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# Research Article
# Parasitic Infection Is Associated with Undernutrition among Primary School Children in Aden Governorate, Yemen

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## Abstract

**Background and Objective:** High prevalence of undernutrition has been documented among school children in Yemen, which may be due to parasitic infection. However, there is currently no published data on the parasitic infection association with undernutrition among primary school children in Aden, Yemen. The study aimed to evaluate the undernutrition association with parasitic infection among school children. **Materials and Methods:** A cross-sectional study was conducted in government schools among primary school children in grades I through VI. The data was collected using a simple questionnaire and a single stool sample. The children's anthropometric measurements (weight and height) were also taken. **Results:** The 16.8% of the 525 children were affected by parasitic infection. The size of the family was found to be a significant determinant of parasite infection ($p<0.00$). In addition, 19% of children were underweight, 17% were stunted and 10% were wasting. There were significant associations between parasitic infection and the state of being underweight and stunting. However, the association between parasitic infection and the state of undernutrition continues even after adjustment for significant age, sex of children and household size. **Conclusion:** Parasitic infection was found significantly associated with undernutrition of the children and is still a public health concern among primary school children in Aden's Governorate, Yemen. Hence, comprehensive efforts to combat undernutrition and parasite infection are crucial.

Key words: Parasitic infection, primary school children, undernutrition, Aden, Yemen

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Parasitic infection is present worldwide, although it is particularly common in tropical and subtropical countries, especially in rural and low-sanitation areas[1-3]. Despite the rapid development in the healthcare sector, parasitic infection remains a crucial health problem, mainly in developing countries, including Yemen[4]. According to the World Health Organization (WHO) two-thirds of the world population, approximately 3.5 billion, were infected by a variety of parasites with the majority being children and 450 million were showing clinical symptoms[5].

Prevalence of parasitic infection varies by region but in general, humid areas, high population density, limited access to clean and safe drinking water, unhygienic or poor sanitary facility areas and low health status promote parasite growth and transmission[6,7]. In crowded places like schools, daycares and barracks, infection mainly occurs through the parasite's egg or cyst[8].

Yemen is a Middle Eastern desert country on the southern tip of the Arabian Peninsula with 22 Governorates and five islands. Yemen's political capital is Sana'a and its economic capital is Aden[9]. Since 1990, the two Yemeni republics (South and North Yemen) have been nominally united as the Republic of Yemen and a southern secessionist movement and a brief civil war in 1994 were rapidly put down[10], resulting in the exclusion of South Yemen and particularly Aden from any future studies[11].

In Yemen, parasitic infection is common and varies in different parts of Yemen[12]. School children are particularly prone to parasitic infection, with infection cases reported in over 600,000 school children[13]. Al-subaie *et al.*[3] found a prevalence of 57.4% parasitic infection among school children in Ibb Governorate with the highest rate among 10-11 years old, while Al-Mekhlafi *et al.*[14] recorded a prevalence of 54.8% parasitic infection among school children from Sana'a city and Alwabr and Al-Moayed[12] reported prevalence of 90% among Al-Mahweet Governorate school children with the highest rate in boys.

In Yemen, the studies on the association of parasitic infection and undernutrition among school children were limited[15] and none of them was conducted in Aden. In addition, identifying the association will contribute to finding out suitable interventions. Also, this study provides relevant information to the schools, Ministry of Education, Ministry of Health and the Non Governmental Organisations (NGOs). Therefore, this study aimed to investigate the nutritional status of school children concerning parasitic infection among Yemeni school children in Aden.

## MATERIALS AND METHODS

**Ethics:** This study was approved by the Medical Council (Republic of Yemen) with reference No. 84521. Permission was also requested from the Ministry of Education, school administration and written consent from the parents was also obtained.

**Study design:** From January to May, 2013, a cross-sectional study was conducted among primary school children enrolled in grades I to VI in government schools in the seven districts of Aden Governorate.

**Study population and sample size:** Al-Mansura, Al Mualla, Al-Shaikh Othman, Altawahi, Crater, Dar Sad and Khormaksar are the seven districts that makeup Aden. Each district contains many schools (A total of 72 primary schools). Lists of government schools within each district were provided by the education office and one school was selected randomly by a simple random sampling technique from each district. The schools were chosen based on the inclusion criteria (i.e., government schools and mixed-gender schools). 14 subjects per grade were chosen randomly from seven schools (one school from each of the seven districts). The researcher, with the help of the teachers, randomly distributed 680 questionnaires to children. The questionnaire was collected the next day by the researcher. Criteria for including in the survey data required children must be registered at the school, between 6-12 years old, with no health issues. Those with missing information, those who did not return the questionnaire and parents who did not provide their consent were among the reasons why the survey data was not accepted in the analysis. To avoid duplication of household data, twins or siblings from the same family were eliminated from the study. As a result, 525 people were included in the study, accounting for 76% of the total responders.

### Measurements

**Anthropometry:** Each subject's weight and height were measured and the results were compared to WHO 2007 growth charts[16] using the computer programme Anthro plus for Windows 10. Underweight, wasting and stunting were determined using the children's weight and height to construct age and sex-specific Z-scores. The weight-for-age Z-score (WAZ) is used to indicate underweight, the height-for-age Z-score (HAZ) is used to indicate stunting (chronic malnutrition) and the weight-for-height Z-score (WHZ) is used to indicate wasting (acute malnutrition).

The Z-scores were derived using the WHO Reference Population's median values. Children with Z-scores below-2 Standard Deviations (SD) of the WHO Reference Population medians were classified as malnourished, while those with Z-scores above -2 SD and below +2 SD were classified as normal and those with Z-scores over +2 SD were classified as overweight/obese. For each measurement, three consecutive readings were taken and the mean was calculated.

**Questionnaire:** To learn more about the individuals' backgrounds, a standardized socio-demographic questionnaire was used. The questionnaire was divided into two sections:

- The first section contained general information about the participant, such as age, academic level and anthropometric measurements like weight, height and Body Mass Index (BMI)
- The second section contained information about the family, such as the parent's education, the number of children in the house, the size of the household, the parent's employment status and the total household income and expenditures

**Stool test:** Participants were subjected to a parasitological examination. Stool cups were supplied to children in the selected schools, along with instructions on how to properly collect them. For each child, one stool sample was collected and labelled.

To avoid contamination, safety procedures were used when collecting the specimens. The laboratory personnel gathered the samples, placed them in a cool box and transported them directly to the lab. As indicated in the WHO Bench Aids for the Diagnosis of Intestinal Parasites[17], samples were transported to a field laboratory in Yemen (General Health Laboratory, Aden) for processing and analysis.

Parasitological examinations of the samples were carried out in the laboratory by trained personnel, with specimens evaluated microscopically for protozoan cysts (or trophozoites) as well as helminth ova or larvae. When the slide reading was negative, it was regarded as no infection and when the reading was positive, it was considered a parasitic infection.

**Data analysis:** The Statistical Package for Social Sciences, version 20[18], was used for all statistical analysis. First, descriptive statistics were used to compare parasite positive and negative cases based on demographic, socioeconomic and anthropometric factors using mean and SD.

For continuous data, the t-test was used to examine differences in mean values, whereas the Chi-square test was employed to quantify differences for categorical variables.

In both the binary and multinomial analyses, logistic regression approaches were employed to identify the association between parasitic infection and the occurrence of undernutrition after adjusting child age, sex and household size. With 95% confidence intervals (CI = 95 %), odds ratios (OR) were calculated. The level of statistical significance was chosen at $p = 0.05$.

## RESULTS

**Socio-demographic characteristics:** This study included 525 school children, with a non-response rate of 24%. A total of 16.8% (n = 88) of the children had positive parasitic tests, whereas, 83.2% (n = 437) had negative parasitic testing in Table 1. Positive cases were found in the majority of boys (54.5%, n = 48) and the age group of 6-10 years (65.9%, n = 58).

Forty-two percent (n = 37) of mothers in positive parasite test groups were primarily educated, while the majority of fathers (73.9%, n = 65) were employed. Positive parasite cases were seen in households with 3-6 people (52.3%, n = 46). The majority of households with positive cases (56.8%, n = 50) were of low income, with monthly incomes ranging from 100-300 USD. There was a significant association between the family size and being positive parasitic cases at $p<0.05$.

**Children's nutritional status:** The anthropometric (WAZ, HAZ, WAH) characteristics of the Yemeni children, who were the subjects of this study were provided in Table 2. The overall prevalence of underweight among children was 18.5%, whilst the prevalence of stunting was 16.7% and the wasting was the lowest among these children (10.1%). After further analysis of the data, 196 (38%) of the school children in this study were found to be malnourished.

**Associations between parasitic infection and nutritional status:** A multiple logistic regression model with age, sex of children and family size as a covariate revealed that children in positive parasite families were statistically substantially more likely to be underweight and stunted than children in non-positive households ($p<0.05$) in Table 3.

In addition, the findings revealed that school children who had a positive parasitic test were twice as likely to be underweight (AOR = 2.27, 95% CI = 1.25-4.11) as children who

Table 1: Socio-demography of children according to stool test (n = 525)

| | Parasitic positive | | Parasitic negative | | |
|---|---|---|---|---|---|
| Variables | n = 88 | 16.8% | n = 437 | 83.2% | p-value† |
| **Gender** | | | | | |
| Male | 48 | 54.5 | 241 | 55.1 | 0.92 |
| Female | 40 | 45.5 | 196 | 44.9 | |
| **Age groups** | | | | | |
| 6-10 years | 58 | 65.9 | 281 | 64.3 | 0.77 |
| 11-12 years | 30 | 34.1 | 156 | 35.7 | |
| **Mothers' education level** | | | | | |
| No education | 16 | 18.2 | 83 | 19.0 | 0.35 |
| Primary and secondary school | 37 | 42.0 | 211 | 48.3 | |
| Diploma/university degree | 35 | 39.8 | 143 | 32.7 | |
| **Fathers working condition** | | | | | |
| Working | 65 | 73.9 | 340 | 77.8 | 0.42 |
| Not working | 23 | 26.1 | 97 | 22.2 | |
| **Family size** | | | | | |
| 3-6 | 46 | 52.3 | 144 | 33.0 | 0.00* |
| 7-10 | 35 | 39.7 | 251 | 57.4 | |
| ≥11 | 7 | 8.0 | 42 | 9.6 | |
| **Households' income (USD)#** | | | | | |
| 0-300 | 50 | 56.8 | 278 | 63.3 | 0.23 |
| 301->1000 | 38 | 43.2 | 159 | 36.4 | |

*Statistically significant (p<0.05), #1USD: 215 Ry, †Independent t-test

Table 2: Nutritional status of school children in Yemen (n = 525)

| | Positive cases | | Negative cases | | Overall (n = 525) | |
|---|---|---|---|---|---|---|
| Anthropometric index | (%) | Mean±SD | (%) | Mean±SD | (%) | Mean±SD |
| WAZ | | 1.72±0.45 | | 1.83±0.37 | | 1.81±0.39 |
| Underweight* | 47 (16.3) | | 49 (20.8) | | 96 (18.5) | |
| Normal^ | 239 (82.7) | | 185 (78.4) | | 424 (80.5) | |
| HAZ | | 1.65±0.48 | | 1.87±0.33 | | 1.83±0.37 |
| Stunting* | 46 (16.0) | | 41 (17.3) | | 87 (16.7) | |
| Normal^ | 243 (84.0) | | 195 (82.7) | | 438 (83.3) | |
| WAH | | 1.94±0.23 | | 1.89±0.31 | | 1.89±0.30 |
| Wasting* | 31 (10.8) | | 22 (9.4) | | 53 (10.1) | |
| Normal^ | 258 (89.2) | | 214 (90.6) | | 462 (89.9 | |

*Underweight/stunting/wasting: <-2 SD, #Normal:>-2 SD-<+2 SD and ≠overweight/obese: >+2 SD

Table 3: Association of under nutrition and parasitic infection among children (n = 525)

| | Simple logistic regression | | | | Multiple logistic regression | | |
|---|---|---|---|---|---|---|---|
| Nutritional status and parasitic infection | Odd ratio | 95.0% C.I. | p-value | B | Adj. odd ratio | 95.0% C.I. | p-value |
| **Underweight** | | | | | | | |
| Parasitic negative | 1 | | 0.01* | 0.64 | 1 | | 0.00* |
| Parasitic positive | 1.90 | 1.11,3.23 | | | 2.27 | 1.25,4.11 | |
| **Stunting** | | | | | | | |
| Parasitic negative | 1 | | 0.00* | 1.3 | 1 | | 0.00* |
| Parasitic positive | 3.70 | 2.20,6.22 | | | 3.90 | 2.26,6.74 | |
| **Wasting** | | | | | | | |
| Parasitic negative | 1 | | 0.13 | 0.71 | 1 | | 0.17 |
| Parasitic positive | 0.49 | 0.18,1.26 | | | 0.52 | 0.19,1.34 | |

*p<0.05, Adj: Adjusted for age, sex of children and household size, C.I.: Confidence Interval and B: This is the coefficient for the constant (also called the "intercept") in the null model

had a negative parasitic test. Similarly, children with a positive parasitic test were four times as stunted as children with a negative parasitic infection (AOR = 3.90, 95% CI = 2.26-6.74). However, no association between parasitic infection and wasting was reported.

## DISCUSSION

This study aimed to evaluate the nutritional status of school children and the parasitic infection in Aden Governorate, Yemen. The prevalence of parasitic infection in

this study was 16.8% and the means of WAZ, HAZ and WHZ of the study population were lower in this study population as compared to the WHO, 2007 reference values[16]. Stunting and being underweight were significantly associated with parasitic infection with a $p<0.05$.

In this study, the prevalence of parasite infection among children was found to be lower than in studies conducted by Al-subaie *et al.*[3] in the Ibb governorate in Yemen (57.4%) and Al-Mekhlafi *et al.*[14] in a rural district of Sana'a city (54.8%). Furthermore, Al-Haddad and Baswaid[19] found that a parasite had infected 41% of school children in the rural area of Hadhramaut governorate. Because this study was conducted in an urban setting, the differences in prevalence could be attributed to the subjects' current living standards. The variation could also be attributed to local endemicity, the research area's geographic condition and a deworming programme that has been in place since 2009 across the country[20].

Boys between the ages of 6 and 10 years were shown to be more susceptible to parasite infection, while the girls between the ages of 11 and 12 were more susceptible to parasite infection. This finding was supported by research conducted in Yemen by Al-subaie *et al.*[3] and Al-Mekhlafi *et al.*[14]. This may be because there are more boys enrolled in school than girls[21].

However, in houses with 7-10 people, nearly 40% of the children in this study had parasite infection (overcrowded). This is in line with Ahmed *et al.*[22], who found a higher frequency of parasite infection in large households (more than 7 members).

According to the findings of this study, 56.7% of the households with positive cases had low incomes, which is similar to research conducted by Al-Mekhlafi *et al.*[14] and Ahmed *et al.*[22].

In under-developing countries like Yemen, malnutrition is a critical cause of illness and death among children[23,24]. This problem is directly connected to the low socio-economic status of the household for a long-time, which resulted in poverty that affected the availability of food and dietary intake. In addition, the parasitic infection might be causing synergism and a high prevalence of undernutrition. Underweight, stunting and wasting were found to be prevalent in 19, 17 and 10% of children, respectively. This finding indicated that the school children in this study were in good health compared to earlier studies in Yemen[25,26]. However, this could be ascribed to the fact that Aden is an urban city with readily available basic services and food, which are the causes of low malnutrition among children[23].

This study demonstrated an association between undernutrition and parasite infection (stunted children were almost four times more likely to be infected and underweight children were almost two times more likely to be infected), which is consistent with other research[27]. As a result, parasite infection could be an independent predictor of undernutrition in this study among school children.

The feco-oral pathway is assumed to be the most common method of parasite transmission, with family members or school bathrooms being the most common sources of transmission. As a result, in households and schools, sanitary precautions such as hand washing after using the restroom, hand washing after playing with soil and gardening should be considered[28-30].

UNICEF[24] specified the major causes of undernutrition in Yemen were infectious diseases (including parasitic infection) among others and this synchronized with the high prevalence of parasitic infection among school children[3,12,14] that was reported in the previous studies included this study. It is well known that parasitic infection causes undernutrition due to utilizing of essential nutrients as well as endogenous nutrient losses. However, the cause of undernutrition among school children in this study is multifactorial including parasitic infection, low socioeconomic status, low education of mothers, overcrowded households, poor hygiene etc.

Some of the limitations of this study include the cross-sectional design of the study, which might establish a time-based relationship between parasitic infection and nutritional status. Furthermore, the sample was limited to a single location. However, it is reasonable to conclude that parasite infection is a major problem among primary school children in the Governorate of Aden.

## CONCLUSION

This study found a significant association between parasitic infection and undernutrition among primary school children in Aden, Yemen. Overcrowd households and parasitic infections were the major prompting factors for undernutrition. Hence, the novel finding of the present study is that undernutrition and parasitic infection are major health problems affecting school children. Thus, activities in the schools and community-based programs, which promote inexpensive and effective practice to eradicate the spread of parasitic infection are essential. Improvements in school and community sanitation facilities are important. Also improving the nutritional status of school children is crucial.

## SIGNIFICANCE STATEMENT

This study discovered the association of nutritional status of school children with parasitic infection, which can be beneficial for planning and implementation of proper interventions and prevention or reduction of undernutrition among school children. This study will help the researchers to uncover the critical areas of nutritional status of school children concerning parasitic infection, also provide reliable and valid resources for similar studies and the ongoing research that many researchers were not able to explore. Thus, a new theory on how to execute appropriate intervention and policies among school children to address undernutrition may be developed.

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## REFERENCES

1. Anuar, T.S., H.M. Al-Mekhlafi, F.M. Salleh and N. Moktar, 2013. New insights of microsporidial infection among asymptomatic aboriginal population in Malaysia. PLoS ONE, Vol. 8. 10.1371/journal.pone.0071870.
2. Geik, O.P. and R. Sidek, 2015. Malnutrition and soil-transmitted helminthic infection among Orang Asli pre-school children in Gua Musang, Kelantan, Malaysia. AIP Conf. Proc., Vol. 1678. 10.1063/1.4931324
3. Alsubaie, A.S.R., A.A. Azazy, E.O. Omer, L.A. Al-shibani, A.Q. Al-Mekhlafi and F.A. Al-Khawlani, 2016. Pattern of parasitic infections as public health problem among school children: A comparative study between rural and urban areas. J. Taibah Uni. Med. Sci., 11: 13-18.
4. Hussein, R.A., M.J. Shaker and H.A. Majeed, 2011. Prevalence of intestinal parasitic infections among children in Baghdad city. J. Essent. Educ. Coll., 71: 139-147.
5. Ahmad, K., H. Sevil, F. Esmail, N. Iran, S. Sedigheh and S. Ahad, 2011. Prevalence of intestinal parasites among symptomless primary school children attending urban health centers, Tabriz. J. Tabriz Uni. Med. Sci., 33: 58-62.
6. Gupta, R., B. Rayamajhee, S.P. Sherchan, G. Rai, R.K. Mukhiya, B. Khanal, S.K. Rai, 2020. Prevalence of intestinal parasitosis and associated risk factors among school children of Saptari district, Nepal: A cross-sectional study. Trop Med Health 10.1186/s41182-020-00261-4.
7. Anuar, T.S., F.M. Salleh and N. Moktar, 2014. Soil-transmitted helminth infections and associated risk factors in three orang asli tribes in peninsular Malaysia. Sci. Rep., Vol. 4. 10.1038/srep04101.
8. Heravi, M.M., 2013. Prevalence of intestinal parasites infections among Afghan children of primary and junior high schools residing Kashan City, Iran, 2009-2010. Iran. J. Med. Microbiol., 7: 46-52.
9. Esmail, S.A.A. and R. Rajikan, 2021. Household food insecurity is associated with undernutrition among primary school children in Aden Governorate, Yemen. J. Gizi Pangan, 16: 11-20.
10. Al-Majdhoub, F.M., A.B. Hamzah and M.Y. Ariffin, 2015. Focus group discussions on the coverage of the southern separatist movement crisis in Yemeni newspapers. SpringerPlus, Vol. 4. 10.1186/s40064-015-1000-0.
11. Terrill, W.A., 2011. The conflicts in Yemen and US national security. Strategic Studies Institute, USA.
12. Alwabr, G.M.A. and E.E. Al-Moayed, 2016. Prevalence of intestinal parasitic infections among school children of Al-Mahweet Governorate, Yemen. Eur. J. Biol. Res., 6: 64-73.
13. Jourdan, P.M., P.H.L. Lamberton, A. Fenwick and D.G. Addiss, 2018. Soil-transmitted helminth infections. Lancet, 391: 252-265.
14. Al-Mekhlafi, A.M., R. Abdul-Ghani, S.M. Al-Eryani, R. Saif-Ali and M.A.K. Mahdy, 2016. School-based prevalence of intestinal parasitic infections and associated risk factors in rural communities of Sana'a, Yemen. Acta Trop., 163: 135-141.
15. Raja'a, Y.A. and J.S. Mubarak, 2006. Intestinal parasitosis and nutritional status in schoolchildren of Sahar district, Yemen. East Mediterr. Health J., 12: 189-194.
16. Best, C., N. Neufingerl, L. van Geel, T. van den Briel and S. Osendarp, 2010. The nutritional status of school-aged children: Why should we care? Food Nutr. Bull., 31: 400-417.
17. Garcia, L.S., M. Arrowood, E. Kokoskin, G.P. Paltridge and D.R. Pillai *et al*., 2018. Practical guidance for clinical microbiology laboratories: Laboratory diagnosis of parasites from the gastrointestinal tract. Clin. Microbiol. Rev., Vol. 31. 10.1128/CMR.00025-17.
18. Gouda, M.A., 2015. Common pitfalls in reporting the use of SPSS software. Med. Princ. Pract., Vol. 24. 10.1159/000381953.
19. Al-Haddad, A.M. and S.H. Baswaid, 2010. Frequency of intestinal parasitic infection among children in Hadhramout governorate (Yemen). J. Egypt. Soc. Parasitol., 40: 479-488.
20. Lo, N.C., S. Heft-Neal, J.T. Coulibaly, L. Leonard, E. Bendavid and D.G. Addiss, 2019. State of deworming coverage and equity in low-income and middle-income countries using household health surveys: A spatiotemporal cross-sectional study. Lancet Global Health, 7: e1511-e1520.
21. Hunersen, K., B. Attal, A. Jeffery, J. Metzler, T. Alkibsi, S. Elnakib and W.C. Robinson, 2021. Child marriage in Yemen: A mixed methods study in ongoing conflict and displacement. J. Refugee Stud., 34: 4551-4571.

22. Ahmed, A., H.M. Al-Mekhlafi, A.H. Al-Adhroey, I. Ithoi, A.M. Abdulsalam and J. Surin, 2012. The nutritional impacts of soil-transmitted helminths infections among Orang Asli schoolchildren in rural Malaysia. Parasites Vectors, Vol. 5. 10.1186/1756-3305-5-119.
23. de Souza, R. and Laetícia, 2015. Stunting among children in Yemen: Prevalence and associated factors. International Policy Centre for Inclusive Growth (IPC-IG), Brasilia, Brazil, Pages: 28.
24. Rajikan, R. and S. Esmail, 2020. Nutrition education to improve nutrition knowledge, attitude and practice among Yemeni school children. Trends Appl. Sci. Res., 15: 207-213.
25. Raja'a, Y.A., S.M. Sulaiman, S.A. Elkarib and J.S. Mubarak, 2001. Nutritional status of Yemeni school children in Al-Mahweet governorate. East. Mediterr. Health J., 7: 204-210.
26. Al-Haidari, S.A., M.A.K. Mahdy, A.M. Al-Mekhlafi, W.M.S. Al Murisi and A.A.Q. Thabit *et al*., 2021. Intestinal schistosomiasis among schoolchildren in Sana'a Governorate, Yemen: Prevalence, associated factors and its effect on nutritional status and anemia. PLoS Negl. Trop. Dis., Vol. 15. 10.1371/journal.pntd.0009757.
27. Tulu, B., S. Taye, Y. Zenebe and E. Amsalu, 2016. Intestinal parasitic infections and nutritional status among primary school children in Delo-mena district, South Eastern Ethiopia, Iran. J. Parasitol., 11: 549-558.
28. Anuar, T.S., H.M. Al-Mekhlafi, G.M.K. Abdul, E. Osman and A.M. Yasin *et al*., 2012. Molecular epidemiology of amoebiasis in Malaysia: Highlighting the different risk factors of *Entamoeba histolytica* and *Entamoeba dispar* infections among Orang Asli communities. Int. J. Parasitol., 42: 1165-1175.
29. Al-Delaimy, A.K., H.M. Al-Mekhlafi, N.A. Nasr, H. Sady and W.M. Atroosh *et al*., 2014. Epidemiology of intestinal polyparasitism among Orang Asli school children in rural Malaysia. PLoS Negl. Trop. Dis., Vol. 8. 10.1371/journal.pntd.0003074.
30. Alemu, G., A. Abossie and Z. Yohannes, 2019. Current status of intestinal parasitic infections and associated factors among primary school children in Birbir town, Southern Ethiopia. BMC Infect. Dis., Vol. 19. 10.1186/s12879-019-3879-5.