revista de pesquisa ISSN 2175-5361

CUIDADO É FUNDAMENTAL

Escola de Enfermagem Alfredo Pinto – UNIRIO

ORIGINAL ARTICLE DOI: 10.9789/2175-5361.rpcfo.v17.13339

SPATIO-TEMPORAL DISTRIBUTION OF MORTALITY AMONG MOTORCYCLISTS: AN ECOLOGICAL STUDY

Distribuição espaço-temporal da mortalidade entre motociclistas: um estudo ecológico

Distribución espacio-temporal de la mortalidad de motociclistas: un estudio ecológico

Ilan de Araujo Carneiro[1]
Andreza Moita Morais[2]
Thalis Kennedy Azevedo de Araujo[3]
Adriano Flávio Santos Gonçalves Filho[4]

ABSTRACT

Objective: to analyze the spatial and temporal distribution of mortality from motorcycle accidents in Piauí from 2011 to 2021. **Method:** this is an ecological study in which deaths from motorcycle accidents in the state of Piauí were analyzed. Temporal regression analysis was carried out using Joinpoint software and spatial analysis using the QGI program. **Results:** 7,250 deaths from motorcycle accidents were recorded in Piauí during the study period. The average mortality rate was 23.81 deaths per 100,000 inhabitants. Spatial analysis showed high mortality rates in the Meio Norte health macro-region. **Conclusion:** although there is a downward trend in mortality rates in the state of Piauí, it is still a cause for concern, as it affects the young and economically active population. This study provides evidence that contributes to the implementation and reformulation of public health policies for traffic monitoring, enforcement and education.

DESCRIPTORS: Accidents; Traffic; Epidemiology; Time series studies.

[1,3,4] State University of Piauí, Piauí, Parnaíba, Brazil
[2] Federal University of Ceará, Ceará, Tianguá, Brazil

Received: 2024/05/31. Accepted: 2024/08/05

CORRESPONDING AUTHOR: Thalis Kennedy Azevedo de Araujo
Email: thaliskennedy@gmail.com
How to cite this article: Carneiro IA, Morais AM, Araújo TKA, Gonçalves Filho AFS. Spatio-temporal distribution of mortality among motorcyclists: an ecological study. R Pesq Cuid Fundam. [Internet]. 2025 [cited year month day];17:13339. Available from: https://doi.org/10.9789/2175-5361.rpcfo.v17.13339

RESUMO

Objetivo: analisar a distribuição espacial e temporal da mortalidade por acidentes motociclísticos no Piauí de 2011 a 2021. **Método:** trata-se de um estudo ecológico, em que foram analisados os óbitos por acidentes motociclísticos ocorridos no estado do Piauí. A análise de regressão temporal foi realizada por meio do *software Joinpoint* e a análise espacial utilizou-se o programa *QGIS*. **Resultados:** no período estudado foram registrados 7.250 óbitos por acidentes motociclísticos no Piauí. A taxa de mortalidade média foi de 23,81 óbitos por 100 mil habitantes. A análise espacial mostrou elevadas taxas de mortalidade na macrorregião de saúde do Meio Norte. **Conclusão:** embora haja uma tendência de queda nas taxas de mortalidade no estado piauiense, ainda é um agravo preocupante, pois atinge a população jovem e economicamente ativa. Este estudo fornece evidências que contribuem para implementação e reformulação de políticas públicas de saúde de monitorização, fiscalização e educação no trânsito.

DESCRITORES: Acidentes de trânsito; Epidemiologia; Estudos de séries temporais.

RESUMEN

Objetivo: analizar la distribución espacial y temporal de la mortalidad por accidentes de motocicleta en Piauí de 2011 a 2021. **Método:** trata de un estudio ecológico en el que se analizaron las muertes por accidentes de motocicleta en el estado de Piauí. Se realizó un análisis de regresión temporal con el programa Joinpoint y un análisis espacial con el programa QGIS. **Resultados:** registraron 7.250 muertes por accidentes de motocicleta en Piauí durante el período de estudio. La tasa media de mortalidad fue de 23,81 muertes por 100.000 habitantes. El análisis espacial mostró altas tasas de mortalidad en la macrorregión sanitaria Meio Norte. **Conclusión:** aunque haya una tendencia a la disminución de las tasas de mortalidad en el estado de Piauí, sigue siendo un problema preocupante, ya que afecta a la población joven y económicamente activa. Este estudio aporta evidencias que contribuyen a la implementación y reformulación de políticas de salud pública para la vigilancia, fiscalización y educación sobre el tránsito.

DESCRIPTORES: Accidentes de tránsito; Epidemiología; Estudios de series temporales.

INTRODUCTION

The incidence and mortality from traffic accidents has increased significantly in recent years across the globe. The World Health Organization (WHO) has identified Brazil as the country with the third highest number of deaths from traffic accidents, surpassed only by India and China.[1] It is estimated that 145,920 individuals were hospitalized in the country as a result of these accidents, with an estimated cost of approximately 187 million reais to the public coffers, financed through the Unified Health System (SUS).[2]

As reported by WHO, road traffic accidents were responsible for over 1.9 million deaths and injuries to between 20 and 50 million individuals in 2021 alone.[1] Notably, there has been an increasing emphasis on motorcycle accidents. The challenge of urban mobility and the limited availability of mass transportation in the country, coupled with the low acquisition and maintenance costs associated with motorcycles, has contributed to a notable rise in their use for Brazilians' daily activities.[3]

A motorcycle is a vehicle that provides a lower level of safety than a car, due to the absence of the structural and protective devices that are present in cars. This results in an increased risk of fatal injuries for motorcycle occupants. Additionally, high speed, alcohol consumption, inattention, fatigue and drowsiness are identified as significant factors contributing to the rise in accidents and the severity of injuries sustained in such incidents.[4-5]

The consequence of this situation is an increase in the number of deaths from motorcycle accidents in Brazil and Piauí. Therefore, in order to gain a more detailed understanding of this problem, it is first necessary to describe how it occurs and to characterise the population at risk. It is of fundamental importance to obtain as much information as possible in order to systematically gather data on the extent, characteristics and consequences of this problem for the country's public health.[5-6]

Moreover, data released by the Ministry of Health indicate that the state of Piauí has the highest mortality and hospitalization rates in the country due to motorcycle accidents. In 2021, the state exhibited a mortality rate of 17.6 deaths per 100,000 inhabitants and a hospitalization rate of 17.4 inpatients per 10,000 inhabitants. This figure is approximately four times higher than the average rate in Brazil.[7] Consequently, this study is justified by the growing incidence of deaths in Piauí, as well as the dearth of research analysing the spatial and temporal occurrence of mortality in motorcycle accidents.

In this context, geoprocessing techniques, which facilitate the identification, visualisation and spatial organisation of territories, can be employed to map mortality rates and assess the risk factors associated with motorcycle accidents. This

enables the planning of intervention and prevention actions.[8] The results will provide insight into the spatio-temporal distribution of mortality among motorcyclists and inform the development of effective strategies and interventions to prevent and reduce mortality.

METHOD

This is an epidemiological and ecological study focused on the Brazilian state of Piauí. With a population of approximately 3.2 million, Piauí is the eighth most populous state in the northeast region of the country. It covers an area of approximately 251,577 km², comprising four distinct health macro-regions: Litoral, Meio Norte, Semiárido and Cerrado.[9]

Secondary data from the Ministry of Health's Information Systems (IS) was utilised. The data was obtained electronically from the portal of the Information Technology Department of the Unified Health System (DATASUS), which collates data from a range of IS. DATASUS provides information on deaths registered in the Mortality Information System, which is fed by the Death Certificate.[10]

The objective of this study is to examine the circumstances surrounding the deaths of motorcyclists in the state of Piauí between 2011 and 2021. In addition to the circumstances of these deaths, the study will also analyse the sociodemographic characteristics of the victims, the year in which the deaths occurred, and the underlying causes of death. Consequently, the deaths in question were selected on the basis of the codes V20, V21, V22, V23, V24, V25, V26, V27, V28 and V29, as defined by the 10th International Classification of Diseases (ICD-10).

The Tabwin software was employed to calculate the crude mortality rates from motorcycle accidents for each year and the standardised average rate. The numerator of the formula was the number of deaths, while the denominator was the population of motorcyclists in the state of Piauí, as reported in the 2022 Demographic Census[11], multiplied by 100,000 inhabitants.

In order to illustrate the sociodemographic profile of the injured individuals, a series of univariate categorical analyses were conducted, employing a range of variables, including gender, race/colour, marital status, age group, level of education, health macro-region and level of education. These variables were described in terms of both their absolute and relative frequencies, and the resulting data were presented in tabular form.

To analyse the temporal evolution of mortality, the raw data on motorcycle accidents recorded each year was tabulated using a Microsoft Office Excel spreadsheet and sent to Tabwin software. The resulting data set was then used to generate a linear regression line with its respective coefficient of determination, which demonstrated the evolution or temporal regression of deaths for each year.[12]

Subsequently, the data was imported into the Joinpoint Regression Program software, which was used to calculate the Annual Percentage Change (APC) with a 95% confidence interval (CI95%). A significance level of 5% was set to test the null hypothesis that the APC of the series is equal to zero. Consequently, for the APC analysis, results with $p<0.05$ or a positive CI95% (increasing trend) or only negative (decreasing trend) are indicative of a statistically significant outcome.[13]

The analysis of the spatial statistics of deaths from motorcycle accidents was based on the mortality rate. This approach enabled the graphic map of Piauí to be divided by municipality and connected to the database containing information on the rates for each of Brazil's 5,570 municipalities. The tabular data was linked to the geographic layer table using codes standardised (geocodes) by the Brazilian Institute of Geography and Statistics (IBGE) common to both files, using the QGIS software.[12]

In accordance with Resolution No. 510 of 7 April 2016, approved by the National Health Council, research utilising information in the public domain is exempt from evaluation and registration by the Research Ethics Committees and National Research Ethics Committee system. However, all ethical and legal aspects of health research were duly respected.

RESULTS

In the Brazilian state of Piauí, between the years 2011 and 2021, a total of 7,250 deaths resulting from motorcycle accidents were recorded. The mean number of cases per year was 659.1, with the highest number of cases occurring in 2014 (n=761; 10.5%) and the lowest in 2021 (n=575; 8.0%). Nevertheless, despite 2021 exhibiting the lowest number of cases, the lowest

mortality rate was identified during the time series in 2019 (19.88 deaths per 100,000 inhabitants) (Table 1).

Table 1 - Distribution of deaths from motorcycle accidents in Piauí between 2011 and 2021, by year of death. Parnaíba, PI, Brazil, 2024

Year of Death	n	%	Mortality Rate
2011	588	8.1	20.89
2012	688	9.5	25.99
2013	647	8.9	23.82
2014	761	10.5	28.85
2015	717	9.9	24.73
2016	730	10.1	27.21
2017	667	9.2	23.96
2018	639	8.8	22.48
2019	604	8.3	19.88
2020	635	8.7	22.79
2021	574	8.0	21.35
Total/Average	7,250	100.0	23.81

Source: DATASUS, 2024.

Table 2 presents the sociodemographic characteristics of deaths from motorcycle accidents in Piauí. The majority of deaths were among males (n=6,188; 89.50%), of parda race/colour (n=4,647; 76.5%), single (n=3,266; 49.4%) and between 20 and 29 years old (n=2,041; 29.5%). Furthermore, the data revealed a prevalence of fatalities among individuals with an educational background spanning between one and three years (n=1,982; 31.7%), residents of the Meio Norte health macro-region (n=3,377; 46.6%), and the primary location of these incidents was on public roads (n=3,780; 55.0%).

Table 2 - Sociodemographic characterization of deaths from motorcycle accidents in Piauí between 2011 and 2021. Parnaíba, PI, Brazil, 2024

Variable	Total	
	n	%
Gender†		
Male	6,188	89.5
Female	722	10.5
Total	**6,910**	**100.0**
Race/Color‡		
Parda	4,647	76.5
White	902	14.8
Black	511	8.4
Asian	15	0.3
Indigenous	3	0.1
Total	**6,079**	**100.0**

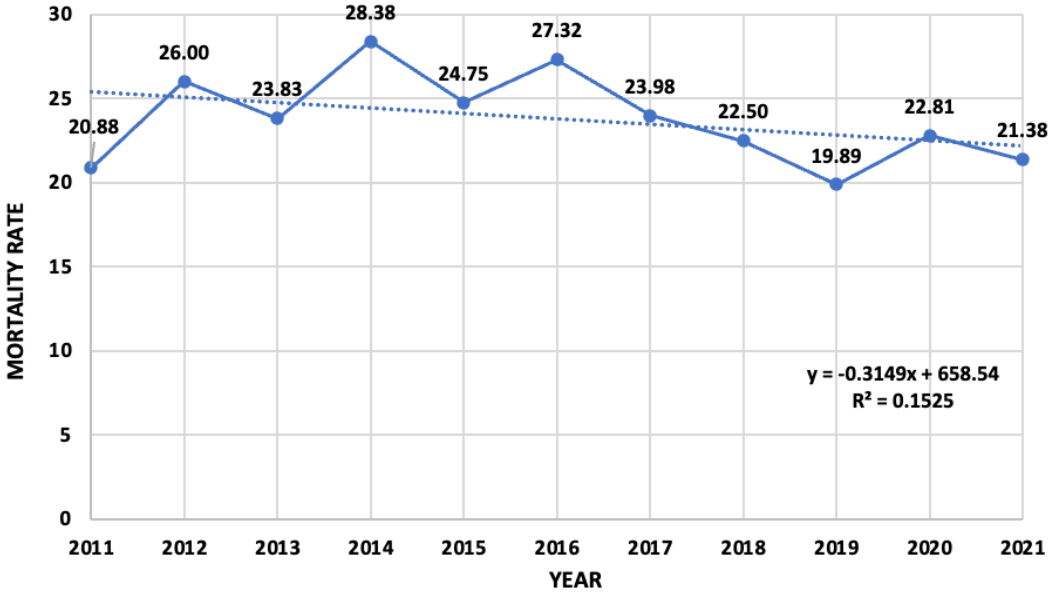
Variable	Total	
	n	%
Marital Status§		
Single	3,266	49.9
Married	1,825	27.6
Other	1,130	17.1
Widowed	218	3.3
Separated	172	2.6
Total	**6,079**	**100.0**
Age Group††		
0 to 9 years	38	0.6
10 to 19 years	692	10.1
20 to 29 years	2,041	29.5
30 to 39 years	1,671	24.2
40 to 49 years	1,149	16.6
50 to 59 years	721	10.4
60 to 69 years	419	6.1
70 years and over	174	2.5
Total	**6,905**	**100.0**
Education‡‡		
None	696	11.1
1 to 3 years of study	1,982	31.7
4 to 7 years of study	1,747	27.9
8 to 11 years of study	1,580	25.3
12 or more years of study	249	4.0
Total	**6,254**	**100.0**
Health Macroregion§§		
Meio Norte	3,377	46.6
Semiárido	1,392	19.2
Cerrados	1,261	17.4
Litoral	1,218	16.8
Total	**7,248**	**100.0**
Place of Occurrence†††		
Public Roads	3,780	55.0
Hospitals	2,749	39.9
Others	344	5.1
Total	**6,872**	**100.0**

Source: DATASUS, 2024.

†340 deaths were excluded because Gender was entered as "Unknown". ‡1,171 deaths were excluded because Race/Color was entered as "Unknown/Not filled in". §638 deaths were excluded because Marital Status was entered as "Unknown/Not filled in". 345 deaths were excluded because the Age Group was "Unknown". ‡‡Ninety-six deaths were excluded due to Education being "Unknown/Not filled in". §§2 deaths were excluded because the Health Macroregion was "Unknown". ††378 deaths were excluded because the Place of Occurrence was "Unknown".

Figure 1 illustrates the temporal evolution of mortality from motorcycle accidents in Piauí. It is evident that there are considerable fluctuations in the rates between the years 2011 and 2016, which are followed by a decline in the rates between 2016 and 2019. Subsequently, there is a gradual increase in the rates between 2019 and 2021. The average mortality rate for the period under analysis was 23.81 deaths per 100,000 inhabitants, with 2014 exhibiting the highest rate (28.38 deaths per 100,000 inhabitants). The coefficient of determination (R^2) explains 15.25% of the variability in the linear regression model.

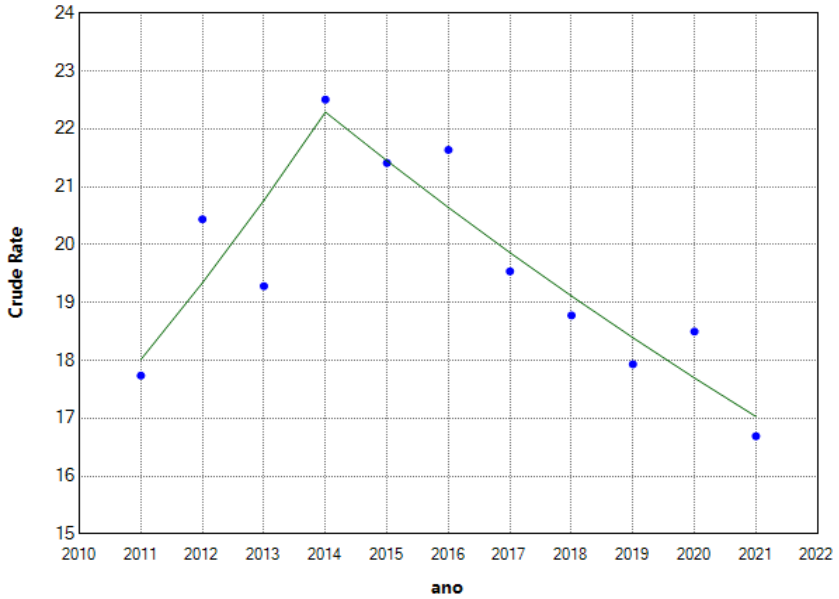
Figure 1 - Temporal evolution of mortality rates from motorcycle accidents in Piauí per 100,000 inhabitants from 2011 to 2021. Parnaíba, PI, Brazil, 2024



Source: Authors, 2024.

The Joinpoint time analysis of motorcycle accident mortality in Piauí revealed the presence of two straight line segments with an inflection point in 2014, indicating a change in trend from initially increasing to decreasing until the last year analysed. From 2011 to 2014, there was a notable increase ($p<0.05$) of 7.4% (CI95%: 1.8-9.2) annually. From 2014 to 2021, there was a notable decline in mortality from motorcycle accidents, with a reduction of -3.8% (CI95%: -5.1 to -0.4) per year (Figure 2).

Figure 2 - Joinpoint analysis of mortality from motorcycle accidents in Piauí between 2011 and 2021. Parnaíba, PI, Brazil, 2024

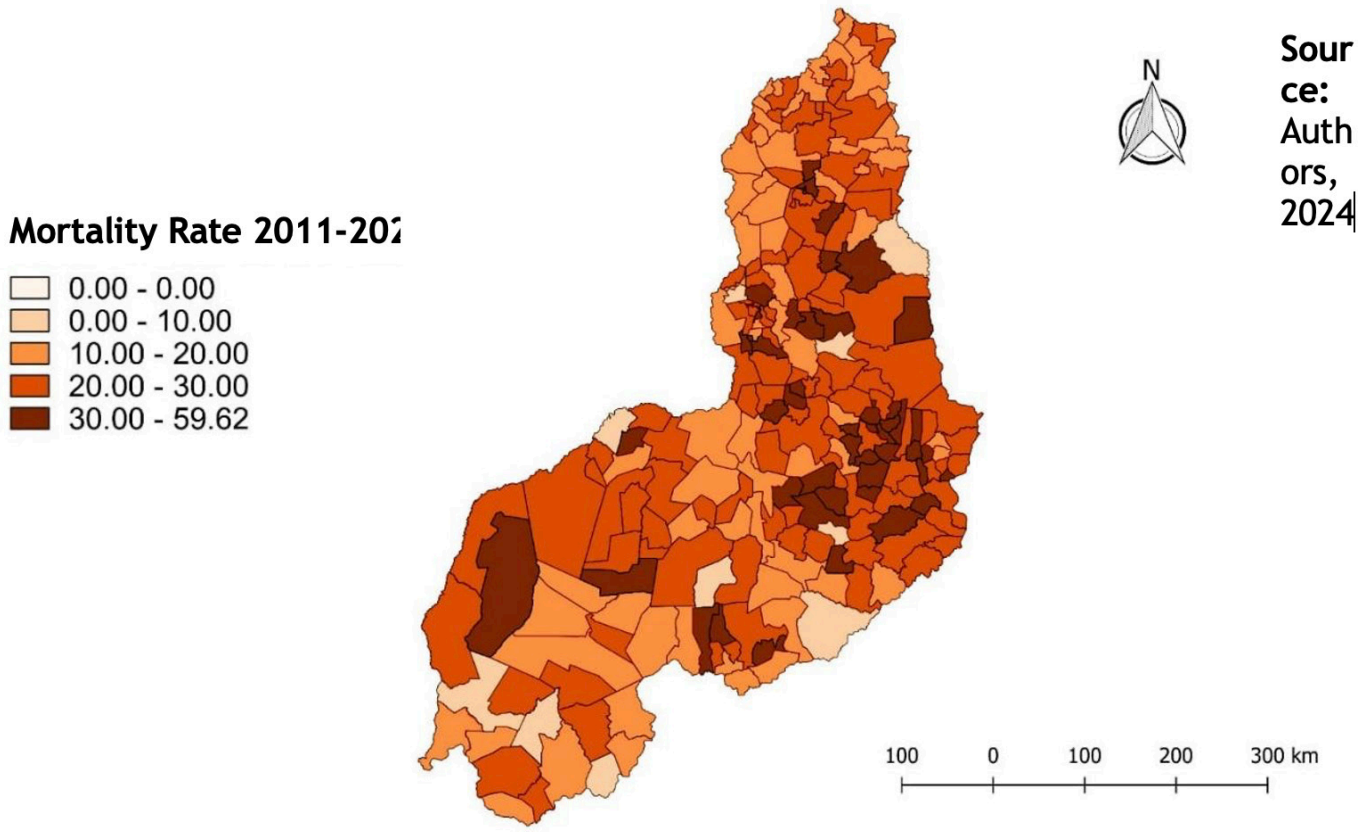


Source: Authors, 2024.

†p<0,05; APC: *Annual Percentage Change*.

Figure 3 presents a map of the standardised average mortality rate from motorcycle accidents in Piauí. A greater concentration of deaths is observable in the state's central municipalities, with the highest rates located in the Meio Norte health region. Moreover, the spatial analysis revealed that 27 municipalities exhibited elevated mortality rates. However, it is noteworthy that the territory of Piauí demonstrated a relatively balanced distribution of rates, with the majority displaying a mortality rate between 20.00 and 30.00 deaths per 100,000 inhabitants within the state.

Figure 3 - Mortality rate from motorcycle accidents in Piauí between 2011 and 2021. Parnaíba, PI, Brazil, 2024



Source: Authors, 2024.

DISCUSSION

The present study revealed an oscillating pattern in mortality data from motorbike accidents in the municipalities of Piauí, which is consistent with the findings of the Ministry of Health. Furthermore, when compared to the figures for Brazil and the Northeast region during the same period, the mortality rates in Piauí were approximately five times higher than those observed in the aforementioned locations.[7] These findings are in line with the results of several national studies, which also observed an oscillating pattern in the number of deaths during the years analysed.[6,14]

The findings of this research demonstrated that men are the primary victims of this issue, which corroborates a study conducted in Teresina that identified a significant proportion of victims as male.[15] It is crucial to emphasise that historical prejudices and resistance to male self-care contribute to the prevalence of this problem, as many accidents could be prevented through reduced exposure to danger and greater social acceptance of personal care. Consequently, a considerable number of men are inclined to undertake greater risks, despite the fact that a significant proportion of these are unwarranted and detrimental.[16]

In this study, the parda race/colour was identified as the predominant category, a finding that aligns with the results of another study conducted in Piauí.[17] Additionally, the IBGE data indicates that the majority of the population in Piauí self-identifies as parda.[18] Conversely, the majority of individuals who sustained this injury were single. This finding may be justified by the fact that these individuals, most of whom are young, are inclined to seek out adventures and thrills in traffic, which may render them more susceptible to engaging in reckless actions that could potentially lead to life-threatening incidents.[19]

A study conducted by the Institute for Applied Economic Research (IPEA) revealed that individuals between the ages of 15 and 29 represent approximately 44% of fatalities resulting from motorcycle accidents.[20] This phenomenon is observed consistently across the North, Northeast, Southeast, South, and Center-West regions of the country.[14] In the state of Piauí, the population between the ages of 20 and 29 is identified as the most vulnerable to this issue. However, these episodes necessitate disparate forms of care, as they result in elevated rates of hospitalisation, premature retirement, and financial assistance, in addition to a diminished quality of life for survivors and their families.[16]

With regard to the issue of education, a high percentage of deaths from motorbike accidents was found among people who had between one and three years of schooling. Another study carried out in the state of Ceará also found similar results, reporting a higher frequency of deaths among individuals with low levels of schooling.[21] Therefore, it can be concluded that poor education and low levels of schooling are directly related to a lack of understanding about the importance of making cautious and preventative decisions.[4,22]

The time analysis of mortality from motorbike accidents in Piauí indicated that there was variability in rates from 2011 to 2021. There was an increase in mortality until 2014, followed by a gradual decline in rates, which remained constant from 2015 to 2021. According to official statistics, the Brazilian Northeast showed similar temporal trends of increases and decreases.[5,7] Moreover, the analysis carried out using the Joinpoint method indicated trends of mortality reduction in Piauí in recent years.

These findings are consistent with a study conducted in the state of Pernambuco, which demonstrated a decline in motorbike-related fatalities between 2015 and 2019.[16] The observed reductions may be attributed to enhanced signage and enforcement on public roads, expanded traffic education initiatives, and the introduction of safer and more comfortable vehicles. Additionally, the pandemic has resulted in a reduction in vehicle traffic, which has contributed to a decrease in fatal motorbike accidents.[23]

One potential explanation for this phenomenon is that the Brazilian Traffic Code (CTB), in conjunction with the Dry Law, has led to a decline in traffic-related fatalities nationwide, thereby making it a viable strategy for addressing this issue.[24] To this end, enhancing and intensifying enforcement actions and continuing education initiatives with the objective of promoting traffic safety represents a promising avenue for further investigation.[25]

However, when these rates are analysed in relation to the health macro-regions of the state of Piauí, significant prevalence is observed in certain locations. For instance, the Meio Norte health macro-region exhibits high mortality rates from motorbike accidents, while the Litorânea displays lower rates. The inequality caused by the centralisation of financial and technological resources in large urban centres may explain these phenomena.[19,22]

Therefore, it can be posited that as an individual's socioeconomic status declines, the probability of their selecting a motorbike as a mode of transportation over a car increases. This is due to the relatively low costs associated with the purchase, maintenance and regulation of vehicles.[4] In contrast, a study conducted in Teresina revealed that the city is the epicentre of motorbike accidents within the state. Furthermore, the capital's high population density, in comparison to other cities in Piauí, is a contributing factor to the elevated mortality rates.[26]

The enhanced mobility afforded by motorbikes has prompted a transformation in their design, creating new employment opportunities in the delivery and passenger transportation sectors. However, these drivers frequently encounter challenging working conditions, including extended hours due to increased productivity demands and heightened risk exposure due to their adoption of high speeds to meet delivery targets.[27]

This study is subject to certain limitations, including the use of secondary data from an IS that is susceptible to inconsistencies in the quality of its data, due to the presence of incorrect and/or inadequate data entries. Therefore, it is possible that a greater number of deaths may be obscured by the exclusion of relevant variables or erroneous categorisation, particularly in the case of the race/colour variable, which exhibited a considerable degree of underreporting. Nevertheless, despite these constraints, the study could still be conducted and its findings remain significant.

CONCLUSION

The findings of this study indicate that mortality from motorbike accidents in Piauí represents a significant public health concern that requires further investigation. The results of this research contribute to the development of intervention strategies aimed at reducing the incidence of fatalities. Additionally, the evidence provided by this study can inform the implementation and reformulation of public health policies, particularly through the implementation of

continuous monitoring, rigorous inspection, and more effective traffic education initiatives.

Furthermore, this research contributes to an understanding of the distribution of the phenomenon within the state of Piauí, thereby facilitating the guidance of educational actions. It does so by sensitising and raising awareness among the population, with the objective of promoting safe actions in traffic, avoiding acts of recklessness, malpractice and negligence. This ultimately contributes to a reduction in the risk factors for motorbike accidents.

REFERENCES

1. World Health Organization (WHO). Global status report on road safety 2023. [Internet]. 2023 [cited 2024 apr 21]. Available from: https://www.who.int/publications/i/item/9789240086517.
2. Damasceno IDS, Alves TM, Santos LRO, Fianco MC, Bastos SNMAN, Silva MNL. Characterization clinical and epidemiological of victims of motorcyclical accidents. Enferm. foco (Brasília). [Internet]. 2018 [cited 2024 apr 28];9(2). Available from: https://doi.org/10.21675/2357-707X.2018.v9.n2.1131.
3. Souza SS, Cardoso JP, Nery AA, Oliveira, JS. Evaluation of the time response to scene among envolved in road traffic accidents with motocicletas. Revista saúde. [Internet]. 2022 [cited 2024 apr 21];18(2). Available from: https://doi.org/10.22481/rsc.v18i2.10754.
4. Corgozinho MM, Montagner MA. Sociodemographic profile of motorcyclists and their vulnerabilities in traffic. Rev. bras. med. trab. [Internet]. 2022 [cited 2024 apr 15];20(2). Available from: https://doi.org/10.47626%2F1679-4435-2022-657.
5. Souza CDFD, Machado MF, Quirino TRL, Leal TC, Paiva JPSD, Magalhães APND, et al. Spatial and temporal patterns of mortality among motorcyclists in a State of the Brazilian Northeast in the 21st century. Ciênc. saúde coletiva (Online), 1678-4561. [Internet]. 2021 [cited 2024 apr 11];26(1). Available from: https://doi.org/10.1590/1413-81232021264.09732019.
6. Sousa RAD, Sousa CMDS, Silva FRS, Rodrigues MTP, Cardoso ODO, Mascarenhas MDM. Transport accident mortality time trend and spatial distribution in Piauí, Brazil, 2000-2017. Epidemiol. Serv. Saúde (Online). [Internet]. 2020 [cited 2024 apr 07];29(1). Available from: https://doi.org/10.1590/S1679-49742020000500005.
7. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Boletim epidemiológico: Cenário brasileiro das lesões de motociclistas no trânsito de 2011 a 2021 [Internet]. Brasília: Ministério da Saúde [acesso em 14 de março 2024]. Disponível em: https://www.gov.br/saude/pt-br/centrais-de-conteudo/publicacoes/boletins/epidemiologicos/edicoes/2023/boletim-epidemiologico-volume-54-no-06.
8. Silva YS, Rodrigues ZMR. Use of geoprocessing in health geography analyses. Geo Conexões. [Internet]. 2022 [cited 2024 apr 13];1(1). Available from: https://doi.org/10.53528/geoconexes.v1i1.69.
9. Instituto Brasileiro de Geografia e Estatística [homepage na internet]. Cidades e estados [acesso em 16 de mar 2024]. Disponível em: https://www.ibge.gov.br/cidades-e-estados/pi.html.
10. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Informações de saúde: tabnet/datasus [Internet]. Brasília: Ministério da Saúde [acesso em 19 de abril 2024]. Disponível em: https://datasus.saude.gov.br/informacoes-de-saude-tabnet.
11. Instituto Brasileiro de Geografia e Estatística [homepage na internet]. Censo demográfico 2022 [acesso em 12 de mar 2024]. Disponível em: https://censo2022.ibge.gov.br.
12. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Abordagens espaciais na saúde pública [Internet]. Brasília: Ministério da Saúde; 2006 [acesso em 24 de janeiro 2024]. Disponível em: https://bvsms.saude.gov.br/bvs/publicacoes/ serie_geoproc_vol_1.pdf.
13. Sousa GJB, Garces TS, Pereira MLD, Moreira TMM, Silveira GM. Temporal pattern of tuberculosis cure, mortality, and treatment abandonment in Brazilian capitals. Rev. latinoam. enferm. (Online). [Internet]. 2019 [cited 2024 may 02];27(1):e3218. Available from: https://doi.org/10.1590/1518-8345.3019.3218.
14. Fidelis FAP, Araújo KCGM, Filho PRSM. Mortality from motorcycle accidents or accidents in the regions of Brazil: temporal analysis 2016 to 2020. RSD. [Internet]. 2022 [cited 2024 apr 23];11(7):e16411729873. Available from: https://doi.org/10.33448/rsd-v11i7.29873.
15. Cavalcante ACB, Holanda VM, Rocha CFM, Cavalcante SW, Sousa JPR, Sousa FHR. Profile of traffic accidents served by the mobile emergency care service. Revista Baiana de Enfermagem (Online), 2178-8650. [Internet]. 2015 [cited 2024 apr 18];29(2). Available from: https://doi.org/10.18471/rbe.v29i2.12656.
16. Lopes LGF, Ribeiro SHP, Sousa SRGR, Veras GC, Albuquerque TV, Pequeno SO, et al. Survey of the epidemiological profile of deaths from traffic accidents in the state of Pernambuco from 2015 to 2019. RSD.

[Internet]. 2022 [cited 2024 apr 26];11(8):e14511830681. Available from: https://rsdjournal.org/index.php/rsd/article/view/30681.

17. Santos FR, Correia ASL, Alves DS, Sousa JMS, Silva FM, Rodrigues JA. Epidemiological profile of trauma victims treated at a hospital emergency room in the south of Piauí. Conjecturas. [Internet]. 2024 [cited 2024 apr 29];24(1). Available from: https://doi.org/10.53660/CONJ-2243-2W40.

18. Instituto Brasileiro de Geografia e Estatística [homepage na internet]. Pela primeira vez desde 1991, a maior parte da população do Brasil se declara parda [acesso em 22 mar 2024]. Disponível em: https://agenciadenoticias.ibge.gov.br/agencia-noticias/2012-agencia-de-noticias/noticias/38719-censo-2022-pela-primeira-vez-desde-1991-a-maior-parte-da-populacao-do-brasil-se-declara-parda.

19. Santos SAS, Azevedo AF. Criminalidade no trânsito e a impunidade: (motivada pela impunidade). Novos direitos. [Internet]. 2020 [acesso em 11 de abril 2024];7(2). Disponível em: http://revistas.unifan.edu.br/index.php/RevistaICJ/article/view/752.

20. Ministério do Planejamento e Orçamento (BR). Instituto de Pesquisa Econômica Aplicada. Balanço da 1ª década de ação pela segurança no trânsito no Brasil e perspectivas para a 2ª década [Internet]. Brasília: Ministério do Planejamento e Orçamento; 2023 [acesso em 22 de abril 2024]. Disponível em: https://repositorio.ipea.gov.br/bitstream/11058/12250/1/NT-Balanco_Primeira_Publicacao_Preliminar.pdf

21. Tavares FL, Leite FMC, Oliveira AB, Berardinelli LMM, Maciel PMA, Coelho MJ. Men and bike accidents: characterization of accidents from pre-hospital care. Rev. Pesqui. (Univ. Fed. Estado Rio J., Online). [Internet]. 2021 [cited 2024 apr 20];13(1). Available from: https://doi.org/10.9789/2175-5361.rpcfo.v13.9682.

22. Cavalcanti IGOR, Fernandes FECV, Mola R. Prevalence and factors associated with motorcycle accidents by area of occurrence. Enferm. glob. [Internet]. 2020 [cited 2024 apr 08];19(3). Available from: https://doi.org/10.6018/eglobal.389411.

23. Valente BG, Rocha AC, Figueiredo HCES, Jorge GDO, Mattos CAD, Junior AC, et al. The impact of COVID-19 on the profile of motorcycle accidents attended at a tertiary hospital in Campinas. Acta Ortopdica brasileira (Online), 1809-4406. [Internet]. 2022 [cited 2024 may 04]; 30(1):e256152. Available from: https://doi.org/10.1590/1413-785220223006e256152.

24. Sassim PVS, Ferreira TCR, Pena JCV, Lima PTS, Neto CADSC, Gabriel DG, *et al*. Profile of patients hospitalized by automobilistic accidents in the metropolitan hospital for urgency and emergency of Ananindeua in the period from 2006 to 2012. Revista CPAQV. [Internet]. 2020 [cited 2024 may 21];12(3). Available from: https://doi.org/10.36692/v12n3-4.

25. Nunes HRDC, Nascimento CM, Lima MCP. Impact of the Dry Law on road traffic mortality in Brazilian states: an interrupted time series analysis. Rev. bras. epidemiol. (Online), 1980-5497. [Internet]. 2021 [cited 2024 may 17];24(1):e210045. Available from: https://doi.org/10.1590/1980-549720210045.

26. Sousa PG, Nogueira TA, Meza RO, Oliveira VA, Abreu MHT. Spatial analysis of fatal victims of motorcycle traffic accidents in Teresina - Piauí. RSD. [Internet]. 2020 [cited 2024 may 11];9(10):e9549109506. Available from: https://doi.org/10.33448/rsd-v9i10.9506.

27. Almeida LS, Onorio DAL, Júnior MABA, Araújo YB. Perfil dos óbitos por acidentes de trânsito no estado de Mato Grosso: estudo ecológico. Revista da Faculdade de Ciências Médicas da Paraíba. [Internet]. 2023 [acesso em 30 de abril 2024];1(3). Disponível em: https://rfcm.emnuvens.com.br/revista/article/view/59.