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Prevalence of Anaemia and Age Related Changes in Haemoglobin Level of the Santal Labourers of Birbhum district, West Bengal, India

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***Abstract*:** *Background:* Haemoglobin level changes with sex, altitude, physiological condition, socio-economic condition, nutrition and so on. However, age related changes in haemoglobin level have not been well demonstrated.
Objective: The study tries to find out (1) the prevalence of anaemia of the Santal labourers (indigenous and endogamous group) of Birbhum district, West Bengal and (2) also to find out age related changes in haemoglobin level of the Santal labourers.
Material and methods: Cross sectional data have been collected on age and haemoglobin level from 697 adult (male = 301 and female = 396) Santal labourers of both sexes of Birbhum district, West Bengal. The data have been classified into five age groups (<30, 30-39, 40-49, 50-59 and 60+). Descriptive statistics and one-way analysis of variance (ANOVA) used separately for males and females.
Results: Mean haemoglobin level of the study participants were 12.60±1.88 and 10.86±1.34 for males and females respectively. Around 60 per cent males and 80 per cent females were classified as anaemic. ANOVA depicts significant difference in haemoglobin level between/ among age groups for males but not in females. A gradual decline in haemoglobin levels observed with increment of age only in males.
Discussion: Present study indicates that haemoglobin level gradually declines with progression of age in males but such consistent pattern was not observed in females. However, it is difficult to conclude with this small sample size and a particular population. Further, studies in different populations with large sample sizes are needed considering concomitant factor affecting haemoglobin level to make a generalized statement.
Key words: Indigenous population, anaemic status, age groups, ANOVA.

Introduction

Haemoglobin is the iron containing pigmented (haem) protein molecules (globin) of erythrocytes (red cells) of blood. It generally helps in transport of oxygen and food molecules. It also plays important role in maintaining acid-base balance and homeostasis. In fetus the red cells are manufactured in the liver, spleen and bone marrow. But, by the time of birth the job is confined exclusively to the bone marrow of flat and irregular bones (Chatterjee 2008, 153-59). Deficiency of haemoglobin level reduces oxygen carrying capacity of the blood and such deficiency is known as 'anemia'. WHO (2011) defines 'anemia' as the state of decreased red blood cell count or alters in its morphology including insufficient oxygen-carrying capacity, which fails to meet the physio-

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logical needs of the human body. Anemia is one of the major public health problems worldwide, affecting one third of the global population. In India, the prevalence of anaemia is higher in most of the population groups (tribe, caste, religion, linguistic etc.) compared to other developing countries (Kalaivani 2009, 627). Many factors are responsible for the deficiency of haemoglobin level of blood (or anaemia) like non-nutritional factors including infection, chronic disease as well drug toxicity (Weiss and Lawrence 2005, 1011). On the other, nutritional factors includes iron deficiency, vitamin (B_{12}), amino acids, copper and protein deficiency (Baker 1978, 661-62; Doorothy et al. 2007, 75). Besides, some reported hereditary abnormality in haemoglobin molecule (e.g. Sickle Cell) (Colah et al., 2015, 511) and defective formation of bone marrow (e.g. aplastic anaemia) (Young et al. 2006, 2509) may also reduce the haemoglobin level of blood.

Several studies have recognized that haemoglobin level of blood as co-morbid factor in many chronic diseases/illnesses and associated with health-related quality of life, increased morbidity and mortality, infection (Horwich et al. 2002, 1782; Cotes et al. 2007, 923). On the other, pregnant women with low haemoglobin level are at risk for preterm delivery and subsequent low birth weight of child, neonatal mortality, inadequate fetal iron stores, increased risk of maternal morbidity and mortality (Allen 2000, 1280s). Edgerton et al. (1979, 1546) reported haemoglobin level is also associated with productivity of the workforce. Therefore, assessment of haemoglobin level is important to understand the overall health status of the individual or population (Haslam et al. 2012, 100). Many studies have reported that haemoglobin level varies between sexes (Khusun et al. 1999, 1672), genetic endowment (Johnson-Spear and Yip 1994, 118) altitude (Beall et al. 1998, 393-98) and exposure to environmental pollutant (Issaragrisil et al. 1997, 1552). On the other, some studies have also tried to relate socio-economic condition (Ghosh 2009, 763; Bharati et al. 2004, 26) anthropometric traits (Hong et al. 2007, 53) and physical state (Bharati et al. 2008, 347), and found significant association for the variation in haemoglobin level. However, the effect of age on haemoglobin level of blood was not well documented except few (Hawkins et al. 1952, 1001-03; Alvarez-Uria 2014, 4). Studies on Indian population regarding age related changes in haemoglobin level are scanty although it is not claimed that the literature review is exhaustive.

In view of the above, the objectives of the present study are to find out (1) the prevalence of anaemia of the Santal (indigenous and endogamous group) labourers of Birbhum district, West Bengal and (2) also to find out age related changes in haemoglobin level if any.

Material and Methods

The present data is a part of a larger ongoing bio-medical project. Cross-sectional data have been collected from Santal labourer population (engaged in stone mining and agricultural work) of Md. Bazar and Suri police station area of Birbhum district, West Bengal. Data comprised of 697 adult (male = 301 and female = 396) Santal individuals of both sexes. The study was restricted to single ethnic group (i.e. Santal) to avoid ethnic/ genetic effect on haemoglobin levels. Santals are the largest scheduled tribe community of West Bengal distributed in most of the districts (Census, 2001). They were classified as 'Pre-Dravidian' tribe. Their language, *Santali* belongs to the Mundari branch of Austro-Asiatic language family (Mukherjea, 1962, 1-50) and now they have their own script i.e. 'O*l Chiki*'. Socio-economic condition of the study participants was assessed in terms of monthly per capita expenditure (in INR) (Male= 537.29±167.20 and Female= 538.81±162.58) which was far below than the poverty line, in terms of monthly per capita expenditure for rural individuals in West Bengal (Planning Commission, 2014).

No statistical sampling has been adopted for the selection of study participants. Individuals who have been persuaded to participate and voluntarily agreed with written consent have been in-

cluded in the present study without any bias. This research was conducted after prior approval from the Ethical Committee for the Protection of Research Risks to Humans, Indian Statistical Institute.

Haemoglobin level of the study participants were assessed with portable HemoCue® Hb201 instrument. The instrument follows modified azide methaemoglobin reaction method for assessing haemoglobin level (Von Schenck et al. 1986, 526). Blood samples were collected by fingure pricking with sterilized lancet and first drop of blood was discarded. The microcuvette was filled with subsequent blood drops. Then the cuvette was placed into the HemoCue, which finally provides result of haemoglobin level of the individual. Anaemic status of the study participants was determined using WHO (2011) classification for adults as follows.

Anaemic status	Haemoglobin level (gm/dL)	
	Male	Female[#]
Normal	≥ 13.0	≥ 12.0
Mild Anaemic	11.0-12.9	11.0-11.9
Moderate Anaemic	8.0-10.9	8.0-10.9
Severe Anaemic	< 8.0	< 8.0

#Non pregnant

Due to the absence of written records of age in most of the individuals, the ages were estimated with reference to important local events and cross-checked with elderly individuals, which were further compared with the ages of individuals for whom age records existed. The sample were classified into five age groups (i.e. <30, 30-39, 40-49, 50-59 and 60+).

Data analysis: Descriptive statistics have been done followed by one-way analysis of variance (ANOVA) to find out the differences between/ among five age groups in terms of mean haemoglobin level, separately for males and females. Scheffe's test (post-hoc) was performed to find out the exact difference between age groups. Scheffe's test is more conservative way of looking into the mean difference between groups and rules out type I error. Further, linear regression analysis was done considering haemoglobin level as dependent variable and age as independent variable. To check the consistency of data, random sampling from each age group was done separately for males and females. Then the mean value of both total data and sampled data for each age group were compared. However, the results of t-test did not show any significant difference. All the statistical analyses have been done using SPSS software 16.0 (SPSS Inc., Chicago, IL, USA).

Results

Table 1 Haemoglobin level of the Santal labourer in either sex following WHO (2011) classification

Haemoglobin level/ Anaemic status	Male		Female	
	n (%)	*Mean ± SD*	n (%)	*Mean ± SD*
Normal	132 (43.85)	14.21 ± 0.98	74 (18.69)	12.65 ± 0.66
Mild Anaemic	115 (38.21)	12.11 ± 0.51	117 (29.55)	11.44 ± 0.29
Moderate Anaemic	50 (16.61)	9.97 ± 0.85	195 (49.24)	10.03 ± 0.71

Severe Anaemic	4 (1.33)	6.40 ± 0.49	10 (2.53)	6.99 ± 0.62
Overall	301 (100.00)	12.60 ± 1.88	396 (100.00)	10.86 ± 1.34

Figure 1: Anaemic status of the Santal labourer in either sex

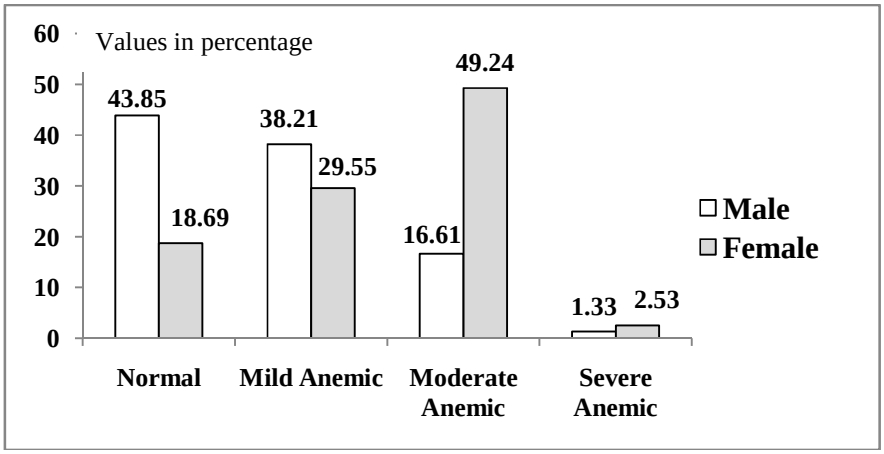


Table 1 depicts haemoglobin level/ anaemic status of the Santal labourers in either sex following WHO (2011) classification. In males, the hemoglobin level was 12.60 ± 1.88 for all and the prevalence of anaemia was 56.15 per cent. Within anaemia category, 38.21 per cent show mild anaemia, 16.61 per cent moderate and 1.33 per cent severe anaemia. In females, the hemoglobin level was 10.86 ± 1.34 for all and the prevalence of anaemia was 81.31 per cent. Within anaemia category, 29.55 per cent show mild anaemia, 49.24 per cent moderate and 2.53 per cent severe anaemia illustrated in Figure 1.

Table 2: Descriptive statistics of haemoglobin level by age groups and ANOVA result of Santal labourers in either sex

Age groups (yrs)		Male (n=301)			ANOVA (df= 4, 296)		Female (n=396)			ANOVA (df= 4, 391)	
		n	Mean	SD	F	p	n	Mean	SD	F	p
I	<30	134	13.20	1.72	12.366*	<0.001	177	10.92	1.38	1.185	0.317
II	30-39	64	12.78	1.73			68	10.93	1.13		
III	40-49	52	12.11	1.73			74	10.83	1.34		
IV	50-59	20	11.53	1.71			55	10.86	1.39		
V	60+	31	11.15	2.00			22	10.28	1.36		

*p≤0.05

Table 2 shows descriptive statistics of haemoglobin level by age groups and ANOVA result of Santal labourers in either sex. The mean value of haemoglobin level was highest in <30 years age group (13.20 gm/dL) followed by other four age groups for males. Females on the other, show marginally highest mean values in 30-39 years age group (10.93 gm/dL) and lowest in the 60+ age group (10.28 gm/dL), however, the mean values are inconsistent between age groups. The ANOVA result show significant difference between/ among age groups in terms of mean hae-

moglobin level only in males but not in females. A gradual decline in haemoglobin level observed with increase of age in male, female data failed to show such consistent trend illustrated in Figure 2 (mean with standard error bar).

Table 3: Post hoc (Scheffe) test between/ among age groups of Santal labourers in terms of haemoglobin level in either sex

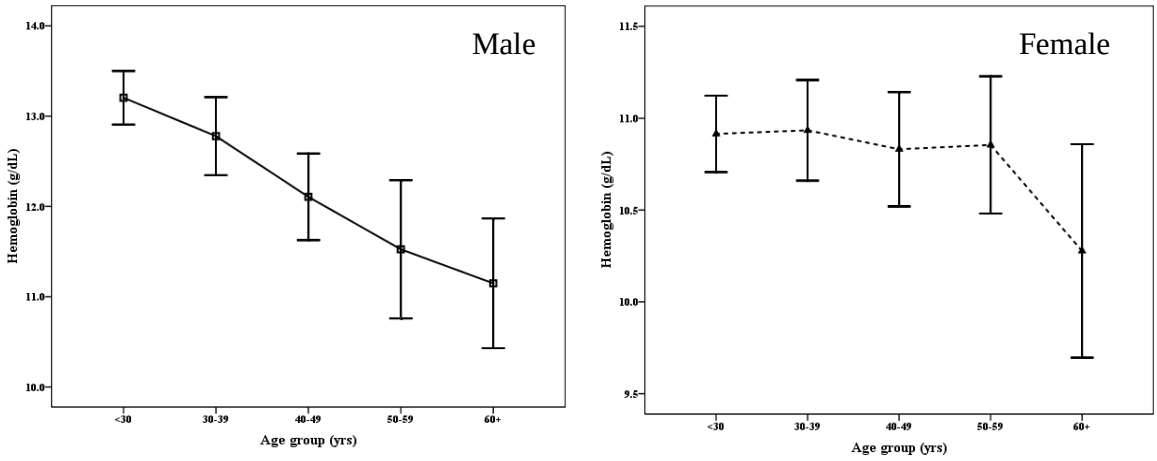
Age groups	Male		Female	
	p	df	p	df
I Vs. II	0.636	196	1.000	243
I Vs. III	0.006*	184	0.995	249
I Vs. IV	0.004*	152	0.999	230
I Vs. V	<0.001*	163	0.348	197
II Vs. III	0.379	114	0.995	140
II Vs. IV	0.103	82	0.999	121
II Vs. V	0.001*	93	0.403	88
III Vs. IV	0.811	70	1.000	127
III Vs. V	0.218	81	0.571	94
IV Vs. V	0.967	49	0.568	75

*p≤0.05

Table 3 shows Scheffe's test (Post hoc) results between/ among age groups of Santal labourers in terms of haemoglobin level in either sex. In males, significant differences exist between <30 vs. 40-49, <30 vs. 50-59, <30 vs. 60+ and 30-39 vs. 60+. But in females, no significant difference exists between/ among age groups.

Figure 2: Age changes in haemoglobin level by different age groups of Santal labourers in either sex

Table 3: Linear regression equation of haemoglobin level (gm/dL) with age (years) of the Santal

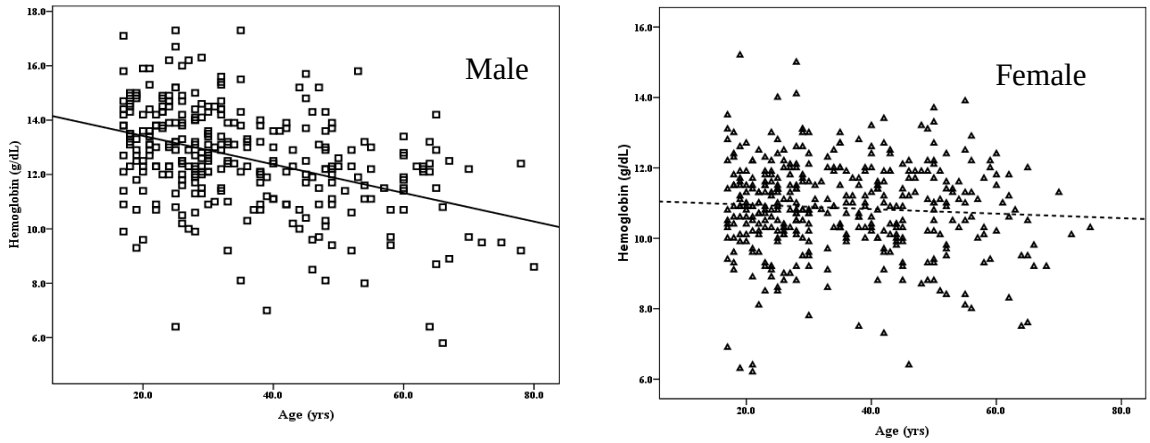


labourers in either sex

	Independent variable = Age (yrs)			
	Constant	S.E.	β coeffi-cient	S.E.
Male	14.469	0.260	-0.052	0.007
Female	11.086	0.187	-0.006	0.005

Table 3 shows result of linear regression analysis between haemoglobin level (gm/dL) and age (years), considering haemoglobin level as dependent variable and age as independent variable. Figure 3 depicts scatter plot with regression line for haemoglobin level by age, separately for males and females.

Figure 3: Regression line of haemoglobin level by age of Santal labourers in either sex



Discussion

The endeavour of the present study was to investigate the prevalence of anaemia and age related changes in haemoglobin level among Santal labourers of Birbhum district, West Bengal. The individuals of the present study were similar in terms of ethnicity, socio-economic condition and live in a similar geographical boundary. The test protocols for collection of data were similar for all the individuals and the data were collected by single investigator with single instrument. In order to understand age related changes in haemoglobin level, the individuals were classified into five age groups.

The result of the present study indicates the mean haemoglobin level of both male (12.60±1.88) and female (10.86±1.34) was below the normal range following WHO (2011) cut-off points. Around 60 per cent males and 80 per cent females were classified as anaemic which is much higher than the National Family Health Survey 2005-06 (NFHS-3) for West Bengal (male=32 per cent and female= 63 per cent) (IIPS and Macro, 2008). Present finding corroborates with few recent studies conducted on rural population (groups not specified) in West Bengal (Maity et al. 2013, 11; Sinha and Halder 2015, 187) which also indicates high prevalence of anaemia in the state. In a cross-sectional study Wankhade et al. (2011, 5) also observed around 80 per cent of women were anaemic in Aurangabad regions of Maharastra. However, Shrinivasa et al. (2014, 121) reported 96.5 per cent tribal women of Wayanad district of Kerala were anaemic, although the study failed to control the ethnic/genetic effect in the study which may have some influence of getting a huge per centage. In contrast to the present findings, Kamath et al. (2013, 345) noted

55.6 per cent prevalence of anaemia among the tribal women of Karnataka. Agarwal et al. (2006, 181) and Dutta et al. (2013, 606) mentioned that among tribal population the load of parasitic infestation and poor nutrition (due to inadequate diet and poor nutritional knowledge) is common. However, prevalence of various parasitic infestations (e.g. hookworm) and dietary habits have not been considered in the present study. The role of socio-economic condition may altogether be considered as an important factor for higher prevalence of anemia among the tribal group (Ghosh and Bharati 2003, 454).

The prevalence of anemia was much higher among females than males which corroborates with the studies of Malhotra et al. (2004, 18) and Deshpande et al. (2013, 64). That may be due to inherent biological reasons (Hawkins et al. 1952, 1005) as well as some social norms (fasting, food deprivation) of Indian females that have created the scenario more complicated (Bentley and Griffiths 2003, 57). However, it is difficult to isolate the role of each of the factors.

Result of the present study indicates the mean values of haemoglobin level reached its peak within 30 years of age in males and then gradually decreases with enhancement of age. On the other, result of females show more or less stable haemoglobin level (although anaemic) throughout their adult life. Boskey and Coleman (2010, 1335) mentioned that with the advancement of age, bone marrow gets stiff and hinders production of red cells so also the haemoglobin content of blood. However, in the present case, higher level of energy expenditure and low caloric food consumption (due to poor socio-economic condition) (data have not been presented) may have some influence which may hinders to compensate body energy level. Females on the other have lower haemoglobin level throughout their life and further decrease in haemoglobin level may be deterrent for maintaining normal body function. Similar observation was made by Hawkins et al. (1952, 1005). They also reported haemoglobin values decrease with advancement of age, but the pattern is more marked in males than females. Alvarez-Uria et al. (2014, 2) noted that haemoglobin level reaches its peak during early adult age in males and after the age of 40 it decrease progressively. Sinha and Halder (2015, 188) noted that haemoglobin level slightly decreases with advancement of age, among females, which corroborates with the present finding. They also further reported that the prevalence of anemia was independent of age.

Conclusion

Present study indicates high prevalence of anaemia, more specifically of the females. Still the population is growing and actively surviving. The factors may be explained that there may be some inherent limit of haemoglobin level for the females, which may vary between populations and secondly, the standard of classification as prepared by WHO is not suitable for comparison of the present population. To our knowledge, there is no Indian standard and or population-wise standard for classifying haemoglobin level. Though, the effect of concomitant factors (like poor dietary consumption, prevalence of parasitic infection and socio-economic condition) cannot be ruled out. Regarding age related changes, present data shows haemoglobin levels reach its peak within third decade of life and then gradually decreases with increase of age in males but such consistent pattern was not observed in females. However, it was not possible to determine the exact age, when the haemoglobin level reaches its peak and when exactly the values were declining, due to small sample size in each ages and the data was cross-sectional in nature. Therefore, studies in different populations with large sample sizes are needed considering concomitant factor affecting haemoglobin level to make a generalized statement.

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