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COMPARATIVE STUDY OF ANTHROPOMETRIC AND BASIC HYSIOLOGICAL PARAMETERS OF FEMALE CHILDREN OF PRE-PUBERTAL, PUBERTAL AND POST-PUBERTAL AGE GROUPS FROM TWO DISTRICTS OF WEST BENGAL, INDIA

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ABSTRACT

Any variations in the anthropometric parameters i.e., height, body mass, BMI, BSA, body fat %, WHR, WHtR etc., and basic physiological parameters i.e., haemoglobin content, respiratory rate, pulse rate, blood pressure etc., in female school children of pre-pubertal, pubertal and post-pubertal age groups from Bankura District and from the district of West Midnapore of West Bengal, India were studied. We also evaluated if there is any significant difference in the various anthropometric and physiological parameters studied in the children of the three different age groups from the two different districts of the state of West Bengal. We observed significant variations in the anthropometric and physiological parameters in the three different age groups of female children of the two districts and also some significant differences were observed between the respective age groups from the two districts. Variations in anthropometric parameters of children bear a direct relationship with possible health risks, growth pattern and socio economic status of the community from which the children belong. Besides, assessment of anthropometric parameters and basic physiological parameters in school children helps us to predict possible suitable physiological predomination for selection of individuals for training of specific types of sports. Above all, the studies helped us to predict the phylogenetic relationship, if any, between the two different communities residing in two different districts of the state of West Bengal India. Besides, the study revealed possible vulnerability of the children to health ailments which may be because of lifestyle and socioeconomic status of those children.

KEY WORDS: **anthropometric parameters, blood pressure, health, growth, haemoglobin.**

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INTRODUCTION

Anthropometry is an adaptable, portable, non-invasive and affordable technique and it is useful in field studies as well[1]. Till date anthropometry is the most widely used method, and it has recently been used to estimate fat distribution[2]. Body surface area (BSA) of an individual can be easily evaluated from body weight and height using the standard equation for the same[3]. The body surface area is useful in many measurements in medical science; those include the calculation of drug dosages and the amount of fluids to be administered intra-venously. Though the body surface area depends on more than one factor i.e., height, weight, age and gender of the individual etc, yet the "normal" body surface area is generally taken to be 1.7 m2. Average body surface area for children (9 years): 1.07 m^2 ; Average body surface area for children (10 years): 1.14 m2 ; Average body surface area for children (12-13 years): 1.33 m2. BSA is also used in evaluating the cardiac index of an individual. This cardiac index is an important measurement for ascertaining a person's cardiac efficiency and output. Often patient's body surface area is considered for Chemotherapy and pharmacotherapeutic dosing. Thus BSA is an important clinical parameter[3, 4]. Body Mass Index (BMI) is the weight of person in kilograms divided by the square of height in meters. For children and teens, is often referred to as BMI-for-age as in children and teen BMI is age- and sex-specific. A high amount of body fat in children may cause overweight related diseases and other health issues while again on the other hand, being underweight can also put children and teens at risk for health issues. A high BMI can be an indirect indicator of high body fat content. Studies have revealed that BMI is correlated with skin fold thickness measurements, bioelectrical impedance, densitometry (underwater weighing) and other methods which are more direct measures of body fat[5-7]. Also, BMI is an easy-to-perform and inexpensive method of screening for weight categories that may lead to health problems. Body mass index i.e., BMI can also be easily evaluated by using Dubois and Dubois equation. Both BSA and BMI are markers of obesity and health status. In children, specially female children health status before puberty, during puberty and post puberty are highly significant for determining their future disease vulnerability and resistance[8]. These days there is an alarming problem with obesity in children in the developed countries. The scenario is changing in Indian metropolitan cities also. In such a situation avoiding childhood obesity and maintaining a healthy weight is extremely important in the life of a child for a healthy future of the child. Measuring body fat in a child serves as an important health status assessment parameter for the child as because changes in child's body fat may indicate health problems which can last into adulthood. A certain amount of fat is necessary for every child to continue his normal physiological activities. More than the normal amount of fat or less than that leads to health issues in the child. The fat content in children varies depending on several factors like age, sex, genetics and ethnic background. As already discussed, BMI is not a direct or perfect measure of body fat hence we need body fat percentage measurement etc. to directly ascertain the body fat content in children [9]. A central fat pattern has bad health implications in both children and adults[10]. Waist–hip ratio or waist-to-hip ratio (WHR) is the ratio of the circumference of the waist to that of the hips. The WHR is an important indicator or measure of health status and the risk of developing health ailments. Research reveals that people with "apple-shaped" bodies at at higher health risks than those with "pear-shaped" bodies. It is worth mentioning that WHR is used as a measurement of obesity, which in turn is a possible indicator of other more serious health conditions and cardiac ailments. According to the World Health Organization, abdominal obesity is defined as a waist–hip ratio above 0.90 for males and above 0.85 for females [11]. While according to The National Institute of Diabetes, Digestive and Kidney Diseases (NIDDK), women with a WHR of more than 0.8, and men with more than 1.0, are at increased health risk which is primarily because of their fat distribution[12]. The waist-to- height ratio (WHtR) is defined as the ratio of waist circumference to the person's height. The WHtR is an indirect measure of the distribution of body fat. Risk of obesity related

cardiovascular diseases and abdominal obesity are directly correlated to the values of WHtR. Research shows that WHtR values are much more reliable in predicting the risk of heart attack, stroke or death than the values of body mass index [13]. A large study performed in 2011 showed that the waist-hip ratio was a better predictor of ischaemic heart disease mortality than WHtR [13]. Waist hip ratio (WHR) and waist height ratio (WHtR) are the parameters for assessing fatness and obesity and are intimately linked with risks of individuals with predisposed cardiac disorder risks[12]. Hemoglobin is the protein molecule in red blood cells that carries oxygen from the lungs to the body's different tissues and carries back carbon dioxide from the tissues to the lungs. Hemoglobin is also known to play an important role in maintaining the shape of the red blood cells. Decrease or increase of hemoglobin content than the normal value indicates some adverse health situation[14]. In females normally the hemoglobin content has a lower reference level than males. Specially in pubertal and post pubertal females a lower level of hemoglobin content is observed due to menstrual bleeding[14]. Respiratory rate i.e., the number of breaths (inhalation-exhalation cycles) taken within a set amount of time (typically 60 seconds). Children often face acute distress and respiratory disorders which is in turn a remarkable parameter for detecting the health status in children. Though respiratory rate is used as an indicator of potential respiratory dysfunction yet, findings suggest that it is of limited value[15]. The pulse rate is an indirect assessment of heart rate. The heart rate (pulse) is altered when the child is unwell. Pulse rate may vary only because of an increase in body temperature as well as because of many other reasons. Blood pressure, pulse rate, and respiratory rate are the routine vital signs measured in medicine. These vital signs remain relatively constant throughout our adult life. However, as infants and children grow and age, the normal range changes. Heart rates and respiration rates tend to be faster in younger children and then slow down as they grow.Blood pressure is expressed as the systolic pressure over the diastolic pressure. Low blood pressure is a sign of shock. High blood pressure in infants, toddlers and older children is usually the result of disease, such as kidney problems. Blood pressure in children tends to increase with increasing age of children. Systolic and diastolic blood pressure is also used as an early marker parameter for detection of individuals with predispositions of cardiovascular disorders[16,17]

MATERIALS AND METHODS

Selection of subjects

We conducted the study on 60 female school going children in two districts of West Bengal i.e., West Midnapore and Bankura. For this work, we divided these female children in three groups according to their age i.e., prepubertal (5-10yrs), pubertal (11-15yrs), postpubertal (16-18yrs). We measured basic anthropometric parameters by anthropometric instruments to assess physical growth pattern and health status of the children. Except this we also have measured some physiological parameters, to know about the physiological status of these female children.

Measurement of Anthropometric variables

Body surface area (BSA)

Body surface area of the subjects were measured by using the formula of Dubois & Dubois[18].

$A = w^{0.425} * H^{0.725} * 71.84$

Where A (cm^2) = Body surface area.

W = Weight in kg.

H = Height in cm.

71.84 is constant

Body mass index (BMI)

Body mass index has been used as a simple anthropometric index which also reflects the current nutritional status of an individual[19].BMI was calculated by weight and height measurements using the following formula[20].

BMI= Weight (kg)/Height (m^2)

Waist-Hip Ratio (WHR)

Waist- circumference (cm) (WC) was measured with a tape midway between the lowest rib & the iliac crest in the upright position[21] (WHO 1998).

Hip-circumference(cm) (HC) was measured in standing erect, feet together at the level of greater trocenters. BMI,WC,HC, mainly measure to identify the Adiposity of subjects. Waist-Hip Ratio (WHR) was evaluated dividing waist circumference (WC) by hip circumference (HC) i.e., WC/HC.

Waist Height Ratio(WHtR)

Waist height ratio was calculated by dividing waist circumference (cm) by height (cm) i.e., WC/Ht. WHR & WHtR mainly diagnose the obesity and also helps to predict cardiovascular risk factor.

Measurements of Physiological variables

Pulse rate (beats /minutes)

Pulse rate was measured from radial artery on the wrist.

Respiratory Rate (cycles/minute)

Respiratory Rate was collected by standard method (taken breathing air mainly expiration air from nostril on the back of our palm).

Haemoglobin Content (Hb)

Hemoglobin estimation of all subjects was carried out by using Sahli's method. Hb estimation is one of the best ways to know whether the subjects suffers from anemia or not by comparing the collected data with standard data of female children of the respective age groups.

Blood Pressure Measurement

Blood pressure is another important physiological parameter, which is systolic & diastolic. Both have greater prognostic value for life[22,23]. We measured blood pressure using a sphygmomanometer.

Fat Content

Holtain skinfold caliper was used for measurement of body fat.

Statistical Evalution

Each parameter was measured at least three times in each individual. Data are presented as Mean± S.E.M. Significance of difference of mean values of different parameters between children from 2 districts of same age group were analyzed using One Way Analysis(ANOVA). Statistical test were performed using Microcal origin version 7.0 for windows.

RESULTS AND DISCUSSION

Anthropometric variables

Body surface area (BSA)

Figure 1. A. reveals that the body surface area of the female children of pre-pubertal age group of West Midnapore district is significantly lower (*P<0.01) than that of the female children of same age-group of Bankura district. No significant difference in BSA of female children of the pubertal age group of West Midnapore and Bankura dstrict is observed and no significant difference is observed in BSA of female children of post-pubertal age group of West Midnapore and Bankura dstrict. BSA is an important clinical parameter which is considered for drug dosing etc.

Basal Metabolic Rate (BMI)

Figure 1. B. shows that the BMI of female children of pre-pubertal age group of West Midnapore district is significantly lower (*P<0.01) than that of the female children of same age-group of Bankura distrit. It is evident from the average BMI of female children from West Midnapore district that they are underweight while that of the female pre-pubertal children from Bankura district shows that the children are not underwight and on the contrary are on the upper median to overweight scale of obesity. Pre-pubertal children if possess body weight slightly on the upper scale of median or lower scale of overweight, are considered to have a positive health status as they are still growing and slight excess reserve of glycogen and protein helps to protect them against invasion of pathogens or in other words srengthens the body's immune defence[24,25]. There is no significant difference in BMI of female children of pubertal age group of West Midnapore and Bankura dstricts. No significant difference is observed in BMI of female children of post-pubertal age group of West Midnapore and Bankura district. It is worth mentioning that BMI values are dependent on pubertal degree of maturation, especially in female children and hence this should always be considered while studying BMI of female children[26, 27].

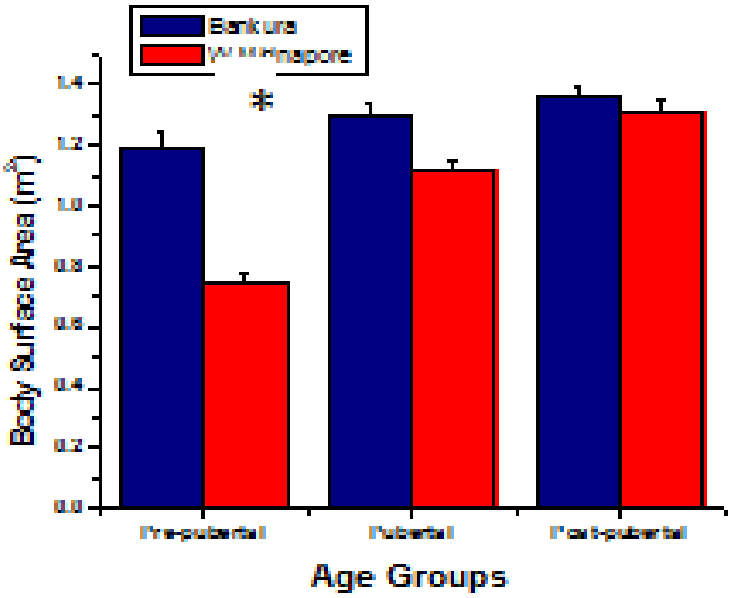

Figure 1A

Body Surface Area (BSA) of pre-pubertal, pubertal and post pubertal female children from Bankura district and West Midnapore district. Values are mean ± S.E.M. *P<0.01

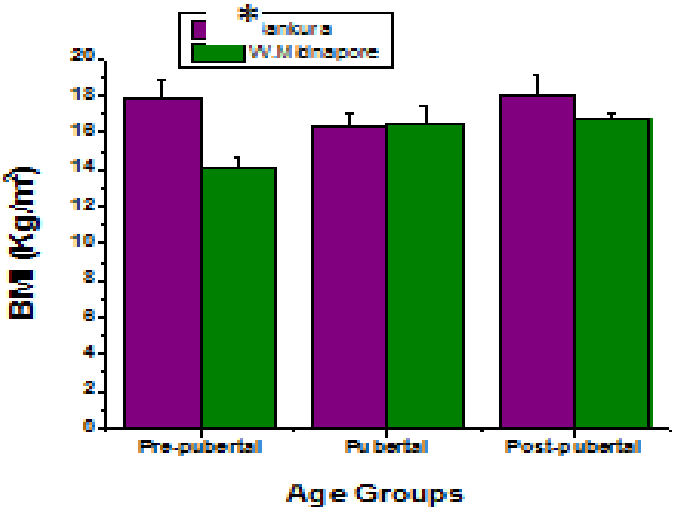

Figure 1B

Basal Metabolic Rate (BMI) of pre-pubertal, pubertal and post pubertal female children from Bankura district and West Midnapore district. Values are mean ± S.E.M. *P<0.01

Waist-Hip Ratio (WHR)

Waist hip ratio (WHR) of the female children of West Midnapore district of pre-pubertal age group are significantly lower (P<0.01) than that of the female children of pre-pubertal age group of Bankura district (Figure 2.A.) No difference in the WHR of the female children from West Midnapore and Bankura district of pubertal age group is observed. Similarly there is no significant difference in WHR of female children of pre-pubertal age group of West Midnapore and Bankura district. The mean WHR of female children of all age groups from West Midnapore district are observed to be below 0.8 and thus they all can be considered to be not obese. Whereas the WHR of the female children of Bankura district of all the three age groups studied are found to be above 0.8 indicating a trend of obesity in pre-pubertal, pubertal and post pubertal female children of Bankura. HDL-cholesterol has

been found to have a correlation with waist-hip ratio in female children studied by researchers in Germany. According to them onset of waist hip ratio seem to be an indicator for body fat distribution in post pubertal age group[28].

Waist – Height Ratio (WHtR)

Figure 2. B. shows that the Waist – Height Ratio (WHtR) of the female children of pre-pubertal age group of West Midnapore district is significantly lower (*P<0.01) than that of the female children of same age-group of Bankura distrit. There is no significant difference in WHtR of female children of pubertal age group of West Midnapore and Bankura dstrict and no significant difference is there in WHtR of female children of post-pubertal age group of West Midnapore and Bankura dstrict.WHtR is only observed to be distinctly different in case of female pre-pubertal children from the two districts. As the difference in the mean value of WHtR is observed to be eliminated in the pubertal and post-pubertal age groups of female children from the two districts, its variation in the pre-pubertal female children can be ignored while predicting growth pattern and health status of the pubertal and post pubertal adolescent chlidren from both the districts. On the other hand the lower mean value of WHtR of pre-pubertal children of West Midnapore district compared to that of the female children of same age group from bankura district is something to be seriously considered for assessing and improving the health status of the pre-pubertal schol going femal children. Health status and growth pattern are significant parameters which impacts a child's physical as well as cognitive performance and thus are the determining factors of the child's sports and academic performances as well.WHtR is also considered as an important parameter for determining childhood obesity [28].

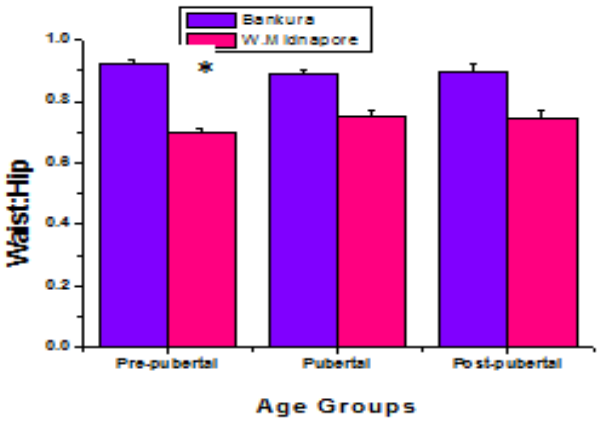

Figure 2A

Waist Hip Ratio (WHR) of pre-pubertal, pubertal and post pubertal female children from Bankura district and West Midnapore district. Values are mean ± S.E.M. *P<0.01

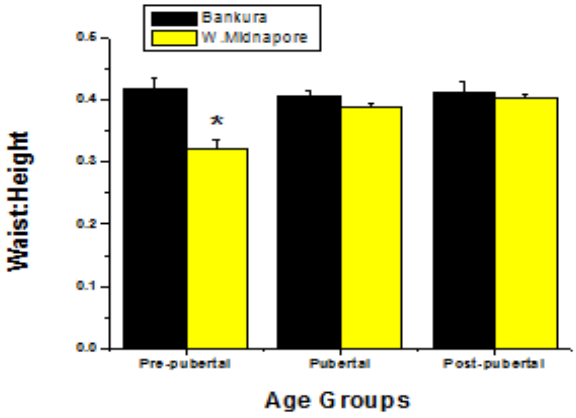

Figure 2B

Waist Height Ratio (WHtR) of pre-pubertal, pubertal and post pubertal female children from Bankura district and West Midnapore district. Values are mean ± S.E.M. *P<0.01

Measurements of Physiological variables

Pulse rate (beats /minutes)

Figure 3. A. shows that there is no significant difference in the pulse rate of the female children of pre-pubertal age group of West Midnapore district and that of the female children of same age-group of Bankura distrit. Whearas the pulse rate of female children of pubertal age group of West Midnapore district is significantly higher (*P<0.01) than that of the female children of same age group from Bankura District. No significant difference is there in pulse rate of female children of post-pubertal age group of West Midnapore and Bankura dstrict. Resting pulse rate is considered as a marker of physical fitness and is considered to have important public health implications for future cardiovascular risk[29, 30].

Respiratory Rate (cycles/minute)

Figure 3. B. shows that there is no significant difference in the respiratory rate of the female children of pre-pubertal age group of West Midnapore district and that of the female children of same age-group of Bankura distrit. Whearas the respiratory rate of female children of pubertal age group of West Midnapore district is significantly lower (*P<0.01) than that of the female children of same age group from Bankura District. There is no significant difference in respiratory rate of female children of post-pubertal age group of West Midnapore and Bankura dstrict. It has been found that there is an interrelationship between pulse rate and respiratory rate[31]. We also observed that the group of female pubertal children from West Minapore district with increased respiratory rate had a lower pulse rate compared to the other group of female children of same age group but of Bankura district. Pulse rate and respiratory rate are related parameters and bear a ratio with each other. If the heart beats slowly, eventually an insufficient amount of blood is supplied to the body which causes an increased concentration of carbon dioxide in blood and insufficient oxygenated blood in circulation triggers the reflexes and leads to increased respiratory rate. Similarly, if the respirations continue too fast or too slow, the concentration of oxygen and carbon dioxide in circulation become imbalanced and this affects the chemo sensors and effects heart rate. However if the ratio of pulse rate and respiratory rate are within the normal range there is nothing to worry about[30, 31, 32]. In pubertal age group, increased pulse rate and increased respiratory rate was observed in female children from both the districts compared to their respective pubertal and post-pubertal age groups. This increase in respiratory rate and pulse rate in puberty may be due to dramatic hormonal changes taking place in the body and due to a changing physiology of the subjects during puberty.

Haemoglobin Content (Hb g%)

Figure 3.C. shows that there is no significant difference in the haemoglobin content of the female children of pre-pubertal, pubertal and post-pubertal age groups of West

Midnapore district and that of the female children of Bankura distrit. Hemoglobin is the chromo-protein present in red blood cells that helps in carraige of oxygen in our body[31]. Hemoglobin also helps in maintaining the normal shape of RBCs [32]. Hemoglobin content in all age groups of female children from both the districts are normal indicating a very good health status of them. Normally, it is observed that in pubrtal and postpubertal female children the concentration of hemoglobin blood remains below normal due to monthly mentrual blood loss and insufficient nutriotional status of the subjects. But contraty to that, our observation reveals that he female children exhibit a good fitness status and their hemoglobin is within normal range. Thus they are not anemic and thus we can eliminate the possibility of the causes of anemia i.e., any kind of heavy metal contamination and toxicity[33], proper nutritional status and good pattern of growth.

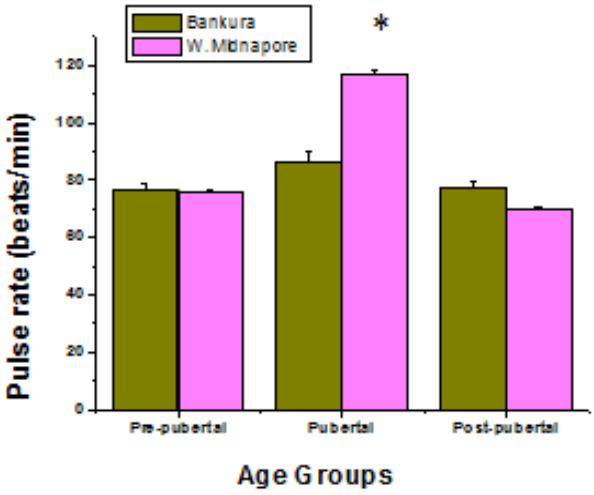

Figure 3A

Pulse rate (beats /minutes) of pre-pubertal, pubertal and post pubertal female children from Bankura district and West Midnapore district; Values are mean ± S.E.M. *P<0.01

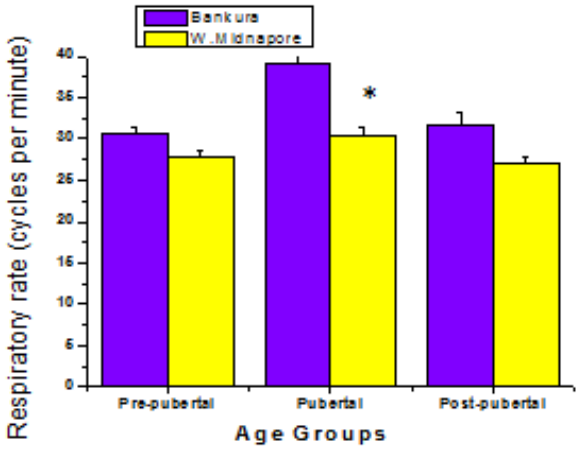

Figure 3B

Respiratory Rate (cycles/minute) of pre-pubertal, pubertal and post pubertal female children from Bankura district and West Midnapore district; Values are mean ± S.E.M. *P<0.01

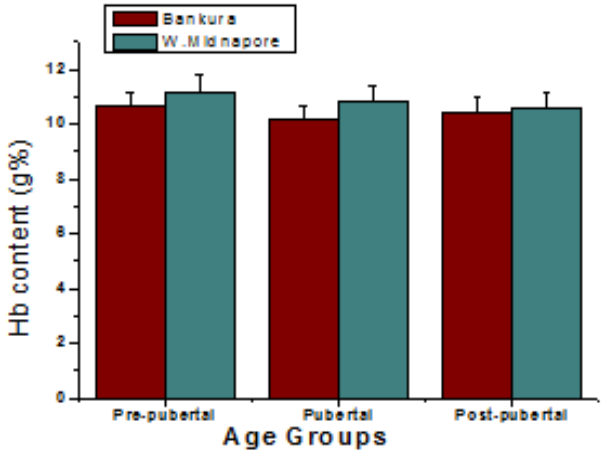

Figure 3C

Haemoglobin Content (Hb g%) of pre-pubertal, pubertal and post pubertal female children from Bankura district and West Midnapore district; Values are mean ± S.E.M. *P<0.01

Systolic and Diastolic Blood Pressure (mm of Hg)

Blood pressure of pre-pubertal chiildren were not considered in our study as it is difficult to measure accurately in children below pubertal age group. Figure 4.A. shows that there is no significant difference in the systolic blood pressure of the female children of pubertal age group of West Midnapore district and that of the female children of same age-group of Bankura district. Whereas 4.B. shows that the diastolic blood pressure of pubertal female children of West Midnapore district is significantly higher (*P<0.01) than that of the female children of same age group from Bankura District. Figure 4.A. and 4.B. shows that there is no significant difference in the systolic and diastolic blood pressure of female children of post-pubertal age group of West Midnapore and Bankura dstrict.The normal blood pressure is 120/80 mm of Hg [systolic/diastolic]. If blood pressure increases beyond this it is called hypertension34. Technically systolic blood pressure more than 160 mm of Hg is termed as hypertension. It has mainly 3 stages: prehypertension: SBP-120-139mmof Hg.DBP-80-90mm of hg: Stage 1 hypertension-SBP-140-159 mm of Hg. DBP-90-99 mm of Hg.: Stage 2- hypertension-SBP-160 mm hg DBP-100 mm Hg[35]. Whereas diastolic blood pressure less than 80 mm of Hg indicates low blood pressure. Diastolic blood pressure less than 60 mm of Hg is called hypotension which may cause inadequate blood flow to the heart, brain, and other vital organs. Blood pressure actually reflects the condition of heart. Hence, a low diastolic blood pressure is indicative of cardiac insufficiency and hypertension indicates a risk factor of arterial rupture due to notwithstanding high latertal pressure of flowing blood through them[36]. We observed that the diastolic blood pressure of the pubertal female children of West Midnapore district is significantly more than that of the children from Bankura district but their diastolic blood pressure is within the normal range. While, the female children of pubertal age group from Bankura district exhibited low diastolic blood pressure.

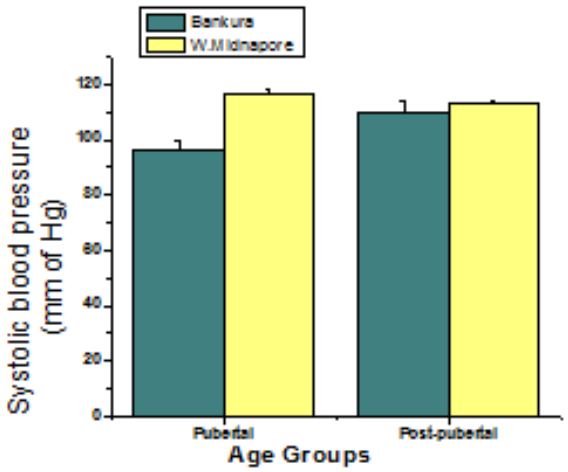

Figure 4A
Systolic Blood Pressure (mm of Hg) of pubertal and post pubertal female children from Bankura district and West Midnapore district; Values are mean ± S.E.M. *P<0.01

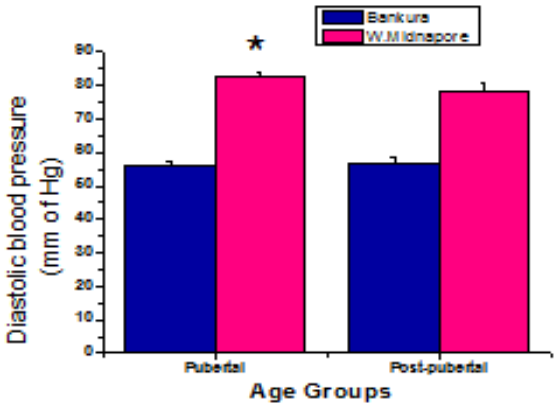

Figure 4B
Diastolic Blood Pressure (mm of Hg) of pubertal and post pubertal female children from Bankura district and West Midnapore district; Values are mean ± S.E.M. *P<0.01

Fat Content (g%)

Fat content of pre-pubertal chiildren were not considered in our study as it is difficult to measure accurately in children below pubertal age group. Figure 5 shows that fat content of female children of pubertal age group of West Midnapore district is significantly lower (*P<0.01) than that of the female children of same age group from Bankura District. There is no significant difference in fat content of female children of post-pubertal age group of West Midnapore and Bankura dstrict. Measurement of body fat content and fat distribution is very important parameter to know the physical growth pattern & nutritional status in children. High content of by fat reflects obesity while low body fat percentage reflects adverse growth pattern and poor health status. The prepubertal, pubertal and post pubertal adolescent years are periods of rapid growth and development. The pubertal and post pubertal ages being the most important ages for fat deposition in an individuals's body. Specially during and after puberty, the gonadal hormones play major roles in regulating the fat deposition in body[9].

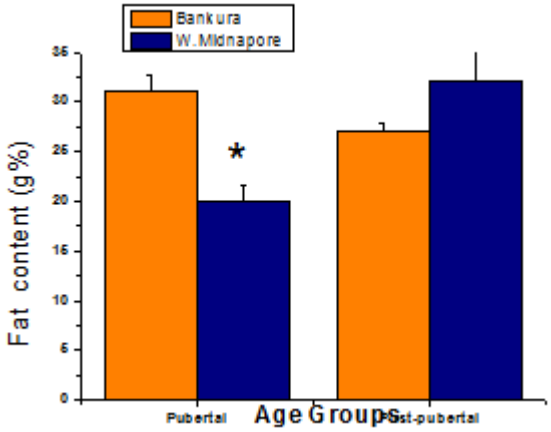

Figure 5
Fat Content (g%) of pubertal and post pubertal female children from Bankura district and West Midnapore district; Values are mean ± S.E.M. *P<0.01

CONCLUSION

We observed that there are significant variations in the anthropometric and physiological parameters of the respective three age groups of female children from Bankura and West Midnapore districts of West Bengal, India. Our study revealed that the female children of pre-pubertal age group of West Midnapore district have significantly low BSA, BMI, WHR and WHtR compared to those from the district of Bankura. We observed no significant difference in BSA, BMI, WHR and WHtR of the female children of pubertal and post-pubertal age group from West Midnapore district and Bankura district of West Bengal, India. Our investigation also showed that the pubertal female children of West Midnapore district have a higher pulse rate, higher diastolic pressure, lower respiratory rate and lower fat content compared to those of the female pubertal children of Bankura district. On the other hand it was found that there is no significant difference in the haemoglobin content of the female children of the three age groups from the two districts. No significant difference is observed in the values of systolic blood pressure and fat content of the female children of post-pubertal age group of the two districts. Thus we may conclude that the female children of the district of West Midnapore and those of the district of Bankura exhibit different growth pattern. The health status of the female children of the district of West Midnapore and Bankura district, which are geographically closely located in the western and South-western part of the state of West Bengal are markedly different in pre-pubertal, pubertal and post pubertal ages. Some of the parameters like heart rate, pulse rate, being overweight or underweight (as evident from fat content and BMI values), diastolic blood pressure etc. are of significant clinical significance as some of those indicate health issues at young age which may continue in adulthood and may result in complicated health concern of youth. For confirming such possibility if any, followed by recommendation for serious medical intervention at young age if required, further detailed investigation in young adult age group of female population of both the districts is needed . Studies also reveal that WHR and BMI are equally important indicators to predict the risk of cardiovascular diseases[35].

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CONFLICT OF INTEREST

Authors declare no conflict of interest

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