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Time Differences in Reaching Minimal Erythemal Doses among Different Fitzpatrick Skin Types Irradiated with NB-UVB

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Abstract
UV exposure is a significant risk factor for skin diseases. UV-B radiation can penetrate the epidermis, the skin's outermost layer, causing erythema (redness), irritation, and burn. Long-term UV-B radiation exposure can also injure the skin, raising the risk of skin cancer and premature aging. Semi-military students are often exposed to UV radiation due to their outdoor activities. The high level of outdoor activity leads to significant UV exposure without adequate protection. Previous studies have shown that the characteristics of each skin type based on Fitzpatrick vary in the general population. This study focuses on the semi-military student group, who are more frequently exposed to the sun. Therefore, it is important to determine the differences in the time required to reach the minimal erythemal dose (MED), which is the time it takes for the skin to become red due to UV exposure. This study aims to determine the difference in time to achieve Minimal Erythema Doses (MED) in semi-military students based on Fitzpatrick skin types. This study is an experimental study with a pretest-posttest two-group design, involving 15 research subjects who will be exposed to NB-UVB phototherapy to observe the time required to reach the Minimal Erythemal Dose (MED) across different Fitzpatrick skin types. The results of this study show that the average time to reach the MED differs across each skin type. Time to reach the MED was observed based on the analysis of differences between each skin type. In contrast, there was no significant difference between Fitzpatrick Skin Types 1 and 2, or between Fitzpatrick Skin Types 2 and 3. The time to reach the MED varies across skin types, with significant differences observed among several Fitzpatrick skin types.

Keywords: NB-UVB, Fitzpatrick Skin Types, Minimal Erythemal Doses, Phototherapy

1. Introduction

Indonesia is one of the tropical countries that receives sunlight throughout the year. Sun exposure to the skin has both positive and negative effects (Fivenson et al, 2021). Ultraviolet (UV) exposure is one of the significant risk factors for skin diseases, such as skin cancer and premature aging. UVB is the most harmful type of ultraviolet

radiation, which causes skin damage (Rodríguez et al, 2021). UVB is the primary component of UV radiation that induces sunburn or erythema caused by UV exposure.

Exposure to UV-B rays can also increase the production of reactive oxygen radicals in the skin. These reactive oxygen radicals can damage cell structures and trigger inflammatory reactions (Tan et al., 2020). Inflammation is the body's defense mechanism against injury or infection. The main manifestations of acute inflammation include blood vessel dilation causing erythema, warmth and itching sensation, plasma and protein fluid extravasation (edema), and increased vascular permeability. Erythema is a characteristic skin lesion, such as red patches, that can occur due to UV exposure (Jacoeb et al., 2020).

Military cadet students are frequently exposed to UV radiation due to their outdoor activities, especially during training and field exercises. The high level of outdoor activity results in significant UV exposure without adequate protection. Therefore, it is important to determine the differences in the time required to reach the minimal erythemal dose (MED), which is the time it takes for the skin to become red (erythema) due to UV exposure (Sabzevari et al, 2021). MED is the minimum amount of UV radiation required to induce erythema on the skin with well-defined borders, appearing 24 hours after ultraviolet exposure.

Previous studies have shown that the characteristics of each skin type based on Fitzpatrick vary. However, these results were obtained from the general population, whereas cadet students may have different skin responses to UV radiation (Tan et al, 2020). Therefore, it is necessary to conduct research focusing on this group to determine the differences in the time required to reach the minimal erythemal dose (MED). Research on the differences in the time to reach MED across different Fitzpatrick skin types has important implications for public health policies (Valbuena et al, 2020).

The results of this study can enhance understanding of the importance of routine skin protection against UV exposure. Additionally, this research can serve as a basis for developing more effective skin protection strategies. This will help reduce the risk of skin damage and skin diseases that can affect the health of personnel and improve the quality of life of military personnel (Hailun, 2021).

2. Methods

2.1. Research Methodology

This study will employ an experimental research method using a pretest-posttest two-group design. This experimental design involves two randomly selected groups, given a pretest before the intervention and a posttest afterward. This design compares the time to reach the Minimal Erythema Dose (MED) across various skin types based on the Fitzpatrick scale (Mukrimaa et al., 2016). In this research, the investigators will assess the MED on skin exposed to UV-B radiation according to the sample's skin type. The MED assessment will follow four steps: preparing UV exposure, conducting UV exposure, evaluating the MED, and determining the MED. For another control group, sunscreen intervention will be provided to compare the MED values under UV-B exposure. The MED evaluation will distinguish the time required to reach MED across different skin types based on the Fitzpatrick scale.

2.2. Study Selection

The population in this study consists of Cadet Students from the Faculty of Medicine at the Defense University of the Republic of Indonesia. The sample will be selected using purposive sampling, which selects samples based on specific considerations. These considerations include a population that meets the inclusion criteria for the study (Mukrimaa et al., 2016).

The sample size will be calculated using the Slovin formula:

$$n = \frac{N}{1+Ne^2}$$

$$n = \frac{75}{1+75\ (0{,}0001)^2}$$

n = 15,002

Description:

- n: sample size
- N: population size
- e: error rate

Based on the calculation above, the sample size required for this study is 15.002, rounded to 15 research samples. Included studies had to meet these criteria: 1) All participants in this study must be between 18 and 24 years old 2) Must not have any skin conditions or diseases that affect the response to UV exposure, such as photosensitivity (dermatitis), autoimmune diseases (e.g., Lupus Erythematosus), etc. 3) Cadet students must fall into Fitzpatrick skin type categories I, II, III, or IV.

2.3. Data Extraction

The data processing technique will utilize SPSS Statistics. The collected data will be analyzed using appropriate statistical methods. The Shapiro-Wilk Normality Test will determine whether the data is normally distributed. Subsequently, an Independent Sample T-test will be used to examine the differences in the time required to reach the Minimal Erythema Dose (MED) across various Fitzpatrick skin types.

3. Result and Discussion

Phototherapy is a therapy that utilizes ultraviolet or visible light for therapeutic purposes. Since the early 20th century, Broadband UVB (BB-UVB) and Narrowband UVB (NB-UVB) have been widely used for treatment. NB-UVB phototherapy operates in the range of 311–313 nm; nowadays, 311 nm is the most used wavelength for phototherapy. Ultraviolet light sources include Narrowband (NB-UVB), Broadband (BB-UVB), and UVA. Different wavelengths of ultraviolet radiation used in phototherapy have varying efficacies. (Widodo et al., 2018)

The inflammatory response in the skin due to UV-B exposure involves the release of inflammatory mediators such as histamine, prostaglandins, and leukotrienes. These mediators cause vasodilation and increase vascular permeability, resulting in erythema on the skin. Erythema is a skin inflammation characterized by redness due to capillary dilation caused by chemical toxins or sunburn. This temporary skin condition is marked by skin or mucosal swelling (wheal) and redness (erythema), often accompanied by itching and sometimes pain (Jacoeb et al., 2020).

The Minimal Erythema Dose (MED) is the minimum amount of UV radiation required to produce clearly defined erythema on the skin, appearing 24 hours after UV exposure (Sabzevari et al, 2021). Measuring the MED involves exposing the skin to UV light for a specific period to determine an individual's skin sensitivity to ultraviolet radiation. Common sites for MED measurement include areas rarely exposed to sunlight, such as the lower back and the inner forearm.

This study was conducted at the Faculty of Medicine, Defense University of the Republic of Indonesia. Researchers screened study subjects in November 2023. From three cohorts of cadet students at the Faculty of Medicine, totaling 227 potential subjects, 15 subjects meeting the inclusion and exclusion criteria were selected through a research form. These 15 subjects underwent NB-UVB phototherapy on the right back area. MED readings were taken 24 hours after phototherapy using the NB-UVB device.

The subjects included 15 male participants aged 18–22 years, divided into five participants with Fitzpatrick skin type 1 (33.33%), five with type 2 (33.33%), and five with type 3 (33.34%). Skin type was determined based on an assessment of the back area using the Fitzpatrick Scale. All participants had no history of skin disease, skin allergies, or medication use in the past month.

The results showed that the data distribution for MED times was statistically normal. Fitzpatrick skin type was associated with longer average MED times. Subjects were classified into three Fitzpatrick skin types: 1, 2, and 3.

- For Fitzpatrick skin type 1, the minimum MED time was 60, the maximum was 90, and the average time was 90 ± 21.21.
- For Fitzpatrick skin type 2, the minimum MED time was 90, the maximum was 150, and the average time was 114 ± 25.09.
- For Fitzpatrick skin type 3, the minimum MED time was 90, the maximum was 150, and the average time was 126 ± 25.09.

Table 1: Time characteristics to reach MED based on Fitzpatrick Skin Types

Fitzpatrick Skin Type	Minimum Time	Maximum Time	MED Average Time ± Standard Deviation	P value (*)
Fitzpatrick Skin Type 1	60	120	90 ± 21.21	0.325
Fitzpatrick Skin Type 2	90	150	114 ± 25.09	0.314
Fitzpatrick Skin Type 3	90	150	126 ± 25,09	0.314

The study before, MC Valbuena's study found that MED values vary across skin types due to differences in melanin pigment levels. The findings indicate that the MED time for Fitzpatrick skin type 1 was lower than for type 2. Statistically, the difference between Fitzpatrick skin types 1 and 2 was not significant, with a p-value of 0.141. However, the MED time for type 1 was significantly lower than for type 3, with a p-value of 0.040. The difference between types 2 and 3 was not significant, with a p-value of 0.471.

Table 2: Differences Between Fitzpatrick Skin Type 1 and 2

	Fitzpatrick Skin Type	MED Average Time ± Standard Deviation	Sig. (2-tailed)
Time to Reach MED	Fitzpatrick Skin Type 1	90 ± 21.21	0.141
	Fitzpatrick Skin Type 2	114 ± 25.09	0.142

Table 3: Differences Between Fitzpatrick Skin Type 1 and 3

	Fitzpatrick Skin Type	MED Average Time ± Standard Deviation	Sig. (2-tailed)
Time to Reach MED	Fitzpatrick Skin Type 1	90 ± 21.21	0.141
	Fitzpatrick Skin Type 3	126 ± 25.09	0.041

Table 4: Differences Between Fitzpatrick Skin Type 2 and 3

	Fitzpatrick Skin Type	MED Average Time ± Standard Deviation	Sig. (2-tailed)

Time to Reach MED	Fitzpatrick Skin Type 2	114 ± 25.09	0.471
	Fitzpatrick Skin Type 3	126 ± 25.09	0.471

MC Valbuena's previous study found that MED values vary across skin types due to differences in melanin pigment levels. The findings indicate that the MED time for Fitzpatrick skin type 1 was lower than for type 2. Statistically, the difference between Fitzpatrick skin types 1 and 2 was insignificant, with a p-value of 0.141. However, the MED time for type 1 was significantly lower than for type 3, with a p-value of 0.040. The difference between types 2 and 3 was insignificant, with a p-value of 0.471.

The differences in erythema onset times can be mitigated using sunscreen, which protects the skin from UV exposure by absorbing or reflecting UV rays, thereby reducing the amount of UV radiation reaching the skin (Fivenson et al., 2021).

This study measured and examined the differences in MED times across Fitzpatrick skin types. Previous research evaluated average MED values without assessing the onset time for each skin type. However, not all skin types were included in this study, so the results cannot be generalized to indicate that every skin type has a different MED time.

4. Conclusions

This study examined the differences in the time required to reach Minimal Erythemal Doses (MED) across various skin types based on the Fitzpatrick scale, evaluated 24 hours after exposure to NB-UVB phototherapy. The researchers concluded the following:

- The time required to reach MED varies across different skin types, each with a distinct average time.
- There is a significant difference between Fitzpatrick Skin Types 1 and 3, while there are insignificant differences between Types 1 and 2 or Types 2 and 3.

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Cholera: Outbreak Preparedness, Prevention and Control in Northern Nigeria

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Abstract
Cholera remains a seasonal epidemic in Nigeria, and the northern region is most affected. Poor sanitary and hygiene practices due to adverse socioeconomic, sociopolitical, and climatic conditions have led to recurrent and new outbreaks in many rural communities, especially in the northern region. Seasonal outbreaks are compounded by seasonal floods, nomadic culture of herders, illicit mining activities, and population displacement by banditry and environmental hazards. Other complicit factors include lack of waste and sewage management facilities, overcrowded refugee and internally displaced persons' camps, prisons and schools, and unsafe drinking water. Despite successive efforts by the government, through the Nigerian Centre for Disease Control and its partners, towards preparedness, prevention, control and elimination of cholera outbreaks over the years, seasonal outbreaks in many northern communities remain a recurring challenge. A review of recent outbreak management strategy reveals systemic challenges such inadequate preparedness and response plan resulting from poor surveillance and early warning, constitution and coordination of the response team, poor mapping of resources and required logistical supports, and poor implementation of preventive actions such as the WaSH protocol. Addressing the recurrent cholera outbreaks in northern Nigeria requires adequate and strategic proactive preparedness planning and response measures, including community education and sensitization for good sanitary and cultural practices, pre-outbreak training of health personnel, and inventory management optimization for relevant health commodities. The author discusses implications and solutions to identified gaps in the existing operational approach to preventing cholera outbreaks in northern Nigeria.

Keywords: Cholera, Outbreak Response, Preparedness, Prevention, Control, Northern Nigeria

1. Introduction

1.1. History and Prevalence

Cholera is believed to have spread across the world during the 19th century from the Ganges-Brahmaputra delta in India. Since then, about seven pandemics have resulted in the death of millions across the globe, including the pandemic of 1961 in South Asia. The cholera pandemic reached the African continent in 1971, followed by the Americas around 1991. Although cholera has been eradicated in most high-income countries, it is endemic in many low-income countries with suboptimal water, sanitation, and hygiene (WaSH) systems (WHO, 2022). Early epidemiological data estimates an annual cholera incidence of 2.8 million cases with a fatality of 91,000 (Ali et al., 2012 as cited in Ali et al., 2015, p.2). More evidence has shown that about 18% of the world population is at

risk, with about 1.3 to 4.0 million cases and 21,000 to 143,000 cholera-related deaths annually in endemic countries (Ali et al., 2015). Cholera is an indicator of low social-infrastructural development and a high level of inequity and inequality (Elimian et al., 2022; Gidado et al., 2018).

Cholera is endemic to Nigeria although its' incident appears to be on the decline with a case fatality ratio (CFR) of 3.2% reported for 2021 by the Nigeria Centre for Disease Control (NCDC, 2022), which is lower than previously reported 5.10% in 2018, 4.98% in 2010 (Ngwa et al., 2021), and 3.8% in 1996 (Ali et al., 2015). According to NCDC, the case definition of cholera for suspected cases in a patient age ≥5 years is severe dehydration or death from acute watery diarrhoea (AWD); but if there is a cholera epidemic, a suspected case is any person age ≥ 5 years with AWD, with or without vomiting. A confirmed case is a suspected case in which *Vibrio cholerae* O1 or O139 serotype has been isolated from the stool (NCDC, n.d.). The World Health Organisation (WHO) defines AWD as an illness characterized by ≥3 loose or watery (non-bloody) stools within a twenty-four hour period (GTFCC, 2017).

1.2 Symptoms, Diagnosis, and Treatment

Many recent cholera outbreaks have been caused by *Vibrio cholerae* O1 (WHO, 2022). *Homo sapiens* are the primary hosts of the parasite but water, molluscs, fish and aquatic floras are feasible hosts. Cholera infection comes from the consumption of food or/and water which has come in contact with faeces infected by the *Vibrio cholerae* O1 or O139. Approximately 20% of infected individuals develop AWD within twelve hours to five days requiring immediate treatment. Symptoms are mild to moderate in about 80% of cases with symptoms, and vomiting may be an associated symptom in about 10-20% (Fagbamila et al., 2023; WHO, 2022). The diagnosis is confirmed by laboratory tests on stool samples to identify *V. cholerae* through organism culture or polymerase chain reaction (PCR) technique. However, rapid diagnostic tests (RDTs) may be used to accelerate testing for surveillance purposes (WHO, 2022). Untreated cases can lead to severe dehydration and death in a few hours due to acute loss of large amounts of body fluids and electrolytes (Fagbamila et al., 2023). Treatment involves rehydration with appropriate intravenous fluid and/or oral rehydration solution (ORS) to prevent shock, and treatment with antibiotics to eliminate the organisms. The use of zinc as an adjuvant in ORS treatment is important in children under-5 to reduce the duration of diarrhoea and its short-term reoccurrence. The CFR in untreated cases could be as high as 50%, while treatment can keep it as low as <1%.

1.3 Transmission

Cholera is transmitted through fecal–oral route and transmission can be facilitated by direct contact with feacally contaminated food or water, human-to-human contact, contact with dead body of infected persons, and by cholera treatment centres with inadequate sanitary and decontamination measures (FMOH-NCDC, 2017). Poor sanitary facilities, which may be due to adverse socioeconomic and socio-political factors, lead to recurrent and new outbreaks that often plague poor communities. Situations such as floods, overcrowded facilities (e.g. refugee camps, internally displaced persons' camps and prisons, etc), nomadic activities, poor waste and sewage management facilities, poor sanitary amenities, and unsafe drinking water often predispose the population to cholera outbreaks. Global warming as a result of climate change creates conducive habitats for the growth of gram-negative bacteria like *V. cholerae,* which are readily transmitted in aquatic ecosystems (Fagbamila et al., 2023; Ngwa et al., 2021).

The virulent nature of cholera increases its potential to spread internationally through food products and individuals, which can affect international trade. This adds to its public health relevance. Cholera control strategies have evolved as multifaceted/multisectoral frameworks encompassing effective surveillance, WaSH initiatives, social mobilization, treatment with antibiotics and intravenous fluid/ORS, and vaccination with oral cholera vaccines (OCVs). Successive governments of Nigeria have implemented strategies to prevent, control and eliminate cholera outbreaks over the years, but seasonal outbreaks reoccur in many communities, especially in northern Nigeria. This article discusses cholera prevention and control in northern Nigeria, with a focus on addressing identified gaps in the preparedness and response to the 2021 outbreak.

2. Discussion

2.1 Cholera in Northern Nigeria

Cholera incidents in Nigeria vary across States with the northern region mostly affected. For the year 2021, there were 111,062 suspected cases and 3,604 deaths across Nigeria (NCDC, 2022). The Federal Capital Territory (FCT) and 33 out of the 36 states were affected (Elimian et al., 2022; NCDC, 2022). The northern region accounted for 89% of all the suspected cholera cases. Four states in the region, including Bauchi, Jigawa, Kano, and Zamfara accounted for nearly 53% of the cumulative suspected cases (NCDC, 2022). The outbreak of cholera in this region and many other parts of the country has been associated with the rainy season. This is because of the seasonal floods that wash sewage into open wells, ponds, and rivers, which usually serve as sources of water for domestic and agricultural use (Adagbada et al., 2012; Fagbamila et al., 2023).

2.2 Prevention and Control in Nigeria

Cholera is reportable as AWD disease under the national Integrated Disease Surveillance and Response (IDSR) system. The Nigerian Manual for Infection Prevention and Control (IPC) and guidelines for preparedness and response to AWD outbreaks apply to the prevention and control of cholera in Nigeria (FMOH-NCDC, 2017, 2021). The NCDC is statutorily mandated to coordinate infectious disease prevention and control across the country using the "one health" principles. The NCDC undertakes these activities in collaboration with multisectoral team and the state's emergency response mechanism, usually the multi-sectoral state-level Emergency Operation Centre (EOC). The EOC is the constituted structure that coordinates emergency response actions and determines the next line of action during an outbreak (NCDC, 2022). The AWD outbreaks response guidelines classify an AWD outbreak as a public health emergency, requiring a swift response and the immediate deployment of WaSH (water, sanitation, and hygiene) resources and public health responses. Response follows an escalation process from the community at the local government area level to the state level, and then to the national level. The framework for AWD outbreak response includes:

1. **Preparedness Plan and Coordination**: All levels of government (local, state and national) are required to undertake advance planning for AWD outbreak prevention, response and coordination. This encompasses routine cholera surveillance, assessments of outbreak risk factors and the WaSH protocol. The preparedness plan articulates the structure of command, communication, and reporting, including escalation of suspected outbreak and response processes. During an outbreak, the NCDC coordinates national response and provides support to the affected state(s) by activating the incident management system (IMS) in collaboration with the Federal Ministry of Health (FMOH), the Federal Ministry of Water Resources (FMWR), the Federal Ministry of Environment (FMEnvrt), and strategic partners. The IMS is responsible for the coordination of surveillance, laboratory tests, case management, risk advisory/community engagement, implementation of the WaSH protocol, activation of reactive OCV campaigns, and reporting/review. The activities of the IMS at the state and local level are undertaken bythe EOCs of the specific state/local government (FMOH-NCDC, 2017, 2021).
2. **Surveillance and outbreak investigation**: NCDC works with hospitals and designated laboratories to conduct routine IDSR and Event-Based Surveillance (EBS) for early detection of outbreaks. This involves effective surveillance data collection and analysis.
3. **Laboratory investigation**: NCDC identifies public health laboratories with capacities for stool testing and water analysis; coordinates requests and delivery of test-kits and medium for specimen transfer to cholera endemic/prone areas; and builds capacity of identified laboratory staff. The National Reference Laboratory (NRL) at NCDC Abuja receives and conducts confirmatory tests on samples collected by the states.
4. **Case Management**: This includes the review of existing cholera IPC and AWD protocols; selection of designated treatment centres, and constitution and training of the case management team on harmonized protocols and SOPs.
5. **Logistics and supplies**: This involves mapping essential health commodities such as intravenous fluids, ORS, antibiotics, OCVs, personal protective equipment (PPE), WaSH kits etc in the affected areas, and

available infrastructure and human resources to distribute the items to the last mile or households for treatment and prevention.

6. **Promotion of WaSH initiatives**: The response teams work with WaSH sector partners to support the promotion of the activities involved in WaSH initiatives in cholera hotspots.
7. **Risk Communication**: The IMS/EOC develops risk communication strategies for pre-, during and post-outbreak period, and also design media tools and strategies for engaging targeted stakeholders.

2.3 Prevention and control measures for recent outbreaks in northern Nigeria

The outbreaks in northern Nigeria between 2019 and 2021, were probably moderated by the COVID-19 pandemic in no certain way. On one hand, the pandemic and lockdown era prevented health-seeking behaviours and access to quality healthcare, weakened the focus on strengthened laboratory capacity for cholera testing, and diminished resources for cholera IPC including OCV campaigns. On the other hand, the COVID-19 IPC measures, such as frequent handwashing and hygiene, social distancing, and use of PPE may have improved general hygiene in hospitals and households, while the city lockdowns and travel restrictions may have helped decrease cholera transmission (Elimian et al., 2022). In spite of the foregoing, the challenges observed in the prevention and control of the 2021 outbreaks were systemic, infrastructural, and operational (Elimian et al., 2022; NCDC, 2022). The systemic challenges were inadequate preparedness and response plans for many of the states in the region. This resulted in poor surveillance and early warning; delays in proper constitution, integration, and coordination of the response team; improper mapping of resources and poor evaluation of required logistical supports; and poor preventive actions such as implementation of the WaSH protocol (NCDC, 2022). The lack of pre-outbreak evaluation and validation of diagnostic kits, poor diagnostics coverage, and timeliness were unfortunate outcomes of logistics failure (Elimian et al., 2022). Another systemic challenge was the community lifestyle of open defecation and poor sanitation and hygiene practices (Elimian et al., 2022). Infrastructural challenges such as lack of effective drainage for flood control, lack of access roads to communities, lack of access to safe water, and inadequate health facilities/diagnostic capacities affected the response time, coverage, and prevention of transmission. Some communities lacked access to basic amenities for WaSH (Elimian et al., 2022; NCDC, 2022). Operational challenges included inadequate health commodities such as vaccines, antibiotics, ORS, and intravenous fluids, PPE and qualified personnel to cover all the affected communities and settlements (NCDC, 2022).

3. Implications

Close to 40% of Nigerians live below the poverty line, i.e. $1.90 per day (Statista, 2023). The poverty rate in northern Nigeria is 57.9% with some of the states as high as 87.7% (World Bank, 2022). The WaSH survey of 2019/2020 indicates that the region has the lowest access to WaSH services in the country (Elimina et al., 2022, p. 10). Cholera is associated with poverty and poor communities, and some studies have shown that the current poverty level in Nigeria will make it difficult for the country to attain the target set in the Global Task Force on Cholera Control (GTFCC) roadmap-2030, which is to reduce cholera deaths by 90% and eliminate the disease in 20 out of the 47 endemic countries by 2030, due to a plethora of socioeconomic and social-political determinants (GTFCC, 2017; WHO, 2022). Some researchers, however, predict 2050 as a more realistic date for Nigeria if certain steps are taken to fast-track interventions and programmes aimed at strengthening WaSH initiatives, alleviating poverty, and promoting environmental hygiene through urban planning (Charnley et al., 2023).

Cholera susceptibility is moderated by the host immunity which could be a function of genetic makeup, hygiene, and nutrition. But the spread is moderated by demographic and socio-economic factors including age, gender, education, and income status, etc (Adagbada et al., 2012). The major determinants of cholera outbreak risks in northern Nigeria are seasonal flood, open defecation, and nomadic lifestyle. Recommended seasonal public health actions should include chlorination of wells and public water supply sources, distribution of WaSH kits to households, and community education on health-promoting behaviours about cholera prevention and control such as good sanitary and hygiene practices, especially during the rainy season. In addition, the government and its partners should improve access to sewage/waste management facilities and strengthen regulatory supervision/monitoring of environmental hygiene and food safety as part of cholera IPC measures (Charnley et

al., 2023). The idea of ranching for animal husbandry to control the nomadic lifestyle can help in controlling inter-community transmission. Adequate preemptive preparedness planning and measures, including pre-outbreak training, validation, and stockpiling of diagnostic kits and other relevant health commodities with longer shelf-life, should be undertaken. The challenge with case management due to the inability to handle the surge in cases at the healthcare facilities could be better managed if there is a timely early warning from the epidemiologic data and the hospitals were better equipped ahead of the outbreak. The use of the limited health facilities, which was worsened by the competing allocation of resources for the COVID-19 pandemic should be predictably and proactively planned for (Elimian et al., 2022).

4. Conclusion

Cholera is an endemic disease of public health importance in Nigeria. Its recurrence is seasonal, and the morbidity and mortality are higher in northern Nigeria where over 50% live in extreme poverty. Between 2019-2021 there has been a yearly outbreak, especially during the rainy season when seasonal flooding is inevitable (Fagbamila et al., 2023). The outbreaks are more in communities with inadequate sewage and waste management facilities, lack of access to safe water, and poor sanitary conditions. The four northern states of Bauchi, Jigawa, Kano and Zamfara led the 2021 outbreak data and accounted for about 89% of all suspected cases. Although the IMS and EOC framework for cholera prevention and control was activated in the region, there were gaps that could have been covered to reduce the cases and mortality. The period coincided with the COVID-19 pandemic, which may have also worsened the outcome.

The outbreak could have been better managed if there had been adequate state-level preparedness and response plans, data reporting and response, OCV campaigns across the region, increased funding for WaSH infrastructure, and sufficient logistic planning for pre-positioning of response commodities across the states. There was also gap in capacity for sample collection, transportation, and laboratory diagnosis (NCDC, 2022). Thus, the After-Action Review (AAR), and review of the National Strategic Plan of Action on Cholera Control (NSPACC) should consider solving these gaps in the revised preparedness and response plan. Specifically, the government at all levels should strengthen healthcare/laboratory infrastructure, sewage/waste handling facilities, climate and environmental impact control and management strategies, as well as risk communication strategies and tools across the northern states. Health promotion for health protective or health-seeking behaviours against cholera should be community-adaptable and driven, and may include off-/in-season media material to promote WaSH initiatives and OCV uptake, ranching, etc. Without prejudice to the foregoing, the government should step up current activities aimed at reducing poverty and strengthening the sociopolitical environment for improved security and social well-being of northern Nigerians to eliminate undesirable population displacement and migration.

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Comparison of Premature Deaths from Non-Communicable Diseases Among BRICS Countries

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Abstract
Introduction: In 2021, noncommunicable diseases (NCDs) caused over 43 million deaths globally, including 18 million premature deaths. This study compares the progress of BRICS countries towards reducing premature deaths and achieving NCD targets. Methods: Data was gathered from various global health resources and presented in a table summarizing NCD indicator progress. Findings: UAE leads in GDP per capita among BRICS countries and ranks among the top three in universal health coverage (UHC), alongside China and Iran. Russia has the highest crude death rate, while UAE has the lowest probability of premature mortality (9%). Egypt has the highest NCD death rate (795 per 100,000). Ethiopia has the most significant mortality change relative to national income. Egypt has the highest NCD age-standardized death rate at 795 while UAE has the lowest at 329 per 100 000 population in 2019, respectively. Four (China, Indonesia, Iran, and Russia) of the BRICS countries achieved the requirements of conducting the risk factor surveys. Nine of ten BRICS countries have time-bound NCD targets. However, Brazil and Russia excel in vital registration systems. Policy achievements vary among BRICS countries with Brazil leads in tobacco demand reduction. Iran led in alcohol-related actions and UAE and Russia led in reducing unhealthy diets. Policies addressing physical activity awareness lag in several countries, while Iran, Russia and UAE had drug therapy and counseling to prevent heart attacks and strokes. Eight of the 10 BRICS countries had guidelines for Management of Major NCDs. Conclusion: This first comparative study highlights disparities in progress and underscores the need to strengthen health systems and financing models to achieve NCD targets by 2050. It serves as a baseline for evaluating and improving policies across BRICS countries.

Keywords: Noncommunicable Diseases, Premature Deaths, BRICS, Hypertension, Cancer, Diabetes, Stroke, Heart Diseases, Public Health Interventions

1. Introduction

In 2021, noncommunicable diseases (NCDs) caused over 43 million global deaths (with 73% occurring in low- and middle-income countries). Part of the global deaths include 18 million deaths that are considered premature. Of these, 82% occurred in low- and middle-income countries (Jamison, 2024; Global burden of disease Report, 2021).

The World Health Organization (WHO) leads global efforts to reduce premature deaths by one-third by 203 and by 50% by 2025. Despite global improvements in reducing premature mortality (dying between ages 30-70) from cardiovascular diseases, cancer, diabetes, and chronic respiratory diseases, these remain leading causes of death.

There are 19 million annual deaths due to cardiovascular diseases, 10 million deaths due to cancers, 4 million deaths due to chronic respiratory diseases and 2 million deaths due to diabetes (Global burden of disease Report, 2021).

In 2019, the World Health Assembly extended the WHO Global Action Plan to 2030 and initiated an Implementation Roadmap (2023–2030) to accelerate progress by focusing on nine impactful global targets for NCD prevention and management. Based on the WHO World health statistics, 2024, NCD service coverage has improved for hypertension treatment (WHO, 2024). Detailed in the Global health 2050 report, published by the Lancet Commission in October 2024, the report highlights global progress across countries and recommends focused health investments for targeted health interventions to promote quality of life and well-being to reduce 50% of premature deaths by 2050. The World Health Organization (WHO) developed a global monitoring framework that was adopted in 2013 which aims to promote advocacy, political commitment, and global action, which has nine global targets and 25 indicators, to track progress in preventing and controlling major NCDs, thereby addressing risk factors and strengthening health systems (WHO, 2024).

The WHO periodically evaluates countries' capacities to prevent and control noncommunicable diseases (NCDs) through the NCD Country Capacity Survey (NCD CCS). This global survey helps monitor progress and achievements in strengthening responses to the NCD epidemic. There are concerns that these targets will not be met noting the current trends. Based on the WHO world health statistics 2024 reports. Of the 32 numeric global health-related SDG targets reviewed, none of the countries have achieved these although most show a positive trajectory.

The aim of the desk review is to compare progress towards reaching NCD targets and reducing premature deaths among the current BRICS countries. The purpose is to highlight and promote the sharing of lessons and knowledge within the partnership and across the regions using BRICS as an example of upper middle-income countries, as defined by the World Bank. This is the first review and comparison on NCD including the new members of the BRICS.

2. Methods

A literature review was conducted, of key documents and databases and used to extract the data for comparison. The document review includes the Global Health 2050 Report, the WHO NCD global monitoring framework, the World Bank economic reports, WHO NCD capacity survey posted on the WHO global health.

In addition, population, economic and Universal Health Coverage (UHC) data was also extracted from the indexmundi.com, by country of interest, where necessary and captured in a Microsoft Excel worksheet. The data is presented in Table 2 below, by country with the main data components for comparisons. The key data components included: demographic, economic, NCD mortality, and nine NCD global targets from the WHO NCD framework (WHO, 2021).

2.1. Inclusion criteria

- Data published from 2019 to December 2024
- The focus is on NCD premature deaths and nine global targets for PPD as stipulated in the WHO framework.
- Selected socio-demographic data, including population, national gross domestic product per capita, out-of-pocket health expenditure and UHC index.
- BRICS countries were included in this review, namely: Brazil, Russia, India, China, South Africa, Egypt, Ethiopia, Indonesia, Iran, and the United Arab Emirates (UAE). This partnership was formed to coordinate economic and diplomatic policies and promote diverse global influence on international institutions. BRICS controls about 41% of global GDP and 50% of world’s population (Niaki,2025).

Table 1: BRICS countries by economic status as defined by the World Bank

Country	Region	Income Group based on World Bank	Gross national income (GNI) per capita (2023)
Brazil	Latin America & Caribbean	Upper middle income	Between $4,516 and $14,005
China	East Asia & Pacific	Upper middle income	
Egypt, Arab Rep.	Middle East & North Africa	Lower middle income	Between $1,146 and $4,515
Ethiopia	Sub-Saharan Africa	Low income	$1,145 or less
India	South Asia	Lower middle income	Between $1,146 and $4,515
Indonesia	East Asia & Pacific	Upper middle income	Between $4,516 and $14,005
Iran, Islamic Rep.	Middle East & North Africa	Upper middle income	
Russian Federation	Europe & Central Asia	High income	$14,005 +
South Africa	Sub-Saharan Africa	Upper middle income	Between $4,516 and $14,005
United Arab Emirates	Middle East & North Africa	High income	$14,005 +

Source: World Bank Country and Lending Groups – World Bank Data Help Desk

3. Results

Table 2: Comparison of progress of BRICS countries towards reducing premature deaths and achieving NCD targets.

	Brazil	China	Egypt	Ethiopia	India	Indonesia	Iran	South Africa	Russia	United Arab Emirates
Demographic, Economic and Universal Health Care Status										
Total population 2024 (https://database.earth/population/by-country)	211,140,729	1,422,584,933	114,535,772	128 691 692	1,438,069,596	281 190 067	90,608,707	63 212 384	145,440,500	10 642 081
Gross Domestic Product per capita (in USD 2019) www.database.earth/economy/south-africa/gdp-per-capita	8,845	10,144	3 017	840	2 050	4 151	3 277	6 703	11 536	45 376
Health expenditure through out-of-pocket payments per capita in USD 2019 (https://www.indexmundi.com/facts/indicators/SH.XPD.OOPC.PC.CD/rankings)	212	189	94	10	35	42	186	31	239	230
UHC Service Index -2019: (https://www.indexmundi.com/facts/indicators/SH.UHC.SRVS.CV.XD38/rankings)	75	82	70	38	61	59	77	67	75	78
Mortality and probability of premature deaths due to NCDs										
Crude death rate 2019 (per 1 000 population per year)- www.indexmundi.com	6,61	7,07	5,75	6,29	7,3	6,57	4,84	9,4	14,6	1,58

P-score for COVID-19 outcomes in the 30 most populous countries (P-scores are calculated by dividing excess deaths by expected deaths for a given period, with a low score suggesting good performance . Estimates for excess deaths are from The Economist (2024).168)	18%	5%	17%	15%	18%	10%	21%	16%	24%	not available
Time required to reduce PPD by 50% in years	43	38	43	30	54	70	30	29	26	not available
Value of change in gross national income (% per year)	-0,1	8,9	1,4	8,4	6,4	4,9	9,1	0,5	1	not available
Value of mortality change relative to the national income value of change (% per year)	1	1,1	1,3	5,4	2,5	1,2	1,2	5,1	2,9	not available
Regional % change in mortality rates from NCD and injury-related priority conditions among people aged 50-69 years, 2000-2019	-1,50%	-2,60%	-1,50%	-1,00%	0,30%	-0,70%	-1,50%	-1,00%	-2,70%	-1,50%
Progress on reducing the National Non-Communicable Diseases (NCD) Country Status source: https://ncdportal.org/										
National NCD Targets	Fully achieved	Fully achieved	Fully achieved	Fully achieved	Fully achieved	Partially achieved	Fully achieved	Fully achieved	Fully achieved	Fully achieved
Mortality Data	Fully achieved	Partially achieved	Partially achieved	Not achieved	Partially achieved	Not achieved	Partially achieved	Partially achieved	Fully achieved	Partially achieved
Percentage of deaths from NCDs	57%	90%	86%	40%	68%	78%	84%	52%	89%	74%
Total number of NCD deaths	1,095,458	9 925 098	489 591	246626	6 302 911	1 487 277	313 065	286 982	1 592 998	7 930
Probability of premature mortality from NCDs Source: https://data.who.int/indicators/i/C540135/country	15%	16%	28%	17%	24%	24%	15%	22%	24%	9%
NCD age-standardized death rate per 100 000 population (2019) www.who.int/ncdportal.org	453	499	795	487	577	661	436	591	620	329
Risk Factor Surveys	Partially achieved	Fully achieved	Partially achieved	Partially achieved	Partially achieved	Fully achieved	Fully achieved	Partially achieved	Fully achieved	Partially achieved
Status of NCD Reduction Public Health Actions (https://ncdportal.org/CountryProfile/GHE110/)										
National Integrated NCD Policy/Strategy/Action Plan	Fully achieved	Fully achieved	Fully achieved	Not achieved	Fully achieved	Not achieved	Fully achieved	Not achieved	Partially achieved	Fully achieved
Tobacco Demand-Reduction Measures	Fully achieved	Partially achieved	Partially achieved	Partially achieved	Partially achieved	Partially achieved	Partially achieved	Partially achieved	Partially achieved	Partially achieved
Harmful Use of Alcohol Reduction Measures	Partially achieved	Partially achieved	Partially achieved	Partially achieved	Partially achieved	Partially achieved	Fully achieved	Partially achieved	Partially achieved	Partially achieved

Unhealthy Diet Reduction Measures	Partially achieved	Partially achieved	Not achieved	Not achieved	Partially achieved	Partially achieved	Partially achieved	Partially achieved	Fully achieved	Fully achieved
Public Education and Awareness Campaign on Physical Activity	Fully achieved	Fully achieved	Not achieved	Not achieved	Fully achieved	Fully achieved	Not achieved	Not achieved	Fully achieved	Fully achieved
Guidelines for Management of Major NCDs	Fully achieved	Fully achieved	Fully achieved	Fully achieved	Fully achieved	Fully achieved	Fully achieved	Partially achieved	Fully achieved	Partially achieved
Drug Therapy/Counselling to Prevent Heart Attacks and Strokes	Not achieved	Not achieved	No Response	Not achieved	Do not Know	Not achieved	Fully achieved	Do not know	Fully achieved	Fully achieved

3.1. Demographic, Economic and Universal Health Care Status

United Arab Emirates (UAE) has the highest gross domestic product (GDP) per capita among the BRICS countries, followed by Russia at USD 11 000 and China at USD 10 000 GDP per capita. The two bottom countries with lowest GDP per capita are India and Ethiopia at USD 2,000 and USD 800 per capita respectively. Russia, UAE, and Brazil are top three countries among BRICS with the highest health expenditure through out-of-pocket payments per capita, while, Ethiopia has the lowest at USD 10.

China, UAE, and Iran are top three BRICS countries with the highest UHC coverage index, at 82, 78, and 77 respectively, while, India, Indonesia and Ethiopia have the lowest UHC coverage index at 61, 59 and 38, respectively. This indicator measures the average coverage of essential services through a single index score based on 14 indicators across four domains: reproductive, maternal, newborn and child health (RMNCH); infectious diseases; NCDs; and service capacity and access (WHO indicator definition, 2025).

3.2. Mortality and probability of premature deaths due to NCDs

In terms of mortality data, Russia has the highest crude death rate at 14.6, followed by South Africa at 9.4, India at 7.30 and China at 7 per 1000 population, while UAE had the lowest crude death rate at 1.58 per 100.000 population.

Russia and Iran are the two top BRICS countries with the highest p-scores at 24% and 21% respectively, while China has the lowest p-score of 5%. The P-scores calculate the percentage of excess deaths relative to expected deaths for a given period, with a low score suggesting better performance (Our World in Data, 2024; The Economist, 2022).

Indonesia (70 years), India (54 years) and Brazil and Egypt (43 years) have the longest time to reduce PPD by 50%, while Russia (26 years), South Africa (29 years) and Ethiopia (30 years) are bottom three BRICS countries with the shortest time to reach the target.

The value of mortality changes relative to the value of national income change per year is estimated based on disease-specific mortality risk changes and the proportion of change in full income due to mortality risk reduction. In this context, Iran, China, and Ethiopia are the top three BRICS countries with the highest value of mortality changes relative to national income changer per year. South Africa, Russia, and Egypt are the bottom 3 BRICS countries with the lowest value of change in gross national income per year, while Brazil reported a slightly decreasing national gross income, with value of change on the negative (Jamison, 2024).

Ethiopia leads at 5.4% in terms of value of mortality change relative to the national income value of change per year, followed by South Africa at 5.1%, and Russia at 2.9%, while Brazil, China, Egypt, Indonesia, and Iran had

the least value of mortality change. The regional data, linked to these countries, shows an increase in mortality rates during the same period.

3.3. Progress on reducing the National Non-Communicable Diseases (NCD) Country Status

Regarding the National NCD targets, only Indonesia has partially achieved this indicator, which requires, a set of time-bound national targets for NCDs and does not cover two of the three areas addressed in the 9 voluntary global targets and the WHO Global Monitoring Framework, while the vast majority (9 BRICS countries) had fully achieved this target.

Brazil and Russia are the only two BRICS countries with high-quality vital registration system that captures deaths and the causes of death routinely and certified using International Classification of Diseases (ICD) code for submission to the WHO Mortality Database. Six (China, Egypt, India, India, Iran, South Africa, and UAE) of the BRICS countries had partially achieved this requirement. Ethiopia and Indonesia did not achieve this indicator.

China, Russia, Egypt, and Iran are the top 4 of the BRICS countries with highest percentage of deaths from NCDs, while Ethiopia has the lowest percentage of deaths (40%) from NCDs.

Egypt at 28% has the highest probability of premature mortality from NCD compared to UAE which has the lowest percentage at 9%. India, Indonesia, and Russia had 24% PPD and South Africa at 22% while China and Brazil are at 16% and 15%, respectively.

Egypt has the highest NCD age-standardized death rate at 795 while UAE has the lowest at 329 per 100 000 population in 2019, respectively. China ranks fifth within the BRICS counties for this indicator, while it ranks first with highest percentage of deaths due to NCDs.

Four (China, Indonesia, Iran, and Russia) of the BRICS countries had fully achieved the requirements of conducting the risk factor surveys. The risk surveys include physical measurements and biochemical assessments covering the key behavioral and metabolic risk factors for NCDs and conducted at least every 5 years. Egypt, Ethiopia, India, Indonesia, South Africa, and UAE risk factor partially achieved the risk factor survey indicator (i.e., excludes other risk factors and the surveys are infrequent) (WHO 2025).

3.4. NCD reduction in public health Actions

Six (Brazil, China, Egypt, India, Indonesia, Iran and AE) of 10 countries had a national integrated NCD plan or policy, addressing the four main NCDs (cardiovascular diseases, diabetes, cancer, chronic respiratory disease) and their main risk factors (tobacco use, unhealthy diet, physical inactivity, harmful use of alcohol), as required by the WHO framework. Only two countries and South Africa and Russia had partial plans (not multisectoral or addressing all 4 main NCDs and risk factors, while Ethiopia did not have a plan aligning to the WHO definition of this indicator.

Brazil is the only country within BRICS that has fully achieved the indicators related to reducing tobacco demand with total taxes set at 75% or more of the retail price of tobacco products, has mass media campaigns, smoke-free policies, has large graphic health warnings/plain packaging, and has bans on advertising, promotion and sponsorship. Russia is the second leading country to achieve this indicator as it has fulfilled 4 and partially achieved the sub-components of this indicator related to retail price tax. The other eight BRICS countries have partially achieved this indicator.

Iran is the only country within BRICS that has fully implemented public health actions against the harmful use of alcohol, increasing the restrictions for access, has an advertising bans or comprehensive restrictions on use of alcohol and an increased excise tax, while other BRICS countries have partially achieved this indicator.

Russia and UAE are the only two BRICS countries that have fully implemented national policies to reformulate foods and beverages which are high in salt, saturated fatty acids, trans-fatty acids, sugars and have restrictions in terms of marketing unhealthy diet to children and against breast milk substitutes. Six countries had partially achieved this indicator, while two countries Egypt and Ethiopia did not achieve this indicator, as they did not have any of the policies related to the sub-components of this indicator.

Four (Egypt, Ethiopia, South Africa, and Iran) of the 10 BRICS countries had partially achieved the indicator related to the public education and awareness campaign on physical activity, while six remaining BRICS countries fully achieved this indicator.

Eight of the 10 BRICS countries had guidelines for Management of Major NCDs, however, only Russia and UAE had partially achieved this indicator, as they only had guidelines for 2 of the 4 main NCDs.

In terms of drug therapy and counseling to prevent heart attacks and strokes, only Iran, Russia and UAE had fully achieved this indicator. Four of BRICS countries did not have these services, while three countries did not respond or stated they did not know in their response to this indicator.

4. Discussion

4.1. Main findings

The countries within the BRICS partnership do have variations in terms of population size, economic status that also affect health care coverage and health expenditure, which in turn may impact on their capacity to respond effectively to reduce the impact of NCD in their countries.

Only 1 country-UAE had PPD less than 10%. Most countries had PPD 15% and above. Other studies have reported that the overall PPD is 21.9% in developing countries, which is 1.5 times greater than the risk of individuals from the high-income countries. Similarly, with the crude death rate per 100 population as well as the age-standardized mortality rate was also higher in BRICS countries located in Africa as compared to UAE, which has the highest GDP per capacity and highest UHC coverage index and lowest probability of premature mortality from NCDs. This aligned with the literature, reporting that the highest burden of NCDs in developing countries.

4.2. What is known?

WHO, the World Bank, The Economist all provide data that allows comparisons among countries based on geo-location, economic status, WHO regional classifications. These institutions also publish reports on the status of world health, an example, which provide comprehensive overview of public health actions employed across countries for NCD prevention and control. Research institutions across the globe have provided information and correlations of risk factors for NCDs, as well as provided guidelines and policies on prevention and control, including examples of behavioral change interventions. Sharing of efforts across countries facilitates consideration and adaptation of effective interventions to achieve the NCD targets set for both 2030 and 2050 (WHO, 2021, 2025, World Bank, the Economist, 2024).

The World Bank report on enhancing longevity (2024), advocates for Investing in health and wellbeing across lifespans to transform aging population to save 150 million lives in low- and middle-income countries by 2050 and yield substantial economic benefits (Jha, 2024).

Studies have also noted that reducing avoidable mortality from major non-communicable diseases (NCDs) and injuries through targeted interventions including multisectoral actions across health care levels and community structures has significant economic, education, equity, and health system implications. There is also data to estimate the economic value of reducing mortality by cause, which can guide multi-sectoral priority setting and inform high-level policy discussions on budget and strategic resource allocation (Verguet, 2024; Steinbach, 2024; Haacker, 2023; Case, 2022; NCD Countdown Collaborators, 2022; Watkins, 2020; Jamison, 2018).

All these metrics and tactics provide a framework for evaluating investments in health and longevity, emphasizing the socio-economic benefits of targeted interventions. (Norheim,2024; Allen, 2017; Steinbach, 2019; Knutson, 2023, Verguet, 2024 and Bukhman,2020.)

4.3. What this study adds

This is the first desktop review to compare the burden and outcome of NCS among BRICS countries. This comparison study suggests simultaneous tracking of a combination of both demographic, economic, and health indicators when comparing health outcomes among countries, in recognition of socio-determinants of health, to prevent assumptions regarding similar capacities and abilities just because countries collaborate and have similar aspirations.

Table 2 depicts the summarizes data by country based on this partnership. This is a more appropriate way of visualizing the unequal distribution among BRICS countries of NCS related indicators including the PPD from NCDs. With greater push to ensure data-driven policies, this desktop review also promotes these comparisons to inform BRICS partnership health-related policies and guidelines as well as resource mobilization. This also makes it easy to identify areas for improvement and collaboration through sharing of best practices within the partnership. (Allen, 2017).

5. Limitations of the Study

The main strength of this study is the use of several of the secondary data published with well-defined methods of collection and indicators that are clearly defined and endorsed at global level, including NCD premature mortality, to allow the first comparison of NCD burden and risk of premature death for individuals among the newly expanded BRICS partnership.

The main weakness is that the data is secondary, extracted from WHO database and other international databases reflecting the variations of vital registration systems and health information systems capacities. Hence data quality and verification are limited. Secondly, we have selected limited indicators and have not considered other indicators related to inequities and equalities that may be affecting the burden of NCDs and related PPD rates.

6. Conclusion

This paper highlights variations of the progress made in reducing the NCD burden and PPD among BRICS countries. This is the very first comparison conducted on the subject matter among BRICS countries. The comparison identifies countries among BRICS highlighting within and between countries variations of progress, in reducing PPDs and overall NCDs.

The summary table can be used as the baseline for future studies to compare progress among BRICS countries. Data on PPD and NCDs has potential to help governments and organizations identify the most pressing health challenges, point out areas for country governments priority setting, assist with planning to meet national and global targets and commitments and guide the allocation of domestic resources.

The study also highlights the importance of countries submitting reliable and high-quality data to WHO for such comparison to occur and to guide the creation of targeted interventions, policies or programs promoting health behaviors and campaigns to address specific health risks within each country.

This study provides an opportunity to evaluate the effectiveness of policies and programs among BRICS countries and has potential to guide areas for cooperation and enable countries to learn from each other's successes and challenges in tackling NCDs for continuous improvement.

It also highlights the need to strengthen health systems, enhance the sustainability and equity of health services and promote effective financing models as critical priorities to contribute to the successful achievement of NCD targets by 2050.

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Data availability: Comprehensive data extracted from the WHO Global Observatory has the NCD Data and selected data for the paper included in table 2. Readers can access it by requesting the original version from the author via email.

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