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Mortality trend analysis of schistosomiasis in the Philippines from 1960-2019

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ABSTRACT

Despite the different reviews and publications about schistosomiasis disease, it remains an economic and public health problem in the Philippines. Thereby, this study examined the trends of schistosomiasis mortality in the Philippines over 60 years concerning sex, age, and region-specific, using the data from the Philippine Health Statistics. Results show that national mortality rates have decreased from 1960-2019. The trend in schistosomiasis sex-specific mortality rates showed that men had a greater schistosomiasis-related death rate than women. For the age-specific mortality rate, children under the age of 1 have the lowest death rate compared with people over 70 having the highest death rate. For the region-specific mortality, Region VIII (Eastern Visayas) has the highest mortality rate with a value of 4, and Region XI (Davao) has the highest morbidity rate with a value of 53. To fully eradicate schistosomiasis in the succeeding years, an extensive transmission control measure and awareness education program must be implemented locally and nationally.

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1. INTRODUCTION

Schistosomiasis, often known as bilharzia, is one of the neglected tropical diseases (NTDs) that can cause infection by the genus Schistosoma worms [1], wherein humans are infected by three major pathogens or schistosome species: *Schistosoma mansoni*, which is found mostly in Africa and South America; *S. haematobium*, found throughout Africa and the Middle East, and *S. japonicum*, only found in Asia [2]. Infection occurs when excreta contaminate surface water, wherein larval stages of the parasites, known as cercariae, are released from aquatic snails and penetrate the skin through water contact. Then cercariae change into schistosomula when inside a human host and are carried to the portal circulation of the liver, where they mature and mate. Adult schistosomiasis worms, such as *S. japonicum* and *S. mansoni* colonize the mesenteric vessels and *S. haematobium* in the veins draining the urinary system [3], [4]. Schistosomes survive for an estimated 3-10 years in human hosts but in some instances, can live for over 40 years [5]. Schistosomiasis clinical signs include Katayama syndrome and chronic indication. The symptoms of Katayama syndrome are headache, fever, rash, myalgia, and respiratory symptoms. The chronic symptoms include hematuria and dysuria, which can lead to genital tract injury that is susceptible to other diseases, and bladder cancer [6]. In children, it can cause anemia, growth retardation, and a loss of learning ability but

these effects are treatable. Chronic schistosomiasis can last for years if not treated, making it difficult for people to work and, in some cases, even leading to death [7].

Globally, schistosomiasis is a third common tropical infection that can cause mortality and morbidity in developing countries, with an estimated 700 million people at risk and 200,000 death yearly [2], [8]. There are currently approximately 26,762 peer-reviewed publications on this subject. Still, it continues to remain a public health issue in 12 endemic regions, 28 provinces, and 196 towns of the Philippines, with an estimated 12.4 million people at risk and 2.7 million precisely exposed to schistosome [9]–[12]. No published studies in the Philippines that comprehensively report the data within 60 years. With this, there is a need to examine the trend of schistosomiasis to inform health actors and policymakers about developing a possible intervention policy and enhancement of national health strategies on schistosomiasis. Thus, this study describes and analyses the profile and trend of mortality caused by schistosomiasis over the past 60 years.

2. RESEARCH METHOD

2.1. Data source and extraction

The data for this study will be gathered using the Department of Health (DOH), which compiles figures on important health topics, and the Philippine Health Statistics (PHS) records from 1960 to 2019, considering the 10th revision of the international classification of disease (ICD-10), which will be made available online. The PHS results from collaboration and coordination between this department, the Philippine Statistics Authority (PSA), and local health unit partners. The data gathered from the source was compiled, evaluated, and presented in tables and graphs to provide more meaningful and helpful information. All the data collection involved the morbidity and mortality data from 1960 to 2019 (60 years) caused by schistosomiasis disease per sex, age group, and region.

2.1.1. Morbidity and mortality rates computations

The mortality and morbidity rates of schistosomiasis were computed by dividing the morbidity or mortality between a specific age group, sex, and region over the total population and then multiplied by 100,000 [13]. The regions were National Capital Region, Cordillera Administrative Region, Regions I, II, III, IV-A, MIMAROPA, Regions V, VI, VII, VIII, IX, X, XI, XII, XIII, and BARMM. For age groups concerning under 1, 1-4 years old, 5-9 years old, 10-14 years old, 15-19 years old, 20-24 years old, 25-29 years old, 30-34 years old, 35-39 years old, 40-44 years old, 45-49 years old, 50-54 years old, 55-59 years old, 60-64 years old, 65-69 years old, 70 and over, and sex (male or female).

2.2. Data analysis

The mortality and morbidity rates of schistosomiasis were evaluated for illustrative purposes in this study to determine the patterns of change for each year, age group, sex, and region. All of the data analysis was done using the microsoft excel software package. To better represent the study's conclusions, the researchers used GraphPad Prism to depict the data. Line graphs was used to illustrate sex-specific and overall mortality rates from 1960 to 2019, while bar graphs were used to show age-specific mortality rates and regional morbidity and mortality rates from 1960 to 2019. The mean of normally distributed data represents the data's central tendency. A two-sample t-test is used to compare the means of two independent samples (male and female), assuming that data are drawn randomly from two unrelated, and normally distributed populations.

2.2.1. Missing data

The CARAGA area was established in 1995, and the initial value has been used to replace missing data 1990-1994. A significant number of missing values were discovered in regional data. Although Region IV in the Philippines is now divided into Region IV-A, CALABARZON, and Region IV-B, MIMAROPA, the current study has consolidated more recent data from Region IV into one for consistency. Furthermore, only four decades were accounted for due to the PHS's incomplete data. Because schistosomiasis disease was not considered a notifiable disease from 1999 to 2019, values for schistosomiasis disease mortality per region are missing from 1999 to 2019. As per standard data mining guidelines, a few missing values were also reinforced with the average values from the previous and succeeding years.

3. RESULTS AND DISCUSSION

3.1. National average schistosomiasis mortality rates in the Philippines from 1960 to 2019

The nationwide population-based analysis indicates a gradually declining pattern in schistosomiasis-related mortality in the Philippines over six decades as presented in Figure 1, which is encouraging because it

demonstrates the efficacy of various strategies, treatments, and drug discoveries (praziquantel) used by the government to treat infected people and endemic areas over decades [14].

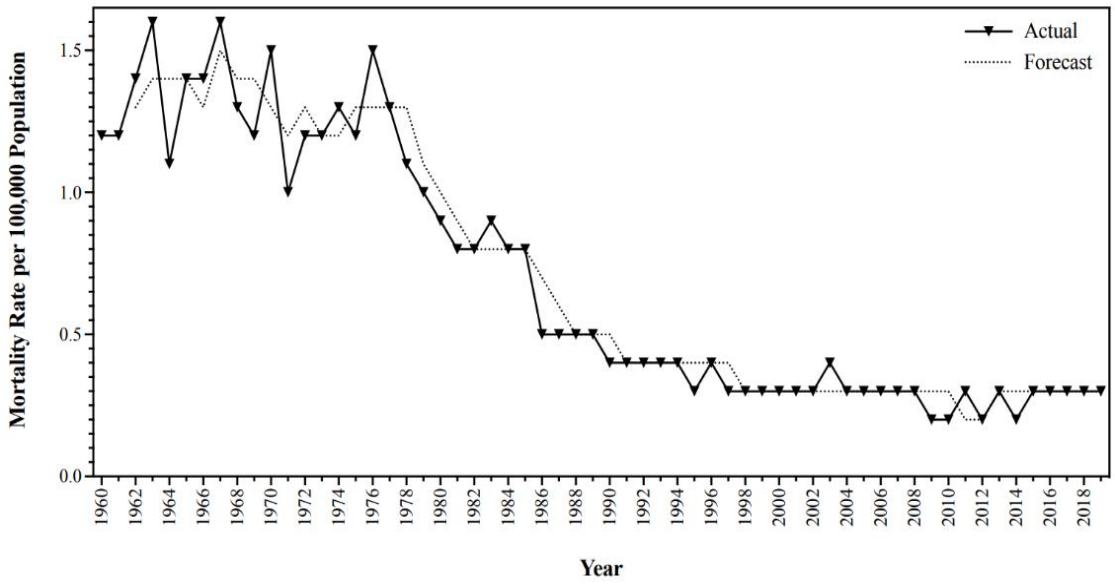

Figure 1. The trend of national schistosomiasis-related mortality rate in the Philippines, 1960-2019

These several strategies implemented over decades were the establishment of the Schistosomiasis Control Pilot Project in 1956, the establishment of the National Schistosomiasis Control Commissions (NSCC) to provide a comprehensive control program and to facilitate good collaboration among government entities in 1964, The transformation of the NSCC into the Schistosomiasis Control Council (SCC), with the Council tasked with developing the Integrated Schistosomiasis Control Program in 1976; Organizing an inter-agency consultation workshop on health education in 1977 resulted in the development of a Schistosomiasis educational program in Sogod Leyte, and 1978, Praziquantel was primarily used in a research trial to treat Schistosomiasis. In 1982, the Integrated Provincial Health Office took over the management of the schistosomiasis program. The province-wide chemotherapy program included mass case screening and therapeutic goals with Praziquantel in Leyte and other areas. In 1990, the Philippine Health Development Project (PHDP) was launched, which covers schistosomiasis control as a sub-component of Communicable Disease Control. In 1991, contractual Schistosomiasis Control itinerant teams were recruited for case identification and treatment, with 100% coverage of eligible populations. A change in the way control was done to improve the results of PHDP III, which included widespread treatment in some areas in 1996 [14], [15]. the launch of the Integrated Helminth Control Program (IHCP) by the Department of Health (DOH) to make policy recommendations for preventing and controlling soil-transmitted helminthiases (STHs) [16]. and the implementation of the modified control technique to improve the results of PHDP III. In 2012, the World Health Assembly passed Resolution WHA65.21 to eliminate schistosomiasis [17]. The program, as mentioned earlier, and policy have all contributed to the decline of schistosomiasis disease over the years. However, it is still a public health concern in the Philippines.

The results are consistent with other international studies entitled "*Trends in schistosomiasis-related mortality in Brazil, 2000-2011"*, research shows a similar declining pattern at the national level. This was due to the influence of control program measures undertaken in recent decades in Brazil that focused primarily on the extensive treatment of at-risk people in endemic areas [18].

3.2. Sex-specific mortality rates

In this study, mortality rates are higher among males than females as shown in Figure 2. It was observed that the mortality rates were highest in 1963, with male mortality at 2.37 deaths per 100,000 males and female mortality at 0.87 per 100,000 females. Nationally, female, and male mortality rates decreased over the year. We discovered that men died from schistosomiasis at higher rate than women, which was consistent with previous research [18]. Men have a higher prevalence of the infection, which is most likely due to their increased exposure to schistosomiases such as agriculture, fishing, and recreational activities like swimming [19].

Several studies have found that the association between sex and infection risk is complex, culturally varied, and influenced by a variety of other factors [20], [21]. The extent to which sex was associated with infection is most likely due to different habits of water interaction between men and women [20] concerning domestic duties involving contact with water and activities related to boating and fishing, as well as use in economic and recreational activities [19], [22]. For the highest disease prevalence in men, certain religious beliefs, such as constraints on women's movement in Muslim communities, were another factor. In research conducted among Muslim communities in the Northern Raivan Sanyi dam region, where women's seclusion was particularly prominent, and their water interaction was correspondingly limited, men were responsible for 98% of activities involving pollution and exposure to schistosomiasis infection [19], [23]. Thus, the male was more at risk of infection than the female.

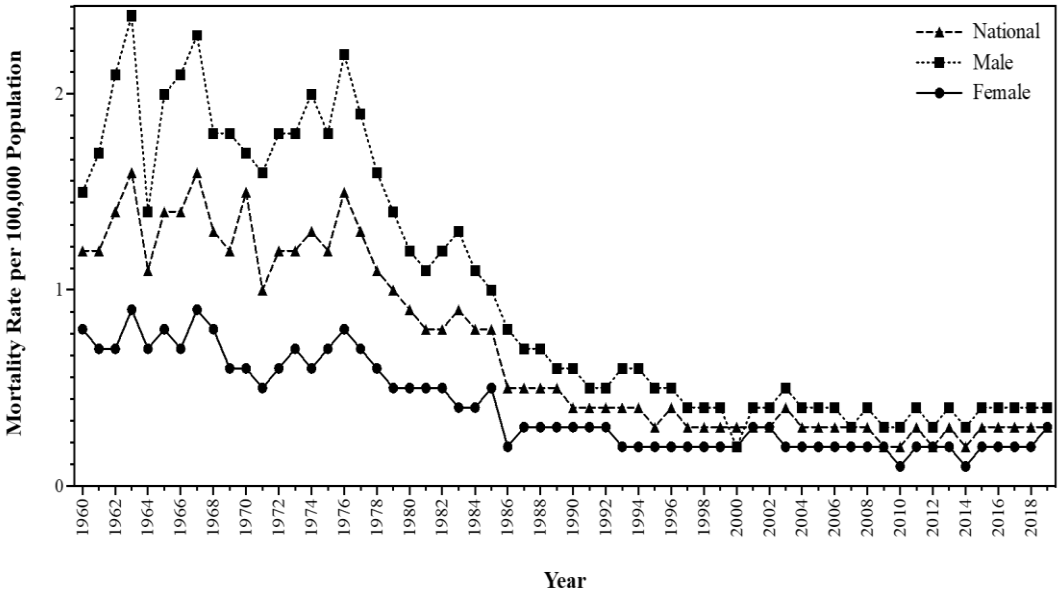

Figure 2. Schistosomiasis-related mortality rate by sex in the Philippines, 1960-2019

A two-independent sample t-test was used to determine if there is a significant difference in the mortality rate of schistosomiasis between males and females in the Philippines. Results show that the t-statistic is 6.18, and the p-value is 0 as described in Table 1. Thus, there is a significant difference in the mortality rate of schistosomiasis between males and females in the Philippines.

Table 1. T-test results of sex-specific schistosomiasis mortality rate

t	df	Sig.
6.181	118	<0.000

3.3. Age-specific mortality

A bar graph depicts the mortality rate per age group for the age-specific schistosomiasis mortality rate trend from 1960 to 2019 shown in Figure 3. As per the figure, people aged 70 and up have the highest mortality rate, with a value of 2.61, while children under the age of one have the lowest mortality rate, which has a value of 0.09.

The results are consistent with previous research [21] conducted in Brazil. This higher risk of death from schistosomiasis in older age groups can be due to the chronic nature of the disease, which progresses to severe clinical forms, and the occurrence of more chronic comorbidities in the elderly [24]. The age groups 55-59 and 35-39 years could represent older farmers and fishermen who have long been exposed to infested water due to their occupations. The slight increase in the mortality rate of those aged 15 to 19 could represent the generation that is gradually following in their fathers' footsteps in farming and fishing [25]. Moreover, the reduction in mortality over time has been greater in age groups under 30 years. This is because, in endemic areas, control programs based on diagnosis and selective chemotherapy treatments are generally designed for children and adolescents [18], [26].

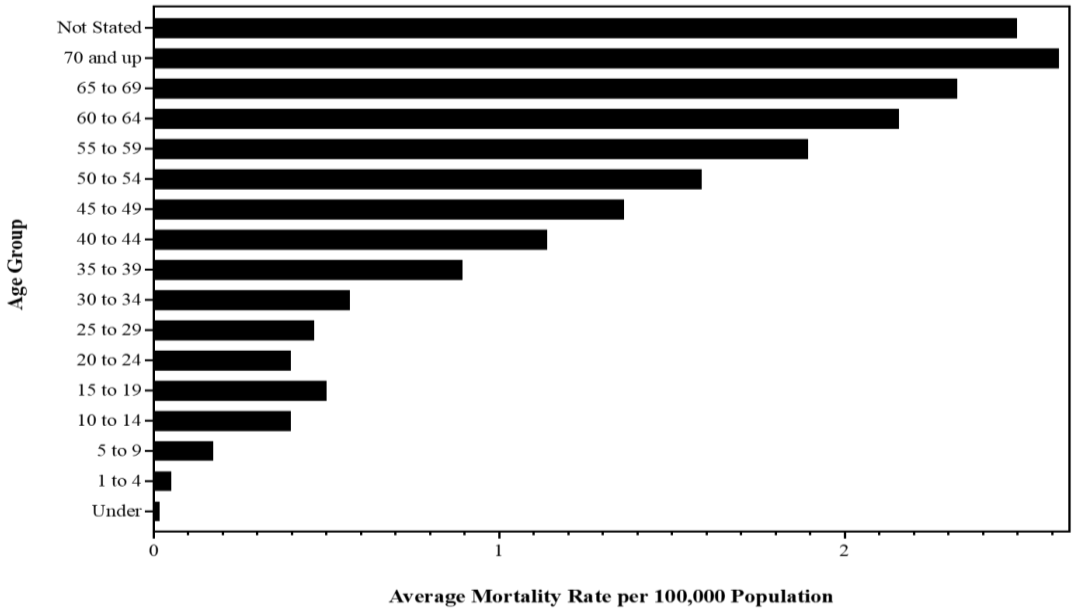

Figure 3. Schistosomiasis-related mortality rate by age group in the Philippines, 1960-2019

3.4. Region-specific mortality and morbidity

For the region-specific shown in Figure 4, it can be noted that the highest average mortality rate is Region VIII (Eastern Visayas), with a rate of 4, and the highest average morbidity rate is Region XI (Davao), with a rate of 53. Region II (Cagayan Valley) and Region Cordillera Administrative Region (CAR) have the lowest mortality and morbidity rates, 0.03 and 0.04, respectively.

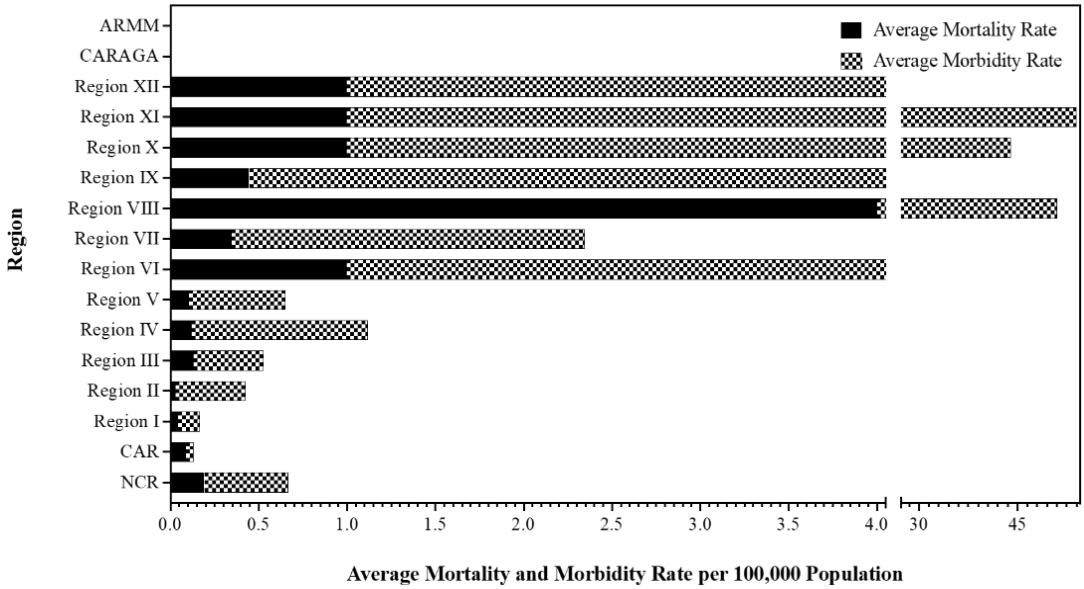

Figure 4. Schistosomiasis-related mortality and morbidity rate by region in the Philippines from 1960-2019

One of the reasons Region VIII has the highest mortality rate is that Leyte, a province in the Philippines' Eastern Visayas region, is one of the major schistosomiasis endemic areas [27], which allows schistosomiasis, soil-transmitted helminthiases, and other coinfections to disperse and result in the highest prevalence. Moreover, the results are related to a study that showed that the number of cattle with Schistosomiasis was higher in Leyte Province (51.5%) [28], compared with the other provinces such as South

Cotabato (48.6%, Region XII) [9], and Cagayan Province (26%, Region II) [29]. Accordingly, a high prevalence of schistosomiasis results in a high infection rate and a high mortality rate in the area. Also, the different levels of schistosomiasis in different areas are caused by physical environmental factors like rainfall and the temperature of the land's surface. For example, constant rain and flooding can cause snail colonies to grow on plants, which puts people in the area at risk of getting schistosomiasis [30].

Furthermore, poverty tends to raise disease prevalence in endemic communities by limiting access to healthcare and increasing exposure to contaminated water [31]. For instance, children who lived in a house or attended a school with an improved latrine were less susceptible to infection with schistosomiasis than those who did not [26]. This study shows that there are many different and creative ways to break the cycle of transmission. This us an idea of how to effectively design programs to reduce infections. Children could stay away from polluted water by building small stations for doing laundry or watering animals near rivers or streams. These stations could be made with cheap materials that are easy to find in the area [32]. Moreover, Significant attitudes toward schistosomiasis regulation, as well as the effects of these attitudes on program responsiveness [33], behavioral and sociocultural contexts should supplement extensive disease control programs to improve impact in endemic communities. Also, the control strategy to be considered is the regular treatment and vaccination of carabaos, which serve as a major reservoir host. When combined with mass treatment and snail control, this approach has the potential to lead to more effective and resilient disease control in the Philippines [11], [14], [34], and the development and mitigation of poverty in the country [25].

4. CONCLUSION

Schistosomiasis mortality rates in the Philippines have dropped dramatically over the last six decades, demonstrating the effectiveness of the country's control measures, including mass drug treatment (praziquantel) of entire communities. In sex-specific mortality, a male has a higher mortality rate than a female, which indicates that males were more exposed to schistosomiasis due to occupational causes such as farming and fishing. The fact that Eastern Visayas and Davao have the highest mortality and morbidity rates, respectively, can be used to inform the Department of Health and other health actors on how to improve the effectiveness of Mass Drug Administration coverage by focusing on these two regions. Moreover, repeated use of praziquantel at high coverage levels may result in the emergence and spread of drug-resistant parasites, quickly negating the drug's efficacy. Because of this, prevention and control measures need to be strengthened. For example, a human vaccine needs to be planned and made, tractors need to be used more in farming, water buffaloes need to be vaccinated so that they don't spread the disease, intervention communities need to have access to essential medicines, water, sanitation, and hygiene, and a program needs to be put in place to raise awareness from the local to the national level.

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