International Journal of Community Medicine and Public Health
*Oo SM et al. Int J Community Med Public Health. 2021 Jan;8(1):9-16*
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20205671

**Original Research Article**

# Soil-transmitted helminthiasis among school-aged children in Myanmar: the result of 14 years after the implementation of deworming

**Soe Min Oo[1]*, Aung Tun[2], Thi Thi Htoon[3], Phyo Phyo Kyaw[4], Win Lae Htut[5], Maung Maung Linn[6]**

[1]Department of Epidemiology, University of Public Health, Yangon, Ministry of Health and Sports, Myanmar
[2]Technical Advisor, Ministry of Health and Sports, Myanmar
[3]Department of Medical Services, National Health Laboratory, MOHS, Myanmar
[4]Department of Public Health, School Health Division, MOHS, Myanmar
[5]Department of Public Health, MOHS, Myanmar
[6]National Professional Officer, WHO Office (Yangon), Myanmar

**Received:** 29 September 2020
**Revised:** 22 November 2020
**Accepted:** 30 November 2020

***Correspondence:**
Dr. Soe Min Oo,
E-mail: soeshine@ucla.edu



## ABSTRACT

**Background:** Soil-transmitted helminth (STH) infections were the most common infections among school-aged children (SAC) in Myanmar. The routine school-based mass drug administration (MDA) with twice a year frequency has started in 2005.
**Methods:** This cross-sectional study aimed to determine the prevalence and intensity of STH infection among SAC as the follow-up study after 14 years of MDA. In August 2019, 1000 school-aged children attending Grades 4 and 5 from four geographical regions across the country were enrolled using a multi-stage sample random sampling. The anthropometry and hemoglobin concentration was measured, and stool specimens were detected parasite eggs using the Kato Katz technique.
**Results:** The intensity of infection was classified according to WHO criteria. Infection prevalence was 17% for any STH infections, 10.4% for *A. lumbricoides*, 17% for *T. trichiura*, and 2% for the hookworm. All STH infections were virtually not detected in the hilly region. The highest prevalence of *A. lumbricoides* and *T. trichiura* infection were seen in the coastal region. The hookworm was seen only in the plain region. The underweight prevalence was 9% and anemia prevalence was 38% while there were huge differences across regions. The finding showed that STH infections continued to be endemic among SAC throughout the country except for the hilly region after 14 years of MDA.
**Conclusions:** The regular deworming program should be reduced to once a year frequency in Myanmar. Triple-dose regimens should be considered to eliminate the whipworms. The burden of anemia among SAC should also be addressed in cooperation with MDA.

**Keywords:** Anemia, Myanmar, Soil-transmitted helminth infections, Underweight

## INTRODUCTION

Soil-transmitted helminth infections (STHs) are among the most widely recognized infections all around the world. They affect the poorest and most deprived communities. STHs is a group of parasitic diseases caused by nematode worms that are transmitted through fecal- contaminated soil among humans. The transmission risk of STHs is associated with the availability of

sanitation facilities.[1] More than a quarter of the world's population is at risk of infection with STHs: roundworms (*Ascaris lumbricoides* and *Strongyloides stercoralis*), hookworms (*Ancylostoma duodenale* and *Necator americanus*), and whipworms (*Trichuris trichiura*).[2] Infections are widely distributed in tropical and subtropical areas, with the greatest numbers occurring in South and East Asia, sub-Saharan Africa, and the Americas.

Approximately 1.5 billion people are infected with soil-transmitted helminths worldwide in 2020.[3] It was estimated that 819 million people were infected with *A. lumbricoides*, 439 million people with hookworms, and 465 million people with *T. trichiura* in 2010. Over 835 million preschool-age and school-age children are living in areas where these parasites are severely transmitted. Thus, Asia alone accounts for 67% of this disease burden and 68% of years lived with the disability (YLD). Among Asian countries, India is one of the largest contributors to the global burden with a national population prevalence of 21%.[4] Hookworm infection was attributable to 65% of the 5 million years living with disability (YLDs) attributable to STH, *A. lumbricoides* accounted for 22%, and *T. trichiura* attributed to the remaining 13%. STHs caused disability-adjusted life years (DALYs) loss of 39 million per year, which was a burden similar to that of malaria or tuberculosis.[5]

In Myanmar, the prevalence of any STH infection was high (69.7%), with 18% of a moderate to heavy intensity of infection in 2002. *T. trichiura* was the common STH species identified, with a country prevalence of 57%.[6] Based on this finding, the Ministry of Health and Sports (MOHS) launched a pilot intervention of deworming activity in the delta areas; Ayeyarwady Region and Yangon Region, where 1.4 million primary school children have been dewormed in 2004.[7] The MOHS started the MDA campaign targeting all children aged between 2 and 5 years, all primary school students, 5 to10 years out-of-school children, and pregnant women with at least three months of gestation for de-worming activity in 2005.

MOHS in cooperation with the Ministry of Education (MOE), expended deworming activity as the routine school-based large-scale distribution of deworming tablets (Albendazole 400mg) throughout the country with, twice a year basis in 2006.[8] Since then, MDA coverage has increased yearly, resulting in reported coverage of 78% in 2006, 86% in 2007, 87% in 2008, 86% in 2009, 94% in 2010, and 2011, and 95% in 2012 among school-aged children(SAC).[9] According to the WHO Preventive Chemotherapy and Transmission Control (PCT) databank by the Myanmar government, the MDA coverage of school-aged children (SAC) was 99.18% in 2015.[10]

However, STH infections remained at a medium prevalence in the adult population of the delta region in Myanmar. According to the 2016 baseline study, 27.8% of the adult population had at least one type of STH infection. The most prevalent STHs were *T. trichiura* (18.1%), hookworm (8.7%), and *A. lumbricoides* (5.3%) subsequently. The majority of infections were of low intensity which was measured by eggs per gram (EPG) of feces. The hookworm prevalence was significantly higher in males, whereas *A. lumbricoides* infection in females showed that adults were a major contributor to the total STH prevalence and EPG burden, probably perpetuating transmission.[11]

After seven years of implementation of MDA, a country-wide survey (2012-2013) among SAC has reported that *A. lumbricoides* infection, *T. trichiura*, and hookworm infection had histrionically decreased to 5.8%, 18.6%, and 0.3%, respectively. Likewise, a heavy infection was seen in only 0.4%. On the contrary, the prevalence of anemia soared to 36%, although it was 22% in 2002. According to the WHO manual of Helminth control in SAC 12, these findings have indicated the possibility to reduce the frequency of deworming and signposted regular deworming frequency can be suspended, reduced, or maintained at the present frequency of twice per year depending on the prevalence observed in geographic areas in Myanmar.

Nevertheless, MOHS maintained the frequency of MDA with the same frequency of twice a year basis for the next 7 years up to 2019. Hence, it is a necessity to update information on the epidemiology of soil-transmitted helminthiasis among SAC in Myanmar. This study aimed to determine the prevalence and intensity of STH infection and to determine the anthropometry and anemia prevalence among SAC in Myanmar after 14 years of MDA. The survey finding is expected to fill the information gap and support the country in strengthening its efforts in school-based STH control.

## METHODS

The cross-sectional study was conducted from August to December 2019 in twenty primary schools of four non-randomly selected townships from the respective four geographical areas of the country; the plain, the delta, the hilly, and the coastal. These townships were the same places where the previous two studies were conducted 7 years and 14 years ago respectively. Using simple random sampling, five primary schools were selected per township to get the required sample size. Approximately 230 to 270 samples were collected from each geographical area.

School children of both sexes attending Grades 4 and 5 and who had attended this school for the previous two consecutive years were included. Those who were newly transferred from other areas or other schools were excluded from the study.

The sample size for the quantitative data collection was calculated by the formula n=z2pq/d2 assuming the

proportion of prevalence of any STH as 21 %.[13,9] The study participants were recruited by carefully explaining the study objective and procedure to students, teachers, and principals to ask for their consent. Then, written informed consent was obtained from all participants and their guardians. A total of 1039 participants were recruited for the study. A response rate of 97% was achieved, and after the exclusion of individuals with missing or incomplete questionnaires, 1000 school children with 487 girls and 513 boys were included in the final analyses.

***Data collection and measurements***

Routine school-based MDA with Albendazole 400mg for the August round was withheld at the selected four townships; Pinlaung township (the hilly), Phyu township (the plain), Naungdone township (the delta), and Myeik township (the coastal) till the completion of the data collection. Drug administration was given accordingly after the survey. Using a standardized data collection procedure, surveyor teams composed of a team leader, two laboratory technicians, and three surveyors recruited the study participants, asked informed consent, interviewed students using predetermined questions, measured anthropometry, collected fecal samples to detect eggs of the worms, and blood samples for hemoglobin assessment. Stool samples were collected in plastic containers and checked by one lab technician to send to National Health Laboratory in Yangon on the same day of collection. Using the Kato Katz technique, parasite eggs were examined on a single slide.[14] Ten percent of the samples were rechecked for the accuracy of counting and identification of the eggs. Any discrepancy was discussed, and if necessary, corrected with retraining. The intensity of infection was classified according to the WHO thresholds.[15] Weight and height was measured according to "Guide to Anthropometry, food, and nutrition technical assistance (FANTA Guide).[16] Weight was measured by an electronic scale to the nearest 100g (0.1kg). Height was measured using a height board.

Using a sterile lancet, a blood drop was collected by finger prick to analyze hemoglobin (Hb) with HemoCue AB, a portable spectrophotometer.[17] To check and revise the procedure as necessary, the pretesting procedure was done at two primary schools before the survey.

We used the following operational definitions regarding the intensity of worm infection, BMI, and hemoglobin cutoffs for anemia:

a. STHs intensity was classified according to WHO criteria.[18] The number of EPG of feces was calculated by the addition of the egg counts in all fields together and multiplied the total by 24.

b. In our study, the BMI-for-age cut-off used is; >95$^{th}$ percentile as overweight and <5$^{th}$ percentile as underweight. Between the 5$^{th}$ and 95$^{th}$ percentile is considered normal weight.[19]

c. Regarding anemia,

For children 8 to 11 years of age, hemoglobin concentration <11.5 g/dl was measured anemic (mild for 11.0 to 11. 4 g/dl, moderate for 8.0 to 10. 9 g/dl, severe for <8 g/dl).

For children 12 to 14 years of age, hemoglobin concentration <12.0 g/dl was measured anemic (mild for 11. 0-11. 9 g/dl, moderate for 8.0 to 10. 9 g/dl and, severe for <8g/dl).

For children > 14 years, <12.0 g/dl for girls, and <13.0 g/dl for boys were measured anemic (mild for 11. 0-11. 9 g/dl (girl) and 11.0–12.9 g/dl(boy), moderate for 8.0 to 10. 9 g/dl and, severe for <8 g/dl).[20]

***Ethical consideration***

The ethical clearance for the study was obtained from the Institutional Review Board (IRB) of the University of Public Health, Yangon. It is also registered by Preliminary Registration: HRID-00565_V2 at Myanmar Health Research Registry, Department of Medical Research, Yangon, The Republic of the Union of Myanmar.

***Statistical methods***

Stata 15.0 was used for data processing and analysis. Prevalence of STH was be calculated as: P= Number of stool sample detected eggs of STH using the Kato Katz technique / # of stool sample examined *100. We used multivariable logistic regression analyses to estimate the adjusted odds ratio (AOR), and 95% confidence interval (CI) to determine the risk of STH infection and the risk of anemia amongst SAC living in the non-hilly region than those living in the non-hilly region. In this study, a p-value of less than 0.05 was considered as statistically significant.

## RESULTS

In this nation-wide study, a total of 1000 school children from 20 primary schools from four representative townships of four geographical areas across the country were included as shown in Figure 1. Fifty-one percent were boys. The mean age was 9.4 years (range: 8 to15) with more or less similar age groups in all regions. The frequency of distribution of primary school children representing four geographical study areas of Myanmar by age and sex was described in Table 1.

Infection prevalence was 17% for any STH, 10.4% for *A. lumbricoides*, 17% for *T. trichiura* and, 2% for hookworm. All STH infections were virtually not detected from all samples of the hilly region. The highest

prevalence (32.8%) of *A. lumbricoides* was seen in the coastal region, where the majority was light infection (287%). Similarly, for *T. trichiura* infection, the coastal region had the highest prevalence with 32.8%, followed by the delta region with 25.6%.

However, the hookworm prevalence was seen only in the plain region with 8.5% predominantly light infection with 7.7%. Apart from the plain region, hookworm infection was not virtually detected from all other regions. Parasitological findings by geographical areas were described in Table 2.

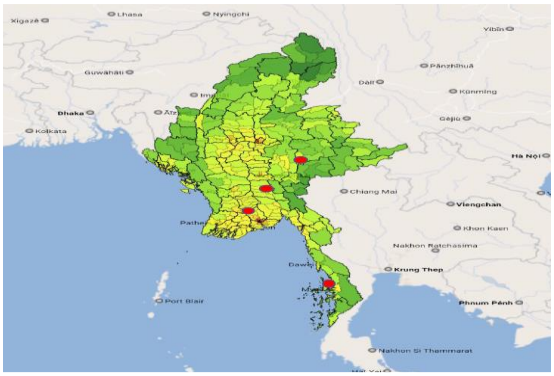


**Figure 1: Map of Myanmar with red circles indicating the location of studied townships from four geographical areas.**

**Table 1: Frequency of distribution of primary school children by age and sex by geographical areas.**

| | | Delta n=250 | Plain n=235 | Hilly n= 250 | Costal n=265 | Total n=1000 |
|---|---|---|---|---|---|---|
| **Sex (proportion %)** | Boy | 132 (52.8) | 122 (51.9) | 135 (54.9) | 124 (46.8) | 513 (51.3) |
| | Girl | 118 (47.2) | 113 (48.1) | 115 (46.0) | 141 (53.2) | 487 (48.7) |
| **Mean age in years** | | 9.58 (9.42-9.73) | 9.36 (9.22-9.50) | 9.0 (8.9-9.1) | 9.45 (9.33 -9.57) | 9.35 (9.29 -9.42) |
| **Age group (proportion %)** | 8 -11 years | 136 (54.4) | 142 (60.5) | 187 (74.8) | 151 (57.0) | 616 (61.6) |
| | 12-13 years | 96 (38.4) | 84 (35.7) | 61 (24.4) | 104 (39.2) | 345 (34.5) |
| | 14-16 years | 18 (7.2) | 9 (3.8) | 2 (0.8) | 10 (37.7) | 39 (3.9) |

**Table 2: Parasitological findings by geographical areas.**

| Geographical areas | Delta n=250 | Plain n=235 | Hilly n= 250 | Costal n=265 | Total N=1000 |
|---|---|---|---|---|---|
| ***A. lumbricoides*[%]** | 16 [6.4] (3.7- 10.2) | 1[0.43] (0.01-0.02) | 0[0] (0- 1.5)* | 87[32.8] (27.2-38.8) | 104[10.4] (8.6-12.5) |
| **Light infection[%]** | 10[4] (1.9-7.2) | 1[0.4] (0.01- 2.3) | 0[0] (0- 1.5)* | 76[28.7] (23.3-34.5) | 87[8.7] (7.0-10.6) |
| **Moderate to heavy infection[%]** | 6[2.4] (0.9-5.2) | 0[0] (0- 0.02)* | 0[0] (0- 1.5)* | 11[4.15] (0.02-0.07) | 17[1.7] (1.0-2.7) |
| ***T. trichiura* [%]** | 64[25.6] (20.3-31.5) | 20[8.5] (5.3-12.8) | 0[0] (0- 1.5)* | 87[32.8] (27.2-38.8) | 171[17.1] (14.8-19.6) |
| **Light infection[%]** | 39[15.6] (11.3-20.7) | 16[6.8] (3.9-10.8) | 0[0] (0- 1.5)* | 52[19.6] (15.0-24.9) | 107[10.7] (8.9-12.8) |
| **Moderate to heavy infection[%]** | 25[10] (6.6-14.4) | 4[1.7] (0.47-4.3) | 0[0] (0- 1.5)* | 35[13.2] (9.4-17.9) | 64[6.4] (5.0-8.1) |
| **Hookworms[%]** | 0[0] (0-1.5)* | 20[8.5] (5.3-12.8) | 0[0] (0- 1.5)* | 0[0] (0- 1.5)* | 20[2] (1.2-3.1) |
| **Light infection[%]** | 0[0] (0-1.5)* | 18[7.7] (4.6-11.8) | 0[0] (0- 1.5)* | 0[0] (0- 1.5)* | 18[1.8] (10.7-28.3) |
| **Moderate to heavy infection[%]** | 0[0] (0-1.5)* | 2[0.8] (0.1-3.0) | 0[0] (0- 1.5)* | 0[0] (0- 1.5)* | 2[0.2] (0.02-0.7) |
| Confidence interval in parenthesis. *one sided 97.5% confidence interval | | | | | |

The nationwide STH prevalence survey was conducted three times, baseline study (S1) in 2002-2003, a follow-up study (S2) after seven years of the commencement of the nationwide school-based deworming program in 2012-2013, and this study (S3) in 2019-2020 conducted seven years after the follow-up study. An overall parasitological prevalence of any STH fell dramatically by 49% (70% to 21%) between S1 and S2, consequently fell slightly by 4% (21% to 17%) between S2 and S3 (P<0.001). The virtual elimination of all worms in the hilly region where the prevalence was zero percent.

The decline in STH prevalence was significantly different among regions across the country based on the types of worms. The prevalence of roundworm (*A. lumbricoides*) has surged again to 10.4% which was 5.8% in 2012, whereas 48.5% in 2002. The whipworm (*T. trichiura*) prevalence decreased slightly to 17%, which was 19% in 2012, and 58% in 2002-2003. For the hookworms (*A. duodenalae* and *N. Americanus*) augmented again exclusively in the plain region with 8% infection which was once virtually eliminated with 0.3% in 2012, and 6.5% in 2002-2003 as shown in Figure 2.

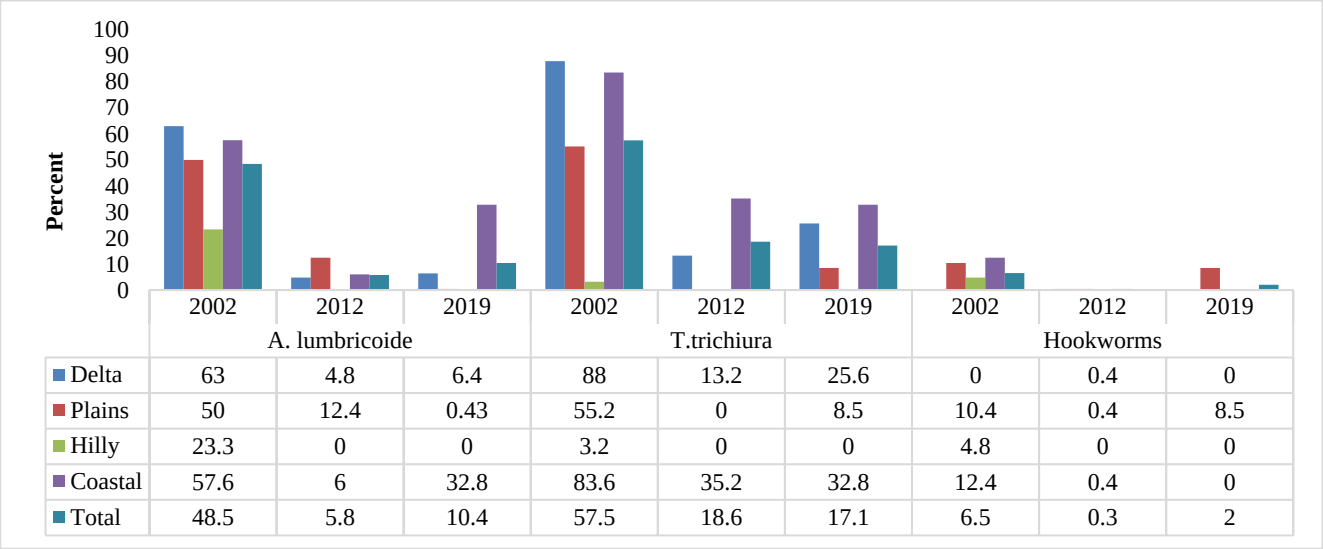


**Figure 2: Prevalence of STH infection in 2002, 2012 and 2019.**

**Table 3: BMI and hemoglobin findings of the school children surveyed by geographical areas.**

| Geographical areas | | Delta n=250 | Plain n=235 | Hilly n= 250 | Costal n=265 | Total n=1000 |
|---|---|---|---|---|---|---|
| **BMI(mean)** | | 14.85 (14.5-15.2) | 19.10 (18.2-20.0) | 16.27 (16.0-16.6) | 15.03 (14.8-15.3) | 16.25 (16-16.5) |
| **BMI (%) both sexes** | Underweight | 42 (16.8) | 11 (4.7) | 11 (4.4) | 27 (10.2) | 91 (9.1) |
| | Normal weight | 202 (80.8) | 164 (69.8) | 235 (94.0) | 231 (87.2) | 832 (83.2) |
| | Overweight | 6 (2.4) | 60 (25.5) | 4 (1.6) | 7 (2.6) | 77 (7.7) |
| **Hb in g/l (%) both sexes** | Mean 95% CI | 11.6 (11.4-11.7) | 11.7 (11.6-11.9) | 13.0 (12.8-13.2) | 11.63 (11.5-11.8) | 11.98 (11.9-12.1) |
| | No anemia (%) | 132 (52.8) | 137 (58.3) | 212 (84.8) | 144 (54.4) | 625 (62.5) |
| | Anemia (%) | 118 (47.2) | 98 (41.7) | 38 (15.2) | 121 (45.6) | 375 (37.5) |
| | Mild anemia (%) | 36 (30.5) | 33 (33.7) | 26 (68.4) | 34 (28.1) | 129 (34.4) |
| | Moderate anemia (%) | 82 (69.5) | 65 (66.3) | 12 (31.6) | 86 (71.9) | 245 (65.3) |
| | Severe anemia (%) | 0 | 0 | 0 | 1 | 1 (0.3) |

On multivariable logistic analyses after adjustment of potential confounders; age and sex, SAC living in the hilly region were less likely to get STH infection than those living in the non-hilly region (OR = 0.56; 95%CI: 0.46 to 0.69) (p<0.001).

Our results showed that the mean BMI was 16.25 (95% CI: 16.0- 16.5). The underweight prevalence was 9% although there was a substantial difference between regions; the highest being the delta region (17%), followed by the coastal region (10%), the plain region (4.7%), and the hilly region (4.4%) (p<0.001).

Nonetheless, the plain region has the highest prevalence of overweight with 25.5% (p<0.001).

The nation-wide (total) anemia prevalence was 38% while there was a huge difference in anemia prevalence across regions like STH prevalence: the highest in the delta region (47%), followed by the coastal region (46%), the plain region (42%), and the lowest in the hilly region (15%). BMI and Hemoglobin findings of the school children surveyed by geographical areas were shown in Table 3. On multivariable logistic regression, after adjustment of potential confounders; age, and sex, SAC living in the non-hilly region are more likely to be anemic than those living in the hilly region (OR = 1.26; 95%CI: 1.2 to 1.42) (p<0.001). BMI was found in no association with all STH infections (p=0.59). Similarly, hemoglobin concentration was not associated with hookworm infection (p=0.20).

## DISCUSSION

According to our study findings, STH infections continued to be endemic among school-aged children in the non-hilly region of Myanmar. The overall prevalence of STH was 17%, which was lower than study findings from the delta region of Myanmar where the prevalence was 27.92% for any STH in any age group. *T. trichiura* was predominant STH (17 %) which was similar to the findings reported in the delta region of Myanmar and peninsular Malaysia.[21-23] *T. trichiura* infection was found as reinfection since the prevalence soared again in the delta region, and was also persistent in the coastal region compared to the nationwide study conducted seven years ago.[9]

The prevalence of *A. lumbricoides* among SAC was 10.4%. It was seen drastically reduced in the plain region but slightly increased in the delta, and still persistent in the coastal region. The finding was lower than in India where STH prevalence ranges from 12.5% to 66%, and infection with the roundworm is greater than with hookworm and whipworm.[24] Our study showed *T. trichiura* prevalence with 17%.

The peculiar finding was that the hookworms (*A. duodenalae* and *N. Americanus*) bounced back and exclusively observed in the plain region (8%), where it was almost undetected seven years ago. However, this finding was similar to that of the study conducted in the delta region where hookworm infection prevalence was 9.75%.[21]

MOHS and MOE initiated school-based mass drug administration (MDA) campaign in 2006.[7] The previous study in 2012, conducted after the 7-year intervention of the school-based mass deworming program suggested that regular deworming can be suspended in the hilly area where STH prevalence is less than 1%, and the epidemiological situation should be assessed at annual intervals to notify possible reinfection. It also suggested reducing the frequency of deworming to once a year basic in the delta area where STH prevalence was between 10% and 20%.[9]

After the 14-years intervention of a school-based mass deworming program, our results indicated that preventive MDA, the intervention chemotherapy according to WHO recommendation was effective in controlling STH in some areas of very intense transmission.[25,26] According to WHO-recommended frequency of re-treatment with preventive chemotherapy for STH in SAC by category of risk, re-treatment schedule for the prevalence of any STH less than 20% is case-by-case treatment.[12]

Nevertheless, infection of moderate to heavy intensity of *T. trichiura* was seen as high as 37 % among all infected children in our study. This was the first reflection regarding the reinfection of *T. trichiura* as a nationwide study in Myanmar. It was also found that the same individuals were being consistently infected between MDA rounds in the delta area in Myanmar.[21] Besides, some studies revealed that single-dose oral albendazole was found to be unsatisfactory to treat *T. trichiura* though it showed high cure rates against *A. lumbricoides* thereby recommending triple-dose regimens of albendazole to achieve high cure rates against both hookworm and *T. trichiura*.[27-30] Thus, the regular deworming program should be reduced to once a year frequency in Myanmar. It might also be reasonable to consider triple-dose regimens in the non-hilly areas to eliminate *T. trichiura* in Myanmar.

Our study showed that STH is highly significant depending on the geographical area. The virtual elimination of all worms was observed in the hilly region where the prevalence was zero percent in both two consecutive studies conducted in 2012 and 2019. This might be because the proportion of the population in conventional households using safe drinking water and access to improved sanitation in the urban area of the hilly region is comparatively higher than those in the non-hilly regions.[31]

Another possible reason is the ecological factors; rainfall, soil type, warmth, and moisture weather condition in the non-hilly region favors the success and speed of worm eggs to develop infective larvae than in the hilly region.[32-35] Additionally, studies revealed that higher prevalence of hookworm infection are limited to areas below 150m above sea level like the coastal and the plain areas and low prevalence to areas above this altitude and the elevation is strongly associated with hookworm prevalence.[36,37] Thus, excluding the hilly region, the regular deworming program should be reduced to once a year frequency in Myanmar.

The underweight prevalence was 9% which was lower than its counterpart in Cambodia.[38] Similarly, it was also lower than 18 to 29-years Myanmar adult (20.2%) although the age group was different.[39] The anemia

prevalence was 38% which was lower than the finding (46.4%) from one cross-sectional study conducted in Yangon.[40] It showed that one out of ten school children were found underweight and about four out of ten school children under study were anemic. As anemia prevalence of over 40% is categorized as a severe public health problem, the burden of anemia among school-aged children should also be addressed.

As school-aged children are vulnerable to the intestinal worm infestation, STHs could be attributed to a significant burden of malnutrition, anemia, and sickness episodes. However, our study found no associations between STHs and underweight as well as hookworms and anemia. Therefore, it might be assumed that other factors such as food accessibility, household food security, and communicable diseases could be more significant affecting the nutritional status of the school children.

This study has several limitations. In our study, only grade 4 and 5 students of both sexes who have attended this school for the previous two consecutive years in the selected primary schools were included and so it might have some limitations to infer the conditions of all school-going age children of Myanmar. Likewise, the study could only assess nutritional anemia rather than all the causes of anemia among the study aged group.

## CONCLUSION

Excluding the hilly region, the regular deworming program should be reduced to once a year frequency in Myanmar. Likewise, to eliminate the whipworms (*T. trichiura*), triple-dose regimens should be considered in the non-hilly regions. The burden of anemia among school-aged children should also be addressed.

## ACKNOWLEDGEMENTS

We would like to thank principals, teachers, all the school children, Township Medical Officers, School Health Teams, and Nutrition Teams from the respective Regions and Townships who have been involved actively in the study. We also highly acknowledged the Ministry of Health and Sports and the Ministry of Education personnel for their support and active participation during the survey and all involved in the activities. We also, thank the Implementing Research Grant, MOHS, Myanmar for financial support for the study.

*Funding: Implementing Research Grant, Ministry of Health and Sports*
*Conflict of interest: None declared*
*Ethical approval: The study was approved by the Institutional Review Board (IRB) of the University of Public Health, Yangon. It is also registered by Preliminary Registration: HRID-00565_V2 at Myanmar Health Research Registry, Department of Medical Research, Yangon, The Republic of the Union of Myanmar*

## REFERENCES

1. Ziegelbauer K, Speich B, Mäusezahl D, Bos R, Keiser J, Utzinger J. Effect of sanitation on soil-transmitted helminth infection: Systematic review and meta-analysis. PLoS Med. 2012;9:1 e1001162.
2. Mark Jourdan P, Helen Louise Lamberton P, Fenwick A, Addiss DG, Lamberton P. Soil-transmitted helminth infections in humans: Clinical management and public health control 1. Lancet. 2018;391(10117):252-65.
3. WHO. Soil-transmitted helminth infections, 2020. Available at https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth-infections. Accessed 11 September 2020.
4. Pullan RL, Smith JL, Jasrasaria R, Brooker SJ. Global numbers of infection and disease burden of soil-transmitted helminth infections in 2010. Parasites Vectors. 2014;7(1):37
5. Brooker S. Estimating the global distribution and disease burden of intestinal nematode infections: Adding up the numbers - A review. Int J Parasitol. 2010;40(10):1137-44
6. Montresor A, Zin TT, Padmasiri E, Allen H, Savioli L. Soil-transmitted helminthiasis in Myanmar and approximate costs for countrywide control. Trop Med Int Heal. 2004;9(9):1012-5.
7. MOHSMyanmar. Health in Myanmar, 2005. Nay Pyi Daw: Ministry of Health and Sports, Myanmar; 2006:30-32.
8. MOHSMyanmar. Health in Myanmar, 2007. Nay Pyi Daw: Ministry of Health and Sports, Myanmar; 2008:35-37.
9. Tun A, Myat SM, Gabrielli AF, Montresor A. Control of soil-transmitted helminthiasis in Myanmar: Results of 7 years of deworming. Trop Med Int Heal. 2013. 2013;18(8):1017-20
10. WHO. PCT databank: Soil-Transmitted Helminthiasis. Available at: http://www.who.int/neglected_diseases/preventive_chemotherapy/sth/en. Accessed 11 September 2020.
11. Dunn JC, Bettis AA, Wyine NY, Lwin AM, Lwin ST, Su KK, et al. A cross-sectional survey of soil-transmitted helminthiases in two Myanmar villages receiving mass drug administration: Epidemiology of infection with a focus on adults. Parasites and Vectors. 2017;10(1):374.
12. World Health Organisation. Eliminating soil-transmitted helminthiasis as a health problem in children: Progress report 2001-2010 and strategic plan 2011-2020. Geneva World Heal Organ, 2012: 4-5.
13. Daniel WW, Cross CL. Biostatistics: A Foundation for Analysis in the Health Sciences, 10th ed. New York: John Wiley & Sons.; 2013: 189-191.
14. Katz N, Chaves A, Pellegrino J. A simple device for quantitative stool thick smear technique in Schistosomiasis mansoni. Rev Inst Med Trop Sao Paulo. 1972;14(6):397-400.
15. WHO. Preventive Chemotherapy in Human Helminthiasis: Coordinated Use of Anthelminthic

Drugs in Control Interventions : A Manual for Health Professionals and Programme Managers.; 2006:11-13.
16. Cashin K, Oot L. Guide to Anthropometry: A Practical Tool for Program Planners, Managers, and Implementers.; 2018;360:93-115.
17. Gwetu TP, Chhagan MK, Craib M, Kauchali S. Hemocue validation for the diagnosis of anaemia in children: a semi-systematic Review. Pediat Therapeut. 2013;4(1).
18. World Health Organization. Prevention and control of schistosomiasis and soil-transmitted helminthiasis: report of a WHO expert committee. World Health Organization; 2002:6-8.
19. Twig G, Yaniv G, Levine H, Leiba A, Goldberger N, Derazne E, et al. Body-mass index in 2.3 million adolescents and cardiovascular death in adulthood. N Engl J Med. 2016;374:2430-40.
20. World Health Organization. Iron deficiency anemia: assessment, prevention, and control. WHO, 2017: 33-43.
21. Dunn JC, Bettis AA, Wyine NY, Lwin AM, Tun A, Maung NS, et al. Soil-transmitted helminth reinfection four and six months after mass drug administration: Results from the delta region of Myanmar. PLoS Negl Trop Dis. 2019;13(2):e0006591.
22. Anuar TS, Salleh FM, Moktar N. Soil-Transmitted helminth infections and associated risk factors in three orang asli tribes in peninsular Malaysia. Sci Rep. 2014;4:4101.
23. Ngui R, Aziz S, Chua KH, Aidil RM, Lee SC, Tan TK, et al. Patterns and risk factors of soil-transmitted helminthiasis among orang asli subgroups in peninsular Malaysia. Am J Trop Med Hyg. 2015;93(2):361-70.
24. Murray JS. Soil-transmitted Helminthiasis in India. J Spec Pediatr Nurs. 2016;21:48-53.
25. Gabrielli AF, Montresor A, Chitsulo L, Engels D, Savioli L. Preventive chemotherapy in human helminthiasis: Theoretical and operational aspects. Trans R Soc Trop Med Hyg. 2011;105(12):683-93.
26. Karshima SN. Prevalence and distribution of soil-transmitted helminth infections in Nigerian children: A systematic review and meta-analysis. Infect Dis Poverty. 2018;7(1):69.
27. Adams VJ, Lombard CJ, Dhansay MA, Markus MB, Fincham JE. Efficacy of albendazole against the whipworm Trichuris trichiura - A randomized, controlled trial. South African Med J. 2004;94(12):972-6.
28. Keiser J, Utzinger J. Efficacy of current drugs against soil-transmitted helminth infections: Systematic review and meta-analysis. JAMA - J Am Med Assoc. 2008;299(16):1937-48.
29. Steinmann P, Utzinger J, Du ZW, Jiang JY, Chen JX, Hattendorf J, et al. Efficacy of single-dose and triple-dose albendazole and mebendazole against soil-transmitted helminths and Taenia spp.: a randomized controlled trial. PloS one. 2011;6(9):e25003.
30. Sungkar S, Putri KQ, Taufik MIS, Gozali MN, Sudarmono P. The Effectiveness of Triple Dose Albendazole in Treating Soil-Transmitted Helminths Infection. J Parasitol Res. 2019;2019.
31. Ministry of Immigration and Population. The 2014 Myanmar Population and Housing Census. 2014 Myanmar Popul Hous Census Census Rep. 2015:32.
32. Mwanakasale V. Environmental factors for transmission of Soil-Transmitted Helminthiasis in school-age children in Zambia. Int J Environ Agric Res. 2017;19(9).
33. Bethony J, Brooker S, Albonico M, Geiger SM, Loukas A, Diemert D, et al. Soil-transmitted helminth infections: ascariasis, trichuriasis, and hookworm. Lancet. 2006;367(9521):1521-32.
34. Hotez PJ, Brindley PJ, Bethony JM, King CH, Pearce EJ, Jacobson J. Helminth infections: The great neglected tropical diseases. J Clin Invest. 2008;118(4):1311-21.
35. Hotez PJ, Bundy DA, Beegle K, Brooker S, Drake L, de Silva N, Montresor A, Engels D, Jukes M, Chitsulo L, Chow J. Helminth infections: soil-transmitted helminth infections and schistosomiasis. InDisease Control Priorities in Developing Countries. 2nd edition 2006. The International Bank for Reconstruction and Development/The World Bank. 2006:342-345.
36. Mabaso MLH, Appleton CC, Hughes JC, Gouws E. The effect of soil type and climate on hookworm (Necator americanus) distribution in KwaZulu-Natal, South Africa. Trop Med Int Heal. 2003;8(8):722-7.
37. Riess H, Clowes P, Kroidl I, Kowuor DO, Nsojo A, Mangu C, et al. Hookworm infection and environmental factors in mbeya region, Tanzania: a cross-sectional, population-based study. PLoS Negl Trop Dis. 2013;7(9):e2408.
38. Horiuchi Y, Kusama K, Kanha S, Yoshiike N. Urban-rural differences in nutritional status and dietary intakes of school-aged children in Cambodia. Nutrients. 2019;11(1):14.
39. Hong SA, Peltzer K, Lwin KT, Aung LS. The prevalence of underweight, overweight and obesity and their related socio-demographic and lifestyle factors among adult women in Myanmar, 2015-16. PloS one. 2018;13(3):e0194454.
40. Wah ST, Yi YS, Khin AA, Plabplueng C, Nuchnoi P. Prevalence of anemia and hemoglobin disorders among school children in Myanmar. Hemoglobin. 2017;41(1):26-31.

**Cite this article as:** Oo SM, Tun A, Htoon TT, Kyaw PP, Htut WL, Linn MM. Soil-transmitted helminthiasis among school-aged children in Myanmar: the result of 14 years after the implementation of deworming. Int J Community Med Public Health 2021;8:9-16.