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ASSOCIATION BETWEEN HEMOGLOBIN LEVEL AND BLOOD PRESSURE: A CROSS SECTIONAL POPULATION BASED STUDY

Gopal Chandra Mandal[1] and Arya Chakraborty[2]

Abstract: It has been reported that elevated hemoglobin level increases blood viscosity. An increase in viscosity elevates the blood pressure level and disturbs the cardiovascular function. There is paucity of data on this regard in Indian context. The aim was to study the association between hemoglobin level and blood pressure among the Sunni Muslim adolescents of Lucknow City, India. This cross sectional study was conducted among 159 adolescent school children aged between 12 and 18 years from a sub urban area near Lucknow city, India. T-test was used to examine the sexual dimorphism in Hb and blood pressure levels. Furthermore, Pearson's correlation as well as linear regression were done to evaluate the association between Hb and BP level. Result shows mean hemoglobin level (g/dL) was higher among boys 12.1 (1.6) than girls 11.4 (1.1) and this difference was statistically significant ($t = 2.79$; $p < 0.05$). The systolic blood pressure showed significant sexual dimorphism ($t = 2.46$, $p < 0.05$); only diastolic blood pressure showed significant positive correlation with hemoglobin levels in both the sexes as well as in sex combined ($p < 0.05$). Considering the categories i.e. anemic and non anemic individuals, the only non anemic showed positive significant correlation with systolic ($r = 0.271$; $p < 0.05$) and diastolic ($r= 0.299$; $p < 0.05$) blood pressure. We conclude from this study that significant sexual dimorphism exists in case of hemoglobin level among the adolescents and individuals with higher Hb are likely to have high blood pressure.

Keywords: Hemoglobin level, blood pressure, hypertension, adolescents, Sunni Muslims, India.

INTRODUCTION

High blood pressure is regarded as one of the most leading risk factors underlying causes of cardiovascular disease**.** It has been reported that high blood pressure is anattributable factorfor 47 % of the ischemic heart disease cases and 54% of the stroke cases (WHO, 2002). It has been reported that elevated hemoglobin level increases blood viscosity. An increase in blood viscosity elevates the blood pressure level and disturb the cardiovascular function (Vazquez, 2012)**.** Some studies have shown that hemoglobin levels are related to blood pressure (Gobel et al.,1991; Kawamoto et al.,2012). For example, Vazquez (2012) showed relationship between high blood pressure and elevated blood viscosity among the people of Victoria de Durango, Mexico.

The World Health Organization (WHO) identified hypertension as one of the independent causal factors of premature deaths worldwide. The Global and Regional Burden of Disease and Risk factor study (WHO, 2001), in a systematic analysis of population health data for attributable deaths and attributable disease burden has

1. Dr. Gopal Chandra Mandal; Associate Professor; Department of Anthropology, Bangabasi College, Kolkata; E-mail: golmal_anth@rediffmail.com
2. Arya Chakraborty; Research Student; E-mail: aryaanthro2018@gmail.com

ranked hypertension in South Asia as second only to child underweight for age (Lopwz et al., 2006). Hypertension is ranked as one of the third most important risk factor for attributable burden of disease among the South Asian countries (Limm et al., 2012).

In Indian context, hypertension exerts a substantial public health burden on cardiovascular health care systems (Leeder et al., 2004; Srinath et al., 2005). In India, hypertension is directly related to 24 % of all coronary heart disease and 57% of deaths due to stroke (Gupta, 2004).

Study demonstrates that onset of hypertension occurs in the younger phase of life and continues during the adulthood (Niece et al., 2007). In most of the cases hypertension is usually non specific and asymptomatic as well (Das et al., 2017). However, detection and prevention of pre hypertension and hypertension in childhood and adolescent becomes important (Rai et al., 2018). Prevalence of pre- hypertension and hypertension varies with region (Ellenga et al., 2014) and study showed cultural environment had great impact on food habit which can ultimately effects the blood pressure levels (Raj et al., 2007). Therefore, measuring and monitoring of blood pressure in adolescent can help to minimize the population stress by maintaining blood pressure at an adequate level.

There is a paucity of work on the association between the hemoglobin levels and hypertension among the adolescents in Indian context especially among the Sunni Muslim. Hence, the objective of the present study was to investigate the association between hemoglobin level and blood pressure among the Sunni Muslim adolescents from Lucknow City, India.

MATERIALS AND METHODS

The area

This cross-sectional study was conducted in two sub urban areas (Aurangabad Jagir and Chilwava) located close to Lucknow city. The research participants were selected from the two schools viz. SuryabalaVidyalaya and M.C.D. Public School. Muslims represent the numerically second largest religious group in India. Among them majority belongs to the Sunni group (Census of India, 2011). This numerical configuration is also true for in and around the city of Lucknow. In a study conducted by Bansal and Joshi (2017) among the Sunni Muslims of urban Delhi reported that they (70.68%) have high SBP and DBP. So, we selected the Sunni Muslims for the study. The selection of the study community, the area and the schools was done because of operational convenience.

The participants

159 Sunni Muslims adolescents (103 boys and 56 girls) aged between 12 -and 18

years were considered for the study.To maintain homogeneity we concentrated only on one ethnic group i.e. Sunni Muslims who belong to the OBC category. Sunni Muslims of the area are poor and mostly work as labourer, live in unhygienic conditions with no access to portable water, lack of adequate balanced diet, permanent latrines, health facilities etc. Most of the families do not allow their girls to study in a co-educational school.

Permission

Before taking Blood Pressure measurements and drawing blood samples verbal consent was taken from the school authority as well as from the parents. The students were selected from those who were present on the days of work.

Measurements

Blood pressure was tested following standard protocol by using mercury based sphygmomanometer and stethoscope. Each subject was asked to seat on a chair and requested to take rest for 10 minutes and then asked to place his or her hand on a plane which was parallel to chest. We created gender specific blood pressure charts on BP thresholds derived from the Fourth Report which can be used to identify any BP percentile, including abnormally high and low blood pressure (National High Blood Pressure Education Program, 2004). Because height accounts for substantially more BP variability than age in children (Rosner et al., 1993; Daniels et al., 1998). We followed the cutoff value given by WHO for classification of hemoglobin levels (WHO, 2001).

For hemoglobin level estimation, the blood samples were drawn by medical experts. 20 micro liter of blood was collected from each individual by finger prick and all blood samples were tested by Sahil's (2016) method in field laboratory. The Sahil's haemometer method utilizes (Meheta, 2015; Kumar and Sharma, 2017) the conversion of haemoglobin into acid haematin which has a brown colour in solution. The intensity of the colour is related to the amount of haemoglobin in the blood sample.

Statistical analyses

Independent sample t-test (two-tailed) was done for SBP, DBP and for hemoglobin to study sexual dimorphism. Pearson correlation coefficient was derived to evaluate the association between systolic and diastolic blood pressure with Hemoglobin level. Regression analysis of Hb level (as predictor variable) with SBP and DBP as independent variable was done. All the statistical calculations were done by using SPSS (v.20).

RESULTS

Table1 represents sexual dimorphism for hemoglobin level, SBP and DBP, of 159 school going adolescents. Considering the sex combined overall participants, the mean (SD) hemoglobin level was 11.8 (1.5) and the mean (SD) SBP and DBP were 117.2 (13.6) and 75.4 (10.5), respectively. Mean (SD) of hemoglobin level (g/dL) was higher among boys 12.1(1.6) than girls 11.4(1.1) and this difference was statistically ($t = 2.79$; $p < 0.05$) significant. Mean (SD) Systolic 119.1(13.8) and diastolic blood pressure 75.9 (10.6) were also higher in boys than girls, where these were 113.7 (12.5) and 74.5 (10.3), respectively.Here, we find that the difference was significant in case of SBP ($t = 2.46$; $p < 0.05$) only not in case of DBP.

TABLE 1: DISTRIBUTION OF AGE, HEMOGLOBIN AND BLOOD PRESSURE LEVELS OF THE STUDY PARTICIPANTS.

Variables	Sex	N	Mean(SD)	t
Age	Boys	103	15.0(2.2)	1.82n.s.
	Girls	56	14.3(2.2)	
	Overall	159	157.9(12.1)	
Hemoglobin (g/dL)	Boys	103	12.1(1.6)	2.79*
	Girls	56	11.4(1.1)	
	Overall	159	11.8 (1.5)	
SBP (mm/Hg)	Boys	103	119.1(13.8)	2.46*
	Girls	56	113.7(12.5)	
	Overall	159	117.2(13.6)	
DBP (mm/Hg)	Boys	103	75.9(10.6)	0.81 n.s.
	Girls	56	74.5(10.3)	
	Overall	159	75.4(10.5)	

* =P<0.05 ; n.s.=non significant

TABLE 2: CORRELATION OF HEMOGLOBIN LEVELS WITH SBP AND DBP BASED ON SEX

Sex	*r*	
	SBP	DBP
Boys	0.143 ns	0.211*
Girls	0.121 ns	0.328*
Sex combined	0.185*	0.248*

*=p<0.05

Table 2 depicts the correlation of Hemoglobin level with SBP and DBP separately for sex combined as well as sex wise separately. Among the studied

population, the SBP (r = 0.185) and DBP (r = 0.248) both were positively ($p < 0.05$) correlated with Hb level in sex combined. However, it is significantly correlated ($p < 0.05$) only in case of DBP, independently for both the sexes.

TABLE 3: DISTRIBUTION OF ANEMIC AND NON ANEMIC PARTICIPANTS AGAINST SBP AND DBP

Category	Hemoglobin level	SBP		DBP	
	Mean(SD)	Mean(SD)	*r*	Mean(SD)	*r*
Anemic	10.9 (1.0)	115.3 (13.9)	0.007	75.0 (9.7)	0.133
Non-Anemic	13.1(0.9)	119.7 (12.1)	0.271*	77.4 (9.8)	0.299*

*=p<0.05

Table 3 outlines correlation between SBP and DBP with categories of hemoglobin levels. Out of 159 individuals, 94 (59.1%) were anemic and 65 (40.9%) were non-anemic. The mean (SD) values of hemoglobin level among the individuals of anemic and non-anemic categories were 10.9 g/dL (1.0) and 13.1 g/dL (0.9) respectively. Within anemic category, mean (SD) of SBP and DBP were 115.3 g/dL (13.9) and 75.0 g /dL (9.7), respectively. In this group, we did not find any significant correlation with SBP and DBP ($p>0.05$). Amongst the non anemic group, mean SBP was 119.7 mm/hg (12.1) and mean DBP was 77.4 mm/hg (9.8) and in both cases they were significantly correlated ($p<0.05$).

TABLE 4: CORRELATION BETWEEN VARIOUS HYPERTENSION STATUS WITH HEMOGLOBIN LEVELS

Item	Systolic Hypertensive (n=56)		Systolic Normotensive (n=79)		Diastolic Hypertensive (n=62)		Diastolic Normotensive (n=70)	
Hemoglobin levels Mean (SD)	Mean(SD)	*r*	Mean(SD)	*r*	Mean(SD)	*r*	Mean(SD)	*r*
	130.4(10.1)	0.207	108.2(6.4)	0.372**	85.1(5.5)	0.368**	67.5(4.9)	0.057
	12.0(1.7)		11.5(1.3)		12.1(1.5)		11.7(1.3)	

**=p<0.01

In this table (Table 4) the study only considers those individuals who were systolically and diastolically hypertensive and normotensive and established a correlation coefficient. The number of systolic and diastolic hypertension was 56 and 62 respectively. The mean (SD) hemoglobin level of systolic hypertensive and diastolic hypertensive individuals were 12.0 (1.7) and 12.1(1.5) respectively. Blood hemoglobin levels were significantly associated with systolic normotension (r = 0.372; $p<0.01$) and diastolic hypertension (r = 0.368; $p<0.01$).

TABLE 5. LINEAR REGRESSION ANALYSES OF HB LEVEL WITH SBP AND DBP AMONG THE STUDIED POPULATION

Variables	β	Seβ	Beta	AdjR^2	t
SBP	1.679	0.714	0.185	0.028	2.352*
DBP	1.444	0.519	0.248	0.041	2.780**

Predictor variable : Hb level, * = $p < 0.05$; ** = $p < 0.01$

Table 5 represents the linear regression analysis of hemoglobin levels (as predictor variable) with SBP and DBP as dependent variable (separately used). The study found hemoglobin could significantly predict the SBP levels ($p<0.05$) and in case of DBP linear regression analysis established the fact that Hemoglobin levels accounted for predictor over DBP statistically ($p<0.01$). The result shows that a unit increase in the level of Hb was likely to rise the SBP and DBP levels 1.679 and 1.444 times respectively.

DISCUSSION

In the present study, we observed significant positive association between hemoglobin concentration and systolic and diastolic blood pressure among the Sunni Muslims of Lucknow City. Similar kind of reporting has also been made in another study (Gobel et al., 1991). In this population, the mean hemoglobin levels increase as the levels of blood pressure increase in both boys and girls. Plange-Rhule et al. (2019) argue that increase in both systolic and diastolic blood pressure is related to higher values of haemocrit, hemoglobin and red blood cell count even in both men and women (Plange-Rhule et al., 2018). Our study also showed positive association between hemoglobin levels and DBP in both boys and girls. Our findings corroborate with another study where positive association existed between Hb level and SBP and DBP in men and women (Atsma et al., 2012). Lee et al. (2015) have reported positive associations between hemoglobin and blood pressure in their cross sectional study. The physiological reason behind all the positive cross section association was explained by Cabrales and others who found high hemoglobin levels can cause vasoconstriction and then elevate the blood pressure (Cabrales et al., 2009). A Japanese cross sectional study reported that the hemoglobin levels are independently associated with hypertension in both Japanese men and women (Shimizu et al., 2014). The study from Netherland also reaffirms the relationship between Hb and BP levels (Hamalainen et al., 2012).

There are some other studies where biological mechanisms for the association between hemoglobin and blood pressure have been pointed out. Kawamoto et al. (2012) opined that hemoglobin is strongly associated to arterial stiffness, as measured by pulse wave velocity, which, in turn, increase SBP and DBP. Furthermore, increased hemoglobin levels associated with increased blood viscosity and Hb levels increase blood viscosity that partly effects on blood pressure. In

another study among the hypertensive patients, Devereux et al. (2000) supported the role of increased blood viscosity in raising blood pressure. Here, it may also be the same reason for the adolescents having higher level of Hb led to increase the blood pressure.

CONCLUSION

Positive association of hemoglobin concentration with hypertensive individuals and association of non-anemic individuals with high blood pressure lead to conclude that higher level of hemoglobin increases the blood pressure among the school going adolescents of Uttar Pradesh, India. There may be a chance of lowering the hemoglobin level by donating blood which may lead to reducing the blood pressure. The current study may add good knowledge about the factors that are associated with blood pressure. In Indian context, no studies have been reported previously on apparent association between Hb level and both SBP and DBP and this study could made a base in hypertension research in the context of the country.

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