured as exports as a percentage of GDP minus imports as a percentage of GDP. All these definitions are from the aforementioned data sources except economic growth and net exports which are generated by the authors based on data from the sources above. Summary statistics of the variables can be found in Table 1. Moreover, per-country trends of GDP, labor productivity, and road injuries over the study period can be found in Figures 1–3, respectively. It must be noted that in addition to the dependent variable and the dynamic term, some of these variables are log-transformed for estimation purposes (see estimation strategy).

3.3 | Estimation strategy

To examine the combined effect of road injuries and labor productivity on economic growth in the 45 African countries, this study uses the dynamic panel system generalized method of moments (GMM) regression [34,35] as the estimation technique. The system GMM is chosen because of the following reasons: (i) it is dynamic in nature,[20,36] hence capable of estimating the dynamic models in Equations (2)–(4), (ii) it deals with endogeneity,[20,36] as there is the likelihood of economic growth affecting some independent variables, which could lead to endogeneity, resulting in biased estimates. For instance, rising economic growth can lead to the construction of modern and less accident-prone roads, which will reduce road injuries; and (iii) the number of countries in the data outweighs the number of years.[36]

In dealing with endogeneity, the system GMM uses the lags of the explanatory or independent variables as instruments while employing level and first-differenced equations. Knowing that the specifications in Equations (2)–(4) are short-run models, long-run estimates of the models are derived using the "nlcom" routine in Stata following the approach of Papke and Wooldridge.[38] The short-run period covers the moment entailing the expeditious or prompt effects of the independent variables on the dependent variable, while the long-run period covers how the independent variables affect the dependent variable over time (cumulatively).[39]

The study does not use approaches such as fixed effects, random effects, and OLS regressions because they are not dynamic in nature and are unable to deal with endogeneity.[20,40] Moreover, estimators such as the instrumental variable fixed effects and the two-stage least-squares regressions that are able to handle endogeneity normally require external instruments, which are difficult to find.[41]

The appropriateness of the system GMM estimates is confirmed by the insignificance of the *p* values of the Hansen overidentification test (Hansen *J*) and the Arellano–Bond second-order serial correlation test (AR(2)), as well as the number of instruments being less than the number of countries (to avoid the proliferation of instruments which can negatively affect results of the Hansen *J*).[20–22,36,37,41–44] The *F*-test is also used to examine the overall significance (fitness) of the models.

To smoothen deviations linked with recurrent data and deal with fluctuations in the business cycle,[45] as well as make the estimates

TABLE 1 Descriptive statistics.

Variable	Observations	Mean	SD	Minimum	Maximum
RI	270	0.022	0.005	0.009	0.037
P	270	1.774	3.425	−11.323	17.286
GDP	265	4.493e+10	8.441e+10	7.111e+08	4.989e+11
INF	264	8.472	13.006	−9.251	143.074
FDI	268	3.835	4.483	−8.312	33.132
RQ	270	−0.696	0.603	−2.199	1.149
EXP	257	83.371	17.87	23.783	133.635
NX	260	−7.256	15.689	−65.061	44.363
DI	256	22.682	8.634	3.101	72.422

Note: Variables are not log-transformed; averaged data are used.

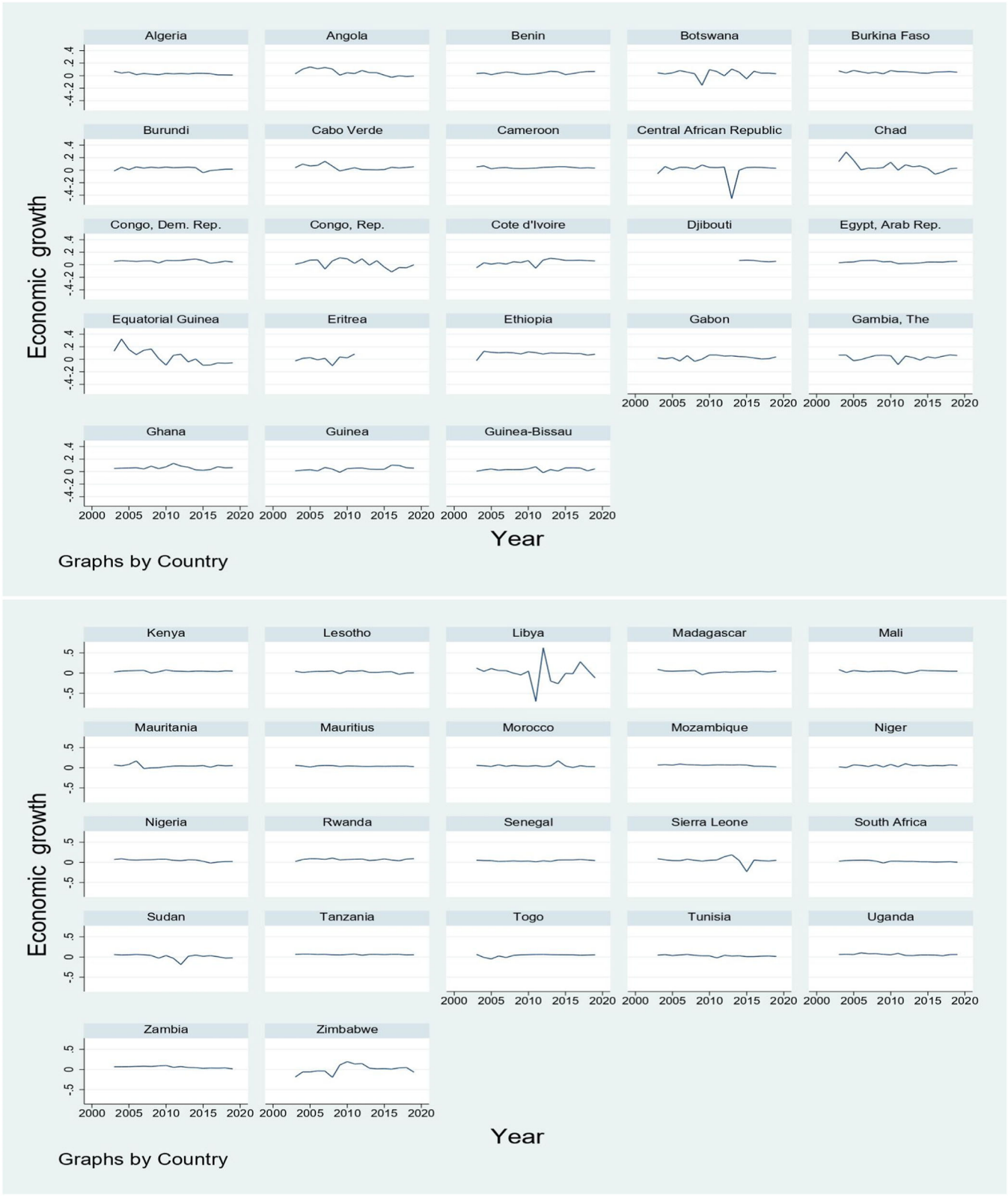


FIGURE 1 Trend of economic growth, per-country, 2002–2019. Unaveraged data are used; economic growth is measured by the log difference between the current year's GDP and the past year's GDP.

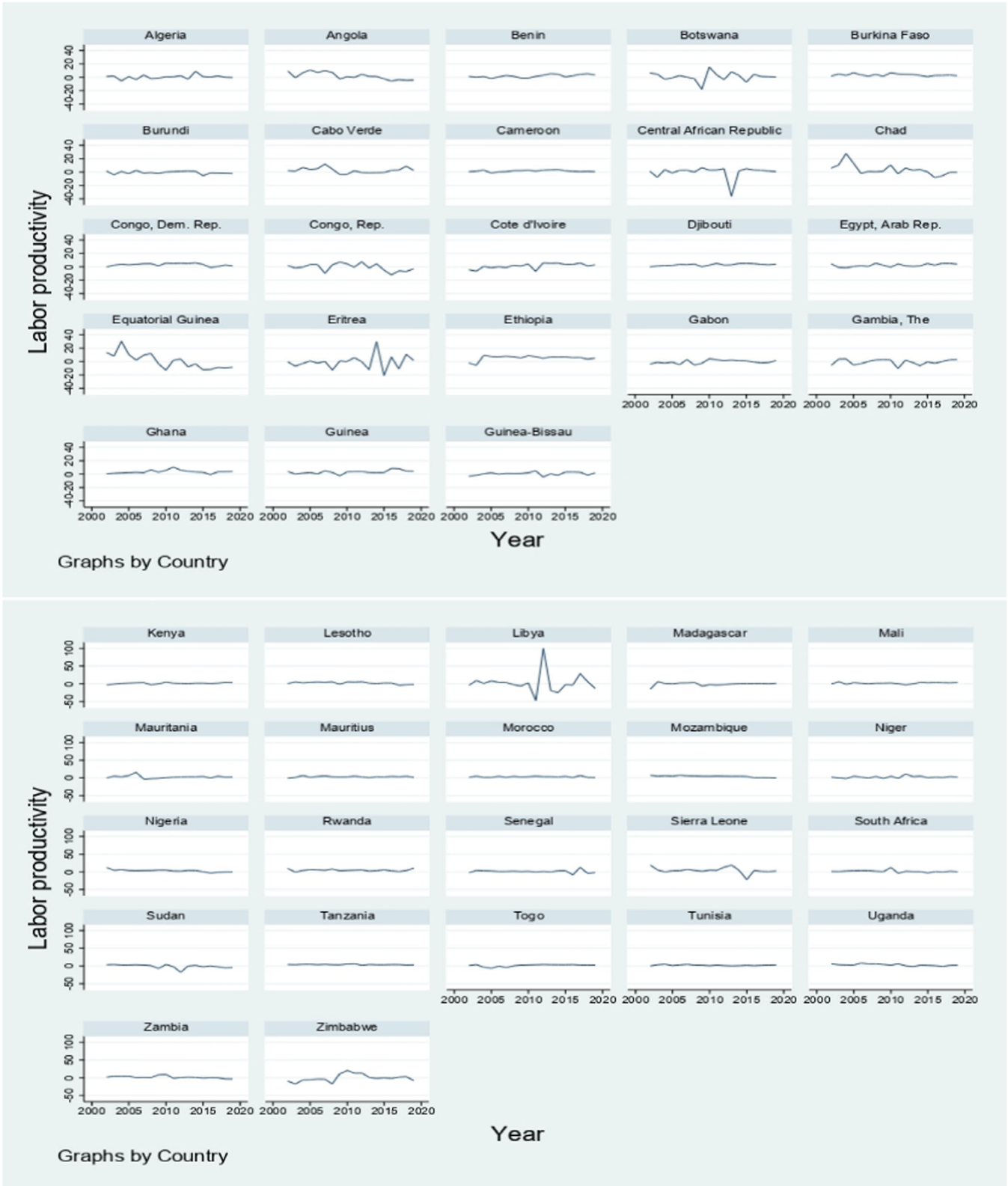


FIGURE 2 Trend of labor productivity, per-country, 2002–2019. Unaveraged data are used.

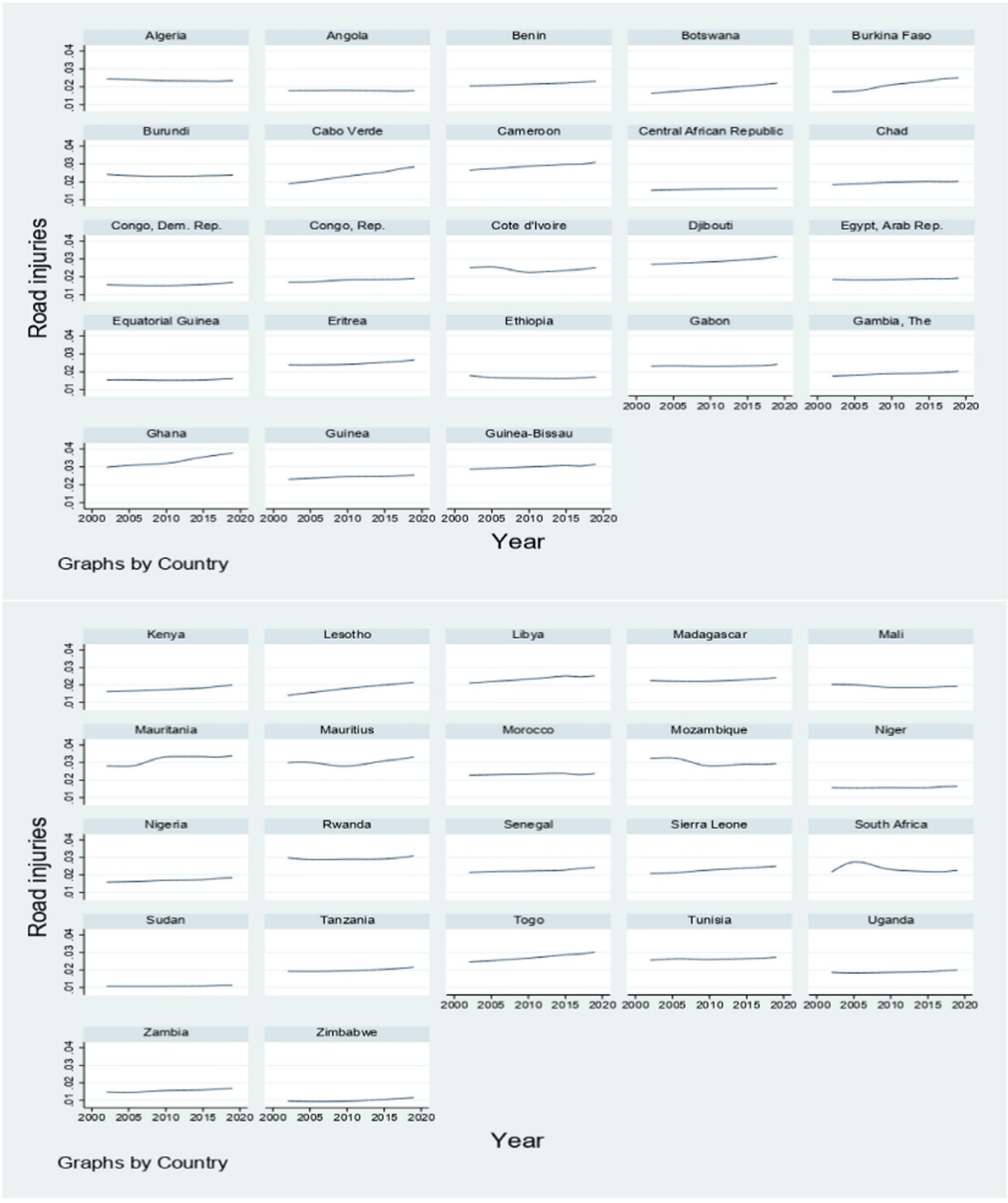


FIGURE 3 Trend of road injuries, per-country, 2002–2019. Unaveraged data are used.

more relevant for designing policies (through long-run analysis),[46] 3-year averages of the data are used to run the system GMM estimates. In addition, using 3-year averages ensures that we have enough observations to display results for all aspects of our estimation technique. Moreover, the study period covers 18 years, hence taking 5-year averages would not have been possible.

In the system GMM regression analysis, all variables except road injuries, labor productivity, inflation, FDI, net exports, and regulatory quality are log-transformed. The logarithms of these variables are not used because they either have negative values or have been interacted. Taking the logarithm of variables aids in decreasing the differences in the units of their measurements and also ensures that the coefficients of variables are interpreted as elasticities.[27,47] Moreover, in creating the interaction of road injuries with labor productivity, the variables are subjected to mean centering to facilitate meaningful interpretation.[20,48]

It must be noted that the regression results are reported using 1%, 5%, and 10% levels of significance, thus giving room for up to 10% margin of error, which is conventional with regard to studies conducted in economics, such as the present one. All the statistical analyses in this study are done using Stata 14.0.

3.4 | Ethical approval and informed consent

Secondary data that have been aggregated are used in conducting this study; therefore, ethical approval and consent to participate are not required.

4 | RESULTS

In this section, the study presents the short- and long-run system GMM estimates of the combined effect of road injuries and labor productivity on economic growth in the 45 African countries over the period, 2002–2019 (Tables 2 and 3).

With regard to the short-run estimates, the dynamic term is found to be negative and statistically significant at the 1% or 5% level in all the models (Table 2), which indicates that there is convergence back to equilibrium when economic growth experiences a shock.

For the purposes of interpretation, we focus on Model 3 results in Tables 2 and 3, since they contain estimates for all variables. Also, given that economic growth is log-transformed and some variables (FDI, inflation, net exports, regulatory quality, road injuries, labor productivity, and the interaction of road injuries with labor productivity) are not log-transformed, to interpret their coefficients meaningfully, we have to exponentiate the coefficients, subtract 1 from the resulting number and subsequently multiply the number by 100.[49]

In the short-run, concerning the main variables of interest, road injuries (coefficient: −3.56, $p < 0.05$) and labor productivity (coefficient: 0.02, $p < 0.01$) are found to have statistically significant negative and positive effects on economic growth, respectively. Nonetheless, we find the interaction of road injuries with labor productivity to have a statistically significant negative effect on economic growth (coefficient: −1.96, $p < 0.01$) (Table 2, Model 3).

Using the exponentiation approach above,* a per unit increase in road injuries and labor productivity is found to decrease and increase economic growth by 97.17% (when labor productivity is at its mean value) and 1.88% (when road injuriesis at its mean value), respectively. In addition, a unit increase in the interaction of road injuries with labor productivity reduces economic growth by 85.97%.

With regard to the other variables, the effects of inflation (coefficient: 0.001, $p < 0.01$) and net exports (coefficient: 0.002, $p < 0.05$) on economic growth are positive and significant (Table 2, Model 3). Thus, a unit increase in inflation and net exports increases economic growth by 0.09% and 0.21%, respectively. In addition, a percentage increase in consumption expenditure and domestic investment is found to increase economic growth by 0.28% and 0.23% at 5% and 1% levels of significance, respectively (Table 2, Model 3).

The system GMM estimates are appropriate because they do not suffer from overidentification, second-order serial correlation as well as the proliferation of instruments. Moreover, the overall p values (F-statistic p values) of the models are highly significant (Table 2), indicating their fitness.

Similar to the short-run results, in the long-run models, road injuries (coefficient: −3.51, $p < 0.01$) and labor productivity (coefficient: 0.02, $p < 0.01$) have negative and positive significant effects on economic growth, respectively (Table 3, Model 3). The implications are that, 97.02% and 1.86% decrease and increase in economic growth are associated with per unit increase in road injuries and labor productivity, when labor productivity and road injuries are at their mean values, respectively. Nonetheless, the interaction of road injuries with labor productivity is found to have a negative significant effect on economic growth (coefficient: −1.93, $p < 0.01$) (Table 3, Model 3). Specifically, a per unit increase in the interaction of road injuries with labor productivity is found to be associated with a decrease in economic growth by 85.55%.

Inflation (coefficient: 0.001, $p < 0.01$) and net exports (coefficient: 0.002, $p < 0.05$) still maintain their short-run behavior in the long-run period by having positive significant effects on economic growth (Table 3, Model 3). Thus, a unit increase in inflation and net exports increases economic growth by 0.08% and 0.21%, respectively.

Moreover, a percentage increase in consumption expenditure and domestic investment is found to be associated with a rise in economic growth by 0.27% and 0.23% at 5% and 1% levels of significance, respectively (Table 3, Model 3).

5 | DISCUSSION

To the best of the authors' knowledge, this study provides the first empirical analysis of the interaction or combined effect of road injuries and labor productivity on economic growth in several African

TABLE 2 Short-run two-step system GMM estimates of the association between road injuries, labor productivity, and economic growth.

	Model 1	Model 2	Model 3
EG_{it-1}	−0.0708*** (0.0178)	−0.0262*** (0.0086)	−0.0152** (0.0067)
RI	−12.1863*** (2.5702)	−6.2483*** (1.8099)	−3.5649** (1.3288)
INF	0.0002 (0.0004)	0.0004** (0.0002)	0.0009*** (0.0002)
FDI	0.0033* (0.0017)	−0.0009 (0.0009)	−0.0010 (0.0015)
RQ	0.0222 (0.0232)	0.0201 (0.0143)	0.0141 (0.0120)
EXP	−0.0261 (0.1515)	0.0440 (0.0886)	0.2770** (0.1097)
NX	0.0005 (0.0018)	−0.0007 (0.0009)	0.0021** (0.0009)
DI	0.1104** (0.0534)	0.1219*** (0.0386)	0.2319*** (0.0468)
P		0.0209*** (0.0017)	0.0186*** (0.0017)
RP			−1.9637*** (0.2950)
Constant	1.5859 (1.0333)	0.1860 (0.5951)	−1.4285* (0.7355)
Observations	216	216	216
Number of countries	45	45	45
Number of instruments	37	39	39
AR(2)	−1.5344	−0.5537	−0.8903
AR(2) *p* value	0.1249	0.5798	0.3733
Hansen *J*	31.4695	22.1091	24.1719
Hansen *J p* value	0.1407	0.6294	0.4518
F-statistic	17.5606	269.2355	1177.0217
F-statistic *p* value	0.0000	0.0000	0.0000

Note: Standard errors are given within parentheses; EG_{it-1}, EXP, DI, and the dependent variable (ΔEG) are log-transformed. For brevity, time fixed effects are not reported.

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

TABLE 3 Long-run two-step system GMM estimates of the association between road injuries, labor productivity, and economic growth.

	Model 1	Model 2	Model 3
RI	−11.3808*** (2.2502)	−6.0887*** (1.7496)	−3.5116*** (1.3004)
INF	0.0002 (0.0003)	0.0004** (0.0002)	0.0008*** (0.0002)
FDI	0.0030* (0.0016)	−0.0009 (0.0009)	−0.0010 (0.0015)
RQ	0.0207 (0.0214)	0.0196 (0.0138)	0.0138 (0.0118)
EXP	−0.0244 (0.1414)	0.0429 (0.0865)	0.2729** (0.1092)
NX	0.0005 (0.0017)	−0.0006 (0.0009)	0.0021** (0.0009)
DI	0.1031** (0.0502)	0.1187*** (0.0378)	0.2284*** (0.0470)
P		0.0203*** (0.0017)	0.0184*** (0.0017)
RP			−1.9344*** (0.2971)
Constant	1.4811 (0.9488)	0.1813 (0.5790)	−1.4072* (0.7315)
Observations	216	216	216

Note: Standard errors are given within parentheses; EXP, DI, and the dependent variable (ΔEG) are log-transformed.

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

countries while employing an estimation technique that is capable of dealing with endogeneity. Doing so provides findings that are not only statistically appropriate but also generalizable to a number of countries. The study finds that, in both the short- and long-run periods, road injuries and labor productivity have negative and positive significant effects on economic growth, respectively. Nonetheless, the interaction of road injuries with labor productivity is found to have a negative significant effect on economic growth in both the short- and long-run periods.

The implication is that road injuries are detrimental to the positive effect of labor productivity on economic growth. These findings are not surprising because Africa bears the greatest brunt of deaths due to road injuries and these injuries normally do happen among the working-age population, thereby decreasing labor productivity, resulting into reduced economic growth.[1,2] These findings are in line with those of Chen et al.[8] who projected the global cost of road injuries from 2015 to 2030 to correspond to a yearly tax of 0.12% on global GDP ($1.8 trillion). Similarly, in Ghana and Nigeria, road traffic accidents have been found to be associated with a decrease in economic growth.[13,15] Specifically, the study in Ghana[13] and Nigeria[15] found road traffic accidents to be associated with a 0.21% and 1.15% reductions in economic growth, respectively. While we acknowledge that our estimates of the effect of road injuries on economic growth are higher than those found by past studies, this could be attributed to differences in the number of countries used and how variables (especially economic growth) are measured as well as the fact that a number of past studies did not account for the combined effect of road injuries and labor productivity on economic growth.

Our findings call for an urgent need to institute measures toward reducing road injuries to decrease their substantial negative effect on economic growth in Africa. For instance, it has been found that, reducing morbidity and deaths attributed to road traffic by 50% and sustaining it for 24 years could lead to an additional income equivalent to 15%, 14%, and 7.1% of GDP in China, India, and Tanzania, respectively.[2] Beyond the GDP gains, there are welfare gains of reducing road injuries.[2]

In reducing road injuries, governments should pay attention to the WHO Save Lives Package.[50] The package is composed of speed management, providing leadership with regard to road safety, enhancing infrastructure design, improving safety standards of vehicles, ensuring traffic laws enforcement, and enhancing survival after a crash. The implementation of these components should be done in an integrated manner to effectively achieve a reduction in road injuries and deaths.[50]

As regards the remaining variables, the positive sign of inflation could be due to higher prices emanating from demand exceeding supply, which would push firms to produce more.[23] The finding on inflation conflicts with a number of past studies.[18,22,23,51–53]

The positive effect of net exports is not surprising because higher net exports means that there is higher domestic production (hence exports) relative to imports. Boachie[19] found a similar outcome for his study on Ghana.

Last but not least, since higher domestic investment will lead to more resources being injected into local production, it is not surprising that domestic investment is found to have a positive association with economic growth.[21] Past studies[19,54] have revealed similar findings as regards the effect of domestic investment on economic growth. Similarly, the positive effect of consumption expenditure could be due to higher demand for goods and services produced by firms, which would increase firm profitability and overall performance, culminating into enhanced economic growth.

Nonetheless, this study is not without limitations. First, irrespective of the fact that the GBD (source of data on road injuries) is the most comprehensive scientific attempt embarked upon to enumerate health trends at the global, regional, and country levels,[55] in low- and middle-income regions such as Africa, it is confronted with a paucity of primary data, which is addressed using out-of-sample predictive accuracy during modeling. However, significant enhancement in the estimates will be attained by gathering not only more but also quality primary data.[56] Second, this study focuses on how road injuries interact with labor productivity to affect economic growth but does not take into account other factors such as treatment cost (including out-of-pocket health expenditure), funeral cost, and property damage as a result of road accidents. Future studies should therefore consider these issues.

6 | CONCLUDING REMARKS

Each year, millions of people in the world suffer from road injuries, with the highest burden of associated deaths found in Africa.[1] While these injuries can adversely affect economic growth by reducing labor productivity, very few related studies have been conducted, with none focused on a sample of African countries. This study, to the best of the authors' knowledge, therefore provides the first empirical examination of the interaction effect of road injuries and labor productivity on economic growth across African countries. The results indicate that road injuries have a statistically significant negative effect on economic growth due to their deleterious effect on labor productivity. Therefore, there is an urgent need to implement measures toward reducing road injuries to curb their deleterious effects on economic growth. In particular, initiatives aimed at reducing road injuries should pay attention to the WHO Save Lives Package measures[50] outlined in the discussion.

AUTHOR CONTRIBUTIONS

Mustapha Immurana: Conceptualisation; methods; data acquisition; analysis; interpretation; writing–original draft; writing–review and editing. **Muniru Azuug:** Data acquisition; writing–original draft. **Ibrahim Abdullahi:** Data acquisition; writing–original draft. **Kwame Godsway Kisseih:** Data acquisition; writing–original draft. **Ayisha Mohammed:** Writing–original draft; writing–review and editing. **Micheal Kofi Boachie:** Writing–original draft; writing–review and editing. **Toby Joseph Mathew Kizhakkekara:** Writing–original draft; writing–review and editing.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data employed in carrying out this study are available at no cost from the websites of the Global Burden of Diseases Study (https://vizhub.healthdata.org/gbd-results/), the International Labour Organization (https://rshiny.ilo.org/dataexplorer12/?lang=en&id=GDP_205U_NOC_NB_A), and the World Bank (https://databank.worldbank.org/reports.aspx?source=World-Development-Indicators#advancedDownloadOptions; https://databank.worldbank.org/source/worldwide-governance-indicators#advancedDownloadOptions). In doing so, attention should be paid toward the dates the datasets were accessed as indicated in the reference list.

ETHICS STATEMENT

Secondary data which have been aggregated are used in conducting this study, therefore, consent to participate or ethical approval is not required.

TRANSPARENCY STATEMENT

The lead author Mustapha Immurana affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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ENDNOTE

* It should be noted that all the exponentiations in this study are done using the coefficients in Tables 2 and 3.

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