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Original Article

Prevalence of infections among 6-16 years old children attending a semi-rural school in Western Maharashtra, India

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Abstract

Background: Infections are an important cause of morbidity in rural India. Reports on the prevalence of infections in older children and their effects on growth are scarce. **Objective:** The objectives were to determine the prevalence of common infections among 6-16 year old school-children in a semi-rural setting in Western India and to assess the influence of infections on the growth status of the children. **Materials and Methods:** This cross-sectional study was conducted in a semi-rural setting in a Zilla Parishad Primary School, Karegaon, Maharashtra. 802 children (boys = 439), 6-16 years of age were assessed. Data on height, weight and infection-related symptoms reported by children (pre-tested, validated questionnaire) were collected. K-means cluster analysis was used to create three clusters based on the severity of infections, and one-way analysis of variance with *post-hoc* Tukey's multiple comparisons was used to test the significance of differences in means of various characteristics of the subjects in three clusters. **Results:** 43% boys and 49% girls reported symptoms of respiratory tract infections occasionally, and 28% boys and 27% girls complained of gastrointestinal (GI) infections occasionally. Children with more severe infections were more likely to be shorter and lighter; this was more marked in girls. **Conclusions:** Rural school-going children (aged 6-16 years) suffer from high rates of infections, mainly upper respiratory tract infections followed by GI tract infections.

Key words: *Gastrointestinal tract infections, K-means cluster analysis, Morbidity, Stunting, Underweight, Upper respiratory tract infections*

Infectious diseases are an important cause of morbidity in the rural areas of India [1]. The most common infectious diseases include respiratory tract infections, infections of the gastrointestinal (GI) tract (including intestinal parasites) and ocular infections. Most reports on infections focus on children under 5 years of age, with prevalence of acute respiratory infections reported as 26.8% in rural Ahmedabad [2], 27% in Kancheepuram district, Tamil Nadu [3], while, diarrheal diseases in Kashmir were found in 25.2% children under 5 years [4]. A recent report on the nutritional status of urban older children has stated that worm infestations are the most common morbidity reported followed by upper respiratory tract infections (URTI) in children aged 5-13 years in urban Ahmedabad [5].

A report on ocular morbidity in 6-16 year old school children from Shimla stated that there was a 31.6% prevalence of ocular morbidity, with conjunctivitis having a prevalence of 0.8%. [6]. Styes were observed in 1.74% of 10-16 year old children in a study conducted by Deshpande et al. [7]. Another study on pre-school children in Pune slums reported that high rates of morbidity significantly affect both the height and weight of children and may also result in negligible catch-up growth [8]. Thus, besides undernutrition, the burden of infections may also contribute to stunting in children [9]. There is scant attention paid to the burden of infections and its association with growth in school-going children [10].

Thus, the objectives of this cross-sectional study were to determine the prevalence of common infections in 6-16 year old school children in a semi-rural setting in the Western India and to assess the influence of infections on the growth status of children.

MATERIALS AND METHODS

This cross-sectional study was carried out in school children (6-16 years) from a village (Karegaon) about 65 km from Pune, Maharashtra state, India during March, 2014. This semi-rural site was chosen after carrying out a survey which specifically looked at accessibility, availability of subjects in the age-group to be studied and cooperation from school and local authorities. This particular site was selected after a survey of eight schools. As a result of industrialization, a majority of the people living in this area are migrants, and a large number of people are employed as industry workers/laborers. The study was approved by the Institutional Ethics Committee. Written informed consent was provided by parents and children gave assent for the study. For illiterate parents, the information was read out to them either in Marathi or Hindi. If they agreed to take part in the study, their signature or thumbprint on the consent form was obtained, and this was witnessed by an independent witness, usually one of the senior school staff.

The children underwent a general pediatric assessment in order to ensure that they did not have any congenital abnormalities, dysmorphic features or chronic systemic illnesses. Children who had an underlying chronic systemic illness or where the growth had been compromised by genetic disorders were excluded.

Anthropometric Measurements

Standing height was measured using a portable stadiometer (Leicester Height Meter, Child Growth Foundation, UK). Weight was measured using electronic scales (Salter, India) to the nearest 100 g. Body mass index (BMI) was calculated as weight in kg ÷ height in meter square. Height for age (HAZ), weight for age (WAZ) and BMI for age Z scores were computed [11]. An average of three readings for all parameters was used for analysis.

Clinical Assessment

Clinical assessment was carried out by pediatricians to confirm good health. Data on common infection-related symptoms were recorded using a pre-tested and validated symptom-based questionnaire administered by trained investigators [12]. In this questionnaire-based study, children were judged to have suffered from the type of infection: Respiratory, GI and ocular, based on the symptoms reported by them. Morbidity was recorded according to the frequency and severity of the common symptoms suffered by the subjects during the preceding 3 months. The symptoms recorded included URTI (cold, cough and fever), GI infections (loose motions and vomiting), eye infections (infective conjunctivitis and stye), headache, fatigue, stomach ache and bleeding gums.

Infection Scoring Technique

The symptoms reported by the children were initially scored separately for frequency and severity [13]. Following this, each symptom was graded on a nine-point scale which took into account both the frequency as well as the severity of the infection as follows: No = 0; infrequently mild = 1; occasionally mild = 2; infrequently moderate = 3; occasionally moderate = 4; infrequently severe = 5; frequently mild = 6; frequently moderate = 7; occasionally severe = 8; and frequently severe = 9. The total score of all symptoms reported by each child was expressed as a percentage.

The K-means cluster analysis was used to create groups with relatively homogenous characteristics based on the percentage scores of infections. Using this technique, we identified three clusters which were labeled as infrequent infections (II), mild infections (MI) and moderate to severe infections (MSI).

Statistical Analysis

All statistical analyses were performed using SPSS software (version 16.0.2007, SPSS Inc., Chicago, IL). All results are expressed as mean ± standard deviation. The significance of the differences in means of the various characteristics of the subjects in the three clusters was tested using one-way analysis of variance with *post-hoc* Tukey's multiple comparisons tests. The generalized linear model was used to test the differences between the mean height, mean weight and mean BMI (all adjusted for age) among the three clusters gender-wise. Chi-square test was used to determine the association between stunting and the infections among boys and girls.

RESULTS

805 school children aged 6-16 years were enrolled in the study. Out of these, three were excluded. Two children had extreme short stature (HAZ score <−4.0) who have been referred for investigations for a possible underlying genetic cause; one child had a weight for age Z score <−4.0. Finally, anthropometric and infection-related data on 802 children were analyzed. The study population consisted of 439 boys and 363 girls with a mean age of 10.1±2.1 years. Mean height, weight and BMI of the boys and girls are given in Table 1. Among 802 children, 17% boys and 13% girls were stunted (HAZ ≤−2.0) while 12% boys and 9% girls were underweight (WAZ ≤−2.0). The mean height,

Table 1: Nutritional status of the subjects according to gender*

Anthropometric parameters	Boys (439)	Girls (363)
Height (cm)	131.4±12	130.6±12.4
HAZ[a]	−1.0±0.9	−1.0±0.9
Children stunted (%)	17	13
Weight (kg)[#]	27.2±7.5	27.3±8.3
WAZ[a]	−1.0±0.8	−0.9±0.9
Children underweight (%)	12	9
BMI (kg/m^2)[#]	15.3±2.7	15.5±2.6
BAZ[a]	−0.7±0.8	−0.6±0.8

***Results are expressed as mean±SD; [#]Non-normal variable; [a]Z scores are computed using Indian growth percentiles data (Khadilkar et al., 2007), BMI: Body mass index, HAZ: Height for age, BAZ: Body mass index for age, WAZ: Weight for age, SD: Standard deviation**

weight, BMI and mean Z scores were not significantly different between boys and girls (Table 1).

The prevalence of common infections in children according to the frequency and severity of the infections has been summarized in Table 2. Based on the symptoms reported, 43% boys and 49% girls were judged to have mild URTI occasionally and 33% boys and 27% girls reported mild URTI frequently. This was followed by GI infections with 28% boys and 27% girls complaining of MIs occasionally while symptoms of frequent mild GI infections were reported by 12% boys and 11% girls, respectively. The other common symptoms reported by the children were eye infections and bleeding gums which have been grouped under "other symptoms."

The general characteristics of the children have been compared according to their infection status (Table 3). The mean ages of the children with MSIs were significantly less ($p<0.05$) than those with infrequent or MIs. In boys, it was observed that the height as well as the weight of boys in the MSI group were significantly lower ($p<0.05$) than the boys in II and MI groups. However, height and weight of the girls in MSI ($p<0.05$) as well as in MI ($p<0.05$) group were significantly lower than those in II group. In addition, while the mean HAZ and WAZ scores for boys were not significantly different among the three groups, the mean HAZ and WAZ scores of girls who reported MSI were significantly lower ($p<0.05$) than that of girls who reported II.

To account for the differences that we may observe in the height and weight of the children due to the difference in ages, we calculated mean height, weight and BMI adjusted for age for each of the three groups. The results that were obtained after adjustments for age were consistent with our earlier observations, i.e., the adjusted height and weight of the children with MSI were significantly lower ($p<0.05$) than their counterparts with II or MI (Table 3).

DISCUSSION

To the best of our knowledge, this is the first study conducted among 6-16 year old children in a semi-rural setting in India to determine the prevalence of infections and the influence of infections on their growth. We found that in these age groups the most common infections are URTI followed by GI infections. We have attempted to express both the frequency as well as the severity of infections in our study population. Our study shows that mild URTI were reported occasionally by almost half and frequently by about one-third of the children. Patel et al. have reported a prevalence of 36.39% of URTI among urban children aged 5-13 years which are comparable to our findings for mild, frequent episodes of URTI [5]. Further, the prevalence of GI infections reported by our study children was similar to that reported in under-fives from a rural community in South India [14].

Table 2: Prevalence of infections in last 3 months among the subjects across severity and frequency of infections

Severity of infections	Gender	Type of infections (frequency)								
		URTI			GI			Others		
		Infrequently	Occasionally	Frequently	Infrequently	Occasionally	Frequently	Infrequently	Occasionally	Frequently
No	Boys	13	-	-	54	-	-	89	-	-
	Girls	11	-	-	57	-	-	86	-	-
Mild	Boys	-	43	33	-	28	12	-	7	3
	Girls	-	49	27	-	27	11	-	7	5
Moderate/severe	Boys	-	7	4	-	2	4	-	1	0
	Girls	-	7	6	-	3	2	-	1	1

URTI: Upper respiratory tract infection, GI: Gastrointestinal infections, Others: Bleeding gums, eye infections

Table 3: Growth parameters of the subjects according to infection status

Gender	Boys (439)			Girls (363)		
	II	MI	MSI	II	MI	MSI
N	168	185	86	157	142	64
Age[#]	10.5±2.2*	10.3±2*	9.1±1.8*[ab]	10.6±1.9*	9.8±2.1*[a]	9.1±1.7*[ab]
Height (cm)	133.5±12.7*	132±11.4*	125.9±10*[ab]	134.2±12.3*	129.5±12.1*[a]	124.3±10*[ab]
Age-adjusted mean height (cm)	135.9±41.2	133.9±37.4	127.7±30.8*[ab]	136.1±38.4	131.7±38*[a]	125.6±30.2*[ab]
Weight (kg)[#]	28.4±7.8*	27.5±7.4*	24.1±6*[ab]	29.9±9*	26.2±7.6*[a]	23.3±5.8*[ab]
Age-adjusted mean weight (kg)	29.6±25.5	28.6±25.1	25±18.6*[ab]	31.1±29.2	27.4±24.1*[a]	23.9±17.7*[ab]
BMI (kg/m^2)[#]	15.5±2.5*	15.4±2.7*	14.6±2.8*[a]	16.1±3.2*	15.3±2.1*[a]	14.8±1.8*[a]
Age-adjusted mean BMI (kg/m^2)	15.7±7.9	15.5±8.7	14.7±8.9*[a]	16.4±10.3	15.5±6.7*[a]	14.9±5.6*[a]
HAZ[c]	−1±1	−1.1±0.9	−1±0.9	−0.9±1*	−1±0.9*	−1.2±0.8*[a]
WAZ[c]	−1±0.9	−1.1±0.8	−1±0.9	−0.8±0.9*	−1±0.8*	−1.2±0.8*[a]
BAZ[c]	−0.7±0.8	−0.7±0.7	−0.7±0.7	−0.5±0.9	−0.7±0.8	−0.8±0.8

[a]Different from children with II, [b]Different from children with MI; [c]Z scores are computed using Indian growth percentiles data (Khadilkar et al., 2007); *p<0.05, [#]Non-normal variable, II: Infrequent infection, MI: Mild infection, MSI: Moderate to severe infection

Recurrent infections such as GI infections have been known to result in malnutrition, anemia, growth failure and cognitive dysfunction [15]. Recurrent GI infections are known to have a deleterious effect on growth mainly due to loss of important nutrients, suppressed appetite as well as alteration of the anatomy of GI tract (villi flattening) leading to impaired nutrient absorption in persistent diarrhea. Reports have suggested that high incidence of diarrhea in children under 2 years were associated with up to 25% of stunting [16]. While the relationship between RTI and growth is not very clear, RTIs accompanied with fever is indicative of "immune system activation." Recurrent RTIs, in turn, may increase the risk of stunting due to the reduction of appetite and diversion of nutrients to facilitate the immune response thus, leading to decreased availability of nutrients for growth [16]. Higher rates of infections are common in rural areas as well as in urban slums because of poor access to basic health care facilities, poor socio-economic status, poor sanitary facilities, overcrowding, improper ventilation and poor personal hygiene [2,14].

We observed stunting in 15% and underweight in 11% of the children enrolled in this study. Similar findings have been reported in 5-15 year old children from rural Bengaluru with stunting observed in 17% and wasting in 16% of the children [17]. Although, we have not been able to establish a direct association between health statuses of the children with their infection levels, we observed that children with more severe infections were more likely to be shorter and lighter; this was more marked in girls (Table 3). Thus, infections might have contributed, to some extent, to the stunting and wasting.

One of the limitations of this study was that we were not able to record dietary intakes of children. However, there have been many reports on the poor quality of diets of children from rural areas in India [18,19]. It is thus, plausible that the children enrolled in this study also consumed nutritionally inadequate diets which would be a contributory cause for poor growth and infections. Nevertheless, our findings suggest that children with MSIs have significantly lower heights and weights as compared to their counterparts who have infrequent or mild infections. Another important limitation was that while all children were examined by a pediatrician for the current status of infection, we have relied on reported symptoms to make a judgment on the infections suffered in the past.

CONCLUSION

This study attempts to draw attention to the high rates of infections that rural school-going children (aged 6-16 years) suffer from and the impact it may have on their growth. Children with more severe infections were more likely to be shorter and lighter; this was more marked in girls. Hence, it is crucial to set up suitable programs to monitor growth and prevalence of infections in rural school-going children and to device suitable strategies to deal with this problem adequately.

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