Prevalence of intestinal parasitic infections and associated risk factors among children attending a tertiary care hospital

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Abstract

Intestinal parasitic infections (IPIs) are one of the major causes of morbidity in the developing world. This hospital-based prospective study was undertaken to estimate the prevalence rates of IPIs and to assess the risk factors associated with these infections in children attending a paediatric hospital. Seven hundred and five patients were analysed for IPIs and associated risk factors from April 2018 to March 2019. Information on the associated risk factors was obtained from a structured questionnaire protocol. Microscopic examination of stool samples was done by direct slide smear and after the formol-ether concentration technique. The overall prevalence of IPIs was 20.9%. In the age group, 5-9 years, the prevalence of parasitic infection (27.4%) was high. Among the intestinal parasites detected helminths and protozoans were 60.8% and 39.1% respectively. Among the helminths, *Ascaris lumbricoides* (20.5%) was most prevalent followed by *Trichuris trichiura* (18.1%) while among the protozoa *Giardia intestinalis* (18.7%) was most prevalent, followed by *Entamoeba* spp. (8.4%). Among the positive samples, the single parasite was detected in 87.8% while dual parasites were detected in 12.2% stool samples. Univariate analysis showed age, drinking water from an open well, a habit of open defecation, illiteracy and living in a rural area to be associated with a high risk of IPIs (P<0.05). Multivariate logistic regression revealed a significant association of intestinal parasitic infections with age (0-5 years) and (10-14 years) and drinking water from an open well. Identifying and rectifying risk factors by creating awareness are needed to prevent community spread. Periodic deworming programmes should be implemented successfully in the community.

INTRODUCTION

Intestinal parasitic infections (IPIs) are a major public health problem in developing countries. According to the World Health Organization, worldwide, more than 1.5 billion people are infected with soil-transmitted helminthic (STH) infections. More than 267 million preschool-age children and 568 million school-age children (SAC) live in areas where parasites are intensively transmitted and are in need of treatment and preventive interventions (WHO, 2020). India accounts for almost one quarter of the world’s ascariasis and hookworm cases (Hotez and Damania, 2018). Most of these infections are trans-
mitted by ova present in human faeces that in turn contaminate soil in areas where sanitation is poor. Factors contributing to the spread of these infections are scarcity of potable drinking water, lack of awareness, failure to practice proper handwashing after defecation, the practice of open defecation and low standard of personal hygiene. Also, increasing population, poor socioeconomic conditions, continuous urbanization, industrialization and climatic changes may contribute to the emergence of previously unrecognized diseases. Infection with STH cause iron deficiency anemia and protein-energy malnutrition. Severe infections may lead to intestinal obstructions and gangrene. (Parija et al., 2017) They are responsible for morbidity, particularly in young children, including growth and cognitive stunting (Weatherhead et al., 2017). In India the prevalence rates of intestinal parasitic infections differ from region to region, Several studies (Barda et al., 2014; Greenland et al., 2015) have been undertaken in different parts of India, but there are only a few studies reported from Rajasthan (Choubisa et al., 2012; Saurabh et al., 2017).

This study was undertaken to find out the prevalence rates of IPIs and to assess the risk factors associated with these infections in children attending a pediatric hospital.

MATERIALS AND METHODS

Study participants and data collection

This prospective study was carried out in the Microbiology laboratory of a paediatric hospital attached to a Medical College between April 2018 and March 2019. All children clinically suspected to have parasitic infections were included in the study. Children who had taken anti-parasitic treatment in the last 1 month and those whose parents/guardians did not give consent were excluded from the study. Demographic details as well as information on risk factors, were collected by interviewing each child’s parents/guardians on a structured questionnaire. This included information such as age, sex, education of mother (literacy status) (illiterate, below or above 10th class), source of drinking water (tap or well water), defecation site (open or modern sanitary toilet) and handwashing habit after defeation. While filling the form finger nails of patients were also inspected. Informed consent was taken from all parents/guardians before data collection.

Stool sample collection and processing

After proper instructions, children/parents were given labelled containers and applicator sticks. On receipt, each stool sample was examined macroscopically for color, consistency, presence or absence of mucus, blood, body segments of parasites and adult worms. Saline and iodine wet mount preparations were made from each sample before and after formal-ether concentration technique. These samples were observed under 100 X and 400 X magnifications to detect cysts, trophozoites, eggs and larvae (Chatterjee and Parasitology, 2017).

Ethical clearance

Ethical clearance was obtained from the institutional review board.

Statistical analysis

Categorical variables were expressed as proportions (%). Prevalence rates were calculated using standard formulae. Chi-square test was used for univariate analysis of categorical variables to find out associated risk factors. Significantly associated determining factors found in univariate analysis were put in the multivariate logistic regression analysis model. Method of entry used was stepwise. Probability of retaining in the model was kept 0.05 while that of exclusion was 0.10.

ROC curve analysis was done to find determining power of model and area under the curve (AUC) was calculated. P-value < 0.05 was considered as significant. All statistical calculations were done by Medcalc software version 16.4.

RESULTS AND DISCUSSION

Socio-demographic characteristics

The study included a total of 705 cases. The prevalence of IPIs was 20.9%. In males, the prevalence rate was 20.7%, and in females 21.3%. The prevalence of parasitic infection was highest (27.4%) in the age group of 5-9 years.

Prevalence of Intestinal Parasites

Nine species of intestinal parasites were identified out of which 6 species were identified as helminths, and the other 3 species were protozoans. Among the intestinal parasites detected 60.8% were helminths and 39.1% were protozoans. Among the helminthes 20.5% were identified as Ascaris lumbricoides, Trichuris trichiura 18.1%, hookworm 17.8%, Hymenolepis nana 6.6%, Taenia spp.6.6%, and Enterobius vermicularis 1.2%. Among the protozoa, 18.7% were identified as Giardia intestinalis and 6.0% as Entamoeba spp. Table 1. Among the non-pathogenic cysts, Entamoeba coli was detected in 12.0 % of stool samples. Single and dual parasitic infection was detected in 87.8% and 12.2% of stool samples, respectively. The most common combination observed was Entamoeba spp. + G. intestinalis.
Table 1: Distribution of single parasitic infection and commensal parasite among the study population

| Cyst/Ova          | Parasites       | Number | Percentage |
|-------------------|-----------------|--------|------------|
| Pathogenic        | Trichuris trichiura | 26     | 20%        |
|                   | Giardia intestinalis | 25     | 19.2%      |
|                   | Ascaris lumbricoides | 22     | 16.9%      |
|                   | Entamoeba spp. | 10     | 7.6%       |
|                   | Hymenolepis nana | 09     | 6.9%       |
|                   | Taenia species | 08     | 6.1%       |
|                   | Hookworm        | 08     | 6.1%       |
|                   | Enterobius vermicularis | 02     | 1.5%       |
| Non-Pathogenic    | Entamoeba coli | 20     | 16%        |
| Total             |                 | 130    | 100%       |

Table 2: Distribution of double parasitic infection among the study population

| Combination of parasite                          | Number | Percentage |
|--------------------------------------------------|--------|------------|
| T. trichiura + A. lumbricoides                   | 04     | 22.2%      |
| Entamoeba spp. + G. intestinalis                 | 04     | 22.2%      |
| A. lumbricoides + A duodenale                    | 03     | 16.6%      |
| A. lumbricoides + Taenia spp                    | 03     | 16.6%      |
| A. lumbricoides + G. intestinalis                | 02     | 11.1%      |
| A. duodenale + H. nana                          | 02     | 11.1%      |
| Total                                            | 18     | 100%       |

and T. trichiura + A. lumbricoides

Intestinal Parasites and Possible Risk Factors

Age, gender, area of residence, maternal literacy, defecation site, personal hygiene, slipper wear, source of drinking water and practice of handwashing after defecation were suspected determining factors studied for parasitic infection. Univariate analysis revealed that significant risk increased in age group 5-9 years (OR= 2.028) and 10-14 years (OR=1.924) as compared to 0-4 years. Residence in a rural area (OR=2.052), open well as source of drinking water (OR=2.556), open field defecation practice (OR=1.715) and illiterate mother (OR=2.024) were also found to increase risk significantly.

However, a habit of handwashing with soap & water showed a significant reduction in risk (OR=0.645). When these variables were put in the multivariate logistic regression analysis model, age group 5-9 years and age group 10-14 years along with drinking water from the open well were found as independent determinants for infection (aOR=1.9902, aOR=2.2572 and aOR=2.4679 respectively). A habit of handwashing with soap & water was the only significant factor for reduction in risk (aOR=0.5737) Table 3. The area under the curve (AUC) in ROC analysis for the prediction model was 0.677 with 79.39% correct prediction.

IPIs are a major public health problem in developing countries like India. They are the main cause of morbidity in SAC who have a high burden of parasitic infections. In the present study, out of 705 stool samples examined, 20.9% were harboring one or more intestinal parasites. This is in concordance with findings of other studies 25.5% in Delhi, (Mahanjan et al., 1993) and 20.3% in Jodhpur, (Saurabh et al., 2017) but lower as compared with reports of other similar studies 38.0 % in Ghaziabad, (Bisht et al., 2011) 51.5% in South India, (Fatima and Shubha, 2011) and 71.5% in Kashmir (Wani et al., 2007). These variations in prevalence might be due to differences in environmental sanitation, socio-economic status and educational status of parents and study subjects. The detection of parasites was almost similar in males (20.7%) and females (21.3%), which are in concordance with another study (Saurabh et al., 2017). This may be attributed to the equal involvement of females in outdoor activities. Some studies have reported a male preponderance, (Bisht et al., 2011; Fatima and Shubha, 2011) while in some females were found to have a predominant infection (Kotian et al., 2014).
Table 3: Univariate and multivariate analysis of potential risk factors

| Variable | Determiner | Total sample | Total | Positive case | OR (95% CI) | 'P' Value* | aOR (95% CI) | P-value** |
|----------|------------|--------------|-------|---------------|-------------|------------|-------------|-----------|
| Age      | 0-4 year   | 376          | 59    | 15.6          | Reference   | 0.001      | 1.9902      | 0.0012    |
|          | 05-09 year | 219          | 60    | 27.3          | 2.028       | (1.350 - 3.045) | 1.9902      | (1.3106 - 3.0222) |
|          | 10-14 year | 110          | 29    | 26.3          | 1.924       | (1.159 - 3.194) | 2.2572      | (1.3350 - 3.8164) |
| Gender   | Male       | 405          | 83    | 20.5          | 0.932       | (0.647 - 1.343) | 0.776       |          |
|          | Female     | 300          | 65    | 21.6          | Reference   |            |             |           |
| Residence| Rural      | 283          | 80    | 28.26         | 2.052       | (1.422 - 2.96) | <0.001      |          |
|          | Urban      | 422          | 68    | 16.1          | Reference   | 0.014      |            |           |
| Maternal Literacy | Illiterate | 399 | 99 | 24.81 | Reference | 2.024 | (1.121 - 3.656) | 0.007 |
|          | Primary    | 199          | 34    | 17.09         | 1.264       | (0.654 - 2.443) | 0.916 |
| Defecation site | Latrine | 499 | 91 | 18.24 | Reference | 1.715 | (1.172 - 2.509) |
|          | Open field | 206          | 57    | 27.67         | Reference   | 0.007      | 0.207       |          |
| Personal hygiene | Clean nails | 448 | 93 | 20.76 | Reference | 1.039 | (0.714 - 1.513) |
|          | Dirty nails| 257          | 55    | 21.40         | 1.039       | (0.714 - 1.513) | 0.0041 |
| Slipper wear | Bare | 332 | 77 | 23.19 | 1.284 | (0.893 - 1.847) |          |
|          | Slipper    | 373          | 71    | 19.03         | Reference   | <0.001     | 2.4679      | <0.0001   |
|          | Open well  | 207          | 68    | 32.85         | 2.556       | (1.755 - 3.723) |          |
|          | Tap water  | 498          | 80    | 16.06         | Reference   |            |             |           |
| Source of drinking water | Soap + Water | 428 | 74 | 17.29 | 0.645 | (0.437 - 0.953) | 0.001 |
|          | Only Water | 233          | 57    | 24.46         | Reference   | 0.5737     | (0.3926 - 0.8382) | 0.0041 |
|          | Mud + Water| 44           | 17    | 38.64         | 1.944       | (0.989 - 3.824) | 0.001 |

*Chi-square test, **MultivariateLogistic regression analysis
The isolation of helminths was higher (60.8%) as compared to protozoa (39.1%). Fatima and Shubha (2011) also reported a higher rate of helminths in their study. However, Bisht et al. (2011); Ashok et al. (2013) reported higher rates of protozoa in their studies. These differences in prevalence rates may be due to diversity in geographic regions, age groups, educational status and personal hygienic practices being followed by the study subjects. STH infections are one of the major health problems in tropical and sub-tropical countries affecting the physical growth and cognitive development in SAC. Among the positive samples, the single parasite was detected in (87.8%) of the single samples while dual parasite was detected in (12.2%) samples. Bisht et al., 2011 reported 32.8% while Tenali et al. (2018) reported 32.2% dual infection respectively in their studies. In the present study, the prevalence of A lumbricoides was maximum (20.5%) followed by G. intestinalis (18.6%), T. trichiura (18.1%) and Entamoeba spp. (8.4%). A study in Gaziabad reported prevalence of E. histolytica to be highest (20.3%) followed by G. intestinalis (14.8%), A. lumbricoides and H. nana (6.2%) each (Bisht et al., 2011). Tenali et al. (2018) reported E. histolytica (31.7%) followed by A. lumbricoides (22.5%), A. duodenale (19.9%) and G. intestinalis (12.1%). T. trichiura and A. lumbricoides are STHs associated with practices of open defecation, poor personal sanitation, lack of footwear wearing habit and poor socio-economic status. In addition contamination of soil by human faeces in combination with a high degree of overcrowding and a low-income level increases the susceptibility to helminthiasis (Wani et al., 2007). G. intestinalis is usually associated with poor sanitary surroundings and insufficient water treatment. Nutritional deficiency is common in children infected with G. intestinalis.

Our study assessed the possible association of intestinal parasitic infection with potential risk factors. As compared to children in 0-4 years age group, children of age group 5-9 years and 10-14 years had a significantly higher risk of acquiring infection (aOR:1.99,95%CI:1.31-3.02, P=0.0012 and aOR:2.25,95%CI:1.33-3.81, P=0.0024 respectively). This finding may be partially explained due to outdoor activities seen at a higher age group. Also, at a higher age, these infected children may have more exposure to the soil during growing vegetables and eating raw, unwashed vegetables. A high prevalence in the age group 5-9 years has been reported in other studies (Bisht et al., 2011; Fatima and Shubha, 2011).

In the present study, the prevalence among rural children was significantly higher than among urban children (OR: 2.05, 95% CI: 1.42-2.96, P= <0.001). Similar results have been reported by Bisht et al. (2011); Tenali et al. (2018). This may be due to poor personal hygiene and literacy rates prevailing in rural areas.

There were significantly more infected children in whose mothers were illiterate as compared to those who were educated (OR: 2.02, 95% CI: 1.12-3.65, P=0.014). A high percentage of these illiterate mothers are likely to be ignorant about proper hygienic practices. Tenali et al. (2018) also reported a higher prevalence of parasitic infections among children of uneducated mothers. Mothers should be provided information on the transmission of IPIs and adoption of preventive measures in order to be actively involved to reduce infections among their children.

Open field defecation was found to have a significant risk for acquiring parasitic infection (OR: 1.71, 95% CI: 1.17-2.50, P=0.007). This practice is common where sanitation infrastructure is not available. The most common reason for this practice is poverty which makes it a challenge to build toilets. The ‘Swachh Bharat Abhiyan’ is a government-led programme which provides funds for villages to construct toilets and thus prevent open defecation.

Children drinking water from an open well were found to have a higher prevalence of infection than those who had access to tap water (OR: 2.46, 95% CI: 1.67-3.62, P= <0.0001). This pattern of prevalence of infection has been reported in different studies (Wani et al., 2007; Bisht et al., 2011; Awasthi et al., 2008). Lack of clean drinking water, poor hygiene and improper waste disposal are important factors contributing to intestinal parasitism. Therefore, improvement in environmental sanitation, i.e. safe water supply and effective human and animal waste disposal are needed to lower parasitic infections. Children washing hands with soap and water after defecation showed a significantly lower prevalence of parasitic infection (OR: 0.573, 95% CI: 0.392-0.836, P=0.0041). Bisht et al. (2011); Awasthi et al. (2008); Tenali et al. (2018) also reported lower infection rates in children using soap and water. Health education on personal hygiene, such as the promotion of washing hands should be part of the educational curriculum in primary schools. No other variables were significantly associated with intestinal parasitosis.

**Limitations of this study**

Optimal laboratory diagnosis of intestinal parasitic infections requires the examination of three stool samples over several days. In our study, only one stool sample was examined for the detection of intestinal parasites which could have underesti-
mated the prevalence. As our study was a hospital-based study, it may not be a true representative of the general population. Due to lack of molecular techniques Entamoeba spp. could not be differentiated.

The strength of our study is that this is the first study on prevalence and risk factors of IPIs among children from this region.

CONCLUSIONS

The findings of this study will help the health care professionals to get sensitized about the burden of IPIs and associated risk factors. Identifying and rectifying risk factors by creating awareness are needed to prevent the spread of IPIs. Health awareness programmes about personal hygiene, hand washing, education for behavioural change and use of sanitary toilets would be crucial for effective control of IPIs. Periodic de-worming programmes should be implemented successfully in the community.

Conflict of Interest

The authors declare that they have no conflict of interest for this study.

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