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Intestinal Parasitic Infections, Nutritional Status and Drinking-Water Quality among School children in the Dal Lake Area of Srinagar, Kashmir, India

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Abstract

Intestinal parasitic infections are one of the major public health problems among school-age children, especially in areas lacking adequate water, sanitation, and hygiene. The present cross-sectional study aimed to investigate intestinal parasitic infections, anthropometric status, and the physicochemical characteristics of school-site drinking water among children aged 7–11 years attending four government schools in the Dal Lake region of Srinagar, India. Between September and November 2025, one drinking-water sample was collected monthly from each school, resulting in 12 site-month samples in total. Stool specimens from 155 children were examined microscopically using direct wet mounts and a concentration method, while anthropometric measurements were available for 200 children. At least one intestinal parasite was detected in 96 of the 155 children (61.9%). Of the 155 children examined, 44 (28.4%) had *Ascaris lumbricoides*, 38 (24.5%) had *Giardia lamblia* and 14 (9.0%) had *Trichuris trichiura*. Age-specific positivity ranged from 51.6% to 67.7%. Among the 200 children whose anthropometric status was assessed, 40 (20.0%) were stunted, 25 (12.5%) were thin, 110 (55.0%) had normal body mass index-for-age, 15 (7.5%) were overweight but not obese and 50 (25.0%) were obese. Physicochemical measurements varied among schools and months. However, because of the restricted water sampling duration, the absence of microbiological analysis of water and the failure to link individual-level data across study domains, waterborne transmission and

exposure–outcome relationships could not be evaluated. The results provide a baseline for the area, which can support health surveillance and improved water and sanitation practices.

Keywords: Intestinal parasites; Schoolchildren; Drinking-water quality; Nutritional status; Dal Lake; Water, sanitation and hygiene

Introduction

Intestinal parasitic infections (IPIs), caused by intestinal protozoa and helminths, continue to be a significant public health issue, especially in developing countries due to the lack of access to clean water, proper sanitation and health care facilities (Ahmed 2023; Yitageasu et al. 2026). According to the World Health Organization (WHO), about 1.5 billion people are infected with soil-transmitted helminthiasis, accounting for 24% of the total world population, while around 654 million school-aged children live in areas with intense transmission (WHO 2023). A recent systematic review and meta-analysis of 47 studies among 20,334 school-age children in low- and middle-income African and Asian countries found the pooled prevalence of at least one intestinal parasite to be 39%. However, substantial variability was observed across geographic locations and testing methods (Yitageasu et al. 2026). Many intestinal parasites are transmitted through faecal contamination of soil, food, water, or hands, while the mode of transmission varies from one species to another (Ahmed 2023; WHO 2023). Among school-aged children, unsafe water sources, poor sanitation, open defecation, lack of soap, poor hand and fingernail hygiene, soil contact, and improper eating habits have been associated with a higher risk of intestinal parasitic infection (Muoghalu et al. 2025; Yitageasu et al. 2026). The clinical effects depend on the parasite species, infection intensity, and the nutritional state of the host; symptoms include diarrhea, abdominal pain, malabsorption, anemia, malnutrition, and stunted physical development. Protozoal infections such as *giardiasis* may impair intestinal function and nutrient absorption, while moderate-to-heavy soil-transmitted helminth infections can lead to blood loss and anaemia (Ahmed 2023; WHO 2023).

Water, Sanitation, and Hygiene (WASH) conditions are significant determinants of children's exposure to intestinal parasites (WHO 2023; Yitageasu et al. 2026). According to the WHO/UNICEF Joint Monitoring Programme, 447 million children globally did not have access to basic drinking water services at school in 2023, while 427 million did not have basic sanitation services and 646 million did not have basic hygiene services (WHO & UNICEF 2024). These gaps in services are epidemiologically significant since poor sanitation, poor water supply, and poor hand washing

facilitate faecal–oral transmission and environmental contamination by parasites (WHO 2023; Yitageasu et al. 2026). Water availability alone is insufficient when drinking-water, sanitation, and handwashing services are unsafe or unreliable (WHO & UNICEF 2024; Yitageasu et al. 2026). An overall assessment of drinking water quality, WASH conditions, parasitological results, and nutritional status can therefore provide a broader picture of children's exposures and health than assessing any one of these domains alone (Birhanu et al. 2025; WHO & UNICEF 2024).

Parasitic infestation and undernutrition may reinforce each other through linked biological pathways. Parasitic infestation can reduce nutritional intake or assimilation and cause inflammatory changes or blood loss, while undernutrition can impair immune responses and increase susceptibility to infection (Ahmed 2023; Bourke et al. 2016; WHO 2023). Recent investigations conducted in schools have established the concurrent prevalence of parasitic infestation and undernutrition in elementary-school-aged children, justifying the importance of combining parasitological testing with anthropometric assessment (Birhanu et al. 2025).

However, parasitism and nutrition are influenced by environmental, dietary, and socioeconomic factors; therefore, relationships observed in cross-sectional studies should be interpreted cautiously (Birhanu et al. 2025; Setia 2016). In India, prevalence of soil-transmitted worm infection in preschool- and school-aged children varies greatly between regions, groups, methodologies of testing, and settings of intervention (Muoghalu et al. 2025). In a survey conducted in schools of Srinagar City, Wani et al. (2007) examined 514 children and concluded that 46.7% had an intestinal parasitic infection, while *Ascaris lumbricoides* was the most frequently encountered species. Similarly, Wani and Amin (2016), in a survey of 352 children from Shopian district, reported intestinal helminths in 75.28% of participants, and the most common helminth was *A. lumbricoides*. In contrast, in a five-year hospital-based study, Peerzada et al. (2022) reported parasitic infections in 7.6% of 2,159 stool specimens; however, its clinical sampling frame and mixed age groups make direct comparison with the two school-based surveys inappropriate. Such results prove that methodology, sampling frame, location and time of study and testing make prevalence rates of parasite infection vary significantly. It also demonstrates the necessity of collecting up-to-date data on the prevalence in specific population of the region.

The area of Dal Lake has a distinctive environmental context as the lake and its surrounding urban areas are subject to persistent anthropogenic pressure and declining water quality. A study identified untreated sewage, agricultural effluents, and sediment inputs from adjacent areas as major

contributors to the declining water quality of Dal Lake (Kumar et al. 2022). A more recent site-specific study reported variations in biological and chemical oxygen demand, nitrate content, and heavy-metal contamination in the water of different parts of Dal Lake (Parray et al. 2024). However, most previous studies on Dal Lake have focused on environmental water quality, whereas past studies on intestinal parasites in Kashmir have examined human infection separately from school water quality and nutritional status (Kumar et al. 2022; Parray et al. 2024; Peerzada et al. 2022; Wani et al. 2007; Wani & Amin 2016). In general, the existing literature provides evidence of an information gap regarding the co-occurrence of water quality, intestinal parasitic infection, and nutritional status among school-aged children in the Dal Lake area.

Accordingly, this cross-sectional study was conducted to assess the physicochemical quality of drinking water from selected school sites of the Dal Lake area in Srinagar; determine the prevalence and distribution of parasites amongst children aged 7–11 years; analyze their nutritional status through anthropometry; and investigate the co-occurrence of environmental, parasitological, and nutritional factors. This integrated approach was intended to generate baseline data for drinking-water surveillance, improvement of school WASH facilities, parasite detection and control, and monitoring of children's nutritional status in the area.

Materials and methods

Study design, setting and participants

A cross-sectional study was carried out between September and November 2025 on school-going children aged between 7 and 11 years in the Dal Lake area of Srinagar district, Jammu and Kashmir, India. The four government schools involved in the study included Government Primary School, Malla Mohalla, Habak; Government Middle School, Bangi Mohalla, Habak Chanpora; Government Boys Higher Secondary School, Habak Homechair; and Government Mixed Primary School, Habak. These schools served as the four drinking-water sampling sites and represented variability in local water sources and sanitation conditions.

A total of 200 children underwent anthropometric assessment. Of these, 155 provided adequate stool samples and were included in the parasitological evaluation. Percentages were calculated using denominators of 200 for anthropometric outcomes and 155 for stool examination results.

Drinking-water sampling

One drinking-water sample was collected monthly from the primary water source at each school premises school taps fed by local supply systems for a total of 3 months, resulting in 12 site-month samples. These samples were collected in properly labelled 1-L polyethylene bottles and taken to the Hydrobiology Research Laboratory, Department of Zoology, S.P. College, Srinagar. Air and water temperatures were measured at the collection site. Dissolved oxygen samples were collected in completely filled Winkler bottles without air bubbles and were fixed immediately with manganous sulphate and alkali-iodide azide reagents.

The water tests included only physicochemical parameters; no bacterial, protozoan, helminth-egg, antigen, or molecular analyses of the water were performed. Therefore, the water-test results were used only to describe site-level physicochemical conditions and not to infer pathogenic contamination.

Physicochemical analysis of water

The physicochemical analysis was carried out using Standard Methods for the Examination of Water and Wastewater by APHA, AWWA, and WEF (1998). All field instruments and analytical equipment were routinely calibrated and quality-checked using standard reference materials prior to sample analysis to maintain measurement accuracy. The specific parameters and analytical methods are listed in Table 1.

Table 1. Physicochemical parameters and analytical methods.

Parameter	Analytical method
Air and water temperature	Measured at the sampling site with a thermometer after approximately 2 min of equilibration in shade or in water, respectively.
Dissolved oxygen	Modified Winkler azide method. After fixation, acidification and mixing, a 50-mL aliquot was titrated with 0.025 N sodium thiosulphate using starch to a colourless endpoint.
pH	Electrometric measurement with a digital pH meter (Systronics model 802) calibrated with pH 4.00 and 7.00 buffers.
Electrical conductivity and TDS	Electrical conductivity was measured with a portable conductivity meter (DB-104) standardized with 0.01 M KCl; total dissolved solids were recorded with the conductivity–TDS meter and reported in mg/L.

Turbidity	Nephelometric measurement in NTU after calibration with distilled water (0 NTU) and a 20-NTU standard.
Free carbon dioxide	Titration of a 50-mL sample with 0.1 N NaOH using phenolphthalein to a faint-pink endpoint; reported as mg/L CO_2.
Chloride	Argentometric titration of a 100-mL sample with 0.0141 N $AgNO_3$ using potassium chromate indicator; reported as mg/L chloride.
Total alkalinity	Titration of a 100-mL sample with 0.02 N H_2SO_4 using phenolphthalein and methyl-orange endpoints; reported as mg/L $CaCO_3$.
Magnesium hardness	Reported as recorded in the source dataset and expressed as mg/L CaCO3; the original analytical records were unavailable for method verification.
Calcium hardness	EDTA titration of a 50-mL sample after addition of NaOH and murexide indicator; reported as mg/L CaCO3.
Total hardness	EDTA titration of a 25-mL sample, diluted to 50 mL, at pH 10.0–10.1 using Eriochrome Black T; reported as mg/L $CaCO_3$.
Taste and odour	Assessed by serial dilution with distilled water to the odour threshold and reported as threshold odour number (TON).

Anthropometric assessment and nutritional classification

Standing height was measured without footwear using a measuring tape fixed vertically to a flat wall and recorded to the nearest inch; values were converted to centimetres for analysis. Body weight was measured using a digital scale while the child wore minimal clothing and no footwear, and was recorded to the nearest 0.5 kg. The body mass index (BMI) was determined as weight in kilograms divided by the square of the height in meters (kg/m^2).

Height-for-age z-scores (HAZ) and body mass index-for-age z-scores (BAZ) were assessed using the World Health Organization (WHO) 2007 growth reference for children and adolescents aged 5–19 years (de Onis et al. 2007). Stunting was defined as HAZ less than -2 standard deviations (SD). BMI-for-age was classified as thinness (BAZ less than -2 SD), nutritionally normal (BAZ from -2 to +1 SD), overweight (BAZ greater than +1 SD), and obesity (BAZ greater than +2 SD). Obesity was considered a form of overweight according to the WHO classification. Overweight without obesity was classified as being within BAZ greater than +1 and less than or equal to +2 SD for mutually exclusive presentation. A separate weight-for-age underweight category was not used because the WHO reference does not cover the full 7–11-year age range.

Collection and parasitological examination of stool specimens

Faecal samples (at least 5 g) were obtained in sterile, leak-proof, properly labelled containers. The containers were labelled with an identification number, age, sex, and specimen-collection date. The samples were transported to the laboratory and examined within 2 hours of collection. Macroscopic examination recorded stool consistency, colour and odour and noted the presence of blood, mucus, adult worms, tapeworm segments or larvae.

Direct saline and iodine preparations were used for microscopic examination. Zinc sulphate flotation was used to improve the recovery of parasite eggs and cysts. Specimens were examined under a compound light microscope, and identification of parasites was based on morphology (WHO 2019). The principal organisms recorded were *Ascaris lumbricoides*, *Trichuris trichiura* and *Giardia lamblia*. A sample was considered positive if at least one parasitic stage was observed in any preparation. Infection intensity was not determined, and antigen testing was not performed.

Data management and statistical analysis

Analyses were descriptive. Arithmetic mean and range for each physicochemical variable were obtained using three months of data collected from each school sampling site (n=3). The arithmetic mean was calculated as the total of the monthly values divided by three. The water data were similarly presented according to site and month to preserve temporal variability.

Overall intestinal-parasite prevalence was calculated as the proportion of the 155 tested children with at least one positive stool examination. Species-specific prevalence was calculated using the total sample size (N= 155) as the denominator. In presenting the proportionate distribution of positive cases, the parasite-positive children (N= 96) were used as the denominator. Anthropometric prevalence estimates used the total sample size (N= 200) as the denominator and were obtained separately for different categories according to HAZ and BAZ scores. Overweight included obese children as a nested subgroup, while mutually exclusive categories of BMI were presented for clarity.

Because water quality was analysed at the school-site level and individual-level linkage among water measurements, stool findings, and anthropometric measures could not be established, the three domains were summarized descriptively and interpreted as co-occurring cross-sectional patterns rather than causal relationships.

Results

Study sample and analytical denominators

Anthropometric measurements were available for 200 children. Stool results are reported for the 155 children examined (77.5% of those with anthropometric data). Drinking-water testing comprised 12 site-month observations, with one observation per month at each of the four schools during September, October, and November 2025.

The four sites were Government Primary School, Malla Mohalla, Habak (Site 1); Government Middle School, Bangi Mohalla, Habak Chanpora (Site 2); Government Boys Higher Secondary School, Habak Homechair (Site 3); and Government Mixed Primary School, Habak (Site 4). School-specific participant counts and a reliable child-level linkage among water, stool and anthropometric records were not available; the three domains are therefore presented descriptively.

Physicochemical characteristics of drinking water

The arithmetic mean and range for each school, based on data collected from September to November, are shown in Table 2. The monthly values of each variable are shown in Figures 1-4.

Table 2. Site-specific arithmetic mean 3

and range of physicochemical measurements (n = 3 monthly observations per site).

Parameter	Unit	Site 1	Site 2	Site 3	Site 4
Water temperature	°C	21.33 (14.00-25.10)	23.37 (20.00-25.60)	23.77 (20.50-26.00)	24.30 (22.50-25.90)
Air temperature	°C	23.10 (16.00-28.30)	24.33 (18.00-27.80)	23.73 (18.90-26.20)	24.23 (20.20-27.00)
Dissolved oxygen	mg/L	12.90 (7.50-22.30)	9.64 (4.60-17.92)	13.43 (8.90-16.50)	14.75 (10.90-21.76)
Free carbon dioxide	mg/L	11.18 (2.10-28.80)	24.65 (1.76-69.20)	13.97 (2.20-34.70)	11.62 (1.76-26.80)
pH	-	10.26 (10.15-10.37)	10.44 (9.80-10.99)	9.77 (7.60-10.98)	10.02 (8.30-10.88)
Electrical conductivity	mS/cm	1.55 (0.06-4.30)	2.62 (0.07-6.90)	1.33 (0.08-3.30)	1.02 (0.07-2.50)
Total dissolved solids	mg/L	3.80 (2.30-4.60)	3.33 (3.10-3.80)	1.73 (1.40-2.40)	2.67 (1.60-4.30)

Chloride	mg/L	26.67 (14.20-37.90)	44.97 (29.10-57.90)	14.10 (5.90-20.20)	25.27 (15.96-30.96)
Total alkalinity	mg/L as CaCO3	66.00 (16.00-156.00)	93.33 (12.00-244.00)	28.67 (8.00-62.00)	43.00 (12.00-93.00)
Threshold odour number	TON	0.67 (0.00-2.00)	2.67 (2.00-4.00)	2.33 (2.00-3.00)	0.33 (0.00-1.00)
Turbidity	NTU	1.10 (0.00-2.40)	0.30 (0.00-0.50)	1.47 (0.10-3.60)	0.27 (0.00-0.50)
Total hardness	mg/L as CaCO3	68.67 (64.00-74.00)	77.33 (70.00-86.00)	61.33 (40.00-80.00)	70.67 (36.00-98.00)
Calcium hardness	mg/L as CaCO3	7.37 (5.31-10.40)	11.31 (6.81-18.40)	6.25 (3.13-9.80)	7.87 (6.40-9.80)
Magnesium hardness	mg/L as CaCO3	60.73 (40.00-82.19)	96.23 (82.69-108.00)	37.30 (18.00-57.89)	34.53 (0.00-56.69)

Values are arithmetic means (minimum–maximum). TDS is expressed in mg/L and conductivity in mS/cm. Water testing was physicochemical only; the measurements do not establish microbiological or parasitological safety.

Dissolved oxygen ranged from 4.60 mg/L at Site 2 in October to 22.30 mg/L at Site 1 in September. Free carbon dioxide ranged from 1.76 to 69.20 mg/L and increased at every site in November, with the highest value at Site 2. The pH ranged from 7.60 to 10.99: values were above 10 at all sites during September and October, whereas the November values were 10.25, 9.80, 7.60 and 8.30 at Sites 1-4, respectively. Electrical conductivity ranged from 0.06 to 6.90 mS/cm and was highest at every site in November (Figure 1).

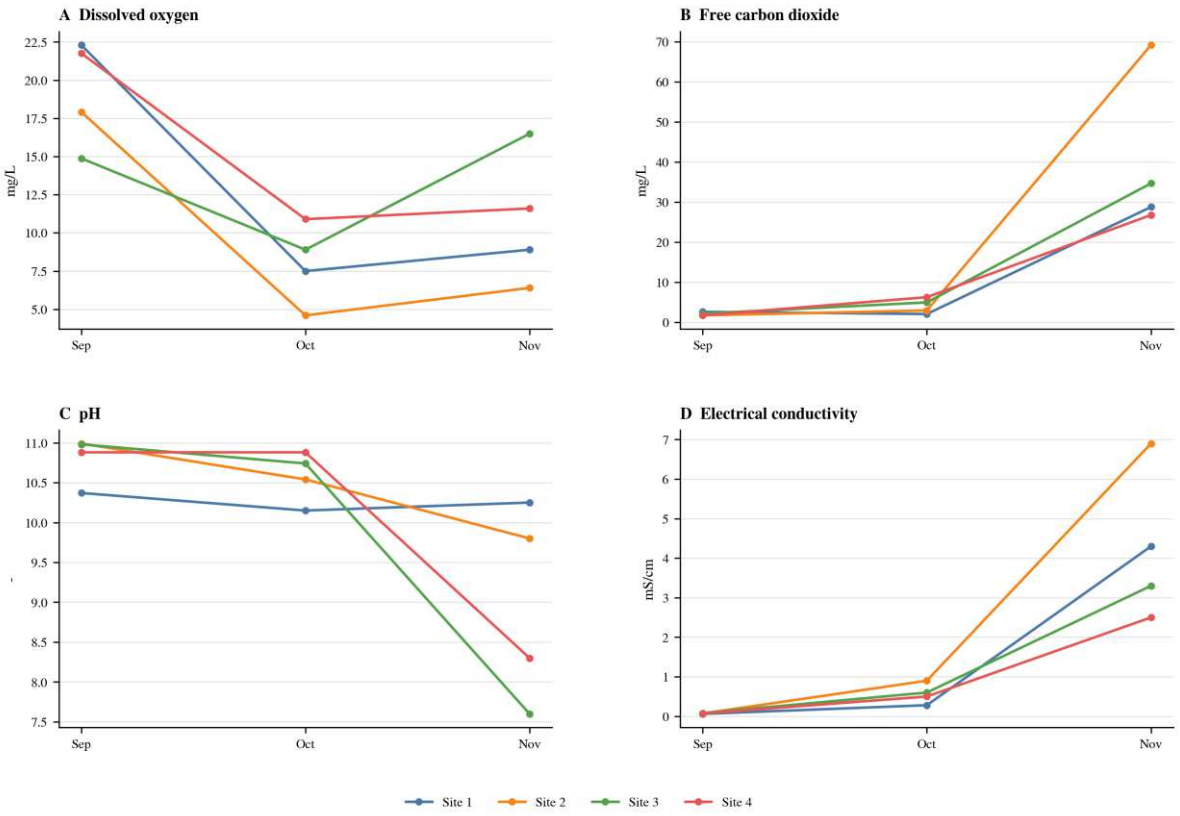


Fig. 1 Monthly variation in (A) dissolved oxygen, (B) free carbon dioxide, (C) pH and (D) electrical conductivity across the four school sites

Total hardness ranged from 36 to 98 mg/L as CaCO3. Site 4 had the highest recorded total hardness in September (98 mg/L), Site 2 had the highest value in October (86 mg/L), and the November values were lower than the corresponding September values at Sites 2-4. Calcium hardness ranged from 3.13 to 18.40 mg/L as CaCO3 and was highest in September at all four sites. Magnesium hardness ranged from 0 to 108 mg/L as CaCO3; it increased across the three months at Sites 1, 3 and 4 but decreased at Site 2 (Figure 2).

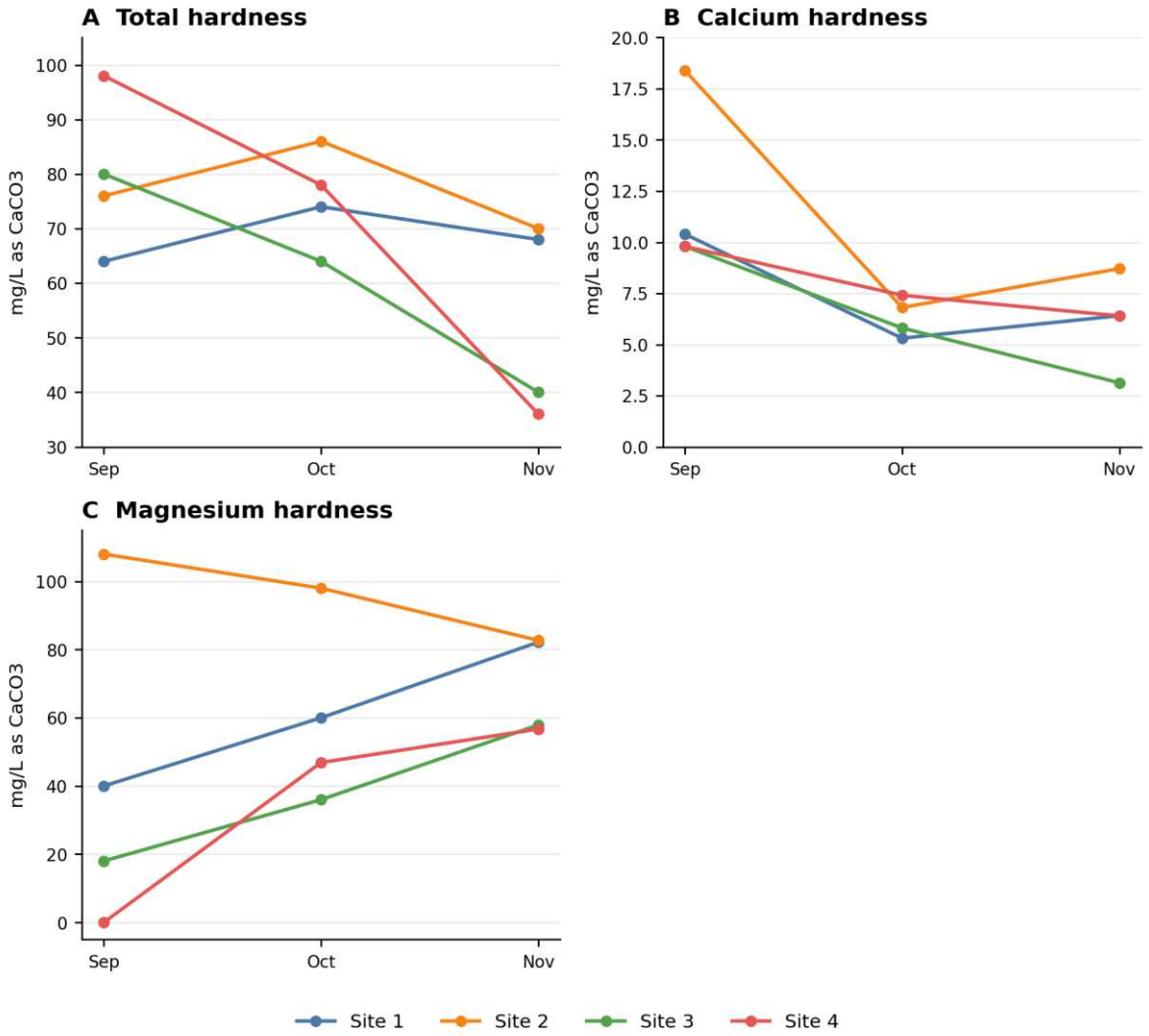


Fig. 2 Monthly variation in (A) total hardness, (B) calcium hardness and (C) magnesium hardness across the four school sites

Chloride concentrations ranged from 5.90 to 57.90 mg/L and peaked in October at each site. Total alkalinity ranged from 8 to 244 mg/L as CaCO3 and increased substantially in November, particularly at Site 2. Turbidity ranged from 0 to 3.60 NTU; the highest value occurred at Site 3 in September, and the monthly pattern was not a uniform increase. Total dissolved solids ranged from 1.40 to 4.60 mg/L and likewise showed no uniform temporal trend across all four sites (Figure 3).

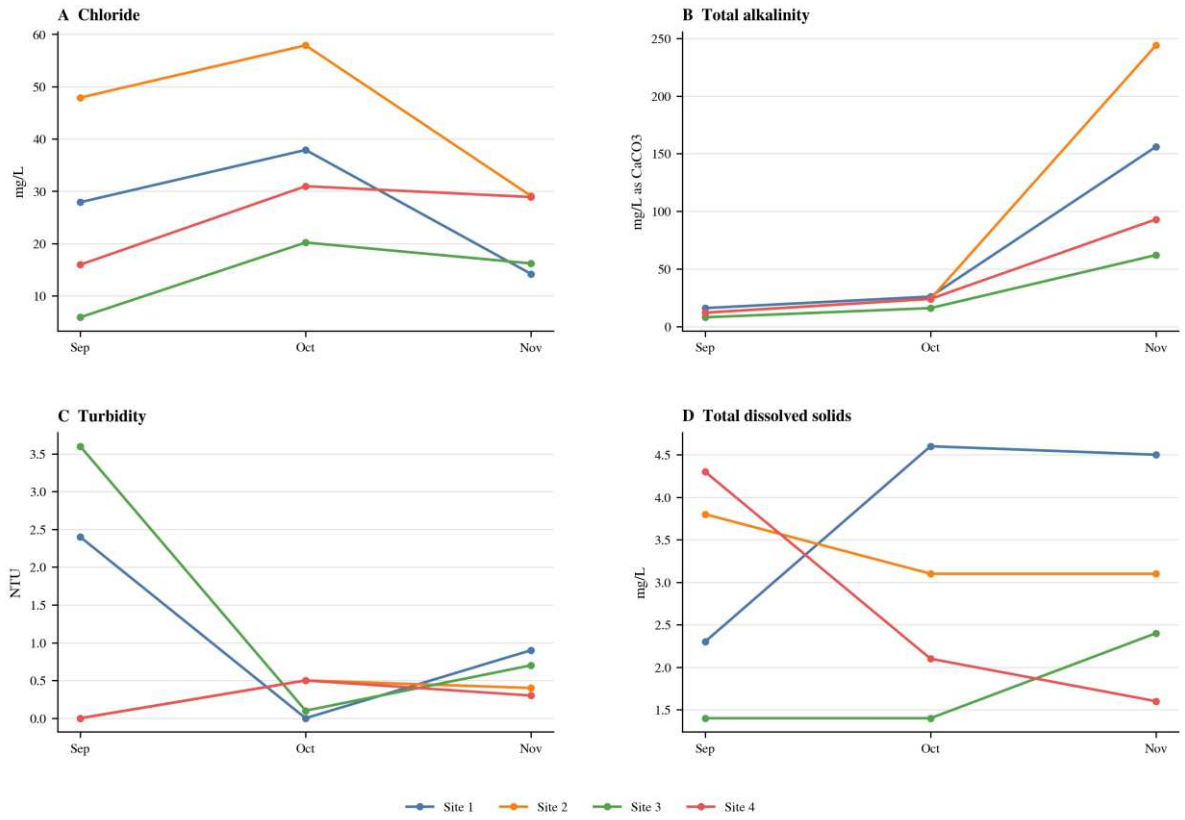


Fig. 3 Monthly variation in (A) chloride, (B) total alkalinity, (C) turbidity and (D) total dissolved solids across the four school sites

Threshold odour number ranged from 0 to 4, with the highest value at Site 2 in November. Air temperature ranged from 16.0 to 28.3 °C and water temperature from 14.0 to 26.0 °C. Both were lowest in November, while the highest recorded air and water temperatures occurred in October (Figure 4).

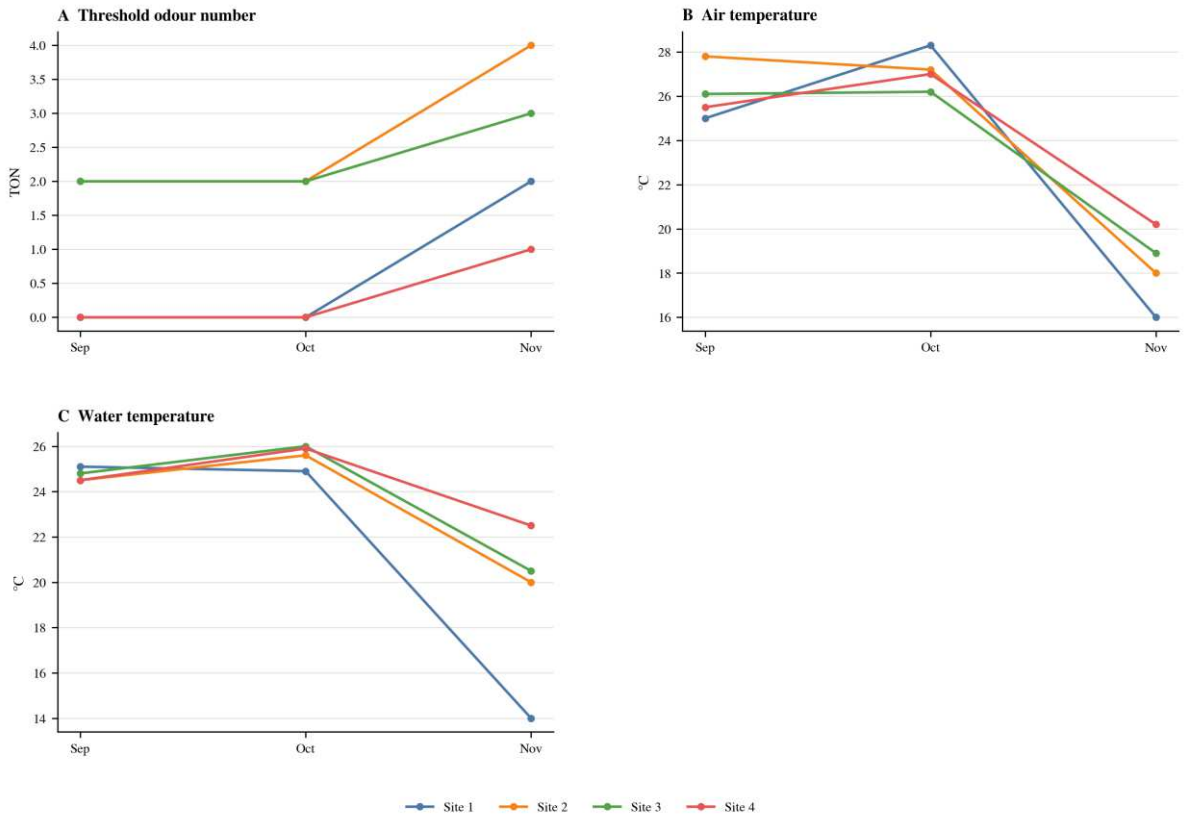


Fig. 4 Monthly variation in (A) threshold odour number, (B) air temperature and (C) water temperature across the four school sites

Intestinal parasitic findings

Of the 155 stool specimens examined, 96 contained at least one intestinal parasite stage (61.9%), whereas 59 were negative (38.1%). Species-specific prevalence was calculated using all 155 examined children as the denominator (Table 3 and Fig. 5).

The most frequently detected species was *Ascaris lumbricoides*, identified in 44 of 155 children (28.4%), followed by *Giardia lamblia* in 38 (24.5%) and *Trichuris trichiura* in 14 (9.0%). All 96 parasite-positive children presented with single-species monoinfections (Ascaris lumbricoides = 44,

Giardia lamblia = 38, Trichuris trichiura = 14). No polyparasitic co-infections were detected in any of the examined stool specimens.

Table 3. Overall and species-specific stool examination results.

Stool finding	Number	Prevalence among 155 (%)
At least one parasite detected	96	61.9
Ascaris lumbricoides	44	28.4
Giardia lamblia	38	24.5
Trichuris trichiura	14	9.0
No parasite detected	59	38.1

Species-specific percentages were calculated using the 155 examined children as the denominator. All positive cases were single-species monoinfections; no co-infections were detected

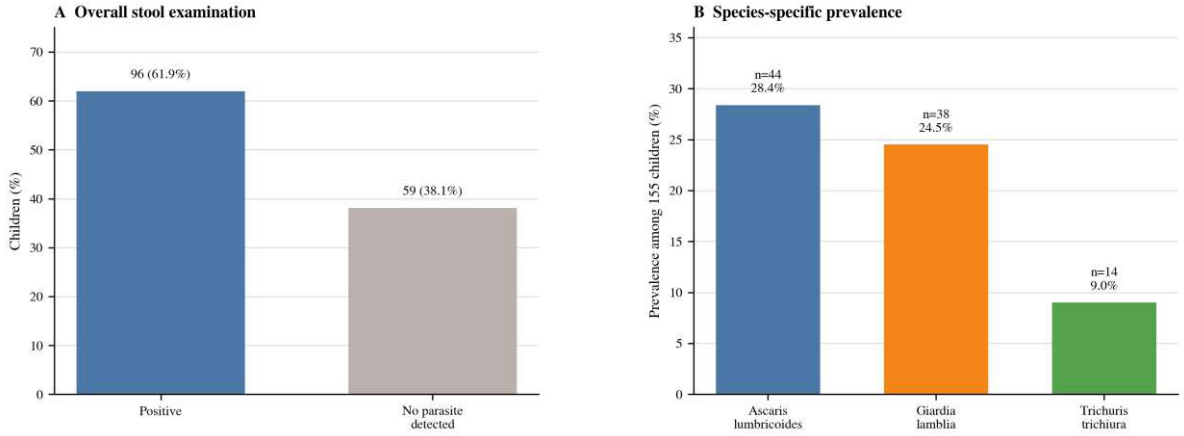


Fig. 5 Overall stool positivity and species-specific prevalence among the 155 children examined. Species percentages use 155 as the denominator; labels show the corresponding case counts

Table 4. Descriptive age-specific distribution of stool positivity.

Age (years)	Examined	Positive	Negative	Positivity (%)
7	31	20	11	64.5
8	31	21	10	67.7
9	31	19	12	61.3
10	31	16	15	51.6
11	31	20	11	64.5
Total	155	96	59	61.9

Age-specific positivity ranged from 51.6% at 10 years to 67.7% at 8 years. The rates were 64.5%, 67.7%, 61.3%, 51.6% and 64.5% at ages 7, 8, 9, 10 and 11 years, respectively, showing a non-monotonic descriptive pattern (Table 4 and Figure 6).

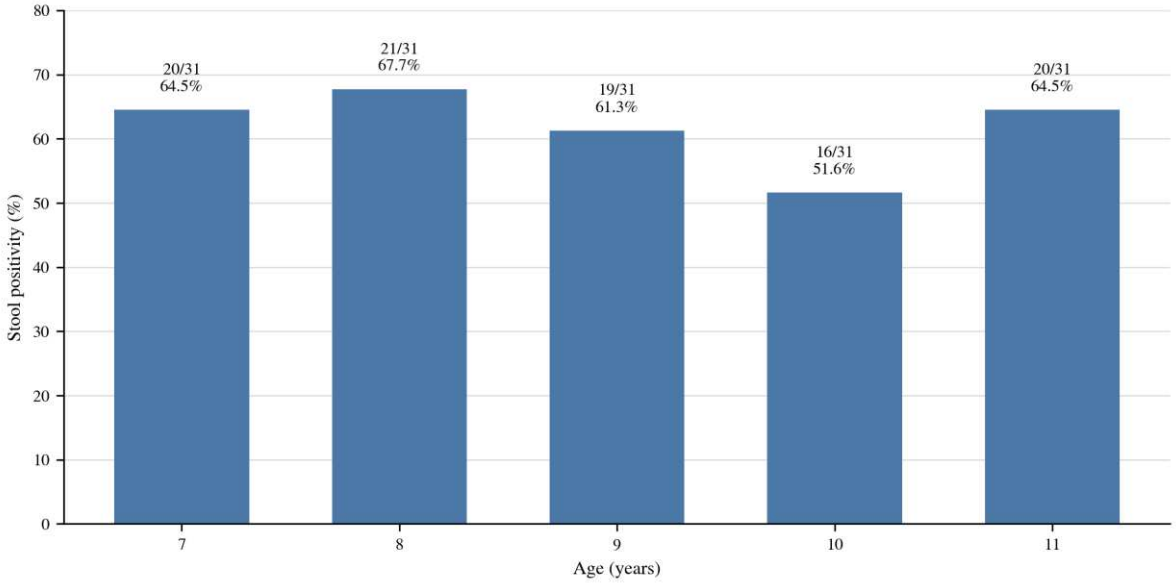


Fig. 6 Descriptive stool positivity by age. Each age group comprised 31 children; labels show positive/examined counts and percentages

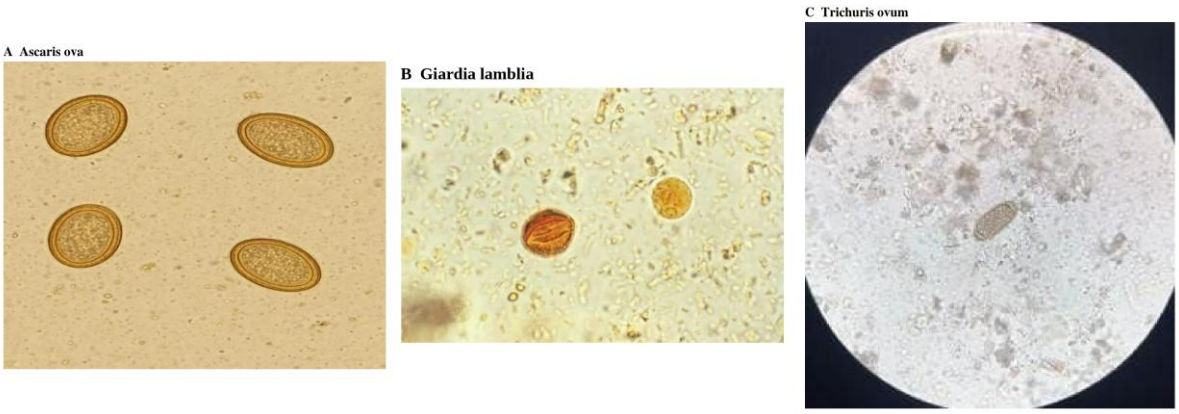


Fig. 7 Representative microscopic images of intestinal parasites detected in the study: (A) ova reported as *Ascaris lumbricoides*; (B) *Giardia lamblia* and (C) ovum of *Trichuris trichiura*

Anthropometric findings

Height-for-age and BMI-for-age were evaluated separately for all 200 children. Forty children were stunted (20.0%). Twenty-five children were thin (12.5%), whereas 65 children (32.5%) exceeded the WHO overweight threshold. Because obesity is nested within overweight under the WHO definition, the 65 children included 50 who were obese (25.0% of the total sample) and 15 who were overweight but not obese (7.5%). The remaining 110 children (55.0%) were in the normal BMI-for-age range (Table 5 and Figure 8).

Table 5. Anthropometric classification of the 200 children.

Indicator	Category	Number	Percentage (%)
Height-for-age	Stunted	40	20.0
Height-for-age	Not stunted	160	80.0
BMI-for-age	Thinness	25	12.5
BMI-for-age	Normal	110	55.0
BMI-for-age	Overweight (not obese)	15	7.5
BMI-for-age	Obesity	50	25.0

Height-for-age and BMI-for-age are separate indicators and can overlap at the child level. The BMI rows are mutually exclusive and total 200. Under WHO 2007, obesity (> +2 SD) is nested within overweight (> +1 SD); therefore, the overall overweight prevalence is 65/200 (32.5%), including the

50 children with obesity, and is not 32.5% + 25.0%. A separate weight-for-age underweight outcome was not retained because the WHO reference does not cover the full 7-11-year age range.

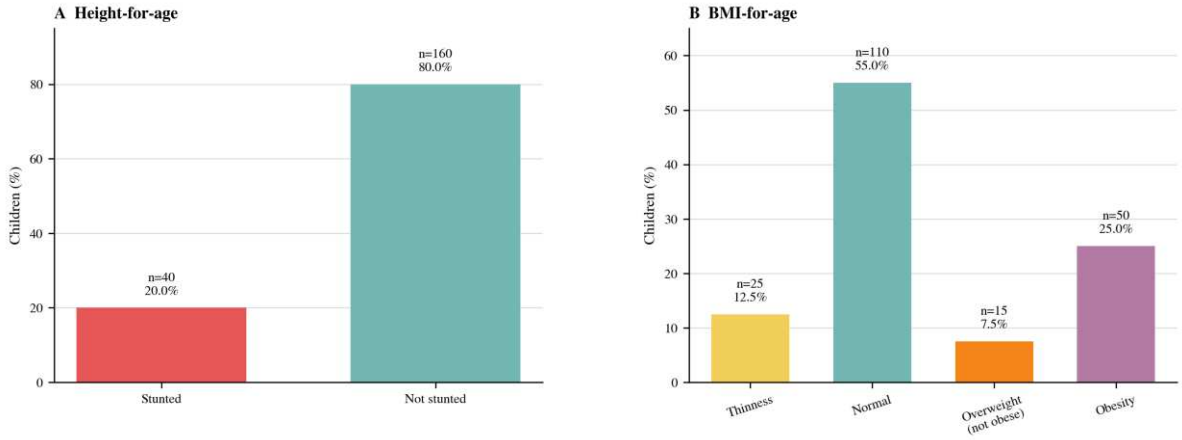


Fig. 8 Anthropometric profile of the 200 children: (A) height-for-age and (B) BMI-for-age classifications. The two indicators are presented separately

Discussion

This study provides a location-based assessment of intestinal parasitic infection, anthropometric status, and school-site drinking-water physicochemistry in four government schools of the Dal Lake region of Srinagar. Of the 155 children whose stool samples were examined, 96 were positive for at least one intestinal parasite, giving an overall prevalence of 61.9%. Among the 200 children with anthropometric data, 20.0% were stunted and 12.5% were thin, while 32.5% exceeded the WHO threshold for overweight, including 25.0% who exceeded the obesity threshold. Physicochemical values also varied among schools and sampling months.

The prevalence of intestinal parasitic infection in this survey was higher than the 46.7% reported among 514 schoolchildren aged 8–13 years from four middle schools in Srinagar City by Wani et al. (2007) and the 24.3% reported among 461 schoolchildren less than 10 years old in Rishikesh by Bansal et al. (2018). In comparison, Wani and Amin (2016) reported a positivity rate of 75.28% among 352 children aged 4-15 years in Shopian district. That figure was specific to intestinal helminths, whereas the current estimate includes both helminths and protozoa. In a five-year retrospective survey from a tertiary care hospital in Kashmir, parasites were found in 7.6% of 2,159 collected stool samples (Peerzada et al. 2022). Hospital-based samples, community school surveys, and helminth-specific surveys represent different source populations and testing approaches. Thus, their prevalence estimates should not be interpreted as direct measures of change over time. The

differences in age, selection criteria, sample size, testing methodology, sanitation, and environmental exposure can all contribute to the substantial differences observed in prevalence rates.

Ascariasis (*Ascaris lumbricoides*) was the most commonly identified parasite, with a prevalence of 28.4% among the 155 children examined. This percentage is identical to that reported in a previous study of Srinagar schools by Wani et al. (2007) despite different periods and study groups. Giardiasis (*Giardia lamblia*) was detected in 24.5% of the examined children, whereas Bansal et al. (2018) identified 15.2% in Rishikesh. *Trichuris trichiura* was detected in 9.0%, compared with 4.9% in the earlier Srinagar survey and 26.4% in the helminth-focused Shopian study (Wani et al. 2007; Wani and Amin 2016). These comparisons are descriptive because the study populations, geographic settings, and analytical methods differ. In the present cohort, all positive cases were single-species monoinfections, with no observed polyparasitism among the examined children.

Age-specific positivity ranged from 51.6% at 10 years of age and 67.7% at 8 years of age. Children aged 7, 9, and 11 years had positivity rates of 64.5%, 61.3%, and 64.5%, respectively. The pattern was non-monotonic and did not indicate a consistent increase or decrease in infection with age. In another study carried out by Wani et al. (2007), the highest rate occurred in the 8–11-year age group; however, the age grouping and sampling procedures differed from those of the current study.

A. lumbricoides, T. trichiura, and G. lamblia infections are biologically compatible with faeco–oral and environmental transmission. However, this compatibility does not establish school drinking water as the source of infection. A systematic review and meta-analysis suggested that water treatment, sanitation availability, access to soap, and handwashing were associated with lower odds of soil-transmitted helminth infection, although most of the evidence was observational (Strunz et al. 2014). Similar findings were reported among Kenyan schoolchildren, where WASH associations at school and household levels varied by parasite exposure (Freeman et al. 2015). Both studies support integrated WASH practices without attributing infections to any specific water source.

Water-parameter values varied among sites and across sampling months at the four schools. The pronounced seasonal variation in dissolved oxygen (peaking at 22.3 mg/L) and pH (exceeding 10.0) during September across school supply points reflects intense daytime photosynthetic activity by local phytoplankton in untreated surface-water storage systems during early autumn. Daytime uptake of free carbon dioxide by active algae drives the carbonate equilibrium towards extreme alkalinity (pH > 10) while generating biological oxygen supersaturation. As ambient water temperatures decreased toward November (14.0°C–20.0°C), reduced photosynthetic rates naturally restored pH (7.5–9.3) and dissolved oxygen levels toward baseline concentrations (Fig. 1A, C). However, because the

evaluation was restricted strictly to physicochemical parameters and did not include faecal indicator organisms or direct parasite screening, these data describe raw chemical suitability but cannot establish microbiological safety.

The anthropometric data indicate impaired linear growth alongside a substantial proportion of elevated BMI-for-age. The 20.0% prevalence of stunting is close to the 22% reported in the Comprehensive National Nutrition Survey for Indian children aged 5–9 years. In contrast, the 12.5% prevalence of thinness in the current cohort is lower than the 23% reported in the national survey (Ministry of Health and Family Welfare et al. 2019). The 32.5% prevalence above the overweight threshold exceeds the 4% prevalence of overweight or obesity reported nationally for children aged 5–9 years, and 25.0% of the present cohort exceeded the obesity threshold. Under the WHO 2007 classification, obesity is a subcategory of overweight (de Onis et al. 2007). Direct comparison between the two datasets is limited by differences in sample characteristics.

At the population level, the coexistence of stunting and elevated BMI-for-age categories is consistent with the concept of a double burden of malnutrition, which is described as the presence of both undernutrition and overnutrition in populations, households, or individuals (Popkin et al. 2020). The current aggregated data support this characterization only at the population level. Height-for-age and BMI-for-age represent separate variables, and individual-level cross-tabulation was unavailable to determine whether both forms of malnutrition occurred in the same children. As a result, the data do not confirm that children with parasites were shorter, thinner or heavier than those without detected parasites. Studies that link WASH practices, stool findings, and anthropometric data at the individual or household level can examine these relationships; for example, Shrestha et al. (2020) noted complex interactions among nutritional, socioeconomic, and WASH variables. Therefore, the current findings should be interpreted as evidence of co-occurrence rather than association.

A strength of the study is its integrated focus on three public-health domains in an under-described school population near Dal Lake. It also provides updated local parasite counts, age-specific descriptive estimates and repeated physicochemical observations from four government-school sites. Several limitations restrict the inferences that can be drawn from the results. Stool samples were available for 155 of the 200 children with anthropometric data; however, the available information did not allow comparison between children with and without stool samples. Information on serial stool samples, infection intensity, confirmatory diagnosis, and co-infection status was unavailable. In addition, school-specific participant counts and linkage among stool, anthropometric, and water records were unavailable.

Further limitations concern representation and measurement. The four chosen schools may not be representative of all children attending schools in Srinagar and Kashmir Valley. Water sampling was conducted from September to November 2025, with only one sample per site-month, and therefore did not cover the full seasonal cycle. Microbial water quality, household WASH conditions, diet, physical activity, socioeconomic status, recent deworming, and relevant clinical signs were not included in the analysis. Finally, the cross-sectional design establishes prevalence at the assessment period but cannot determine temporal sequence or causality (Setia 2016).

The findings identify clear priorities for further investigation. A follow-up study should use a matched child-level dataset; record their sex, age, school attended, water source, sanitation, handwashing practices, diet, exercise habits, and deworming status; and apply quality-controlled anthropometric measurements. The parasitology study could be strengthened by repeat stool collection, standardized concentration methods, estimates of infection intensity, and confirmatory tests using antigen- or molecular detection if possible. For water quality monitoring, replicate physicochemical analyses, E. coli or another faecal indicator, and protozoan testing, where epidemiologically appropriate, should be included. This would permit multivariable analysis and clearer distinction between community-level environmental conditions and individual exposure–outcome associations.

In the absence of further evidence, the high stool-positivity rate supports continued school-health measures, including handwashing with soap, appropriate sanitation, safe water access and storage, health education, and deworming in accordance with public-health policies. The anthropometric profile indicates the importance of looking out for children who are stunted, thin, overweight, or obese. The global figures continue to point towards deficiencies in water, sanitation and hygiene in schools (World Health Organization and United Nations Children's Fund 2024).

Conclusion

This study found a high burden of intestinal parasitic infection among school-going children in the Dal Lake area, with 61.9% of the examined stool samples testing positive. *Ascaris lumbricoides* was the most commonly detected parasite, followed by *Giardia lamblia* and *Trichuris trichiura*. The anthropometric findings showed that stunting and thinness were present alongside a considerable proportion of children with overweight and obesity, indicating a mixed nutritional burden in this population.

Drinking-water physicochemical characteristics varied across the four schools and sampling months. Because the water, stool, and anthropometric data could not be linked at the individual-child level, and the water was not tested microbiologically, these findings should not be interpreted as

evidence that school drinking water caused the parasitic infections or nutritional patterns. Overall, the study provides useful local baseline information and supports continued school-based parasite surveillance, WASH improvement, deworming, and nutritional monitoring in the Dal Lake area.

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Consent to participate: Informed consent was obtained from the parents or legal guardians of all participating children.