Assessing the Burden of Years of Life Lost (YLL) Due to Traffic Fatalities in Algeria (2020-2023)

Évaluation de la Charge des Années de Vie Perdues (AVP) en raison des Fatalités Routières en Algérie (2020-2023)

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Abstract
This study assesses the public health burden of fatalities resulting from traffic accidents in Algeria during the period between 2020 and 2023, by measuring the Years of Life Lost (YLL). The findings reveal significant demographic disparities, with young adults, particularly males aged between 20 and 34, bearing the highest burden of lost years. The study also highlights that children and the elderly face different levels of risk based on their gender. The study's recommendations emphasize the need for targeted interventions to enhance road safety, through stricter enforcement of traffic laws, intensified gender-sensitive road safety awareness campaigns, and improved protective measures for the age groups that bear the most significant burden of lost years. The results and recommendations of this study can support road safety strategies in Algeria to reduce the overall burden of fatalities caused by traffic accidents.

***Keywords**: Years of Life Lost (YLL), Traffic Fatalities, Public Health Burden, Road Safety, Algeria.*
***JEL Codes:** H51, I12, J17.*

Résumé
Cette étude évalue le fardeau de santé publique lié aux décès résultant des accidents de la route en Algérie entre 2020 et 2023, en mesurant les Années de Vie Perdues (AVP). Les résultats révèlent d'importantes disparités démographiques, les jeunes adultes, en particulier les hommes âgés de 20 à 34 ans, supportant le plus grand fardeau en termes d'années perdues. L'étude souligne également que les enfants et les personnes âgées sont exposés à différents niveaux de risque selon leur sexe. Les recommandations de l'étude mettent l'accent sur la nécessité d'interventions ciblées pour améliorer la sécurité routière, à travers une application plus stricte des lois de circulation, des campagnes de sensibilisation à la sécurité routière tenant compte des différences de genre, ainsi que des mesures de protection renforcées pour les groupes d'âge portant le plus grand fardeau des années perdues. Les résultats et recommandations de cette étude peuvent soutenir les stratégies de sécurité routière en Algérie dans le but de réduire le fardeau global des décès dus aux accidents de la route.

***Mots-clés :** Années de Vie Perdues (AVP), Décès dus aux Accidents de la Route, Fardeau de Santé Publique, Sécurité Routière, Algérie.*
***JEL Codes:** H51, I12, J17.*

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1. Introduction

Road traffic fatalities represent a significant and escalating public health crisis on a global scale, with extensive consequences for both people and societies. The World Health Organization (WHO) underscores that Traffic accidents rank among the top causes of mortality worldwide, particularly affecting young individuals aged 5–29 years, where they rank as the foremost cause of mortality (World Health Organization, 2018, p. 3). The repercussions of these fatalities extend beyond the immediate loss of life, contributing substantially to the global burden of disease by accelerating premature mortality. The socio-economic impact of traffic fatalities is equally profound, as these deaths lead to both direct and indirect economic losses, including medical costs, lost productivity, and long-term financial strain on families and communities. Peden et al. (2004) emphasize that the premature deaths resulting from traffic accidents contribute significantly to the lost years of potential life, highlighting the dual importance of mortality rates and the ages at which these fatalities occur (Peden, et al., 2004, p. 10).

In addition to the tragic human toll, road traffic fatalities impose severe economic burdens on societies. The WHO estimates that the global economic cost of traffic accidents ranges from 1% to 3% of a nation's gross domestic product (GDP) (World Health Organization, 2015, p. 20). These costs are multifaceted, encompassing direct expenses such as medical treatment and rehabilitation, as well as indirect costs like lost productivity due to injury or death, diminished quality of life for survivors, and property damage. Furthermore, the administrative costs associated with managing the aftermath of traffic crashes, including legal and insurance expenses, exacerbate the overall economic burden (World Health Organization, 2018, p. 12). In Algeria, this socio-economic burden is particularly pronounced, reflecting the unique challenges the country faces in mitigating traffic-related fatalities and injuries.

The global distribution of traffic deaths is markedly uneven, with Lower- and middle-income nations bearing an uneven share of the burden. These regions account for over 90% of global traffic fatalities, despite possessing less than 60% of the global vehicle fleet (World Health Organization, 2018, p. 7). This stark disparity underscores the urgency for targeted interventions and robust policy frameworks to address the factors contributing to road traffic deaths in these regions. Effective policies and interventions are essential to reduce the mortality rate and mitigate the economic and social impacts of traffic accidents (Peden, et al., 2004, p. 13). In Algeria, this disproportionate impact is particularly pronounced, as reflected in recent traffic accident statistics, which emphasize the need for sustained efforts to improve road safety.

1.1. Measuring YLL as a Key Indicator of Traffic Fatality Burden

While the number of traffic fatalities provides an immediate picture of road safety, it does not fully capture the long-term impact these deaths have on public health and society. The concept of Years of Life Lost (YLL) offers a more nuanced measure by quantifying the total years of life that are lost when individuals die prematurely due to traffic accidents. This metric takes into account not just the occurrence of death but also the age at which death occurs, making it a more comprehensive indicator of the burden these fatalities impose on a population. In Algeria, traffic accidents frequently involve younger individuals, leading to a significant loss of potential years of life. This loss translates into a substantial socio-economic impact, exacerbating the burden on the country's economy and health systems. For example, the death

of a young adult in a road traffic accident may result in several decades of lost life, which translates into a substantial socio-economic impact. By measuring YLL, we better understand which demographic groups are most affected and how severely they are impacted. This insight is crucial for identifying vulnerable populations and directing targeted interventions to where they are most needed (Murray & Lopez, The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability from Diseases, Injuries, and Risk Factors in 1990 and Projected to 2020, 1996, p. 25).

Moreover, YLL is vital for informing public health policy and prioritizing resources. It allows policymakers to evaluate the broader implications of traffic fatalities beyond mere counts of deaths. The socio-economic impact is particularly pronounced when YLL data is used to assess potential productivity loss and economic contributions, which can guide more effective policy interventions. Additionally, YLL serves as a valuable metric for comparing the impact of traffic fatalities with other public health issues. It assists in evaluating the significance of various causes of death and in determining how to allocate scarce public health resources. For example, suppose traffic fatalities are found to cause a higher YLL compared to other causes of death. In that case, it underscores the need for intensified efforts to improve road safety as a public health priority (Murray & Lopez, Global Health Statistics: A Compendium of Incidence, Prevalence, and Mortality Estimates for over 200 Conditions, 2013, p. 45).

In summary, measuring YLL as an indicator of the burden of traffic fatalities is essential for a more accurate and comprehensive assessment of the public health impact of these deaths. It highlights the socio-economic consequences of traffic accidents in Algeria, particularly among younger populations, and supports the development of targeted strategies to mitigate these effects. By incorporating YLL into road safety assessments, policymakers can better understand the full scope of the problem and design more effective interventions to reduce the toll of traffic fatalities on society.

1.2. Research Objectives

The central purpose of this research is to quantify the burden of YLL due to traffic fatalities in Algeria. By calculating YLL, this research seeks to offer a clearer insight into the scope and nature of the impact that traffic fatalities have on the country's population. This quantification is crucial for informing policy decisions and prioritizing interventions that can effectively reduce the burden of traffic fatalities. A secondary objective is identifying the demographic groups most affected by traffic fatalities in Algeria. Understanding which populations are at the most significant risk will help tailor public health interventions more effectively, ensuring that resources are allocated to where they are most needed. By disaggregating the data by age, sex, and region, this study will offer insights into the specific vulnerabilities contributing to traffic-related mortality patterns. Finally, this research aims to provide policy recommendations based on the findings, focusing on reducing the YLL burden in Algeria. The identification will inform these recommendations of high-risk groups. It will consider best practices from other contexts where traffic fatalities have been successfully reduced. The ultimate goal is to contribute to developing a more effective and equitable road safety strategy in Algeria that addresses the root causes of traffic fatalities and minimizes the loss of life.

1.3. Research Questions and Hypotheses

This study is directed by the following research questions:

- **How significant is the burden of YLL due to traffic fatalities in Algeria?** This question seeks to quantify the overall impact of traffic fatalities on Algeria's population, measured in terms of YLL. It aims to establish a baseline understanding of the extent to which traffic deaths contribute to premature mortality in the country.
- **Which demographic groups are most vulnerable to traffic fatalities in Algeria?** This question focuses on identifying the populations most at risk of dying prematurely due to traffic accidents. It involves a detailed analysis of the data to uncover patterns related to age, sex, and geographic location, thereby revealing the demographic characteristics that are most closely associated with higher YLL.

In addressing these questions, the study also tests the hypothesis that young adults and males are disproportionately represented in the YLL burden due to traffic fatalities in Algeria. This hypothesis is based on existing global and regional data that suggest younger populations, particularly males, are more prone to being involved in fatal road traffic accidents. Confirming or refuting this hypothesis will provide critical insights for the development of targeted interventions.

2. Literature Review

The conceptual framework of this study provides a structured approach to analyzing Years of Life Lost (YLL) as a result of road traffic fatalities in Algeria, linking these deaths to broader socio-economic and demographic factors. It aims to define and operationalize the YLL metric within public health and traffic safety, highlighting its importance in measuring premature mortality. This framework aligns the YLL metric with the study's objectives, focusing on the burden of traffic fatalities across different demographic groups in Algeria. By considering age, sex, and regional disparities, the framework emphasizes the urgency of addressing traffic fatalities as a significant public health issue, ensuring the study's findings are both academically rigorous and practically applicable for policy recommendations.

2.1. Definition and Importance of Years of Life Lost (YLL)

The concept of Years of Life Lost (YLL) functions as a vital measure in quantifying the impact of premature mortality. YLL is defined as the total potential years of life lost due to early deaths, in this case, resulting from traffic fatalities. It is determined by subtracting the age at death from the standard life expectancy at that age, thus offering an estimate of the years of life an individual could have lived if not for an early death. This metric is particularly useful in assessing the impact of mortality on a population, as it shifts the focus from mere death counts to the more profound implication of lost years of productive life (Murray & Lopez, 1996, p. 12).

YLL is a crucial metric in public health, as it provides a deeper insight into the impact of traffic fatalities beyond the mere count of deaths. While death counts provide a general picture of mortality, they fail to capture the magnitude of loss in terms of life potential and productivity. By focusing on the age at which individuals die, YLL highlights the severity of fatalities among younger populations, where the loss of potential life years is greatest. This insight is vital for policymakers and public health officials, as it underscores the urgency of interventions aimed at reducing traffic-related deaths, particularly among the most vulnerable age groups. Additionally, YLL facilitates a more comprehensive analysis of the socio-

economic burden imposed by traffic fatalities, enabling a better allocation of resources for prevention and control strategies (Mathers, Sadana, Salomon, Murray, & Lopez, 2001, p. 15).

2.2. Origin and Development of YLL

The concept of Years of Life Lost (YLL) originated from early initiatives aimed at assessing the global disease burden and understanding the impact of premature mortality across populations. The term gained prominence through the pivotal work of Christopher J.L. Murray and Alan D. Lopez during the 1990s, particularly in the context of the Global Burden of Disease (GBD) study. This study aimed to develop a comprehensive framework for evaluating health outcomes across different regions and populations. YLL became an essential metric within this framework, helping to quantify the years lost from premature deaths. This provided a more nuanced measure of mortality's impact on public health (Murray & Lopez, 1996, p. 32). Since then, YLL has been widely adopted in public health research and policy, serving as a standard metric for comparing the burden of various causes of death across different populations.

YLL is closely related to other health indicators, particularly Disability-Adjusted Life Years (DALYs). While YLL focuses exclusively on the impact of premature mortality, DALYs encompass both YLL and Years Lived with Disability (YLD), offering a more thorough assessment of disease burden. However, when analyzing traffic fatalities, YLL is particularly relevant because it emphasizes the loss of potential life years among younger populations, highlighting the severity of premature deaths. Unlike crude mortality rates, YLL accounts for the age distribution of fatalities, making it a more sensitive and informative metric for policymakers aiming to reduce the socio-economic burden of traffic-related deaths (World Health Organization, 2008, p. 28).

2.3. Calculation of YLL

The calculation of Years of Life Lost (YLL) relies on a well-established methodological approach that quantitatively measures the impact of premature mortality. The standard formula for calculating. YLL involves calculating the number of deaths at each specific age and multiplying it by the remaining life expectancy at that age. Mathematically, it is expressed as:

$$YLL = \sum (D_a * L_a)$$

where D_a represents the count of deaths at age a, and L_a denotes the expected life span at age a. This approach allows for the aggregation of years of life lost across different age groups, offering a comprehensive view of the mortality burden (Murray, Quantifying the Burden of Disease: The Technical Basis for Disability-Adjusted Life Years, 1994, p. 428). The simplicity and clarity of this formula have made it a cornerstone in public health metrics, particularly in assessing the burden of traffic fatalities where age-specific mortality data is readily available.

The accuracy of YLL calculations depends on the use of appropriate life expectancy tables, which provide the expected remaining years of life for individuals at different ages. For the YLL metric to truly reflect the local demographic context, it is crucial to use life expectancy tables specific to Algeria. These tables account for the unique socio-economic, health, and environmental factors that influence life expectancy in the country. Utilizing generalized or global life expectancy tables can lead to significant misestimations, either overstating or

understating the true burden of premature mortality (Mathers, Sadana, Salomon, Murray, & Lopez, 2001, p. 21). Therefore, applying Algeria-specific life expectancy data ensures that the YLL calculations are accurate and relevant, thereby enhancing the reliability of the findings and their applicability to local public health strategies (World Health Organization, 2013, p. 53).

2.4. YLL in the Context of Traffic Fatalities

The application of Years of Life Lost (YLL) to traffic fatalities is a crucial aspect of public health analysis, providing insight into the premature mortality caused by road accidents. Unlike general mortality statistics, which only account for the number of deaths, YLL emphasizes the age at which these fatalities occur, thus highlighting the loss of potential years of productive life. Traffic accidents disproportionately affect younger individuals, making YLL a particularly powerful tool in capturing the socio-economic impact of these deaths. For example, a fatality involving a young adult results in a higher YLL compared to an elderly individual, as the remaining life expectancy is significantly greater (Nantulya & Reich, 2002, p. 1220).

Calculating YLL for traffic fatalities involves several unique challenges. One major consideration is the accuracy of age-specific mortality data, which must be detailed and precise to ensure the reliability of the YLL estimates. Additionally, life expectancy tables must be adjusted to reflect the specific conditions of the population under study. In countries like Algeria, where traffic fatalities are a leading cause of death, it is also essential to consider underreporting and the potential discrepancies in mortality data, which can lead to either underestimation or overestimation of YLL (Peden, et al., 2004, p. 17). Moreover, traffic fatalities often involve complex scenarios, such as multiple causes of death and delayed mortality, which can complicate the direct attribution of YLL to road accidents (Bhalla, Naghavi, Shahraz, Bartels, & Murray, 2009, p. 253). Despite these challenges, YLL remains a vital metric for understanding and addressing the burden of traffic fatalities, guiding public health interventions aimed at reducing premature deaths on the roads.

2.5. Demographic and Regional Considerations

Years of Life Lost (YLL) calculations offer significant insights into how traffic fatalities impact different demographic groups, with notable disparities evident across age and sex. Age-specific YLL estimates are particularly revealing as they highlight how premature deaths in younger age groups contribute disproportionately to the total YLL burden. Younger individuals, such as adolescents and young adults, typically have higher remaining life expectancy, leading to a more significant loss of potential years when they die prematurely. This is particularly evident in traffic fatalities, where younger populations are often overrepresented (Peden, et al., 2004, p. 15).

Sex differences also play a crucial role in YLL calculations. Research has demonstrated that males, particularly young men, are more prone to be involved in fatal road accidents compared to females. This increased vulnerability is reflected in higher YLL estimates for males across various age groups. For instance, a study by Hyder and Peden (2005) found that male road traffic fatalities in countries with low- and middle-income economies resulted in significantly higher YLL compared to female deaths, emphasizing the need for targeted interventions (Hyder & Peden, 2005, p. 152).

Regional variations further complicate YLL assessments. Differences in road infrastructure, enforcement of traffic laws, and cultural practices can affect traffic fatality rates and, consequently, the YLL burden. For example, regions with poor road conditions or inadequate traffic safety measures may experience higher YLL due to more severe accidents and fatalities (Mohan & Tiwari, 2000, p. 288). Understanding these demographic and regional considerations is essential for developing effective, targeted strategies to lessen the impact of Road traffic fatalities and address the disparities identified through YLL calculations.

2.6. Strengths and Limitations of the YLL Measure

The Years of Life Lost (YLL) measure offers several strengths, making it a valuable tool for assessing the impact of premature mortality. One significant strength is its ability to quantify the potential loss of life due to premature deaths, thereby providing a comprehensive view of the public health burden. YLL captures the number of deaths and their timing, reflecting the full extent of the impact on a population's health and productivity. This is especially pertinent in the context of road traffic fatalities, where young and productive individuals are often affected, leading to substantial YLL (Murray & Lopez, The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability from Diseases, Injuries, and Risk Factors in 1990 and Projected to 2020, 1996, p. 21). Additionally, YLL allows for comparisons across different causes of death and geographic regions, aiding in prioritizing health interventions (Mathers, Vos, & Stevenson, The Burden of Disease and Injury in Australia, 2002, p. 420).

Despite its strengths, the YLL measure has notable limitations. One key criticism is its reliance on life expectancy tables, which may not accurately reflect different populations' specific demographic and socio-economic conditions. For instance, using generalized life expectancy estimates can introduce biases, particularly in settings where health disparities are significant (Riley & Kessler, 2007, p. 558). Moreover, YLL does not account for the quality of life lost or the economic impact of disability before death, which can be a significant oversight in comprehensive health assessments (Vos, Flaxman, & Naghavi, 2006, p. 29).

In the context of analyzing traffic fatalities in Algeria, YLL remains the most appropriate measure despite its limitations. The ability of YLL to capture the potential loss of life in a population heavily affected by traffic accidents provides a critical perspective on the socio-economic impact of these fatalities. While acknowledging the limitations, such as potential biases in life expectancy estimates, YLL offers a robust framework for quantifying the burden of traffic-related deaths and guiding public health interventions aimed at reducing road traffic mortality (Murray & Lopez, Global Health Statistics: A Compendium of Incidence, Prevalence, and Mortality Estimates for over 200 Conditions, 2012, p. 18). Its comprehensive approach to measuring premature mortality makes it an indispensable tool for this study.

3. Methodology

This section details the methodology used in this study to assess the impact of traffic accidents concerning public health, specifically through the estimation of Years of Life Lost (YLL). The methodology provides a structured approach to understanding how traffic fatalities contribute to the overall burden on society. It includes the study's design, data sources, methods for calculating YLL, statistical analyses, and ethical considerations. By systematically addressing these components, the methodology aims to ensure a comprehensive and accurate assessment

of the consequences of traffic accidents, ultimately supporting efforts to improve road safety and public health interventions.

3.1. Study Design

This research is designed as an observational study to estimate the burden of Years of Life Lost (YLL) attributable to traffic accident fatalities in Algeria. The study analyzes data from the most recent four-year period, spanning from January 1, 2020, to December 31, 2023. By analyzing this specific period, the study seeks to thoroughly evaluate the impact of road traffic accidents on public health in Algeria. The analysis will shed light on the extent to which premature deaths due to traffic accidents contribute to the overall public health burden, offering valuable insights for policymakers, road safety authorities, and healthcare professionals. Through this investigation, we seek to quantify the loss of potential years of life, thereby highlighting the urgent need for effective interventions to mitigate the rising toll of traffic-related fatalities in the country.

3.2. Data Sources

The main data source for this study is the yearly road safety reports prepared by the National Delegation for Road Safety. These reports provide comprehensive data on traffic accidents in Algeria, including the number of fatalities, geographic information (such as the location of each accident), and demographic characteristics of the victims (such as age and sex). The study also relies on annual reports from the National Center for Road Safety and Prevention, which compile detailed records of traffic accidents, including similar data on fatalities, accident locations, and victim demographics. The data was supplemented with demographic information obtained from the National Office of Statistics (NOS) of Algeria. This includes life tables stratified by age and sex for the same period. The life tables provided by the NOS were used to calculate the expected years of life remaining at the age of death, which is essential for computing YLL.

3.3. YLL Calculation

This study calculates the Years of Life Lost (YLL) associated with traffic accident fatalities. To determine the YLL, we used life expectancy data from Algerian life tables, aligning the data according to the year of death, sex, and age group of the individuals. The formula used is:

$$YLL_{(s,a,y)} = D_{(s,a,y)} \times L_{(s,a,y)}$$

In this formula:

- $D_{(s,a,y)}$ denotes the number of deaths resulting from traffic accidents for sex s, age a, and year y.
- $L_{(s,a,y)}$ refers to the standard life expectancy for sex s, age a, and year y, based on Algerian life tables.

The study also considers variables such as the year of death (from 2000 to 2023), age at death (grouped as: <5; 5-9; 10-14; 15-19; 20-24; 25-29; 30-34; 35-39; 40-44; 45-49; ≥ 50), and sex (female or male).

3.4. Statistical Analysis

Initially, the data related to traffic accident fatalities were analyzed using a descriptive statistical approach, including the calculation of frequencies, means, medians, and

interquartile ranges (IQR). The average Years of Life Lost (YLL) per traffic fatality was determined by calculating the total YLL divided by the number of reported traffic-related fatalities.

3.5. Ethical Considerations

This study utilized data from national databases, specifically the National Delegation for Road Safety (NDRS) and the annual reports from the National Center for Road Safety and Prevention (NCRSP), which contain anonymized and aggregated information on traffic fatalities. It is worth noting that these data sources are publicly accessible and do not include any personally identifiable information.

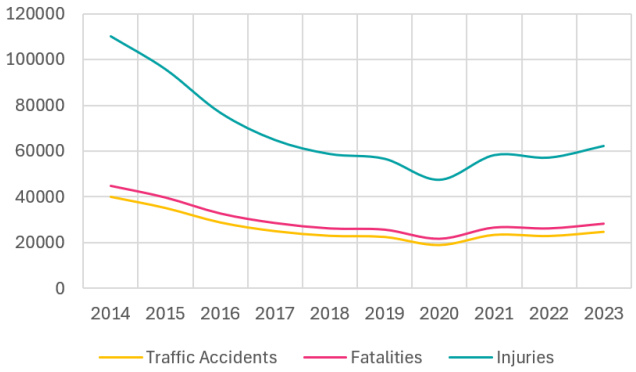
4. Results

This section provides a detailed analysis of the data on traffic fatalities in Algeria, offering insights into their socio-economic impact. It begins with an overview of the descriptive statistics, followed by the estimation of Years of Life Lost (YLL), and concludes with key findings. Each subsection addresses different aspects of the data, highlighting the extent of the burden across various demographic groups and setting the stage for targeted interventions and policy recommendations.

4.1. Descriptive Statistics

Analyzing traffic accident data is essential for assessing the impact of Years of Life Lost (YLL) resulting from road traffic fatalities in Algeria. This section covers data from 2014 to 2023, highlighting key trends and patterns in traffic accidents, fatalities, and injuries. Significant variations and disparities across different regions and time periods are revealed by exploring annual statistics. The analysis addresses the variations in accident rates between urban and non-urban (rural) areas. It assesses how the severity of outcomes has evolved. These insights are crucial for understanding the overall impact of traffic fatalities on YLL. They will provide a foundation for identifying targeted interventions to improve road safety and reduce the associated burden on public health.

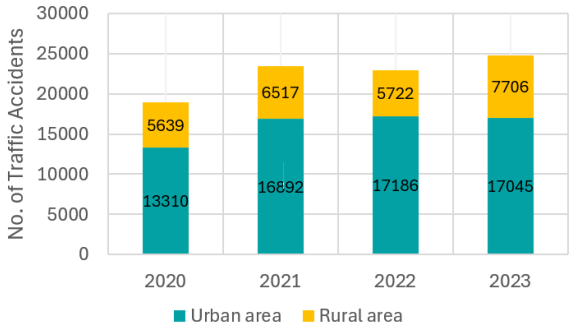
Figure 01: Annual Traffic Accidents, Fatalities, and Injuries in Algeria (2014-2023)



Source: National Center for Road Safety and Prevention. (2017). Statistics of Traffic Accidents in Algeria. Algeria: NCRSP; National Delegation for Road Safety. (2023). Road Safety in Algeria. Algeria: NDRS.

Over the past decade, there have been significant fluctuations in traffic accident statistics in Algeria. Annual traffic accidents varied considerably, peaking at 40,101 incidents in 2014 and declining to 22,751 in 2023. This downward trend signifies a substantial reduction in traffic incidents, though the annual figures remain high. Fatalities have similarly decreased from 4,812 in 2014 to 3,628 in 2023, reflecting an overall improvement in road safety. However, the number of injuries peaked at 65,263 in 2014, shows a less consistent trend. Despite improvements, the continuing high injury figures underscore the need for ongoing safety measures. These statistics provide a foundational understanding of traffic-related challenges and set the stage for a deeper analysis of fatality and injury trends in the following sections.

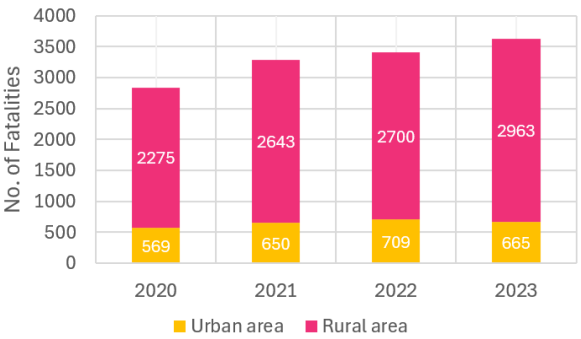
Figure 02: Traffic Accidents in Algeria by Area (2020-2023)



Source: National Delegation for Road Safety. (2023). Road Safety in Algeria, Algeria: NDRS.

A detailed breakdown of traffic accidents by area for 2020 through 2023 reveals that urban areas consistently experience a higher volume of traffic accidents than rural areas. For instance, urban areas reported 13,310 accidents in 2020, increasing to 17,045 in 2023. In contrast, rural areas saw fewer accidents, with 5,639 in 2020 and 7,706 in 2023. This disparity underscores the concentration of traffic incidents in urban settings, likely driven by higher traffic density and infrastructure challenges. The increased number of accidents in urban areas, coupled with a rise in rural accidents over the years, suggests evolving patterns in traffic safety that may require targeted interventions. Understanding these geographic variations is crucial for developing effective traffic management strategies.

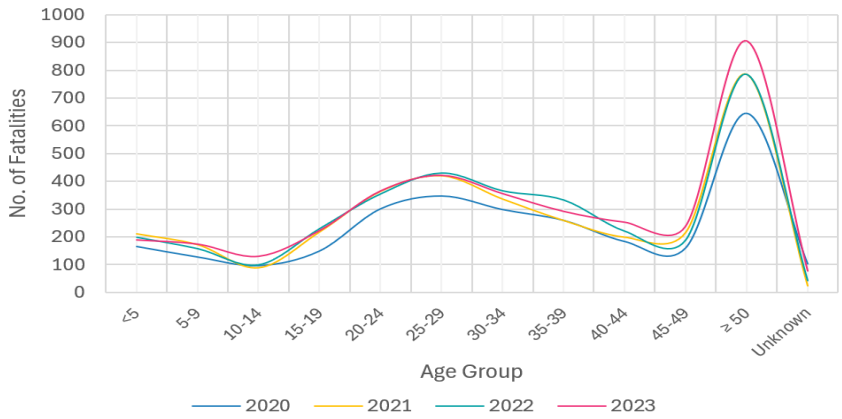
Figure 03: Traffic Accident Fatalities by Area in Algeria (2020-2023)



Source: National Delegation for Road Safety. (2023). Road Safety in Algeria, Algeria: NDRS.

Traffic accident fatalities in Algeria also exhibit a geographic disparity. Urban areas have reported consistently lower fatalities compared to rural areas. In 2020, urban areas accounted for 569 fatalities, while rural areas reported 2,275 fatalities. This trend persisted through 2023, with urban fatalities at 665 and rural fatalities at 2,963. The elevated fatality rates in rural areas may be attributed to factors like less advanced medical facilities, longer response times, or more severe accidents. The increase in fatalities over time, especially in rural areas, underscores the need for focused safety measures and improved emergency response systems. Addressing these disparities is essential for reducing the overall fatality rates and enhancing road safety across all areas.

Figure 04: Traffic Fatalities by Age Group (2020-2023)



Source: National Delegation for Road Safety. (2023). Road Safety in Algeria, Algeria: NDRS.

The data on traffic fatalities by age and sex groups from 2020 to 2023 reveal critical trends across different demographics. Fatalities among males aged 50 and above consistently show a marked increase over the years, reaching their highest levels in 2023. This pattern highlights a critical need for targeted interventions for older male drivers or passengers. Additionally, males in the 25-34 age groups also exhibit relatively high fatality numbers, though with more fluctuation compared to the ≥50 group. In contrast, female fatalities are significantly lower across all age groups, with the highest numbers observed among those aged 50 and above. However, these figures remain much lower than those of their male counterparts. The steady yet lower trend in female fatalities may reflect differences in driving behavior, exposure, or other risk factors. Overall, the data indicate a strong sex disparity in traffic-related deaths, with males, particularly older ones, being at greater risk.

The data provides valuable insights into the patterns and impacts of traffic accidents and fatalities in Algeria. The heightened incidence of accidents and fatalities in both urban and rural areas, alongside fluctuating injury rates, underscores the need for tailored policy interventions. Strategies should focus on addressing the specific challenges faced by urban and rural areas, such as enhancing traffic management in urban settings and improving emergency response in rural regions. Additionally, there is a need for targeted public awareness campaigns and infrastructure improvements to decrease both the incidence of accidents as well as the seriousness of injuries. By leveraging these insights, policymakers and public health officials can develop more effective measures to enhance road safety and reduce the burden of traffic-related incidents.

4.2. YLL Estimates

To estimate Years of Life Lost (YLL), the process begins with determining the midpoint for each age group. The midpoint represents the average age of individuals within that group, and it plays a vital role in accurately calculating YLL. This value is determined by identifying the center of each age range; for instance, 2.5 years is the midpoint for the "<5" age group, and 7 years for the "5-9" age group. These midpoints provide a more precise basis for estimating YLL by allowing comparisons between life expectancy at these points and the midpoint itself. This calculation is consistently applied across all age groups to ensure that each midpoint accurately reflects the average age within the respective demographic. This step is critical in laying a solid foundation for the subsequent calculations.

Following this, the remaining life expectancy for each age group is estimated by subtracting the midpoint age from the life expectancy specific to that year and sex. For example, if the midpoint age for a group is 2.5 years in the "<5" age group and the life expectancy for males in 2023 is 74.89 years, the remaining life expectancy would be calculated as 74.89 minus 2.5, resulting in 72.39 years. This method enables a tailored approach to calculating YLL, reflecting the demographic-specific life expectancies. Finally, YLL for each age group and sex is determined by multiplying the fatalities in each group by the remaining life expectancy. This calculation is performed separately for males and females, providing a comprehensive understanding of how traffic fatalities affect different demographic segments. These steps together produce a clear metric that quantifies the burden of premature death within the population.

Determining the midpoint for certain age groups, such as "≥ 50" or "Unknown," presents additional challenges in YLL calculations. For the "≥ 50" age group, where individuals are 50 years or older, it is crucial to estimate a midpoint that reasonably reflects life expectancy beyond 50 years. In this study, an upper bound was assumed based on general population demographics. For instance, if the life expectancy is approximately 76 years, a midpoint of 65 years may serve as a reasonable estimate. This approach accounts for variations in life expectancy and offers a practical means to calculate YLL for an age group with an open-ended range.

Similarly, when dealing with fatalities in the "Unknown" age group, where the exact ages of the individuals are not recorded, the midpoint can be approximated by analyzing the distribution of known age groups. In this study, the average age at death across all recorded fatalities, particularly those within the most common age ranges, is used to estimate this midpoint. For example, if most fatalities occur within the 20-40 age range, a midpoint of 30 years might be appropriate for the "Unknown" group. This method provides a practical solution for calculating YLL when precise age data is unavailable, ensuring that the impact of these fatalities is still incorporated into the analysis.

To further address the challenge of calculating the midpoint for the "unknown sex and unknown age" group, this study employs a Weighted Average Approach. By analyzing the distribution of fatalities across all known age groups, a weighted average midpoint is derived, reflecting the most frequent age range within the dataset. This approach ensures that the estimated midpoint aligns with overall demographic trends observed in the data. By applying this weighted average midpoint to the "unknown sex and unknown age" group, the study maintains inclusivity and representativeness in the YLL calculations, even when exact

demographic details are unavailable. This method enhances the accuracy of YLL estimation by effectively integrating unknown cases into the broader analysis, thereby capturing the full impact of traffic fatalities on public health.

4.3. Key Findings

The analysis of Years of Life Lost (YLL) resulting from road traffic fatalities in Algeria from 2020 to 2023 provides critical insights into the public health burden posed by traffic accidents. The data reveals significant disparities across different age and sex groups, highlighting the specific vulnerabilities within the population and underscoring the need for targeted interventions.

4.3.1. YLL Among Males

The data indicates a substantial and increasing burden of YLL among males, with the total YLL rising from 84,160.6 years in 2020 to 117,866.9 years in 2023. This upward trend reflects the persistent danger that traffic accidents pose to male lives in Algeria, especially among certain age groups.

Young adult males, particularly those in the 20-34 age range, bear a disproportionately high burden of YLL. The 25-29 age group consistently accounted for the highest YLL throughout the four-year period. In 2020, this group lost 14,134.68 years, which increased to 18,857.3 years in 2022 before a slight decline to 18,293.98 years in 2023. Similarly, the 20-24 age group exhibited a steady increase in YLL, starting at 13,675.75 years in 2020 and reaching 17,718.15 years in 2023.

Table 01: Calculated YLL Males (2020-2023)

Age Group (Years)	2020	2021	2022	2023
<5	6438	10558	8452	8470
5-9	5696	7687	7519	7604
10-14	3882	4452	4580	6163
15-19	7498	10800	11952	11925
20-24	13676	17263	17299	17718
25-29	14135	18033	18857	18294
30-34	10528	13012	13976	14368
35-39	8231	8657	10794	9965
40-44	5054	5890	6319	7433
45-49	3536	4912	4549	5634
≥ 50	3607	5560	6146	7150
Unknown	1878	789	1834	3142
Total	**84161**	**107614**	**112278**	**117867**

Source: Author's calculations

The significant YLL in these age groups can be attributed to several factors, including higher exposure to riskier driving behaviors, such as speeding, alcohol consumption, and less seatbelt use, which are more prevalent among young males. Moreover, this age group often represents economically active individuals engaged in frequent travel, increasing their likelihood of involvement in traffic accidents. The high YLL in these groups also implies a considerable

loss of potential future contributions to society and the economy, emphasizing the need for targeted road safety campaigns focused on young drivers.

Another notable trend is the increasing YLL among males aged 50 and above. This age group saw a significant rise in YLL from 3,607.28 years in 2020 to 7,150.47 years in 2023. This nearly doubling of YLL in older males suggests a growing vulnerability in this demographic, which may be linked to factors such as slower reaction times, potential health issues that could impair driving, and the severity of injuries sustained in accidents at an older age.

The rise in YLL among older males also highlights the importance of addressing the specific needs of aging drivers. Initiatives such as regular health check-ups, promoting the use of assistive driving technologies, and ensuring safer vehicle designs could help mitigate the risks faced by older drivers. Additionally, road safety programs tailored to the needs of older adults, including refresher driving courses and public awareness campaigns, could play a crucial role in reducing YLL in this age group.

While the 20-34 and ≥50 age groups exhibit the highest YLL, other age groups also show significant contributions to the overall YLL burden. For instance, the 35-39 age group saw an increase in YLL from 8,231.01 years in 2020 to 9,965.07 years in 2023, indicating a notable risk for individuals in their late 30s. The 40-44 age group also experienced a rise in YLL, particularly in 2023, with a total of 7,433.14 years lost, suggesting an emerging risk that warrants further investigation.

The "Unknown" age category also saw fluctuations, with YLL increasing notably from 789.12 years in 2021 to 3,142.3 years in 2023. This increase may indicate issues with data collection or reporting but could also point to a broader trend of unidentified victims or underreported age data. Addressing these discrepancies is essential for ensuring accurate and comprehensive public health strategies.

4.3.2. YLL Among Females

The YLL data for females, while significantly lower than for males, still shows a concerning trend of increase over the analyzed period. The total YLL for females rose from 18,845.58 years in 2020 to 23,591.71 years in 2023, highlighting the growing impact of traffic fatalities on women in Algeria.

Table 02: Calculated YLL Females (2020-2023)

Age Group (Years)	2020	2021	2022	2023
<5	5288	4671	6157	5414
5-9	2718	3970	3318	4383
10-14	2014	1099	1771	2102
15-19	753	1670	1394	1032
20-24	1429	1694	1501	1726
25-29	1534	1738	1771	2028
30-34	1460	1116	1778	959
35-39	873	952	1908	1180
40-44	461	485	997	964
45-49	503	978	765	1136
≥ 50	1093	1817	1939	2335
Unknown	719	280	95	334
Total	18846	20471	23392	23592

Source: Author's calculations

The most striking finding among females is the consistently high YLL in the <5 age group. This group saw a peak YLL of 6,157.38 years in 2022, which slightly decreased to 5,413.68 years in 2023. The high YLL in this very young age group is alarming, as it suggests that infants and toddlers are highly vulnerable to traffic-related fatalities, possibly as passengers in vehicles involved in accidents or due to inadequate child safety measures.

This finding underscores the urgent need for enhanced child safety regulations, including the mandatory use of car seats and booster seats, stricter enforcement of traffic laws related to child passengers, and public awareness campaigns focused on protecting the youngest and most vulnerable road users. Moreover, improving the overall safety of vehicles and road environments could significantly reduce the YLL in this age group.

The 25-29 age group among females also showed an increasing YLL trend, with a rise from 1,534.08 years in 2020 to 2,027.6 years in 2023. Although the absolute numbers are lower than those for males within the same age bracket, the upward trend indicates that young adult females are also at considerable risk, likely due to similar factors affecting young males, such as higher exposure to traffic and potentially riskier behaviors.

The YLL among females aged 50 and above similarly increased from 1,093.4 years in 2020 to 2,334.96 years in 2023. This doubling of YLL in older females parallels the trend observed in older males, indicating a broader demographic shift where older adults, regardless of sex, are becoming more vulnerable to fatal traffic incidents. This could be due to similar factors, including age-related physical decline, slower reaction times, and the severity of injuries in accidents involving older individuals.

Overall, the YLL data for females also reveals a substantial sex disparity in traffic-related deaths. While male YLL is consistently higher across all age groups, the increasing YLL among females, particularly in specific age groups, highlights the need for sex-sensitive road safety interventions. These could include campaigns tailored to female drivers and passengers, promoting safer driving habits, and addressing specific risks women face on the road.

The findings from this YLL analysis provide crucial evidence for policymakers and public health officials in Algeria. The high YLL among young adult males and very young females points to a significant loss of potential years of life, with broader socio-economic implications. These demographic groups represent critical segments of the population, with young adults contributing to the workforce and the economy, while very young children represent the future potential of society.

Addressing the high YLL in these groups requires a multifaceted approach that includes more rigorous enforcement of traffic regulations, enhanced road infrastructure, and focused public awareness initiatives. Additionally, the rising YLL among older adults suggests that interventions must also focus on the aging population, ensuring that road safety measures are inclusive of all age groups.

The sex disparity observed in the YLL data further emphasizes the need for sex-specific strategies in road safety programs. By tailoring interventions to the specific risks and needs of both men and women, public health efforts can be more effective in reducing the overall burden of traffic fatalities.

In conclusion, the analysis of YLL due to traffic fatalities in Algeria from 2020 to 2023 reveals critical trends that demand targeted public health interventions. The data underscores the importance of continued efforts to improve road safety, reduce traffic accidents, and ultimately decrease the YLL associated with traffic fatalities. By addressing the specific needs of vulnerable demographic groups, policymakers can work towards a safer and healthier society for all Algerians.

5. Discussion

The results of this study, which examined the Years of Life Lost (YLL) due to traffic fatalities in Algeria from 2020 to 2023, offer valuable insights into the impact of traffic accidents on public health. By analyzing YLL across different age and sex groups, we have highlighted key demographic vulnerabilities and identified critical areas where interventions can significantly reduce mortality rates. This discussion will provide a detailed interpretation of the results, explore the policy implications for Algeria's road safety strategies, and acknowledge the limitations of the study.

The YLL metric is a powerful tool that not only quantifies the number of deaths but also captures the extent of premature mortality by assessing the years of life that could have been lost. The findings of this study underscore the uneven distribution of traffic fatalities across the population, with certain groups, particularly young adults and males, bearing a disproportionately high burden.

One of the most significant findings is the pronounced sex disparity in YLL, with males consistently showing higher YLL across all age groups. For instance, in 2023, males accounted for a total YLL of 117,866.9 years compared to 23,591.71 years for females. This trend mirrors global patterns, where males are more prone to engaging in hazardous driving behaviors, like speeding, aggressive driving, and non-compliance with seat belt use. Additionally, males' higher exposure to traffic risks due to work-related travel further exacerbates this disparity. These behaviors contribute significantly to the elevated YLL observed among males, particularly in the 20-34 age group, which experiences the highest YLL burden.

Conversely, the lower YLL observed in females suggests more cautious driving behaviors and less exposure to high-risk driving environments. However, the rising YLL among females in certain age groups, such as <5 and 25-29, signals that female road users are increasingly vulnerable to traffic-related risks. This trend emphasizes the need for sex-sensitive road safety measures to mitigate these emerging risks.

Another critical finding is the substantial YLL observed among young adults, particularly males aged 20-34. This demographic is highly mobile, economically active, and more inclined to engage in risk-taking behaviors. The 25-29 age group, for example, exhibited a peak YLL of 18,857.3 years in 2022, marking it as the most vulnerable demographic. The high YLL in this age range has profound socio-economic implications, as these individuals are often in the prime of their working lives. The loss of such a significant number of years impacts not only the affected families but also the broader economy due to lost productivity.

In parallel, the youngest age group (<5) also demonstrated a notable YLL, particularly among females, with 5,413.68 years lost in 2023. This finding highlights the vulnerability of children as passengers in vehicles or pedestrians in traffic environments. These results underscore the critical need for enhanced child protection measures, including stricter enforcement of car seat laws and child pedestrian safety programs.

The study also reveals an increasing YLL among older adults (≥50), indicating an emerging trend where older individuals are becoming more susceptible to traffic-related fatalities. The rise in YLL from 3,607.28 years in 2020 to 7,150.47 years in 2023 for males in this age group suggests that age-related factors such as declining cognitive and motor skills, as well as the increased frailty of the elderly, may contribute to higher fatality rates. This trend calls for tailored interventions for aging drivers, such as mandatory health checks, promotion of vehicle safety features that support older adults, and refresher driving courses. Improving road infrastructure, such as better lighting and clearer signage, could also enhance the safety of older road users.

The implications of these findings for road safety policy in Algeria are significant. The high YLL in specific age groups and the observed sex disparity necessitate a more focused and strategic approach for implementing road safety measures. For instance, the high YLL among males aged 20-34 highlights the urgent need for road safety campaigns specifically targeting young male drivers. These campaigns should focus on changing risky driving behaviors like speeding, reckless driving, and driving under the influence of alcohol consumption. Additionally, stricter enforcement of traffic laws, including speed limits and seatbelt usage, is critical in reducing the high fatality rates in this demographic.

The significant YLL in the <5 age group calls for stronger child safety initiatives. These could include stricter regulations on the implementation of car seats and booster seats for children, public education campaigns targeting parents and caregivers, and increased enforcement of child passenger safety laws. Moreover, urban planning and road design should prioritize child safety, particularly in areas with high pedestrian traffic involving children, such as near schools and playgrounds.

The rising YLL among older adults further underscores the need for policies aimed at protecting aging drivers and pedestrians. Such policies could include mandatory health checks for drivers above a certain age, promoting the use of vehicles equipped with advanced safety

features, and encouraging older adults to participate in refresher driving courses. In addition, road infrastructure improvements, such as better lighting and clearer signage, can make the road environment safer for older road users.

While males are disproportionately affected by traffic fatalities, the increasing YLL among females signals the necessity for sex-sensitive road safety policies. These could include campaigns that address the specific risks faced by female drivers and passengers, as well as efforts to increase women's participation in road safety decision-making processes.

Moreover, the fluctuations in the "Unknown" age category suggest gaps in data collection and reporting, which could hinder the effectiveness of road safety interventions. Enhancing the accuracy of road traffic fatality data is essential for designing effective interventions. This could involve better training for traffic police and health professionals on data collection, as well as the integration of advanced technologies, such as automated reporting systems, to ensure more comprehensive data coverage.

While this study offers important insights, it's essential to recognize several limitations. To begin with, relying solely on YLL as a metric captures the socio-economic impact of premature deaths but overlooks non-fatal injuries which also contribute significantly to the public health burden from road traffic accidents. Future research should consider including Years Lived with Disability (YLD) for a more comprehensive understanding of the broader impact of road traffic injuries.

Another limitation is the use of aggregated data, which may obscure regional variations in traffic fatality rates. Given Algeria's vast and diverse landscape, regional differences in traffic conditions, road infrastructure, and enforcement of traffic laws are significant. Conducting a more detailed regional analysis of YLL could pinpoint specific areas needing targeted interventions.

Furthermore, this study depends on reported traffic fatalities, which might not fully capture the true death toll. Underreporting remains a common challenge, especially in countries with low- and middle-income economies where data collection systems may lack robustness. Enhancing the precision and reliability of traffic fatality data is crucial for crafting effective road safety policies.

Lastly, while this study highlights gender and age-specific vulnerabilities, it does not explore other potential risk factors, such as socio-economic status, education level, or access to healthcare, which could further elucidate the underlying causes of traffic fatalities. Future research should address these factors to offer a fuller picture of the determinants of traffic-related mortality.

6. Conclusion

This research thoroughly examines the burden of traffic fatalities in Algeria by utilizing the Years of Life Lost (YLL) metric, thereby highlighting the significant public health and socio-economic impact of road traffic accidents. By focusing on the period from 2020 to 2023, the research highlights critical demographic vulnerabilities, with a particular emphasis on age and sex disparities. The findings underscore the urgency for targeted road safety interventions, and this conclusion synthesizes the key insights, policy implications, and avenues for future research.

The analysis reveals that YLL, as a metric, offers a more nuanced understanding of the impact of traffic fatalities compared to mere mortality counts. While mortality statistics enumerate the number of deaths, YLL quantifies the extent of premature mortality, providing a more comprehensive view of the loss experienced by society. The study's findings indicate that traffic fatalities in Algeria disproportionately affect certain groups, particularly young adults and males. This demographic pattern aligns with global trends, yet the specific context of Algeria presents unique challenges that require tailored policy responses.

One of the most significant findings of this study is the pronounced sex disparity in YLL. Males consistently exhibit higher YLL across all age groups, with the 20-34 age group being the most affected. This pattern is reflective of higher risk-taking behaviors among males, including speeding, aggressive driving, and non-compliance with traffic safety measures such as seat belt use. The socio-economic implications of these findings are profound, as the high YLL among young adult males, who are often in the prime of their productive lives, translates to a considerable loss of potential human capital. This loss not only affects the immediate families but also has broader economic repercussions, including reduced workforce productivity and increased social costs.

Conversely, the lower YLL observed in females suggests that women engage in more cautious driving behaviors and are less exposed to high-risk driving environments. However, the rising YLL among females in certain age groups, such as <5 and 25-29, indicates that female road users are not immune to traffic-related risks. This trend calls for a more sex-sensitive approach to road safety, one that recognizes the specific risks faced by female drivers and passengers and seeks to address them through targeted interventions.

The study also emphasizes the vulnerability of children and older adults to traffic-related fatalities. The significant YLL observed among the youngest age group (<5) underscores the urgent need for enhanced child protection measures, including stricter enforcement of car seat laws and pedestrian safety programs. Meanwhile, the increasing YLL among older adults (≥50) highlights that age-related factors, such as declining cognitive and motor skills, contribute to greater vulnerability. Tailored interventions for these age groups, such as regular health checks for aging drivers and infrastructure improvements that accommodate elderly pedestrians, are essential to mitigate these risks.

The implications of these findings for road safety policy in Algeria are evident. The high YLL among specific age groups, particularly young adult males and the elderly, calls to achieve a more strategic and targeted road safety plan. Public education campaigns, more rigorous enforcement of traffic regulations, and enhancements to road infrastructure are all critical elements of a comprehensive road safety strategy. Additionally, the gender disparity observed in YLL highlights the necessity of incorporating gender-sensitive measures in road safety policies, ensuring that both men and women benefit from protective interventions.

While this study provides valuable insights into the burden of traffic fatalities in Algeria, it is important to acknowledge its limitations. The use of YLL as a metric, though powerful, does not fully capture the impact of road traffic accidents, particularly non-fatal injuries that significantly contribute to the public health burden. Future research should consider incorporating complementary metrics, such as Years Lived with Disability (YLD), to offer a more holistic perspective on the consequences of traffic accidents.

Moreover, the study relies on aggregated data, which may obscure regional variations in traffic fatality rates. Algeria is a diverse country with varying traffic conditions, road infrastructure, and law enforcement practices across its regions. A more detailed analysis that accounts for regional differences could yield critical insights for designing effective, localized interventions.

Furthermore, the study's dependence on reported traffic fatalities may result in an underestimation of the true burden of road traffic accidents. Underreporting is a well-known issue, especially in countries with low- and middle-income economies where data collection systems may be less robust. Enhancing the accuracy and reliability of traffic fatality data is essential for informing effective policy decisions.

Finally, while this study focuses on age and gender disparities, it does not explore other potential risk factors, such as socio-economic status, education level, or access to healthcare. These factors could provide additional insight into the underlying causes of traffic fatalities and help identify populations that are particularly vulnerable. Future research should consider these dimensions to develop a more comprehensive understanding of traffic-related mortality.

In conclusion, this study highlights the importance of utilizing YLL as a metric to assess the burden of traffic fatalities in Algeria. The findings underscore the need for targeted interventions to address the specific vulnerabilities of different demographic groups, particularly young adult males, children, and the elderly. The study also advocates for the inclusion of gender-sensitive measures in road safety policies and emphasizes the importance of improving data collection and reporting systems. By addressing these challenges, Algeria can develop more effective road safety measures that mitigate the burden of traffic fatalities and contribute to a safer, healthier society.

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