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Anaemia Prevalence and Contributory Factors among Children in Uttarakhand, India

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Authors' contributions

This work was carried out in collaboration among all authors. Author SS conducted the research, collected data, performed statistical analysis of the results and wrote the first draft of the manuscript. Author AD guided the work, developed the framework for the research and corrected the manuscript. Author RSR gave guidance regarding the research technique and reviewed the results of the study. Author AS guided in the development of the experimental design for the research work. Author CSC gave guidance regarding the study design. All authors read and approved the final manuscript.

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ABSTRACT

Background: In India, Anaemia among children is still one of the major nutritional problems of public health concern.
Aim of the Study: The aim of the present study was to assess the prevalence of anaemia among *Anganwadi* children (3-6 years of age) and to determine the important risk factors associated with anaemia.
Study Design: Cross-sectional study.
Place and Duration of Study: Study was conducted among 390 *Anganwadi* children of Udham Singh Nagar district of Uttarakhand, during April, 2019- August, 2019.

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Methodology: In this cross sectional study, data on socio-demographic, socioeconomic, hygiene and dietary practices were collected using a self-structured questionnaire. Hemoglobin (Hb) and anthropometric measurements were carried out. Multivariable logistic regression analysis was employed to estimate the adjusted odds ratio (AOR).

Results: A majority, 70.54% of the *Anganwadi* children were found to be anaemic, with higher prevalence among male children (51.30%) as compared to female children (48.70%). The mean hemoglobin concentration of children was 9.91 (±1.9 g/dl). Stunting was higher among males (54.83%) as compared to females (45.17%).Multivariable logistic regression analysis showed that anaemia was significantly associated with monthly income of family AOR (95% CI) 3.25(2.49, 4.00), mother's illiteracy AOR (95% CI) 1.98 (1.49, 2.46), history of anaemia in mother AOR (95% CI) 1.60(0.67, 2.52), history of worms in child's stool AOR (95% CI) 3.17(2.26,4.03), barefoot walking AOR (95% CI) 3.08(2.11,4.04) and lack of habit of hand washing AOR (95% CI) 1.55(0.98, 2.11).

Conclusion: The prevalence of anaemia among children was high. Iron supplementation, nutrition education among mothers and overall personal hygiene are important to ameliorate their iron status.

Keywords: Iron deficiency anaemia; children; hemoglobin; micronutrient; Anganwadi children.

1. INTRODUCTION

Anaemia is a major nutritional problem of public health significance. Globally, Iron deficiency anaemia occurs in more individuals as compared to any other health-related problem, making it a public health epidemic [1]. Two billion people constituting almost 30% of the world's population are anaemic, predominantly because of iron deficiency and in developing nations. Among the various risk factors leading to death, iron deficiency anaemia is among one of the 'Top Ten Risk Factors' [2]. Iron deficiency anaemia is the leading cause of reduced scholastic performance and delayed cognitive development among children. It is also associated with learning and behavioral difficulties thus they may be the leading cause of decreased productivity in adulthood [3,4]. The financial expenses of iron deficiency anaemia from annual physical productivity fatalities have been estimated to be 0.57 % of gross domestic product (GDP) for ten developing nations [5].

During the last ten years, India has been the leading contributor to childhood anaemia among the developing nations [6]. According to the National Family Health Survey (NFHS- III), the prevalence of anaemia among children under five years of age is around 70% [7]. The recent National Family Health Survey (NFHS- IV) report showed that around 58% of children aged between 6-59 months suffer from iron deficiency anaemia [8]. Studies of anaemia among children with representative samples for the state are scanty in India including Uttarakhand state. The authors therefore conducted study on prevalence and important contributory factors of anaemia among underprivileged *Anganwadi* children aged 3-6 years residing in one of the districts of Uttarakhand.

2. METHODOLOGY

2.1 Sampling Design

A community-based cross-sectional study adopting a simple random sampling procedure was conducted among children (3-6 years) during the month of April-August 2019. The study was carried out at the *Anganwadi centers* present in the villages of Udham Singh Nagar district of Uttarakhand (India). *Anganwadi* is a type of rural child care center or playschool plus health center in India. They were started in 1975 under the Integrated Child Development Services (ICDS) program to combat childhood hunger and malnutrition. Basically, the ICDS program offers a set of six services such as supplementary nutrition, pre-school education, nutrition and health education, immunization, health checkup, and referral services. An *Anganwadi* center is also used for providing preschool education to children. It provides basic health care in Indian villages as part of the Indian public healthcare system. The beneficiaries included in *Anganwadi* are children (up to 6 years), pregnant and lactating mothers (15-44years) and adolescent girls. Considering the prevalence of anaemia as 64.6% in the study population [8] and with 95% confidence interval (CI), 5% absolute precision and non-response of 10%, a total sample size of 350 was calculated (Eq. 1.) [9].

$$Sample\ size = (1.96)^2 \times P_{exp} \times (1 - P_{exp}\ )(DEFF)/(d)^2 \quad \text{(Eq.1.)}$$

Where,

P_{exp}= expected prevalence of disease (anaemia);
DEFF= design effect;
d= precision

The Udham Singh Nagar district comprises of seven developmental blocks out of which three developmental blocks namely Jaspur, Khatima and Rudrapur (located in extreme left, right and middle of the district) were selected. These blocks were randomly selected considering the even division of the population. A two stage simple random sampling was employed in the study. In the first stage, Simple random sampling technique was used to select 10 percent of total villages (26 in numbers) in these three developmental blocks in proportion to number of villages in each block. In the second stage, 15 subjects from each anganwadi present in the selected village was taken for the study using the same sampling procedure (Fig. 1).

2.2 Data Collection

A structured questionnaire was framed to collect data on general characters, standard of living, socio-demographic and socioeconomic status using standard classification. The information was collected from the parents/guardians/ caregiver of the subjects. A pilot study was carried out in an area not included in the study area to validate the questionnaire. Anthropometric estimations were carried out to assess nutritional status. Height was measured using an anthropometric rod to the nearest 0.10 cm and weight was measured with minimum clothing using a SECA digital weighing balance to the nearest 0.50 kg. Height and weight measurements were done as per WHO guidelines and anthropometric indices (weight for height, weight for age and height for age) were computed. Assessment of the nutritional status of children was done using these anthropometric indices. The weight for height and height for age indices reflects the presence of acute and chronic malnutrition in children whereas weight for age indices shows the occurrence of underweight. The interpretation of stunting, wasting and underweight were done by Z-score using the World Health Organization standard [10].

2.3 Hemoglobin Estimation

Hemoglobin estimations were carried out using hemoglobin meter (Model no. SN195 AOO16E3E) with a measurement range of 4.5-25.6 g/dl. The accuracy of the instrument has

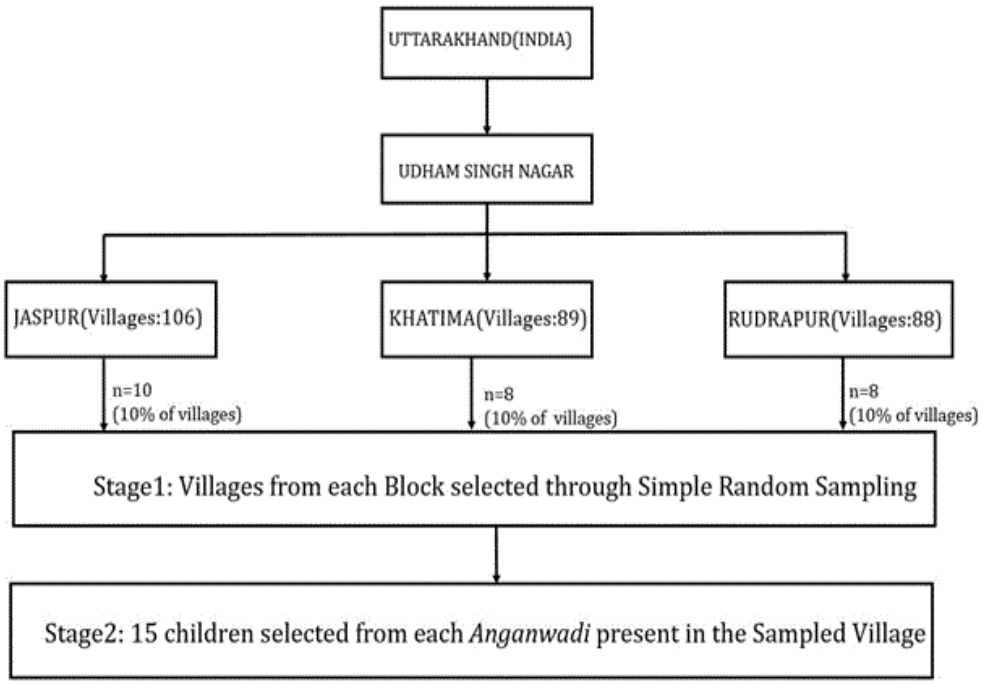


Fig. 1. Schematic presentation of sampling procedure for the study

been ensured by cross checking with the standard non-invasive cyanmethemoglobin method of hemoglobin estimation. Children with a hemoglobin concentration of less than 11 g/dl were considered anaemic, whereas children with a hemoglobin concentration of 10-10.9 g/dl, 7-9.9 g/dl and <7 g/dl were considered as mild, moderate and severely anaemic respectively [11].

2.4 Statistical Analysis

The univariate analysis along with multivariable logistic regression analysis was carried out using R statistical software (R version- 3.6.1). Unadjusted odds ratio (UOR) with their 95% CIs were reported for the bivariate analysis. Furthermore, multivariable logistic regression analysis was performed to test the strength of association between dependent and independent variables. The final model estimates are reported with the adjusted odds ratios (AOR) and 95% CI. The p-value <0.05 was considered statistically significant. The model fitness was tested by goodness of fit test of Hosmer- Lemeshow. The goodness of fit test showed that *p*-value of 0.721 displays that the model was fit.

3. RESULTS

3.1 Details of Coverage

The population had a mean age of 4.81 years (±1.10 years). Out of the 390 children, 203 (51.3%) were male, and 187 (48.7%) were females. Around 60% of mothers of children covered in the study were literate. More than half (59.23%) of the households were having built-in toilets Furthermore, 84.36% families were nuclear families (family group consisting of parents and their children living together), 12.05% were joint families (family group consisting of two or more generations living together under one roof) and remaining 3.59% were extended families (family group consisting of grandparents, aunts, uncles, and cousins all living together in the same household). The major households (62%) came under the medium standard of living index (SLI) category. Also a high proportion of families (79.48%) have monthly family income less than fifteen thousand Indian national rupees (INR). The demographic background of the study participants is presented in Table 1.

3.2 Prevalence of Anaemia

The study revealed that out of 390 children evaluated, 70.54% children were identified to be anaemic. A majority of children (59.28%) were moderately anaemic. The mean Hemoglobin concentration of children was 9.91 g/dl (±1.9 g/dl) (Fig. 2(a) and (b)).

3.3 Anaemia versus Socio-demographic Factors

The univariate analysis showed that among all the socio-demographic factors studied the literacy status of the mother was significantly associated with the increased odds of anaemia UOR (95% CI) 1.93(1.21, 3.07). Other factors that were associated with anaemia included history of anaemia among mother discovered during prenatal checkup, number of children in a family, monthly income of the family, and ordinal position of the child (Table 2).

3.4 Anaemia versus Hygiene and Sanitation-related Factors

The study revealed that out of all the children only 32% have the habit of hand washing, 45.3% children have an history of worm infestation and 69.48% children usually have a habit of barefoot walking. Furthermore, only 9.2% children usually drink boiled or purified water. The study reported that various hygiene and sanitation-related factors were positively associated with the increased prevalence of anaemia. The children with lack of habit of hand washing, having history of worm infestation and the habit of barefoot walking were at high risk of having anaemia (Table 3).

3.5 Anaemia versus Dietary Habits Related Factors

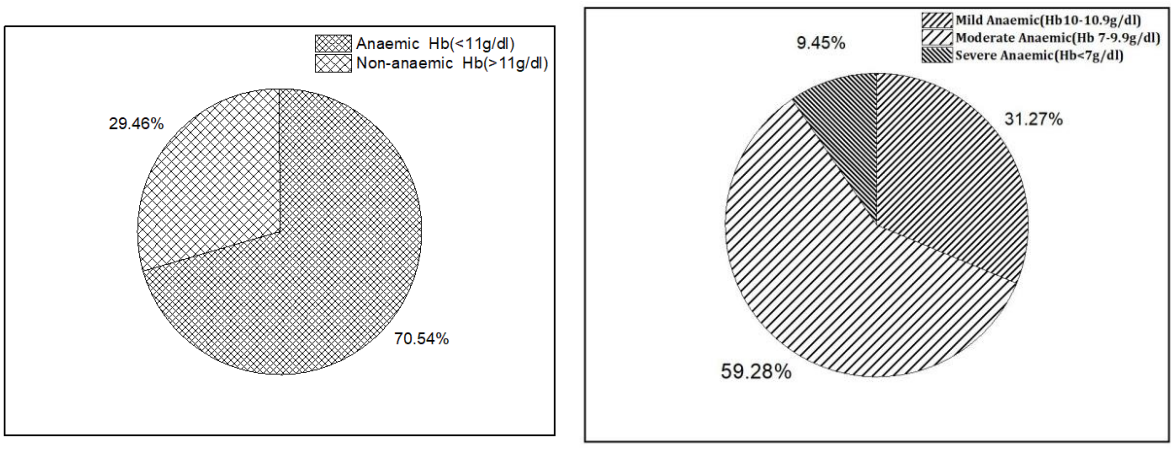
A lot many children (71.79%) were having a habit of drinking milk regularly. The study showed that fruits and vegetables were regularly consumed by around 79.23% and 92.30% children respectively. Around 32.30% children have the habit of skipping meals. The dietary practice of having regular consumption of milk and fruits was found to be protective against anaemia (Table 4).

3.6 Multivariable Logistic Regression Analysis

At multivariable logistic regression analysis, factors such as the number of children in a family, birth order of children, regular consumption of milk and fruits had no significant correlation with anaemia. Of the variables that remained significantly associated with anaemia among children were monthly income of family

Table 1. Characteristics of the sample covered for the study particulars (n=390)

Characteristics	n (number)	Percentage
Gender		
Male	203	51.3%
Female	187	48.7%
Age		
3-4 years	140	35.89%
4-5 years	108	27.69%
5-6 years	142	36.42%
Type of family		
Nuclear	329	84.36%
Joint	47	12.05%
Extended	14	3.59%
Family size		
Small(1-4)	176	45.12%
Medium(5-8)	199	51.02%
Large(>8)	15	3.86%
Standard of living index (SLI)		
Low (0-14)	144	36.92%
Medium (15-24)	241	61.79%
High (25-67)	5	1.29%
Literacy status		
Attending *Anganwadi*	377	96.66%
Not attending *Anganwadi*	13	3.34%
Type of diet		
Vegetarian	191	48.97%
Non-Vegetarian	199	51.03%
Mother literacy		
Illiterate	157	40.25%
Primary school	125	32.05%
Middle school	73	18.71%
High school +	35	8.99%
Toilet facility		
Present	231	59.23%
Absent	159	40.77%



(a) **(b)**

Fig. 2(a). Prevalence of anaemia among study population; (b). Incidence of type of anaemia among study population

Table 2. Association between anaemia and socio-demographic factors

Variable	Anaemic (n=275)	Non- anaemic (n=115)	Total (n=390)	UOR(95% CI)	*P* –value
Monthly income of family (Indian National Rupees)					
<15,000 (<200US$)	236	38	274	5.73(2.43, 13.49)	0.0001
15,000-25,000 (200-330US$)	26	65	91	3.20(1.39, 5.37)	0.006*
≥25,000 (≥330 US$)	13	12	25	Ref	
Mother's literacy status					
Illiterate	123	34	157	1.93(1.21, 3.07)	0.005*
Literate	152	81	233	Ref	
Father's literacy status					
Illiterate	81	24	105	1.58(0.94, 2.66)	0.08
Literate	194	91	285	Ref	
Number of children in a family					
1-2	120	63	183	Ref	0.04*
3-4	57	49	106	0.61(0.37, 0.99)	
5-6	98	3	101	17.15(5.22, 56.29)	<0.0001*
Birth order					
1	54	42	96	Ref	0.37
2	52	52	104	0.77(0.44, 1.35)	
3	55	19	74	2.25(1.16,4.35)	0.01*
4+	114	2	116	44.33(10.34, 189.95)	<0.0001
History of anaemia among mother assessed during prenatal care					
Anaemic	70	20	90	1.62(0.93, 2.82)	0.05*
Non- Anaemic	205	95	300	Ref	

**Data in parentheses is the United States Dollar equivalence to Indian National Rupees*

Table 3. Association between anaemia and hygiene and sanitation-related practices

Variable	Anaemic (n=275)	Non- anaemic (n=115)	Total (n=390)	UOR(95% CI)	*P*-value
Habit of hand washing					
Yes	80	45	125	Ref	0.05*
No	195	70	265	1.56(0.99, 2.47)	
History of worms in stool					
Present	147	30	177	3.25(2.01, 5.25)	<0.0001*
Absent	128	85	213	Ref	
Barefoot walking					
Yes	213	58	271	3.37(2.12, 5.36)	<0.0001*
No	62	57	119	Ref	
Use of Boiled/ Purified water for drinking					
Yes	26	10	36	Ref	0.81
No	249	105	354	0.91(0.42, 1.95)	
Type of drainage system					
Underground	197	86	283	Ref	0.52
Open	78	29	107	1.17(0.71, 1.92)	

AOR (95% CI) 3.25(2.49, 4.00), mother's illiteracy AOR (95% CI) 1.98 (1.49, 2.46), history of anaemia in mother AOR (95% CI) 1.60(0.67, 2.52), history of worms in child's stool AOR (95% CI) 3.17(2.26,4.03), barefoot walking AOR (95% CI) 3.08(2.11,4.04) and habit of handwashing AOR (95% CI) 1.55(0.98, 2.11) (Table 5).

3.7 Nutritional Status of the Children

The percentage of underweight (Weight for age Z score < −2SD), stunting (Height for age Z score < −2SD) and wasting (Weight for height Z score<−2 SD) among the study subjects (aged 3-6 year) was 6.4%, 7.9% and 4.1% respectively.

Out of total underweight children, 56% were boys and remaining 44% were girls. Similarly of all wasted children, 62.5% were boys and 37.5% were girls. (Fig. 3(a) and (b)).

4. DISCUSSION

The present study has given data on the anaemia prevalence among the children of the Uttarakhand state of India. The study estimated that 70.54% of children were anaemic. The current prevalence was consistent with the

Table 4. Association between anaemia and various dietary habits related factors

Variable	Anaemic (n=275)	Non- anaemic (n=115)	Total (n=390)	UOR(95% CI)	*P* value
Regular milk intake					
Yes	207	73	280	Ref	0.01*
No	68	42	110	1.75(1.09, 2.79)	
Regular fruits intake					
Yes	201	108	309	Ref	<0.0001*
No	74	7	81	5.68(2.52, 12.76)	
Green leafy veggies intake					
Yes	256	104	360	Ref	0.371
No	19	11	30	0.70(0.32, 1.52)	
Habit of eating Lunchbox					
Yes	113	51	164	Ref	0.552
No	162	64	226	1.14(0.73, 1.77)	
Habit of skipping meals					
Yes	87	39	126	0.90(0.56, 1.43)	0.661
No	188	76	264	Ref	

Table 5. Multivariable logistic regression analysis showing an association between the prevalence (%) of anaemia and various study parameters

Variables/Predictors	AOR(95% CI)	P-value	Coefficient	SEM
Monthly income of family (INR)	3.25(2.49, 4.00)	0.01*	1.180	0.3832
Mother's illiteracy	1.98(1.49, 2.46)	0.013*	0.683	0.2452
History of anaemia in mother	1.60(0.67, 2.52)	0.04*	0.475	0.4711
History of worms in child's stool	3.17(2.26, 4.03)	0.001*	1.156	0.4510
Barefoot walking	3.08(2.11, 4.04)	<0.0001*	1.120	0.4932
Habit of hand washing	1.55(0.98, 2.11)	0.05*	0.442	0.2543

**significant at 95% C.I*

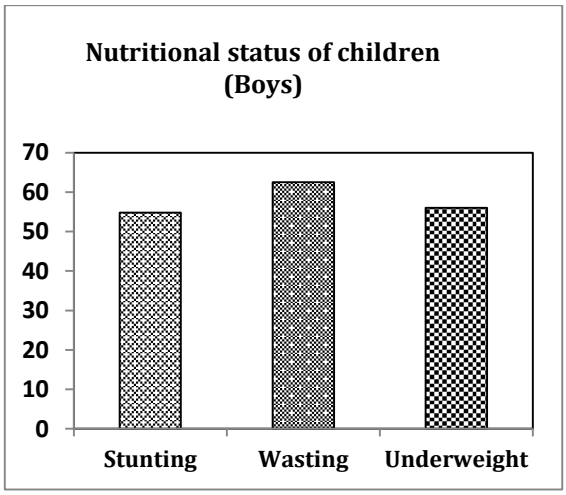


Fig. 3(a). Percentage of children (Boys) with stunting or wasting or underweight (Z-score <-2SD) by age

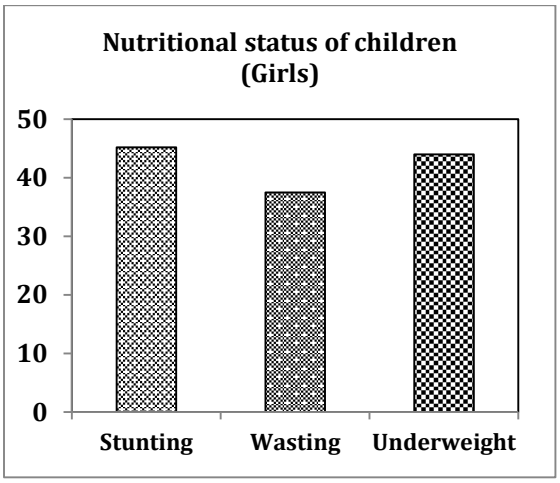


Fig. 3(b). Percentage of children (Girls) with stunting or wasting or underweight (Z-score <-2SD) by age

results of other similar studies of India performed in pre-school children of the Gond tribal community and pre-school children of Kerala respectively [12,13]. A prevalence rate of 72.79% was found among the 822 hospitalized children aged 6 months-12 years at a multispecialty hospital in Bangalore, Karnataka, India [14]. A previous study done in India reported the prevalence of 44% (95% CI 40.67–47.33) from a sample of 880 school students [15]. A cross-sectional study based on Demographic and Health Surveys (DHS) conducted between the years 2006 and 2017 in 45 different nations showed that the prevalence of any kind of anaemia is 55.1% in children (47 countries, *n* = 385,541) [16].

Our study revealed that childhood anaemia is somehow associated with the monthly income of the family. Children residing in families with a lower monthly income had more chances to develop anaemia as compared to those who belong to families with high monthly income [17-19], and it might be explained by the fact that children belonging to low monthly income families do not get access to iron dense foods such as food from non-vegetarian sources or they might not get proper health care facilities during disease or illness.

It was observed that children with illiterate mothers showed increased odds of anaemia. This finding was supported by previous research which has established that the children of illiterate mothers were at higher risk of developing severe anaemia [20]. Children with less educated mothers were likely to develop iron deficiency (p = 0.0577) than were those with more educated mothers. A significant inverse association is seen between maternal education and anaemia among children OR (95% CI) 0.52(0.32, 0.85) [21].

Our study also showed that the history of anaemia in mothers was also associated with anaemia in children. Our findings were consistent with results from various other studies, which found a positive relationship between childhood

anaemia and maternal iron status [22-23]. The child's hemoglobin level showed associations with hemoglobin level of mother (0.16; $p < .001$). Thus, an important socio-economic determinant of anaemia among children in India is anaemia among mother [6]. History of worms in stool and walking barefoot were other associated factors of anaemia among children. The children of growing age/ school going are at more danger for developing anaemia as compared to other age group people since they are predominantly vulnerable to parasitic infestation [24]. Barefoot walking by children increases the possibility of having hookworm infestation incidence rate ratio (IRR) (95% CI) 4.2 (1.2–14.5), which interferes with dietary iron leading to anaemia among children [25].

Various associations between poor hygienic conditions and malnutrition or diseased condition among children were well acknowledged [26-27] but due to different study populations comparisons are hard to make. Children keeping their hands unclean were expected to be anaemic. Open-air defecation near the backyard of the house leads to the poor nutritional status of the children. Not using the latrine and keeping unclean fingernails was somehow associated with the occurrence of hookworm infestation [28]. A similar association was seen in the present study, where the lack of personal hygiene or lack of habit of washing hands AOR (95% CI) 1.55(0.98, 2.11) was related to the prevalence of anaemia. There is a need to make people sensitized about anaemia and they should be encouraged to maintain personal and environmental hygiene.

5. CONCLUSION

In general, the prevalence of anaemia was high among the 3-6-year-old *Anganwadi* children of Udham Singh Nagar district of the Uttarakhand state of India. The study concluded that 9.45% of children suffer from severe anaemia and 59.27% suffer from moderate anaemia thus constituting more than half of the children included in the study. Monthly income of the family, mother illiteracy, history of anaemia in mother, child history of worms in stool and lack of personal hygiene relating to lack of awareness about the habit of hand washing are the main factors significantly associated with increased odds of anaemia. Therefore it is essential to take appropriate steps such as primitive preventive measures that integrate iron supplementation, nutrition education among mothers and overall personal hygiene. The use of *Anganwadi* for pre-school education of children and nutrition plus health education of mothers is important in monitoring anaemia to some extent.

CONSENT

Written informed consent of parents/guardians and approval of children was obtained.

ETHICAL APPROVAL

The study received ethical approval from the University Ethics Committee for Human Research (UECHR), G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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