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Correlation Between Haemoglobin Level and Anthropometric Variables: A Study on Women of Reproductive Age Group, West Bengal

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ABSTRACT The recent study attempts to find the association between haemoglobin level and different anthropometric indices among the women belonging to reproductive age group with low socio-economic status. In this study haemoglobin level of 353 women belonging to the reproductive age group (15 years to 45 years) residing in Paschim Medinipur district, West Bengal, India was measured. The socio-economic status of the women in this study was assessed by revised Kuppuswami's socio-economic status scale. Analysis of the data revealed a significant ($p<0.05$) correlation between haemoglobin level in this group of women with their corresponding anthropometric parameters like weight, height, waist circumference (WC), Waist–hip ratio (WHR) while the basal metabolic rate was found to be strongly correlated ($r=0.172$; $p<0.001$) with haemoglobin level. Approximately 3 out of 4 women belonging to the reproductive age group with low socio-economic status in Paschim Medinipur district had low haemoglobin levels and positive association were noted between weight, height, WC, WHR of these women.

INTRODUCTION

Anaemia continues to be a major public health problem worldwide (Raghuram et al. 2012). According to estimates of the World Health Organization (WHO), 2 billion people suffer from anaemia in the world (Underwood 1996). The prevalence of anaemia is 80% in pregnant women and 60% in non- pregnant women in South East Asia (Trinh and Dibley 2007) which is due to poverty, inadequate diet, certain diseases, pregnancy/lactation and poor access to health services (Kaur et al. 2006). The third National Family Health Study (NFHS-3) conducted during 2005–06 found that the prevalence of anaemia is 55.3% amongst women aged 15 to 49 years in India as a whole, while in West Bengal state of India, the prevalence of the same being 63.2% (IIPS 2007). Micronutrient deficiencies such as iron, folate, and vitamin B_{12} are important causes of anaemia (Provan and Weatherall 2000). Iron deficiency (ID) is the most common cause of nutritional anaemia and is accountable for almost a million deaths annually (Hercberg and Galan 1992; Cook et al. 1994). In India iron deficiency anemia (IDA) is a major nutrition problem which can arise either due to an inadequate intake or poor bioavailability of dietary iron or due to excessive losses of iron from the body (Gupta et al. 2014). The other important biological causes of anaemia are infections by malarial parasite and intestinal worms (Trinh and Dibley 2007). Hookworm infection may cause anaemia because it induces iron deficiency by chronic intestinal blood loss. Some non-biological factors like lack of education, household size, family income, age, parity, birth spacing, antenatal care and Body Mass Index (BMI) also play role in anaemia (Trinh and Dibley 2007; Mishra et al. 2012; Sinha et al. 2013). Anaemia is a major factor in women's health, in developing countries (Brooker et al. 2008). Low socio-economic status plays a major role in disease, including anaemia (Dey et al. 2010; Gebremedhin and Enquselassie 2011). Thus, women belonging to low socio-economic group are at high risk for anaemia, especially during their reproductive age (15 to 45 years). Anthropometric parameters of women may be altered by anaemia during this period. The researchers

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have presented a study of 353 women with their corresponding anthropometric data.

Objectives of the Study

The purpose of the study is to examine the association between haemoglobin level and different anthropometric indices like BMI, waist hip ratio (WHR), mid-upper arm circumference (MUAC), conicity index (CI) among the women belonging to reproductive age group with low socio-economic status.

METHODOLOGY

Study Population

Midnapore is a small district town of Paschim Medinipur District and 127 km away from Kolkata city towards west. The study design was community based cross-sectional type and the researchers randomly studied 353 non-pregnant women of 15 – 45 years of age group living in the area during time period of November 2011 to February 2012. The data was collected by personal interviews on a pre-tested, semi-structured questionnaire. Prior to the study all necessary permission was obtained from relevant authorities. The confidentiality of information was assured and their consent in writing was taken from each participant before initiating the data collection. In case of the minor (<18years) group the consent was taken from their guardians. The questionnaire was based on demographic information, anthropometric data and personal hygiene. Each subject was identified by name, age and sex.

The researchers included all the women who fulfilled the following inclusion criteria:

- Age between 15 and 45 years
- Non-pregnant and non-lactating female

Women with a past history of chronic illnesses were excluded from this study.

Socio-economic Status

The score of socio-economic status was determined as per revised Kuppuswami's socio-economic status scale (Mishra and Singh 2003).

Anthropometric Measurements

All anthropometric measurements were made by trained investigators using the standard techniques (Lohman et al. 1988). All the equipments were checked regularly to minimize random errors. Height was measured to the nearest 0.1 cm using Martin's anthropometer. Body weight of lightly-clothed subjects was recorded to the nearest 0.5 kg on a weighing scale (Doctor Beliram and Sons, New Delhi, India). The weighing scale was set to zero before every measurement. For height and weight, individuals were requested to remove their shoes before taking measurements. MUAC, waist circumference (WC) and hip circumference (HC) were measured with a rigid measuring tape and recorded to the nearest 0.1 cm. WC was measured at the smallest horizontal circumference between the ribs and iliac crest (the natural waist), or, in case of an indeterminable waist narrowing, halfway between the lower rib and the iliac crest. HC was measured at the largest horizontal expansion of the buttocks. The subjects stood erect with abdomen relaxed, the arms at the side and feet together and breathing normally. Errors of measurements were computed and they were found to be within acceptable limits (Ulijaszek and Kerr 1999).

Body mass index (BMI), waist hip ratio (WHR), Conicity Index (CI) and Basal Metabolic Rate (BMR) were computed using the following standard equations (Park 2005; Flora et al. 2009; FAO/WHO/UNU 1985):

BMI (kg/m^2) = Weight (kg) / height^2 (m^2) (Park 2005)

WHR = Waist circumference (cm)/hip circumference (cm) (Park 2005)

CI = Waist Circumference (m) / [0.109 X√{Body weight (kg) / Height (m)}] (Flora et al. 2009)

Equations for estimating BMR (Kcal/day) from body weight and different age groups (years) (FAO/WHO/UNU 1985)

10–18 years: BMR=17.5 x weight (kg) + 651; 18–30 years: BMR=14.7 x weight (kg) + 496; 30–60 years: BMR=8.7 x weight (kg) + 829.

Nutritional status was evaluated using internationally accepted World Health Organization BMI (kg/m^2) guidelines (WHO 1995). The following cut-off points were used:

Chronic energy deficiency (CED) Grade III: BMI < 16.0; CED Grade II: BMI = 16.0 – 16.9; CED Grade I: BMI < 17.0 – 18.4; Normal: BMI = 18.5 – 24.9; Overweight: BMI ≥ 25.0.

For the age of <18 years, thinness and overweight were determined as per Cole et al (2000, 2007).

Determination of Haemoglobin Level

Two milliliters of venous blood were drawn from each subject. An aliquot of the blood was placed immediately in a tube containing Drabkin's solution for haemoglobin estimation. The haemoglobin concentration was measured using cyanmethaemoglobin method (Dallman 1984). Three levels of severity of anaemia are classified: mild anaemia (10.0-10.9 g/dl for pregnant women, 10.0-11.9 g/dl for non-pregnant women), moderate anaemia (7.0-9.9 g/dl for women), and severe anaemia (less than 7.0 g/dl for women) (IIPS 2007).

The researchers followed the UNICEF/UNU/WHO (UNICEF/UNU/WHO 2001) of the public health problem of anaemia, based on adult populations worldwide. This classification categorises the prevalence of public health problem according to the prevalence of anaemia, which is as follows.

<5% anaemia signifies no public health problem, 5–19.9% anaemia signifies mild public health problem, 20–39.9% anaemia signifies moderate public health problem and >40% anaemia signifies severe public health problem.

Statistical Analysis

Data processing and statistical analyses were done using the SPSS for Windows statistical software package (SPSS Inc., Chicago, IL, USA 2001). Data is expressed as means and standard deviations, and group comparison was done using one way ANOVA. Pearson's chi-square test was used to determine significant differences observed within the various categories of nutritional status. Product moment correlation coefficient (r) between haemoglobin level and different anthropometric parameters were determined. Similarly, correlation between intra-parameters of anthropometric measurements was also calculated.

RESULTS

Age of Women in the Study Group

The study population of female was separated into four groups, according to their age viz. below 20 years, 20-29 years, 30-39 years and 40 years and above and all were non-pregnant with mean age being 28.64±8.98 years. The frequency of these age-groups was 68, 124, 98 and 63 respectively with mean±Sd were 16.78±1.58, 24.13±2.74, 33.87±2.64 and 42.21±2.00 years respectively.

Socio-economic Status

Among the studied population, majority of them (239 that is 67.71%) belong to lower socio-economic group (Group V) and the rest (114 that is 32.29%) belong to upper lower socio-economic group (Group IV) according to revised Kuppuswami's socio-economic status scale (Mishra and Singh 2003). In the present study, upper lower socio- economic group had highest percentage of women suffering from anaemia (77.19%) while in case of lower socio- economic group it was 73.64% though the association between socio-economic status and the haemoglobin level were not significant (χ^2=0.978; p>0.05), but significant association was observed in case of anthropometric parameters like BMI (χ^2=63.982; p<0.001) which indicated that higher level of under nutrition was found in lower socio-economic group 49.79% while 20.18% of the upper-lower group were suffering from under nutrition. A strong association was observed between socio-economic status and other anthropometric parameters like WHR (χ^2=10.464; p<0.001), CI (χ^2=12.426; p<0.001), MUAC (χ^2=52.705; p<0.001).

Prevalence of Anaemia

This study noted that the prevalence of anaemia in the study group was 74.79 per cent as a whole, out of which 55.24 per cent was mildly anaemic (Hb10.0-11.9 g/dl), 16.15 per cent of these women were classified as moderately anaemic (Hb 7-9.9 g/dl) and 3.4 per cent as severely anaemic (Hb <7 g/dl). So the result suggest that the prevalence of anaemia is much high in this population.

Different Anthropometric Data on the Study Group

The mean of weight and height of the female in the study group were 44.49±8.61 kg and 150.07±6.63 cm respectively. BMI of the studied women ranged between 12.4 – 31.5 kg/m^2 the mean being 19.74±3.50 kg/m^2. The prevalence of underweight and overweight were 40.23% and 9.35% respectively. MUAC, WC and HC were

22.76±2.80 cm, 70.47±9.89 cm and 85.39±7.44 cm respectively. The WHR and CI were 0.82±0.07 and 1.19±0.10 respectively (Table 1).

Table 1: Anthropometric parameters of the female aged 15 – 45 years

Parameters	*Range*	*Mean ± SD*
Weight (Kg)	27.5–76.0	44.49±8.61
Height (cm)	130.1–169.6	150.07±6.63
BMI (Kg/m^2)	12.4–31.5	19.74±3.50
Waist circumference (cm)	39.9–102.4	70.47±9.89
Hip circumference (cm)	61.3–109.0	85.39±7.44
Waist hip ratio	0.63–1.05	0.82±0.07
Mid- upper arm circumference (cm)	17.6–35.7	22.76±2.80
Conicity Index	0.72–1.54	1.19±0.10

Anthropometric Parameters and Haemoglobin Level of Different Age Group

The anthropometric parameters like BMI, WHR, MUAC, CI as well as BMR and haemoglobin level in four different age groups of the women in this study are presented in Table 2. The values of these anthropometric parameters of different age groups were analyzed by ANOVA. A significant increase of BMI (P<0.001), WHR (P<0.05), MUAC (P<0.05), CI (P<0.01) and BMR (P<0.001) were noted. However, no significant (P>0.05) change in the age wise variation of haemoglobin level was noted.

Anaemia Status on Anthropometric and Biological Parameters

The status of anaemia (mild, moderate and severe) as determined by haemoglobin level in the said study group is presented in Table 3. Data were statistically analyzed by ANOVA. Interestingly, when all the groups that is mild, moderate and severe anemic, females are analyzed by ANOVA with anthropometric parameters of normal, only the WHR have been found to be significant (P<0.05), though the other anthropometric parameters like weight, height, BMI, WC, HC, MUAC, CI have not been found to be significant (P>0.05).

Correlation of Different Anthropometric Parameters and Haemoglobin Level

It may be noted that the haemoglobin level of the female in the study group is positively correlated (P<0.05) with their corresponding anthropometric parameters like weight, height, WC, WHR (correlation coefficient (r) ranged between 0.116 – 0.128, P<0.05), however no correlation was found with BMI, MUAC and CI. The BMR was found to be strongly correlated (r = 0.172, P<0.001) with haemoglobin level (Table 4).

Correlation between Intra-parameters of Anthropometric Measurements

The correlation between the intra-parameters of the anthropometric measurements of the study group is presented in Table 5. It may be noted that BMI was strongly correlated (P<0.001) with weight, WC, HC, WHR, MUAC and CI, although no correlation (P>0.05) was noted between BMI and height. In case of WHR was strongly correlated (P<0.001) with weight, BMI, WC, HC, MUAC and CI although no correlation (P>0.05) was noted between WHR and height. MUAC was positively correlated (P<0.001) with all the anthropo-

Table 2: Distribution of body mass index, waist-hip ratio, mid-upper arm circumference, conicity index, basal metabolic rate and haemoglobin level according to different age group

Parameters	*Age (years)*				*ANOVA*
	<20 years N=68	*20-29 years N=124*	*30-39 years N=98*	*40 years and above N=63*	
BMI (kg/m^2)	18.18± 2.13	19.70± 3.13	20.18± 3.99	20.78± 4.03	F=7.302; p<0.001
WHR	0.81± 0.07	0.81± 0.07	0.83± 0.07	0.84± 0.09	F=3.426; p<0.05
MUAC (cm)	21.92± 2.28	22.87± 2.69	22.96± 3.27	23.11± 2.63	F=2.642; p<0.05
CI	1.16± 0.11	1.18± 0.09	1.21± 0.10	1.22± 0.12	F=5.162; p<0.01
BMR	1120.32±82.69	1103.48±95.71	1048.49±119.53	1031.82±138.35	F=11.804; p<0.001
Haemoglobin level (g/dl)	10.99± 1.59	10.81± 1.75	10.71± 1.40	10.65± 1.87	F=0.574; p>0.05

Significant increase of BMI (P<0.001), WHR (P<0.05), MUAC (P<0.05), Cindex (P<0.01) and BMR (P<0.001) were noted with respect to different age group, while no significant (P>0.05) change in the age wise variation of haemoglobin level was noted.

Table 3: Data on biological and anthropometric parameters according to the categories of anaemia among female aged 15 to 45 years

Parameters	*Normal controls Haemoglobin level (>12 g/dl) N=89 (mean±sd)*	*Anaemia status by haemoglobin level*			*ANOVA*	*P value*
		Mild anaemia (10.0-11.9 g/dl) N=195 (mean±sd)	*Moderate anaemia (7.0-9.9 g/dl) N=57 (Mean±sd)*	*Severe anaemia (<7.0 g/dl) N=12 (Mean±sd)*		
Age (year)	28.09± 9.03	28.56± 8.79	29.77 ± 9.63	28.75 ± 9.1	F=0.417	0.741
Weight (Kg)	45.88± 8.80	44.13± 8.44	44.12 ± 9.30	41.83 ± 5.49	F=1.306	0.272
Height (cm)	151.43± 7.05	149.45± 6.24	150.4 ± 6.80	148.58 ± 7.76	F=2.087	0.102
BMI (Kg/m^2)	19.96± 3.10	19.75± 3.59	19.48 ± 3.89	19.04 ± 3.02	F=0.372	0.773
Waist circumference (cm)	71.93± 9.95	70.23± 9.65	70.17 ± 9.80	64.92 ± 12.36	F=1.986	0.116
Hip circumference (cm)	85.53± 7.04	85.76± 7.37	84.41 ± 7.54	82.83 ± 10.70	F=0.974	0.405
Waist hip ratio	0.84± 0.08	0.82± 0.07	0.83 ± 0.07	0.78 ± 0.06	F=3.549	0.015*
MUAC (cm)	22.70± 2.81	22.91 ± 2.88	22.45 ± 2.55	22.17 ± 2.76	F=0.615	0.606
Conicity index	1.20± 0.11	1.19 ± 0.1	1.19 ± 0.09	1.12 ± 0.16	F=2.305	0.077
BMR (Kcal/day)	1223.65±121.27	1217.00±126.85	1204.35±145.17	1162.48±100.72	F=0.958	0.413

*significant ($p<0.05$)

Table 4: Pearsons product moment correlation between haemoglobin level and different anthropometric parameters

Anthropometric parameters	*Correlation coefficient (r)*
Age (year)	-0.074
Weight (Kg)	0.127*
Height (cm)	0.128*
BMI (Kg/m^2)	0.062
Waist circumference (cm)	0.122*
Hip Circumference (cm)	0.08
Waist hip Ratio	0.116*
Mid Upper Arm Circumference (cm)	0.047
Conicity Index	0.097
Besal Metabolic Rate (Kcal/day)	0.172**

*$p<0.05$, **$p<0.001$.

metric parameters like weight, height, BMI, WC, HC, WHR, CI. It may be noted that CI is strongly correlated ($P<0.001$) with weight, BMI, WC, HC, WHR, and MUAC, although no correlation ($P>0.05$) was noted between CI and height.

Anaemia and Its Relationship to Nutritional Status of the Female

Prevalence of anaemia in chronic energy deficiency (CED), normal and overweight group (as determined by BMI Score) of female is presented in Table 6. Critical condition (>40%) of anaemia was observed in all the groups.

DISCUSSION

Micro-level studies on community health, in the Paschim Medinipur District, have not been conducted so far. Thus, the study was designed to yield data for further research and public health improvements.

The present study demonstrates high prevalence (74.79%) of anaemia in non-pregnant women in the study group. This is higher than the recent studies of different states of India which report a prevalence of anaemia as 55.3% while in West Bengal it is reported as 63.2% (IIPS 2007), but is lower than the hospital based study conducted by Gupta et al. (2014) among the rural female of Madhya Pradesh, India (82%). The prevalence of anaemia in Bangladesh was found to be lower (46.0%) than what is found in this study (HKI and IPHN 2006). Chandyo et al. (2007) found the prevalence of anaemia among non-pregnant women in Nepal to be only 12.0% while Gebremedhin and Enquselassie (2011) found 27.4% among the women of reproductive age in Ethiopia. When the researchers compared their result with the international scenario, it is observed that it is much higher than the global prevalence of anaemia among women which is 30.2% (McLean et al. 2007).

In the present study, the researchers tried to determine the distribution of anemic women according to the severity of anaemia and its asso-

Table 5: Correlation between intra-parameters of anthropometric measurements among female aged 15 to 45 years

Parameters	*Age (year)*	*Weight (Kg)*	*Height (cm)*	*BMI (Kg/m2)*	*WC (cm)*	*HC (cm)*	*WHR*	*MUAC (cm)*	*CI*	*BMR (Kcal/day)*
Age (year)	1	0.179^{***}	-0.101	0.238^{***}	0.256^{***}	0.250^{***}	0.152^{**}	0.139^{**}	0.201^{***}	0.295^{***}
Weight (Kg)	0.179^{***}	1	0.403^{***}	0.886^{***}	0.786^{***}	0.844^{***}	0.378^{***}	0.771^{***}	0.270^{***}	0.831^{***}
Height (cm)	-0.101	0.403^{***}	1	-0.058	0.112^{*}	0.203^{***}	-0.03	0.174^{***}	-0.02	0.707^{***}
BMI (Kg/m²)	0.238^{***}	0.886^{***}	-0.058	1	0.797^{***}	0.820^{***}	0.421^{***}	0.756^{***}	0.297^{***}	0.554^{***}
WC (cm)	0.256^{**}	0.786^{***}	0.112^{*}	0.797^{**}	1	0.783^{**}	0.782^{**}	0.644^{**}	0.790^{**}	0.533^{**}
HC (cm)	0.250^{***}	0.844^{***}	0.203^{***}	0.820^{***}	0.783^{***}	1	0.230^{***}	0.735^{***}	0.386^{***}	0.612^{***}
WHR	0.152^{**}	0.378^{***}	-0.03	0.421^{***}	0.782^{***}	0.230^{***}	1	0.269^{***}	0.862^{***}	0.215^{***}
MUAC (cm)	0.139^{**}	0.771^{***}	0.174^{***}	0.756^{***}	0.644^{***}	0.735^{***}	0.269^{***}	1	0.229^{***}	0.590^{***}
CI	0.201^{***}	0.270^{***}	-0.02	0.297^{***}	0.790^{***}	0.386^{***}	0.862^{***}	0.229^{***}	1	0.118^{*}
BMR (Kcal/day)	-0.295^{***}	0.831^{***}	0.707^{***}	0.554^{***}	0.533^{***}	0.612^{***}	0.215^{***}	0.590^{***}	0.118^{*}	1

$^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$.

Table 6: Haemoglobin level of the female according to age group and BMI

Parameters	*N*	*Normal controls*	*Anaemia status by haemoglobin level*			*Chi-square*
		Haemoglobin level(>12 g/dl) N=89 (mean±sd)	*Mild anaemia (10.0-11.9 g/dl) N=195 (mean±sd)*	*Moderate anaemia (7.0-9.9 g/dl) N=57 (mean±sd)*	*Severe anaemia (<7.0 g/dl) N=12 (mean±sd)*	
Age (years)						
<20 years	68	16 (23.53)	40 (58.82)	10 (14.71)	2 (2.94)	$\chi^2=4.512$; $p>0.05$
20-29 years	124	35 (28.23)	66 (53.23)	18 (14.52)	5 (4.03)	
30-39 years	98	21 (21.43)	59 (60.20)	15 (15.31)	3 (3.06)	
40 years and above	63	17 (26.98)	30 (47.62)	14 (22.22)	2 (3.17)	
BMI (kg/m²)						
Grade III	33	2 (6.06)	21 (63.64)	9 (27.27)	1 (3.03)	$\chi^2=13.932$; $p>0.05$
Grade II	24	8 (33.33)	11 (45.83)	3 (12.50)	2 (8.33)	
Grade I	85	24 (28.24)	46 (54.12)	14 (16.47)	1 (1.18)	
Normal	178	44 (24.72)	101 (56.74)	26 (14.61)	7 (3.93)	
Overweight	33	11 (33.33)	16 (48.48)	5 (15.15)	1 (3.03)	

ciation with some biosocial factors and anthropometric indices including age. The prevalence of anaemia has been found to be independent of age of non pregnant women in this group. Bharati et al. (2008) reported that prevalence of anaemia is higher in lower age groups compared with higher age groups among Indian non-pregnant women and this is also the same in Tarahumara non-pregnant women in Northern Mexico (Monarrez-Espino et al. 2001).

The prevalence of CED based on body mass index (BMI, kg/m²) of the women in study group are in very critical situation (>40%) (WHO 1995). Undernourished women have a comparatively higher prevalence (76.06%) of anaemia than normal (75.28%) and overweight women (66.67%) and in the case of severe under nourished women (CED grade III) this figure is much higher (93.94%). Similar findings have also been reported among non-pregnant women from Andhra Pradesh (Bentley and Griffiths 2003). This study's results on BMI indicate that normal and overweight (as per BMI) also exhibit high percentage of anaemia suggesting a non-existence of correlation of BMI and haemoglobin level. This suggest that not only under nutrition but some other factors including pathophysiological, psychological, low healthy diet, unhygienic sanitation, inadequate health care facilities attribute to anaemia. While analyzing the data on BMI the researchers noticed a decreasing trend of BMI value from mild to severe anaemia, although no statistical significance could be established. It may be noted that Ghosh and Bharati (2003) reported a decreasing trend of BMI among Munda and Pod women along with low level of haemoglobin.

That the anaemia is a determining factor for general health of women is supported from this study showing positive correlation between WHR and haemoglobin level. Lack of correlation between haemoglobin level and MUAC including CI suggested the insignificant role of these anthropological indices for the development of anaemia.

Since, haemoglobin plays an important role in oxidation, thus body metabolism, the positive correlation of BMR and haemoglobin is expected. This is supported from the data obtained in this study.

CONCLUSION

The researchers have recorded approximately 3 out of 4 women belonging to the reproductive age group with low socio-economic status residing in Paschim Medinipur district, West Bengal, India were anaemic, and this exhibited a correlation with some anthropometric indices. The study indicated the necessity of implementing a public health program for prevention and early diagnosis of anaemia in women of child bearing age.

RECOMMENDATIONS

Although, anaemia has been recognized as a public health problem for many years, little progress has been made and the global prevalence of anaemia remains unacceptably high. An urgent need is indicated to combat anaemia and stress the importance of recognizing its multifactorial aetiology for developing effective control programs. Periodic screening for anaemia among adolescent girls and women of child bearing age is strongly recommended.

LIMITATIONS OF THE STUDY

In the present study the researchers have covered only a limited population (only 353 female) and the study group comprises of the non-pregnant female only of the child bearing age group. Micronutrient (iron, folate, and vitamin B_{12}) levels, which might be root causes of anemia, were not assessed in this study.

FUTURE STUDIES

The researchers suggested that there is need of further and detailed research works that cover the female of reproductive age with pregnant, lactating and non-pregnant including the fertility status, physical health, reproductive health and accessibility of health facilities, their dietary pattern will reveal the clear picture of nutritional status of that geographical area. The association of these confounding factors with anaemia and other co-morbidity will be explored in future.

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REFERENCES

Bentley ME, Griffiths PL 2003. The burden of anemia among women in India. *Eur J Clin Nutr,* 57: 52-60.

Bharati P, Som S, Chakrabarty S, Bharati S, Pal M 2008. Prevalence of anemia and its determinants among non-preganant and pregnant women in India. *Asia Pac J Public Health,* 20: 347-359.

Brooker S, Hotez PJ, Bundy DAP 2008. Hookworm-related anaemia among pregnant women: A systematic review. *PLoS Negl Trop Dis,* 2(9): e291.

Chandyo RK, Strand TA, Ulvik RJ, Adhikari RK, Ulak M, Dixit H, Sommerfelt H 2007. Prevalence of iron deficiency and anemia among healthy women of reproductive age in Bhaktapur. *Nepal Eur J Clin Nutr,* 61(2): 1-8.

Cole TJ, Bellizzi MC, Flegal KM, Dietz WH 2000. Establishing a standard definition for child overweight and obesity worldwide: International survey. *BMJ,* 320: 1240-1243.

Cole TJ, Flegal KM, Nicholls D, Jackson AA 2007. Body mass index cut offs to define thinness in children and adolescents: International survey. *BMJ,* 335: 194-198.

Cook JD, Skikne BS, Baynes RD 1994. Iron deficiency: The global perspective. *Adv Exp Med Biol,* 356: 219-228.

Dallman PR 1984. Diagnosis of anemia and iron deficiency: Analytic and biological variations of laboratory tests. *Am J Clin Nutr,* 39: 937–941.
Dey S, Goswami S, Goswami M 2010. Prevalence of anaemia in women of reproductive age in Meghalaya: A logistic regression analysis. *Turk J Med Sci*, 40(5): 783-789.
Flora MS, Mascie-Taylor CGN, Rahman M 2009. Conicity index of adult Bangladeshi population and their socio-demographic characteristics. *Ibrahim Med Coll J,* 3(1): 1-8.
Food and Agriculture Organization/World Health Organization/United Nations University 1985. Energy and Protein Requirements. Report of a Joint FAO/WHO/UNU Expert Consultation. *WHO Technical Report Series* No. 724. Geneva: World Health Organization.
Gebremedhin S, Enquselassie F 2011. Correlates of anemia among women of reproductive age in Ethiopia: Evidence from Ethiopian DHS 2005. *Ethiop J Health Dev,* 25(1): 22-30.
Ghosh R, Bharati P 2003. Haemoglobin status of adult women of two ethnic groups living in a peri-urban area of Kolkata city, India: A micro-level study. *Asia Pac J Clin Nutr,* 12(4): 451-459.
Gupta SK, Agarwal SS, Kaushal R, Jain A, Gupta VK, Khare N 2014. Prevalence of anemia among rural population living in and around of rural health and training center, Ratua Village of Madhya Pradesh. *Muller J Med Sci Res,* 5(1): 15-18.
Helen Keller International (HKI), Institute of Public Health Nutrition (IPHN) 2006. The burden of anemia in rural Bangladesh, the need for urgent action. *Nutr Surveill Proj Bull,* 16: 1-4.
Hercberg S, Galan P 1992. Nutritional anaemias. *Baillieres Clin Haematol,* 5: 143-168.
IIPS 2007. *National Family Health Survey (NFHS-3), 2005–06*. Volume I. Mumbai: International Institute for Population Sciences (IIPS) and Macro International, pp. 309-313.
Kaur S, Deshmukh PR, Garg BS 2006. Epidemiological correlates of nutritional anemia in adolescent girls of rural Wardha. *Indian J Comm Med,* 31(4): 255-258.
Lohman TG, Roche AF, Martorell R 1988. *Anthropometric Standardization Reference Manual*. Champaign, Illinois: Human Kinetics Books.
McLean E, Cogswell M, Egli I, Wojdyla D, de Benoist B 2007. Worldwide prevalence of anemia in preschool aged children, pregnant women and non-pregnant women of reproductive age. In: K Kraemer, MB Zimmermann (Eds.): *Nutritional Anemia.* Basel, Switzerland: Sight and Life Press, pp. 1-12
Mishra D, Singh HP 2003. Kuppuswami's socio-economic status scale – A revision. *Indian J Pediatr,* 70: 273-274.
Mishra P, Ahluwalia SK, Garg PK, Kar R, Panda GK 2012. The prevalence of anaemia among reproductive age group (15-45 yrs) women in a PHC of rural field practice area of MM Medical College, Ambala, India. *J Women Health Care*, 1: 113.
Monarrez-Espino J, Martinez H, Grenier T 2001. Iron deficiency anemia in Tarahumara women of reproductive age in Northern Mexico. *Salud Publica Mex,* 43: 1-10.
Park K 2005. *Park's Textbook of Preventive and Social Medicine.* 18th Edition. Bhanot, Jabalpur: M/s Banarsidas, pp. 317-318.
Provan D, Weatherall D 2000. Red cells II: Acquired anaemias and policythaemia, *Lancet,* 355: 1260-1268.
Raghuram V, Manjula A, Jayaram S 2012. Prevalence of anaemia amongst women in the reproductive age group in a rural area in South India. *Int J Biol Med Res*, 3(2): 1482-1484.
Sinha NK, Chattopadhyay JC, Das PK, Maiti S, Maiti K 2013. Prevalence of anemia and its possible attributing factors in psychologically healthy women of reproductive ages in Midnapore (Jangalmahal-area), India. *Indian J Community Health,* 25(3): 226-232.
Trinh LTT, Dibley M 2007. Anaemia in pregnant, postpartum and non pregnant women in Lak district, Daklak province of Vietnam. *Asia Pac J Clin Nutr,* 16(2): 310-315.
Ulijaszek SJ, Kerr DA 1999. Anthropometric measurement error and the assessment of nutritional status. *Br J Nutr,* 82: 165-177.
Underwoo B 1996. The extent and magnitude of iron deficiency and anaemia. In: Anna Verster (Ed.): *Guidelines for the Control of Iron Deficiency in Countries of the Eastern Mediterranean, Middle East and North Africa*. Alexandria: World Health Organization Regional Office for the Eastern Mediterranean, pp. 14-18.
United Nations Children's Fund / United Nations University / World Health Organization 2001. *Iron Deficiency Anaemia: Assessment, Prevention, and Control.* Geneva: World Health Organization.
World Health Organization 1995. Physical Status: The Use and Interpretation of Anthropometry. *Report of a WHO Expert Committee. Technical Report Series,* No. 854. Geneva: World Health Organization.
World Health Organization, United Nations Children's Fund 2004. *Focusing on Anaemia: Towards an Integrated Approach for Effective Anaemia Control: Joint Statement by the World Health Organization and the United Nations Children's Fund*. Geneva: World Health Organization.