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Assessing six decades of rabies in the Philippines

Ralf Benjo Goder Morilla, Kathleen Laum Cabanlit, Angel Mae Frias Luga, Chin-Chin Jimenea Demayo, Jamerah Baniaga Sidic, Cesar Guinanao Demayo
Department of Biological Sciences, College of Science and Mathematics, Mindanao State University-Iligan Institute of Technology, Iligan City, Philippines

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ABSTRACT

Despite initiatives to address the disease, rabies remains a public health threat in the Philippines. To determine the trend of rabies infections in the country and provide possible interventions to reduce or eliminate deaths of the affected, we evaluated rabies morbidity and mortality statistics over sixty years. Over the last six decades, rabies mortality rates in the Philippines have steadily decreased. The Philippines' rabies sex-specific mortality rate trend from 1960 to 2019 showed that males account for higher rabies mortality than females. People aged 70 and up have the highest mortality rate, while children under the age of 1 have the lowest. The region with the highest mortality rate in the Philippines is region II (Cagayan Valley), with 39.5. The region with the highest morbidity rate is XI (Davao region), with 148.7. The correlation value was 0.197, indicating a weak correlation between regional morbidity and mortality rates in the Philippines over the years. Hence, those who have contracted rabies are less likely to die over time. Comprehensive control measures by both the national and local government units should be strengthened to eliminate rabies in the Philippines within the next few years.

Corresponding Author:

Ralf Benjo Goder Morilla
Department of Biological Sciences, College of Science and Mathematics, Mindanao State University-Iligan Institute of Technology
Iligan City, Philippines
Email: ralfbenjo.morilla@g.msuiit.edu.ph

1. INTRODUCTION

Rabies is a fatal infectious and zoonotic disease caused by a virus from the genus Lyssavirus and the family Rhabdoviridae that affects domestic and wild animals and can be transmitted to humans. It is a disease that both affects and kills people worldwide [1]. The World Health Organization (WHO) envisioned that rabies kills 59,000 humans yearly in over 150 international locations, with 95% of cases in Africa and Asia [2]. Although the disease is 100% deadly, it is entirely avoidable through human and animal vaccination, the primary intervention strategy for canine rabies eradication [3], [4] Despite attempts to deal with the issue, rabies remains a public health risk in the Philippines. The Philippines is one of the top ten countries globally with the highest rabies prevalence, with 200 to 300 deaths yearly [5]. In most human rabies cases worldwide, dogs and cats are the most prevalent reservoirs of the rabies virus [1]. Humans contract the virus through bites from infected animals or direct contact with virus-laden saliva on mucosal surfaces such as skin breaks, lips, mouths, and eyes [2].

Collaborations, such as United Against Rabies, have been formed to achieve zero human dog-mediated rabies deaths worldwide by 2030 [2]. In the Philippines, the Anti-Rabies Act of 2007 (R.A. 9482) (PAWS 2013) mandates that all dogs are fully vaccinated and registered by local government entities [6]. The

Philippines' national rabies control and prevention program, a collaboration among the Department of Agriculture, the Department of Health, and different partners, set an intention for rabies eradication in 2020 [7]. Thus, the country urgently requires an efficient rabies control policy. To attain a rabies-free Philippines by the year 2020, the R.A.9482 was adopted, dog impoundment and castration, dog impoundment and castration performing information, education, and communication (IEC) sessions [8]. According to the program's manual of operations, dog vaccination and population management, pre-and post-exposure prophylaxis, health promotion, a central database system, and responsible pet ownership are all critical components [8]

Two common epidemiological monitoring indicators are morbidity and mortality. These indicators show how a health problem develops and how serious it becomes. They help determine what underlies diseases and compare health outcomes and demographics [9]. It analyzes current health conditions, predicts risk patterns, and tracks trends in specific hospitalization and mortality causes across time. As a result of the public's concern about health, these data have become critical for study [10].

Given the constantly changing pattern and trend in national and global morbidity and mortality statistics, having comprehensive data and analysis of cause-specific health statistics is critical for a country's general health awareness and contextualizing national and social development. To the best of the author's knowledge, no published studies have focused on the profile and trends of morbidity and mortality rates from rabies in the Philippines. Therefore, the current study described and analyzed rabies morbidity and mortality statistics over sixty years to comprehensively review primary data for disease analysis and management.

2. RESEARCH METHOD

2.1. Data collection

The Philippine health statistics (PHS) series, the Department of Health's (DOH) yearly publication that accumulates information on crucial health events, was utilized to obtain rabies morbidity and mortality statistics for each age-groups, sex, and region. It comprehensively summarizes the country's current natality, morbidity, and mortality statistics. The PHS results from collaboration and coordination between the Philippine statistics authority (PSA), this department, and local health unit partners. The data collected from the source was compiled, evaluated, and presented in tables and graphs for more meaningful and helpful information.

2.1.1. Morbidity and mortality rates computations

The mortality rates of rabies in the Philippines were calculated concerning different age groups (for babies aged under 1, 1-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, and 70 years old and over), and sex (male or female). Meanwhile, morbidity and mortality rates by 100,000 were also calculated in different regions (National Capital Region, Cordillera Administrative Region, Region I, Region II, Region III, Region IV-A (CALABARZON), Region IV-B (MIMAROPA), Region V, Region VI, Region VII, Region VIII, Region IX, Region X, Region XI, Region XII, Region XIII (CARAGA), and Bangsamoro Autonomous Region in Muslim Mindanao (BARMM) from 1960-2019 [11], [12].

2.2. Data analysis

For illustrative reasons, rabies mortality and morbidity rates were evaluated to determine the patterns of mortality change for each year, age group, sex, and region in this research. A spreadsheet software (Microsoft Excel package) was used for all of the data analysis. The researchers employed line graphs and cluster bar charts to depict better the data to represent the study's conclusion. From 1960 to 2019, line graphs were used to show sex-specific mortality trends and overall morbidity death rates, while bar graphs were used for age-specific mortality trends. On the other hand, cluster bar charts displayed regional morbidity and mortality rates. In normally distributed data, the mean represents the central tendency of the data values. However, when attempting to explain the shape of a distribution, the mean alone is insufficient; as a result, many medical works of literature use the standard deviation (SD) and standard error of the mean (SEM) in addition to the mean to report statistical analysis results [13]. A measure of variability is the standard deviation [14]. The greater the proportion of standard deviations, the more the data for that sample is dispersed. The standard error reflects the precision with which a sample distribution represents a population by analyzing the standard deviation. With a significant standard error, sample means are widely spread around the population mean, signaling that your sample may not precisely reflect your population. With a low standard error, sample means are uniformly distributed around the population mean, indicating that your sample reflects the total population. Independent samples test (also known as the two samples t-test) is generally used for comparing the means of two independent samples [15]. The independent samples t-test assumes that data are sampled at random from two unrelated populations that are roughly normally distributed [16]. The researchers utilized the Pearson correlation to show the correlation between rabies morbidity and mortality data in different regions of the Philippines from 1960 to 2019. The Pearson correlation coefficient indicates how strong the linear relationship between the two random variables is. A and b are considered to be

uncorrelated if p2 (a, b)=0. The closer the value of ρ2 (a, b) is to 1, the stronger the correlation between the two variables is [17].

3. RESULTS AND DISCUSSION

3.1. Overall rabies mortality rates in the Philippines from 1960 to 2019

Figure 1 shows the overall mortality from rabies in the Philippines from 1960 to 2019. Rabies mortality rates in the Philippines have gradually declined over six decades as shown in Figure 1, which is a positive thing, as it shows the impacts of the efforts of the Philippines' national rabies control and prevention program. This program collaborates with the Department of Agriculture, the Department of Health, and different partners with a similar perspective. The visualization of rabies mortality rates as presented in Figure 1 is supported by evidence, as the Department of Health (DOH) has declared 49 municipalities rabies-free since 2017, including Bohol, and Camiguin island [18]. The findings are consistent with other international studies of a similar design [19]–[25].

Figure 1. National rabies mortality rate trend in The Philippines, 1960 to 2019 (3-point moving averages, centered in the last year of three years)

In recent years, the number of rabies-related deaths in Bangladesh has decreased by around 50% resulting from a concerted government effort comprising advocacy, communication, social mobilization (ACSM), mass dog vaccination (MDV), contemporary treatment for animal bites, and dog population management [19]. From 1938 to 2018, the elimination of the canine rabies virus variant (CRVV) in the United States by the canine rabies vaccine resulted in a tenfold reduction in human rabies cases [20]. Another consistent finding is that after years of implementing rabies control programs and initiatives, no single case of human rabies was documented in South Africa in 2011 and Tanzania in 2013 [21], [22]. Due to increasing public awareness and the effective deployment of mass dog vaccination (MDV), Sri Lanka and Bhutan have also achieved substantial progress in their rabies elimination efforts [23], [24]. A spatial analysis of rabies cases in China revealed that, while the overall number of rabies cases reduced from 2007 to 2011, the infection's spread is still rising [25]. Even though rabies mortality rates have been steadily declining for the past six decades, the Philippines has observed an upsurge in the number of new cases and a spreading trend in recent years, specifically in 2016-2019. Over the previous decade, however, rabies has remained endemic in the Philippines under the radar of government policies and programs [26].

For past decades, managing rabies outbreaks in domestic animals has been challenging. In the event that the domestic animal contracted rabies, the exposure occurrence would undoubtedly lead to future human exposure. Healthy cats and dogs who bite someone should be sedated and monitored for a period of 14 days. It is advised against administering the rabies vaccine while under monitoring. When these animals exhibit the first symptoms of illness while being kept in captivity, a veterinarian should examine them. Animal illnesses should be reported right once to the nearest veterinarian clinic. If symptoms suggestive of rabies appear, the animal should be euthanized, its head should be removed, and it should be kept in a sealed, and chilled container for testing at the diagnostic lab. Other animals that have bitten people and may have done so in a way that

exposed them to rabies should be reported right away to the local veterinary clinic and health authority. The management of animals other than dogs and cats is based on the species, conditions of the bite, local rabies epidemiology, history of the animal that bit the person, current health status, and risk of rabies exposure [8].

3.2. Sex-specific rabies mortality rates

Figure 2 shows the differences in rabies mortality between sexes in the Philippines from 1960 to 2019. In some cases, males are more susceptible to infectious diseases than females [27], [28]. From 1960 to 2019, the rabies sex-specific mortality rate trend demonstrates that males account for the more significant number of rabies deaths in the Philippines. This finding indicates that males are far more susceptible to rabies than females. Although various reasons may contribute to sex variations in rabies distribution, occupational activities that expose people to dog bites are more likely to occur in males than in females [29]. Although human activities related to dog bites have not been extensively researched, males frequently engage in activities such as hunting and herding that require close connection with dogs. According to research, males are more likely to be bitten by dogs because males are more adventurous and aggressive, and females spend more time at home than males [30]–[32]. Due to hormonal differences between the sexes, sexual dimorphism can cause differing immunological responses to viral infection [33]. Sexual hormones, such as estrogen, play a crucial role in immune-endocrine interactions and impact the host's ability to fight infection [27]. In addition, females have more robust humoral and cell-mediated immune responses to antigenic stimulation, immunization, and infection than males [34]. Females have consistently stronger, more robust antibody responses to infections and vaccinations than males [35], [36]. Furthermore, more females developed serum sickness in humans than males when testing rabies immunoglobulin (RIG), emphasizing differences in immune responses among sexes [37].

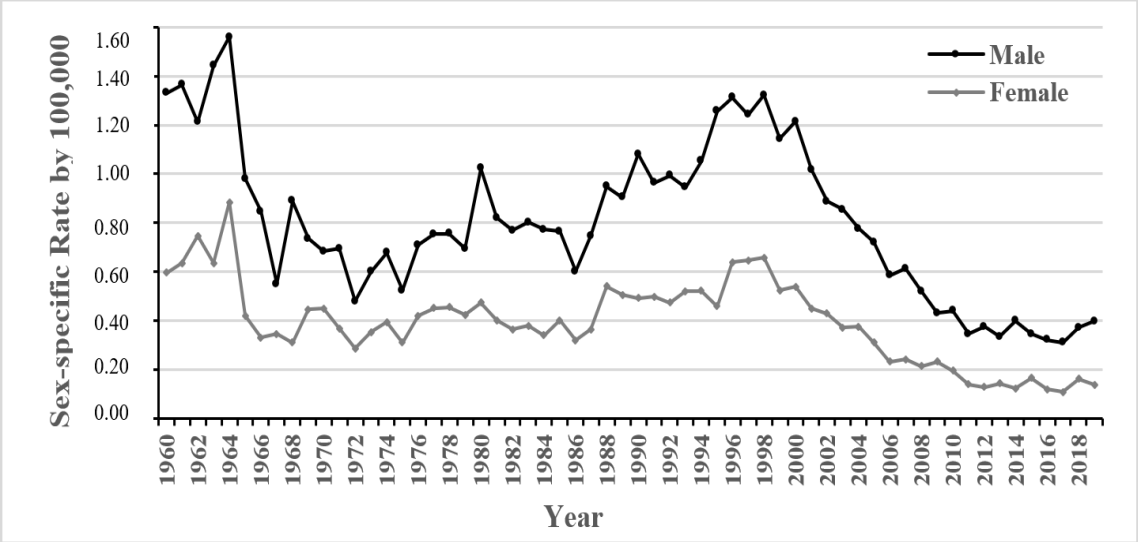

Figure 2. Mortality trend of rabies in the Philippines from 1z960 to 2019 by sex

Features of rabies sex-specific mortality cases found in this study were similar to those reported in studies in the Philippines and elsewhere in neighboring countries. In fact, the study by Dimaano *et al*. stated in their results that male patients with rabies outnumbered females by a ratio of 2.2:1 [38]. The dog is the most prevalent biting animal and also the principal rabies vector in the Philippines [39]. Animal bite exposures were seen predominantly as almost twice as common in boys (61%) as it was in girls (39%) [40]. The results are in line with those of other studies carried out across the globe [41]–[45]. International studies revealed that rabies victims mainly were males [41]–[43]. When disaggregated by sex, the proportion of animal bites (dog bites are the majority) and human rabies, post-exposure prophylaxis (PEP) was significantly higher in males than females across all age groups [32], [44], [45].

Table 1 shows the t-test results of sex-specific rabies mortality rates. A two-independent sample t-test was used to test if there is a significant difference in the mortality rate of rabies between males and females in the Philippines. Results showed that the t-statistic is 8.80, and the p-value is 0 as shown in Table 1. Hence, there is a significant difference in the mortality rate of rabies between males and females in the Philippines.

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

t	df	Sig.
8.80	118	0.000

Table 2 shows the group statistics of sex-specific rabies mortality in the Philippines. The result above shows us that the mean mortality rate for the male is around 0.803 while around 0.393 for the female. The standard deviation values above tell us that the male mortality rate data are more dispersed than the females-implying that the male mortality rate from 1960 to 2019 is more scattered than the female. In the mortality rate of rabies, the male samples have a higher standard error mean than the female samples-indicating that the female sample more closely represents their population than the male sample.

Table 2. Sex-specific rabies mortality group statistics

Sex	N	Mean	Standard deviation	Standard error mean
Male	60	0.803	0.319	0.041
Female	60	0.393	0.169	0.021

3.3. Age-specific rabies mortality rates

As for the age-specific rabies mortality rate trend from 1960 to 2019, the mortality rate per age group is depicted in Figure 3. The graph showed that people aged 70 and over have the highest mortality rate while those under 1 year old have the lowest mortality rate. The findings are in accordance with a previous study conducted in the Philippines [38] but in contrast to some studies in other countries [42], [46]–[48]. In the Philippines, rabies mortality in adults outnumbered children (classified as less than age 20) by a ratio of 2:1 [38]. Perhaps one of the reasons why adults have a greater mortality rate is that following a dog or other animal bite, parents rush their children to get vaccinated.

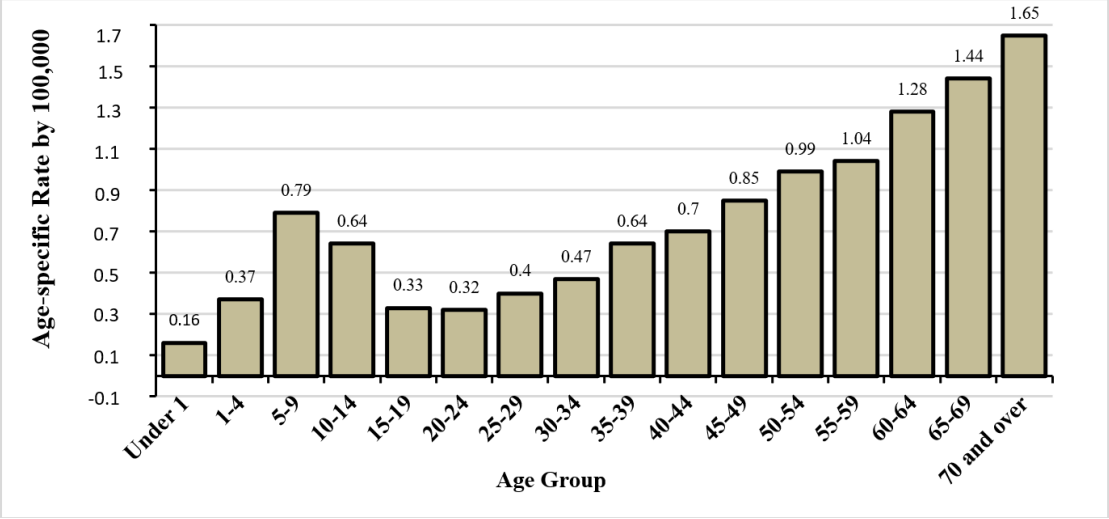

Figure 3. Average mortality rate of rabies per age group in the Philippines, 1960 to 2019

On the other hand, parents may choose not to vaccinate after a dog bite if the wound is not severe [49]. In recent years, it was discovered in an international survey that the rate of vaccination following dog bites among children was higher than in adults [50]. In developed countries, the probability of a negative outcome from infectious diseases, in particular, increases for older people [51]. Therefore, changes in pathogenicity, immune responses, infection rates, survival periods, and mortality rates might be expected depending on the individual's age [33].

3.4. Region-specific morbidity and mortality rates

Figure 4 shows rabies morbidity and mortality rates in all regions in the Philippines. Based on the figure, the highest mortality rate among the regions in the Philippines is region II (Cagayan Valley), with a 39.5 mortality rate. In contrast, the region with the lowest mortality rate is BARMM, with a mortality rate of 3.74. Meanwhile, the highest morbidity rate among the regions in the Philippines is region XI (Davao region),

with a 148.7 morbidity rate. In contrast, the lowest morbidity rate is region IVB (MIMAROPA), with a morbidity rate of 4.35. It was discovered that most animal rabies cases are in the Davao region, a highly urbanized city with a population of 1,632 million [52]. Since it is the country's largest city, cases were coming from 210 rabies-infected dogs documented from 2006 to 2017. Even though mass canine vaccination has been in place in Davao City since 2006, when other control measures like impounding and neutering were implemented in 2011, rabies incidents continued to fluctuate [53].

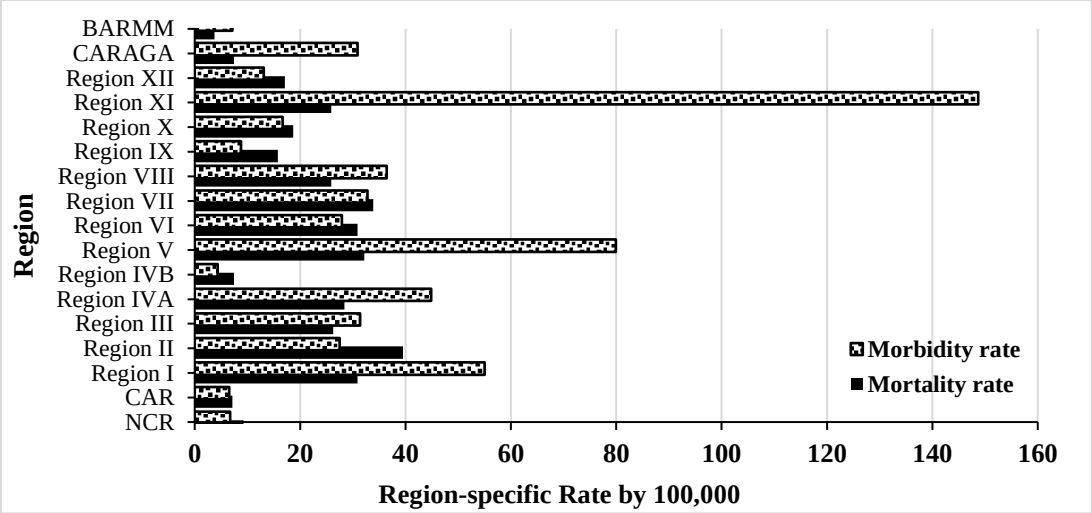

Figure 4. Region-specific morbidity and mortality rates of rabies in the Philippines, 1960 to 2019

Geographical differences in regions, population density, and local rabies epidemiology may also explain variations in the prevalence of animal bites by region [41]. Because of low vaccination coverage among dogs in the different areas of the Philippines, the rabies control effort has not successfully eliminated rabies. As a result, the country urgently requires more efficient and feasible rabies control techniques. Because rabies can become endemic if the virus is introduced in locations where there were no known cases, it's critical to determine if inter-island or regional transmission can occur [54].

Table 3 shows the statistical results of Pearson's Correlation and the significance value of the Regional Morbidity and Mortality Rates of Rabies in the Philippines from 1960-2019. Results showed a correlation value of 0.197 as shown in Table 3, which shows a weak correlation between the Philippines' regional morbidity and mortality rate from 1960 to 2019. Hence, the implication of the government's programs and initiatives to eradicate rabies have a significant impact.

Table 3. Pearson's R correlation and the significance value of the regional morbidity and mortality rates of rabies in the Philippines, 1960-2019

Variables	Pearson's R correlation	Significance value
Dependent: Mortality rate Independent: Morbidity rate	0.197	0.131

Rabies in the Philippines had a 100% mortality rate from 1960 to 1983 due to non - the availability of vaccines. In other words, because immunizations were not accessible then, everyone who contracted rabies died. Even though there is currently no standard approach for oral vaccination of dogs (OVD) field trials against rabies in the Philippines, it was decided to include as many WHO recommendations as possible [55]. As a result, the trial gathered data on dog biology, including dog density, population structure, and dog: human ratio, as well as information on bait distribution (staff training, bait delivery system, bait costs, and local human population acceptance, risk assessment (possible nontarget species exposure to baits), and vaccination coverage efficacy [56]. The OVD-trial protocol has received approval from all regulatory and other local and national agencies in the Philippines. Before the field testing, the active assistance of the local community and authorities was also secured [55].

The rabies mortality rate increased in 1996 due to the government's decision to relocate its biological production service, which resulted in the suspension of rabies vaccine production. Only 42,000 doses of the vaccine were available in the country, which was insufficient to immunize the country's seven million dogs [57]. To prevent and control the country's rabies problem, the Philippines passed Republic Act (RA) No. 9482, also known as the "Anti-Rabies Act of 2007," which mandates the "control and elimination of human and animal rabies, prescribing penalties for violations, and authorizing monies accordingly." This bill was passed on May 25, 2007. It established the national rabies prevention and control program (NRPCP), a multi-agency initiative to control and eradicate rabies in the Philippines [58]. Evidence shows that people who have contracted rabies are less likely to die over the years. This is undeniably due to government control initiatives such as inter-sectoral coordination, access to modern rabies vaccines, awareness education, and most importantly, national & local cooperation. However, numerous private animal bite clinic facilities in the Philippines do not keep track of the number of bitten people they treat. Hence data was unavailable for analysis [26].

4. CONCLUSION

Mortality rates from rabies in the Philippines have gradually decreased over the last six decades, demonstrating the efficiency of the country's national rabies control and prevention program. Despite this decline in recent years, new cases and a spreading trend have been observed. The researchers strongly recommend evaluating the government's disease surveillance system. Reconfiguring the operations, including a continuing early detection program as a minimum requirement to ensure that suspected cases of rabies virus carriers are investigated and reported. Additionally, as required by law, an extensive investigation must be conducted into the institutions and programs of cities and municipalities, as well as the upkeep of a dog pound where impounded dogs must be held. To eliminate rabies in the Philippines within the next few years, comprehensive control measures such as management commitment to control initiatives, inter-sectoral coordination, sensitive surveillance systems, access to the modern rabies vaccine, awareness education, and national and local cooperation should be strengthened.

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BIOGRAPHIES OF AUTHORS

Ralf Benjo Goder Morilla graduated from Mindanao State University-Iligan Institute of Technology (MSU-IIT) in January 2020 with a bachelor's degree in Biology major in General Biology. During his undergraduate years, he was a DOST-Junior Level Science Scholar under RA 7687. He is currently a DOST-ASTHRDP (Department of Science and Technology-Accelerated Science and Technology Human Resource Development Program) scholar at MSU-IIT, where he is pursuing a master's degree in Biology and focusing on research in Public Health. He can be contacted at email: ralfbenjo.morilla@g.msuiit.edu.ph.

Kathleen Laum Cabanlit is a Department of Science and Technology–Accelerated Science and Technology Human Resource Development Program (DOST-ASTHRDP) scholar, taking up a Master of Science in Biology at Mindanao State University–Iligan Institute of Technology (MSU-IIT), Iligan City, Philippines. Currently working on Big Data Research in Public Health. She can be contacted at email: kathleen.cabanlit@g.msuiit.edu.ph.

Angel Mae Frias Luga is a student from Mindanao State University–Iligan Institute of Technology (MSU-IIT), Philippines. She graduated with a bachelor's degree in Biology from MSU-IIT last January 2020. She is a Department of Science and Technology-Accelerated Science and Technology Human Resource Development Program (DOST-ASTHRDP) scholar, taking up a master's in biology in MSU-IIT, and is currently working on her thesis entitled, "An epidemiology study on Infectious Diseases in the Philippines from 1960-2019". She can be contacted at email: angelmae.luga@g.msuiit.edu.ph.

Chin-Chin Jimenea Demayo is a is a graduate student from Mindanao State University-Iligan Institute of Technology taking up Doctor of Philosophy in Biology, and a Department of Science and Technology-Accelerated Science and Technology Human Resource Development Program (DOST-ASTHRDP) scholar. She can be contacted at email: chinitademayo@gmail.com.

Jamerah Baniaga Sidic is a Mindanao State University–Iligan Institute of Technology (MSU-IIT) student in the Philippines. She received her bachelor's degree in Biology in June 2020 with a scholarship from the Department of Science and Technology–Science Education Institute (DOST-SEI). She is currently a scholar at the Department of Science and Technology-Accelerated Science and Technology Human Resource Development Program (DOST-ASTHRDP) pursuing a Master of Science in Biology at the same school. Her email address is jamerah.sidic@g.msuiit.edu.ph.

Cesar Guinanao Demayo is a professor at Mindanao State University–Iligan Institute of Technology, having a Ph.D. in Entomology and Ph.D. in Genetics from the University of the Philippines–Los Banos. As a researcher, his skills and expertise encompass Computational Biology, Entomology, Ethnomedicine, Genetics, Phylogenetic Analysis, Systematics, Morphometrics, Functional Morphology, Ecology and Evolution, and Biodiversity. He can be contacted at: cgdemayo@gmail.com; cesar.demayo@g.msuiit.edu.ph.