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Review of global burden of disease studies: trends, challenges, and future directions

Oche Joseph Otorkpa[1], Chinenye Oche Otorkpa[2], Stephen Emmanuel[3], Abiodun Paul Olaiya[1], Helen Shnada Auta[4], Ebenezer Obi Daniel[5], Onifade Adefunmilola Adebola[6], Paul Isaac Ojodale[7]
[1]Department of Public Health, School of Public Health, Texila American University, Georgetown, Guyana
[2]Department of Physiology, College of Health Sciences, Federal University Lokoja, Lokoja, Nigeria
[3]Department of Biological Sciences, Faculty of Science, Taraba State University, Jalingo, Nigeria
[4]Department of Microbiology, School of Life Sciences, Federal University of Technology, Minna, Nigeria
[5]School of Health and Social Care, Faculty of Medicine, Health and Life Science, Swansea University, Swansea, United Kingdom
[6]Department of Family Medicine, Federal University Teaching Hospital, Lokoja, Nigeria
[7]Department of Microbiology, Faculty of Natural and Applied Sciences, Baze University, Abuja, Nigeria

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ABSTRACT

Global burden of disease (GBD) studies plays an important role in assessing the variability of risk factors, injuries, and diseases worldwide, providing essential evidence for policy-making and healthcare planning. This study presents a review of current literature on GBD studies, aiming to analyze the trends, challenges, and future directions in this field. We conducted a review of published GBD studies from inception to date, utilizing major scientific databases and relevant sources. Our findings reveal several noteworthy trends in GBD studies. Over the years, GBD studies have expanded to cover a wider range of diseases and risk factors, providing a more comprehensive understanding of global health. Advances in data availability, technology, and modeling techniques have improved the accuracy of disease burden estimates. The inclusion of disability-adjusted life years (DALYs) has enabled comparisons as well as prioritization of interventions. However, challenges remain, such as limited data in middle and low-income countries and methodological complexities. The COVID-19 pandemic has emphasized the need for responsive methodologies. Future directions include strengthening data collection, utilizing machine learning, big data analytics, ethical use of artificial intelligence and promoting collaboration for consistent GBD studies.

Corresponding Author:

Oche Joseph Otorkpa
Department of Public Health, School of Public Health, Texila American University
Georgetown, Guyana
Email: drochejoseph@gmail.com

1. INTRODUCTION

Global burden of disease (GBD) studies have become the cornerstone of public health research, providing valuable insights into the distribution, causes, and impact of diseases and injuries on a global scale [1], [2]. These studies play an important role in informing healthcare policies, resource allocation, and priority setting, thereby aiding governments, organizations, and researchers in addressing the health challenges faced by populations worldwide [3]. The first study was carried out in the early 1990s, this landmark effort in global health research was published in 1996 [4]. The first GBD study was a collaborative effort which involved the World Health Organization (WHO), the World Bank, the Harvard School of Public Health and several other academic and research institutions, since then many studies have followed [5], [6]. The most recent study titled GBD 2019 was published in The Lancet in October 2020 [7].

GBD Studies have faced criticisms as a result of growing concerns about reliability and completeness of data sources, limitations when it comes to accurately quantifying certain health conditions, bias in data collection and modeling, and the difficulty in accounting for complex social and environmental factors that influence health outcomes [8]. These concerns has led to debates over the accuracy and comparability estimates from GBD studies and questions about the methodologies used to attribute disease burdens and the effectiveness of interventions.

The objective of this review is to analyze the trends, challenges, and future directions of GBD studies. This review aims to provide a good understanding of the methodological advancements, data sources, limitations as well as important findings from GBD studies conducted over the past few decades. By critically evaluating the strengths as well as the weaknesses of GBD studies, this review seeks to identify the challenges faced by researchers and propose potential strategies to address these limitations. Furthermore, it explores emerging trends and future directions for GBD studies, including the incorporation of new technologies, improved data collection methods, and enhanced collaboration across disciplines.

2. METHOD

In this review article, a current understanding of trends, challenges, and future prospects of global burden of disease studies presented. Relevant search terms like "global burden of disease" or "global disease trends" and "global burden of disease studies", were used as search terms in Google Scholar, PubMed, Web of Science, and Scopus. The vast majority of citations originate from studies published within the last ten years.

2.1. Inclusion criteria

The review adopted PRISMA guidelines as shown in Figure 1 as the main criteria for identifying, screening, and selecting primary articles. The inclusion criteria employed for determining the selection of studies for the review were as: i) articles published in English and subjected to peer review; ii) relevant title; iii) research that focused on exploring the methodological challenges in GBD estimation, such as data quality, standardization, uncertainty quantification, and other sources of potential bias or limitations; iv) studies that employ rigorous and reliable methodologies for estimating disease burden, risk factors, and their impact on population health.

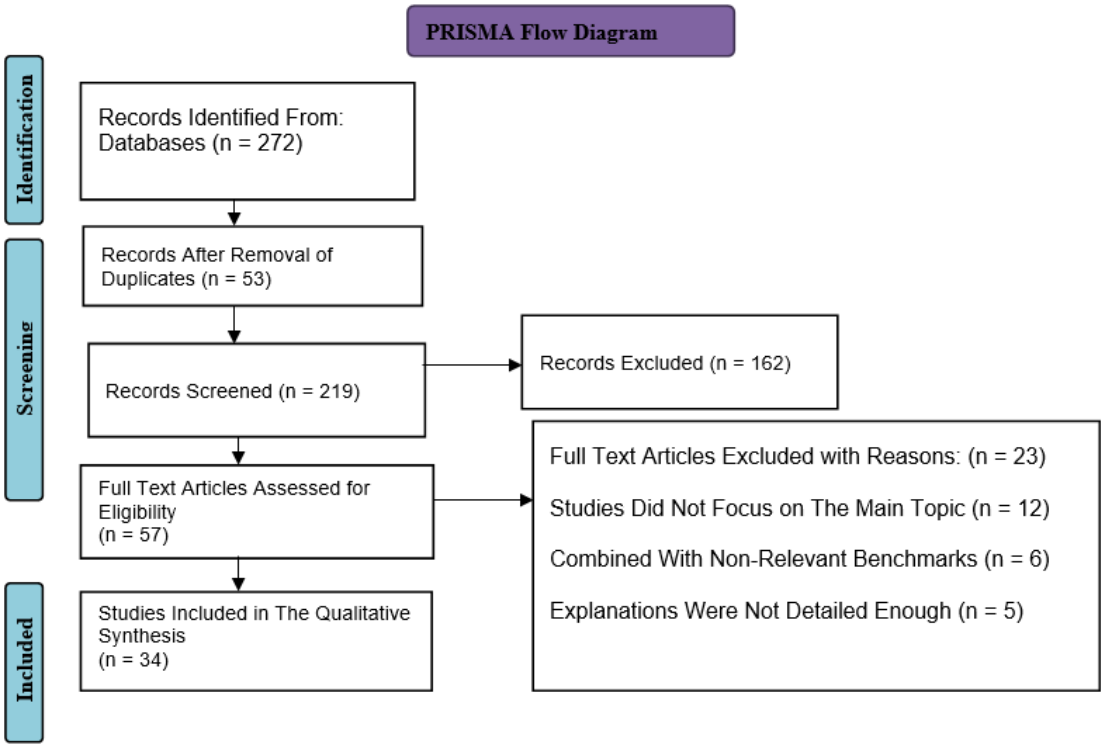

Figure 1. PRISMA flow diagram

3. RESULTS AND DISCUSSION

GBD studies are of paramount importance in understanding the health challenges faced by populations globally and formulating effective public health interventions [9]. By providing comprehensive and comparable estimates of disease burden, GBD studies enable policymakers to prioritize health issues, allocate resources efficiently, and design evidence-based strategies that will help reduce the burden of injuries and diseases. The recent COVID-19 pandemic has also demonstrated unequivocally that swift assessment of basic disease burden indicators like incidence, mortality, and case fatality ratio is exceedingly challenging when dealing with a novel disease [10].

These studies also serve as a valuable tool for monitoring progress towards global health goals, such as the Sustainable Development Goals (SDGs). By analyzing vast amounts of data from multiple sources, including surveys, registries, and health records, the GBD generates estimates and metrics that enable policymakers, researchers, and organizations to understand the distribution and trends of diseases and their impact on populations. This enables stakeholders to identify priority areas for intervention, allocate resources effectively, and track progress towards achieving the SDGs [11].

3.1. Methodological advancements in GBD studies

Over the years, GBD studies have undergone significant methodological advancements to enhance the accuracy and comprehensiveness of disease burden estimates as shown in Table 1. Several studies have highlighted significant methodological considerations and obstacles that are important when computing burden of disease measurements. Meanwhile, individual countries have devised their own approaches to data utilization and the application of statistical methods in generating estimates of disease burden. Nevertheless, the absence of fair capacity development and standardization of methodologies continues to pose a challenge [12].

One of the main advancements in GBD studies is the introduction of disability-adjusted life years (DALYs) as a metric, DALYs for a particular cause are calculated as the sum of the years of life lost as a result of premature mortality (YLLs) caused by that specific factor with the years of healthy life lost on account of disability (YLDs) experienced by individuals living in suboptimal health states resulting from the same cause. YLLs for a cause are estimated by multiplying the total deaths attributable to that cause by a loss function that quantifies the years of life-lost at the age which death happens [13]. DALY metric offers several advantages when measuring the burden of diseases and injuries on a population. It provides an indepth assessment by combining years of life lost as a result of premature mortality and the number of years lived with disability. This integrated approach provides a broader insight of the overall health impact and enables policymakers and researchers to prioritize interventions and allocate resources based on the proportional impact of different diseases and conditions. Futhermore, DALYs provide a standardized measure which enables comparison across different diseases, injuries, or risk factors. By quantifying the burden in a common metric, policymakers can identify the major contributors to disease burden in a given population, target specific areas for intervention, and allocate resources effectively to maximize health outcomes. In addition, DALYs consider the age at which health loss occurs, enabling time-based analysis and highlighting disparities in health outcomes among different population groups. This helps policymakers address health inequities and make informed decisions regarding interventions and policy strategies. The DALY metric thus serves as an important tool for population health planning, resource allocation, and communicating health information to a broader spectrum of stakeholders [14].

The use of systematic reviews and meta-analysis to synthesize available data, and the incorporation of uncertainty analysis to account for the inherent limitations in data sources is also another significant development in this field. One of the study analysed concluded that overcoming “error” variation as a result of the use of low-quality data and different methodologies should be prioritized in burden of disease studies [15]. While others reported that there is a limited number of published systematic reviews on the subject matter in addition to an imbalance in their coverage across various diseases and aspects of healthcare [16]. Furthermore, disease modeling techniques have evolved to incorporate the dynamic nature of diseases over time. Time-series models, like the autoregressive integrated moving average (ARIMA) model, have been employed to analyze historical data and predict disease burden. These models provides information on seasonality, trends as well as other temporal patterns, which allows for more accurate predictions and estimations of disease burden in the future [17].

By combining advanced statistical methods and the integration of diverse data sources, disease modeling methods have played a significant role in enhancing the accuracy as well as the reliability of GBD estimates. These advancements have also contributed to an improved assessment of the global health landscape and have enabled policymakers and healthcare professionals to make informed decisions that will help to address disease burdens effectively. However, there are still limitations when it comes to translating advances in disease modeling techniques into clinical practice [18].

3.2. Data sources for GBD studies

GBD studies depend on a wide range of data sources to provide a true reflection of the burden of diseases and injuries. These sources include vital registration systems that contain births, deaths, and causes of death, disease surveillance systems that monitor specific diseases, health surveys that provide information on disease prevalence and risk factors, census data for population estimates, health facility data for assessing disease burdens and treatment outcomes as well as disease registries that focus on specific diseases [19]. High-quality cause-of-death registration data continues to remain the gold standard for estimating deaths [20]. The integration of multiple data sources has enabled researchers to overcome limitations associated with individual datasets and obtain a comprehensive understanding of the global disease burden [21].

3.3. Limitations and challenges in GBD studies

Despite their significant contributions to public health research, GBD studies face several limitations and challenges. These include data quality, availability issues and utilization of GBD data in arriving at decisions on resource allocation. This limitation has generated controversies, while some studies have employed GBD data to assert that global health funding does not correspond adequately with the GBD. Others disagree with the underlying assumptions shared by these studies, given that resource allocation entails challenging trade-offs among various, potentially conflicting objectives and as a result, any perceived "misalignment" between resource allocation and disease burdens does not necessarily imply that the allocation of funds neglects the needs or interests of recipient countries [22].

Other limitations that has bedeviled these studies are the issues of heterogeneity, comparability challenges associated with different data sources, variations in disease classification and diagnostic criteria, handling of missing data and uncertainty, and the need to incorporate social determinants of health [23]–[25]. Addressing these limitations is crucial to ensure the accuracy and reliability of GBD estimates and to provide policymakers with robust evidence for informed decision-making.

3.4. Key findings from GBD studies

GBD studies have yielded crucial insights into the global burden of diseases and injuries. They have provided evidence on the leading causes of morbidity and mortality, one study reported that the top five level 3 causes of death globally in people aged ≥70 in 2019 were stroke, ischaemic heart disease and chronic obstructive pulmonary disease [26]. Other studies have utilized data from GBD studies to identify the various factors contributing to disease burden, and highlighted health disparities across regions and populations [27]. Some key findings from GBD studies include the shifting patterns of disease burden, with non-communicable diseases (NCDs) gaining prominence [28]. According to GBD 2019, the global impact of smoking tobacco was significant, resulting in approximately 7.69 million deaths (with a range of 7.16 to 8.20 million) and causing a loss of approximately 200 million disability-adjusted life-years. In addition, smoking also remained the primary cause of death among males, accounting for 20.2% (with a range of 19.3% to 21.1%) of male fatalities [29], [30].

Another significant finding is the impact of injuries on the global disease burden. Injuries, whether they result from accidents, violence, or self-harm, have substantial impacts on individuals, families, and communities worldwide [31]. Most studies listed injuries as a growing contributor to the burden of disease globally and among the major challenges for public health in this century [32].

In addition, findings from the global health studies have provided insights into the contribution of mental health disorders, and communicable diseases to the burden of disease in different regions of the world. In 2019, mental disorders were reported to be responsible for an estimated 418 million DALYs, comprising approximately 16% of global DALYs. This represents a significant three-fold rise compared to previous estimates. The economic impact of this burden is estimated to be around USD 5 trillion. When analyzed regionally, these losses could range from 4% of gross domestic product in Eastern sub-Saharan Africa to 8% in high-income North America [33]. Furthermore, findings have also revealed that infectious diseases of poverty disproportionately affect the poorer countries and populations across the globe, perpetuating a vicious cycle of poverty as a result of reduced productivity caused by prolonged illness, associated disability, and social stigma associated with some conditions [34].

3.5. Addressing challenges in GBD studies

To address the challenges faced by GBD studies, several strategies can be employed. Improving data quality and availability through enhanced surveillance systems, standardized data collection tools, and investments in data infrastructure is critical [35]. Efforts to enhance comparability and standardization of data across different sources and countries as well as the sharing of knowledge and expertise through the engagement of researchers in burden of disease networks (BODNs) are essential for generating accurate and comparable estimates [36]. In addition, advancing disease modeling techniques, including the use of quicker and advanced statistical methods and machine learning algorithms, can improve the precision of burden

estimates [37], [38]. Moreover, the incorporation of social determinants of health, such as socioeconomic status, education, and environmental factors, provides a good understanding of disease burdens and its determinants [39].

3.6. Emerging trends and future directions

Public health policymakers encounter progressively intricate choices, in the management of a growing volume of data and information [40], [41]. As technology advances, GBD studies are poised to benefit from emerging trends and technological advancements. Integration of artificial intelligence (AI) and machine learning algorithms can streamline data analysis, improve disease modeling, health management and enhance the accuracy of burden estimates [42], [43]. Stakeholders have opined that responsibly and ethically leveraging on AI can help reduce global disease burden and improve population health-outcomes [44]–[46]. Big data analytics and the use of novel data sources, such as social media data and wearable devices, hold promise in capturing real-time health information and providing timely updates on disease burden [47]. The integration of geospatial data and remote sensing techniques can enable a more nuanced understanding of the spatial distribution of diseases and their determinants [48], [49]. In addition, fostering interdisciplinary collaborations and engaging stakeholders from various sectors can promote a holistic approach to GBD studies, facilitating the translation of findings into effective policies [49]–[51].

Future GBD studies may undergo significant transformations, moving from known traditional methods, largely due to the integration of artificial intelligence. AI has the potential to revolutionize the way data is collected, processed, and analyzed, enabling more efficient and accurate assessments of disease burdens and health trends [52], [53]. With AI-powered algorithms, GBD studies can process vast amounts of data from diverse sources, including real-time health records, genetic information, environmental factors, and social determinants of health. This convergence of advanced technology and comprehensive data could lead to a broader understanding of global health challenges and eliminate the recurrent reports and complaints about data quality and gaps in middle and low-income countries [54], [55], which raise doubts about the credibility and reliability findings and result in the formulation of more targeted and effective public health policies and interventions.

Table 1. Showing summary of strengths and weaknesses of GBD studies

GBD study	Strengths	Weaknesses
GBD 1990	Spawned multiple disease burden studies and serves as the baseline for comparisons. Brought global attention to hidden and neglected health problems	Limited information on data and methodology employed
GBD 2001	Introduced a new framework for risk factor assessment as well as the focus on individual countries as the basic unit of analysis	Lack of consistency with GBD 1990
GBD 2010	Enhanced data and broadened scope using improved methods for estimating disability weights	Challenges in data quality and gaps especially in middle- and low-income-income countries raising doubts about the credibility and reliability of findings
GBD 2013	Methodological improvements including switching from incidence to prevalence-based DALYs Systematic compilation of the burden attributed to 5 tiers of risk factors.	Data variations and gaps that fail to provide intuitively appealing means of comparing across health conditions.
GBD 2015	Expanded data sources, refined estimate methods, and introduced the socio-demographic index (SDI) Introduced new transparency about the evidence supporting causal links for each risk-outcome pair	Data Quality Issues and Uncertainties In many countries, data sources for the estimation of cancer burden were sparse, and estimates relied mainly on covariate selection in the models and regional patterns
GBD 2017	Improved collaboration and introduced a new set of population estimates, which led to substantial changes in mortality estimates in many countries.	Complex modeling, methodological changes in the measurement of deaths, years of life lost, years lived with disability, disability-adjusted life years, prevalence, incidence, life expectancy, probability of death, and healthy life
GBD 2019	Utilized a vast selection of epidemiological models and incorporated systematic reviews, data from census, surveys, and registries to calculate DALYs.	Challenges in estimating non-fatal outcomes Insufficient primary data and certain modeling methodologies that rely on estimated models rather than actual observed data.

4. CONCLUSION

In conclusion, GBD studies provide valuable insights into the trends, challenges, and future directions of this critical area of research. GBD studies play a pivotal role in understanding the global burden of diseases and injuries, informing policy decisions, and monitoring progress towards health-related goals. While GBD studies have made significant advancements in methodology and data sources, challenges remain

in data quality, comparability, and incorporating social determinants of health. Addressing these challenges and embracing emerging trends and technologies such as the ethical usage of artificial intelligence will further enhance the accuracy and relevance of GBD estimates. By continually improving the methodology, data sources, and interdisciplinary collaboration, GBD studies can continue to serve as a vital tool for evidence-based decision-making and improving global public health.

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BIOGRAPHIES OF AUTHORS

Oche Joseph Otorkpa is a Public Health specialist and Fellow of the Royal Society for Public Health, he Holds, a PhD in Public Health and his primary research area revolves around the fields of health policy, disease surveillance systems. He can be contacted at email: drochejoseph@gmail.com.

Chinenye Oche Otorkpa is the Director of Health Services and adjunct lecturer at the College of Health sciences at the Federal University Lokoja, she is a consultant family physician and researcher specializing in the field of non-communicable diseases (NCDs). She holds a Masters degree in International Public Health. She can be contacted at email: chinenye.otorkpa@fulokoja.edu.ng.

Stephen Emmanuel is a senior Lecturer in the Department of Biological Sciences, Taraba State University, He holds a PhD in Microbiology with strong interest in Pollution Control and Environmental Health. He can be contacted at email: psychsea07@gmail.com.

Abiodun Paul Olaiya is a visiting professor in the department of Public Health at Texila American University, Georgetown Guyana. He holds a PhD in Public Health with strong interest in global health issues. He can be contacted at email: oabiodun@who.int.

Helen Shnada Auta is a senior lecturer in the Department of Microbiology, Federal University of Technology Minna, Nigeria. She has published over 20 scientific papers in the fields of environmental Microbiology Food, Industrial Microbiology and Public Health. She can be contacted at email: Helen.shnada@futminna.edu.ng.

Ebenezer Obi Daniel is a Senior Lecturer in the Department of Public Health, at Swansea University, United Kingdom. He is also a visiting Professor and board of study member to the Public Health Programme at Texila American University, Georgetown, Guyana. He holds Ph.D. in Public Health with a strong capacity in International Health issues. He can be contacted at email: e.o.daniel@swansea.ac.uk and edaniel@who.int.

Onifade Adefunmilola Adebola is a Consultant Family Physician at the Federal Teaching Hospital Lokoja, Nigeria. She specializes in Adolescent Health and Family Medicine. She can be contacted at email: oadefunmilola@gmail.com.

Paul Isaac Ojodale is a lecturer with the Department of Microbiology, Baze University, Abuja, Nigeria. He holds a Doctorate in Microbiology from the prestigious Ahmadu Bello University, Zaria, Nigeria with his area of specialization being Medical Microbiology and Parasitology. His research interest is in reemerging zoonotic diseases, Neglected Tropical Diseases and Hand Hygiene. He can be contacted at email: isaac.paul@bazeuniversity.edu.ng.