STUDY ON THE NUTRITIONAL ASSESSMENT OF RAJBANSHI ADULT WOMEN OF NORTH BENGAL

THESIS SUBMITTED FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (SCIENCE) IN ANTHROPOLOGY

UNIVERSITY OF NORTH BENGAL

SUBMITTED BY

ISITA SINHA

UNDER THE SUPERVISION OF

Dr. ARGINA KHATUN

ASSISTANT PROFESSOR

DEPARTMENT OF ANTHROPOLOGY

UNIVERSITY OF NORTH BENGAL

June, 2022

DECLARATION

I declare that thesis entitled **"STUDY ON THE NUTRITIONAL ASSESSMENT OF RAJBANSHI ADULT WOMEN OF NORTH BENGAL"** has been prepared by me under the supervision of Assistant Prof. Dr. Argina Khatun, Department of Anthropology and University of North Bengal. No aspect of this thesis has ever been used to justify the awarding of a degree or fellowship.

Date: 30/05/22

Isita Sinha

Isita Sinha
NFSC Research Fellow
Department of Anthropology
University of North Bengal

Dr. Argina Khatun
Assistant Professor
Phone : +91 82401 38887
WhatsApp : +91 97354 56754
ENLIGHTENMENT TO PERFECTION

Department of Anthropology
UNIVERSITY OF NORTH BENGAL
(Accredited by NAAC with Grade A)

P.O.: North Bengal University, Raja Rammohunpur
Dist.: Darjeeling, PIN - 734 013, West Bengal, INDIA
E-mail : arginakhatun87@gmail.com / argina.khatun@nbu.ac.in

Ref. No. :......................

Date :..30.05.2022

TO WHOM IT MAY CONCERN

(1) This is to certify that **Ms. Isita Sinha** is a registered Ph.D. research scholar working under my guidance at Department of Anthropology, University of North Bengal, Darjeeling, West Bengal. She has been undertaking research work under my supervision for her Ph.D. work entitled **"Study on the nutritional assessment of Rajbanshi adult women of North Bengal".**

(2) Ms. Sinha personally carried out fieldwork in connection with her Ph.D. work. Her Ph.D. thesis is based on original data-set collected by her.

(3) I also certify that the content of the thesis has not been submitted to any other University/Institution for the procurement of Ph.D. Degree/any other Degree/Diploma/other academic award.

(4) Ms. Sinha has incorporated all the recommendations/ suggestions/modifications forwarded by the Ph.D. committee in Anthropology for the improvement of the thesis.

(5) I am satisfied on her performance and progress of the Ph.D. work.

(6) I am recommending her thesis for submission for the procurement of Ph.D. Degree in Anthropology.

(7) Finally, I hope she will be awarded a Ph.D. degree and wish her all success in life after successful completion of her Ph.D.

Argina Khatun 30/05/22
(DR. ARGINA KHATUN)
Ph.D. Supervisor

Dr. Argina Khatun
Assistant Professor
Department of Anthropology
University of North Bengal

Curiginal

Document Information

Analyzed document	Isita Sinha_Anthropology.pdf (D138108759)
Submitted	2022-05-26T13:15:00.0000000
Submitted by	University of North Bengal
Submitter email	nbuplg@nbu.ac.in
Similarity	9%
Analysis address	nbuplg.nbu@analysis.urkund.com

Sources included in the report

W	URL: https://ir.nbu.ac.in/bitstream/123456789/3610/17/Full%20thesis%20of%20Binu%20Dorjee.pdf Fetched: 2021-05-21T03:54:21.4800000	72
W	URL: https://en.wikipedia.org/wiki/Rajbanshi_people Fetched: 2021-11-23T08:02:00.6800000	1
W	URL: https://ir.nbu.ac.in/bitstream/123456789/3603/12/Full%20thesis%20of%20Nitish%20Mondal.pdf Fetched: 2021-12-24T14:22:08.3370000	7
W	URL: https://www.allresearchjournal.com/archives/2017/vol3issue7/PartI/3-7-94-833.pdf Fetched: 2021-02-01T06:43:46.9770000	1
W	URL: https://ir.nbu.ac.in/bitstream/123456789/3610/11/11_chapter%202.pdf Fetched: 2021-08-27T06:14:35.6570000	3
W	URL: https://ir.nbu.ac.in/bitstream/123456789/4237/4/04_abstract.pdf Fetched: 2022-04-26T14:05:14.0700000	1
W	URL: https://ir.nbu.ac.in/bitstream/123456789/3610/13/13_chapter%204.pdf Fetched: 2021-05-08T07:26:23.6930000	14
W	URL: http://14.139.211.59/bitstream/123456789/3603/10/10_chapter_05.pdf Fetched: 2022-05-26T13:14:50.7470000	1

Argina Khatun 30/05/22

Dr. Argina Khatun
Assistant Professor
Department of Anthropology
University of North Bengal

Isita Sinha
30/05/22

Entire Document

STUDY ON THE NUTRITIONAL ASSESSMENT OF RAJBANSHI ADULT WOMEN OF NORTH BENGAL THESIS FOR PhD DEGREE (SCIENCE) IN ANTHROPOLOGY UNIVERSITY OF NORTH BENGAL SUBMITTED BY ISITA SINHA UNDER THE SUPERVISION OF Dr. ARGINA KHATUN ASSISTANT PROFESSOR DEPARTMENT OF ANTHROPOLOGY UNIVERSITY OF NORTH BENGAL 2022

CHAPTER I INTRODUCTION

1.1 An Overview Nutrition can be defined as the process of ingesting food and utilizing it for the purposes of development, metabolism, and repair. It refers to how an organism consumes, absorbs, transports, uses, and excretes dietary substances (Lagua and Claudio, 1996). Nutrition is the study of the nutritional content of various foods, as well as the amount of nutrients required for optimal growth and function, and how this varies for different people. A living organism's ability to grow, maintain, and reproduce is aided by the process of nourishment. Human nutrition research is multidisciplinary, encompassing not only biochemistry, physiology, and molecular biology, but also psychology and anthropology, which investigate the impact of attitudes, beliefs, preferences, and cultural tradition on food consumption. It may be further connect with economics and political science as the world responds to the suffering and death caused by malnutrition. As a result, nutritional science has a considerably broader research field with new technology and social change, which provide new opportunities (Pelletier et al., 2013). One of the most essential variables impacting the quality of human life is nutrition. Nutritional science aims to promote optimal health by lowering the risk of chronic diseases (such as cancer and cardiovascular disease) and preventing nutritional deficient diseases (such as kwashiorkor and pellagra). Human body needs a good nutrition through a well balanced diet to fulfill body requirements and to maintain body functions. A poor diet can result in a lack of essential nutrients (Causes malnutrition) or excessive calorie consumption (overeating) (Causes overnutrition). Undernutrition and overnutrition are currently two of the main causes of death worldwide. For developing countries like India, both undernutrition and overnutrition are important health issues. Double burden of malnutrition causes nutrition related complications and different

diseases with decreasing the power of immunity. Undernutrition impairs physiological function, resulting in low weight, growth retardation, a weakened immune system, which leads to an increase in infections, the emergence of chronic diseases (such as diabetes mellitus, hypertension, and coronary heart disease), and mental health problems (Hoet JJ, 1997; Martins et al., 2002 and Muller and Krawinkle, 2004). Whereas overnutrition (obesity and overweight) is linked to a number of non-communicable diseases, including hypertension, diabetes, cancer, and cardiovascular disease (Ni Mhurchu et al., 2004; Berrington et al., 2010; Zheng et al., 2012). Females are more likely to be underweight, overweight, or obese than their male partners due to biological and behavioral differences. Women with insufficient nutrients suffer from infertility, abortion, preterm birth and neonatal mortality. 1.2 Women Nutrition Woman plays an important role in the society. They form a major part of our society. As per 2011 census, the total population of India is 1.2 billion out of which 655.8 million are males and 614.4 millions are females and out of that West Bengal state contents 54 million women population. As women constitute half of its population and play crucial role in different field of society like agriculture and livestock production, household economy and reproductive functions. In view of all these India's first Prime Minister rightly said that "You can tell the condition of a nation by looking at the status of women." Indian women have high mortality rates during their childhood and in reproductive years. From a global perspective, NFHS-3 data, India accounts for 19% off all live birth and 27% of all maternal deaths. India has highest proportion of malnourished women compared to other developing countries. A recent estimate suggests that about 70% of non pregnant women and

75% of pregnant women aged 15-49 years were anemic (Masson et al., 2005). Researchers discovered that Indian women's contributions to society are usually underestimated because they are viewed as economic burden. There is a great desire in Indian society for sons over daughters. Daughters are mistreated as a result of this son preference and exorbitant dowry cost. Assessment of nutritional status of women still remains a low priority in the public health agenda of most developing countries. Maternal nutritional status is important for a host of reasons. These reasons include: a) For the woman herself b) For her capacity to reproduce c) For the development of her children, with implications for the health and reproductive capacity of the next generation's mothers. However, for decades, issues in women's nutrition have focussed on nutritional assessment during pregnancy and lactation. The health and well-being of the children has thus been a major source of worry. Women's dietary difficulties have rarely been investigated, and there are few nutritional data available from non-pregnant women. India has developed a framework of programmes to combat undernutrition in recent decades, including a Public Distribution System (PDS), an Integrated Child Development Services (ICDS) programme, a National Mid-day Meals Program (NMMP), and several employment schemes that provide food in

ACKNOWLEDGEMENT

First and foremost, praises and thanks to the God, the Almighty, for His showers of blessings throughout my research work to complete the research successfully.

I would like to acknowledge my ex research supervisor late **Professor Jaydip Sen,** Department of Anthropology, University of North Bengal, for his untiring , enthusiastic inspirations and constant support to formulate this research work. His valuable suggestions and meticulous supervision have given me the energy to complete my PhD thesis. I would like to thanks him to formulate and giving me this opportunity to work with him. I am extremely grateful for what he has done for me.

I would like to express my deep and sincere gratitude to my current supervisor **Dr. Argina Khatun,** Assistant professor, Department of Anthropology, University of North Bengal, for providing me invaluable guidance throughout this research. Her dynamism, vision, sincerity and motivation have deeply inspired me. She has taught me to present the research works as clearly as possible. It was a great privilege and honor to work and study under her guidance. I would also like to thank her for her friendship, empathy, and great sense of humor.

I would like to say thanks to my respected teachers **Prof. Pinak Tarafder, Dr. Samar Kuar Biswas** and **Dr. Rinzi Lama** and others faculty members of the Department of Anthropology, University of North Bengal for their constant encouragement.

I am extremely grateful to my parents specially my **Father** and **Mother** for their love, prayers, caring and sacrifices for educating and preparing me for my future. I am very much thankful to my **Husband** for his love, understanding, prayers and continuing support to complete this research work. Also I express my thanks to my brothers for their support and valuable prayers.

I express my special thanks to University Grant Commission (UGC) for Financial support in the form of Junior and Senior Research Fellowship [UGC-F1-17.1/2017-18/RGNF-2017-18-SC-WES-42802] throughout my research work.

I am extending my sincere gratitude to my all Rajbanshi participants for their valuable co-operation and immense patience during data collection. I also express my special thanks to my senior Dr. Binu Dorjee, Dr. Pushpalata Tigga and my friend Dr. Sampriti Debnath and my juniors who supported me in any respect during the completion of this PhD thesis.

I thank the all staff of Administrative section for their genuine support to complete this thesis successfully.

Finally, my thanks go to all the people who have supported me to complete the research work directly or indirectly.

Isita Sinha

30/05/22

Isita Sinha

Department of Anthropology

University of North Bengal

ABSTRACT

Introduction:

Nutrition is the process of taking in food and using it for growth, metabolism and repair. Through the process of nutrition a living organism are enable them to maintain, grow and to reproduce. To meet physiological requirements and functions, the human body needs appropriate nourishment from a well-balanced diet. Unhealthy eating habits can result in a lack of micronutrients (undernutrition) or excessive calorie consumption (causes over-nutrition). Undernutrition and overnutrition are becoming major public health concerns in developing nations such as India. As a result, nutritional status is now widely acknowledged as a key indication of an individual's health, and the World Health Organization (WHO) considers that the ultimate goal of nutritional evaluations is to improve human health. Nutritional status is beneficial to overall health. The prevalence of under-nutrition along with regional adiposity is known to cause ailments such as hypertension, diabetes, cardiovascular disease, and cancer in both developed and developing countries. India is no different; due to the country's vast population and extensive poverty, the most of its citizens are malnourished and underprivileged. One of the major groups of the country that remain nutritionally vulnerable is *women*, both among tribal and non-tribal populations. The double burden of malnutrition leads to nutrition-related difficulties and a variety of diseases, as well as a reduction in immunity. Undernutrition and overnutrition affect body function, resulting in low weight, growth retardation, a weakened immune system, which leads to an increase in infections, the emergence of chronic diseases (such as diabetes, hypertension, and coronary heart disease), and mental health problems. Females are more likely to be underweight than their male partners due to biological and behavioral factors. Infertility, abortion, premature birth, and

neonatal mortality are all problems that women with insufficient nutrition face. The nutritional status of a woman has a significant impact on her health, as well as the health of her children and family. To improve maternal and child heath as well as the nutritional status of overall population, it is important to evaluate the nutritional status of adult women. Keeping the above-issues in mind, the present study aims to assess the nutritional status of adult women of an ethnic population of North Bengal using anthropometric method. The current study is likely to be the first of its sort in North Bengal, and it will provide basic information on nutritional status and associated issues. Anthropometry method was utilized in this study to measure the nutritional status of Rajbanshi populations because it is the most widely used methodology for assessing nutritional status.

The objectives of present study are as follows:

- To assess the nutritional status and body composition measurement by using internationally accepted cut-off values.
- To assess the prevalence of undernutrition among Rajbanshi female population.
- To find out the association of different socioeconomic, demographic and lifestyle related variables with nutritional status and body fat distribution.
- To assess the age related changes in anthropometric characteristics and body fat distribution among this targeted population.
- To assess the mean age at menarche and menopause among this population.
- To compare the results of the current study with other (national and international) studies.

Materials and Methods:

The present cross-sectional study has been conducted among 800 adult female *Rajbanshi* individuals aged between 18-64 years of age. Present study was carried out in rural area of Darjjeling District of North Bengal. The population was exclusively selected from Rajbanshi dominated villages under Block: Kharibari (Latitude 26. 34’ 19” N, Longitude 88. 08’ 51” E), Sub-Division: Siliguri, Police Station: Kharibari, District: Darjeeling, West Bengal, India. This study area is situated adjacent to the Mechi River which is forms the Indo-Nepal International border and an approximate distance of 32km to 39km from the sub-divisional town of Siliguri. The population of the present study was selected by using multistage stratified sampling procedures. The data have been collected during the period from April 2018 to December 2019. In this process 12 villages were listed but further it is reduced to 10 villages which were convenient for data collection, easy road accessibility and subjects availability. Demographic, socio-economic, reproductive and life style data of these target population are being collected by door to door surveys using a structured schedule. The data recorded about the different socio-economic and demographic variables were age, marital status and educational status, birth order, no of children, family size, family type, water supply, electricity facility, toilet facility, monthly income and occupations. Reproductive data like age at menarche and age at menopause was also recorded. The anthropometric measurements are recorded from the individuals using standard protocols and instruments as outlined by Weiner and Lourie (1981). The measurements are: Height, Weight, Mid upper arm circumference (MUAC), Biceps skin fold (BSF), Triceps skin fold (TSF), Sub-scapular skin fold (SSF), Supra iliac skin fold (SISF), Waist circumference (WC) and Hip circumference (HC). Various nutritional and body composition indices were derived from these measurements to assess nutritional status of this population. The all statistical analyses such as mean ± SD, ANOVA, $\chi 2$, correlation, regression, logistic regression were performed by using SPSS 20.

Results:

The mean value of anthropometric measurements like height, weight and MUAC were considerably lower but the mean value of HC, WC, BSF, TSF, SSF and SISF were slightly higher. Age specific variations in different anthropometric variables were also observed in present study. Some derived indices like WHR, WHtR, TUA and UFA were slightly higher among Rajbanshi female individuals. In present study body composition indices like PBF%, FM, FFM and FFMI had lower value. The central adiposity measured by WC, WHR and WHtR were above the cutoff values. It is indicated that some people had higher risk of adiposity related health issues. The result of Pearson correlation analysis between different anthropometric variables showed that all variables were significantly correlated with each other ($p<0.05$).The result of linear correlation of age on different anthropometric variables reported that age is significantly co-related with height, weight, WHR, TUA, UMA, BFMA and FMM ($P<0.05$). The result of linear regression of BMI on different anthropometric variables indicated that all variables were significantly co-related with BMI.

The prevalence of undernutrition based on BMI classification (WHO, 1995) among Rajbanshi women was high (39.88%) and most of the individuals were suffered from CED grade I level of undernutrition. And the prevalence was high among early (18-29 years) and later (50-94 years) aged women. When nutritional status assessed by MUAC (James et al., 1995), the observed prevalence was 37.00%. In present study the prevalence of undernutrion was 23.75%, based on BMI measure in combination with MUAC.

The overall prevalence of overweight and obesity was 15.62% and 9.78% respectively based on BMI classification (WHO, 1995). The prevalence of regional adiposity was 52.37%, 96.63% and 68.37% respectively when adiposity measured by WC, WHR and WHtR. The prevalence of regional adiposity was high among middle aged women (30-49 years). Fat individuals were less in present study. Only 16.23% (based on Neiman classification, 1995) and 12.88% individuals (based on Muth classification, 2009) have identified with over fat status. Thus amount of risk factors associated with PBF% was less in number in present study. A logistic regression analysis was performed to find the effect of different socioeconomic, demographic and lifestyle variables on underweight among Rajbanshi women population. The association of BMI, WHR and WHtR with different variables showed a significant influence on being underweight and overweight. The result of this analysis indicated that family type, source of water supply, toilet type, house type, family occupation, living conditions and low socioeconomic status of family were significantly associated with underweight ($p<0.05$).

The association of high WC, HC, WHR, WHtR with different socioeconomic, demographic and life style variables showed a significant effect on high adiposity among Rajbanshi female population. Present study also reported the mean ages at menarche and menopause among Rajbanshi individuals were 12.42 years and 48 years respectively.

Conclusion:

According to the findings of this study, a large number of adult Rajbanshi women in North Bengal have received schooling and have become educated, but they still suffer from undernutrition. The prevalence of undernutrition in this population was higher than the WHO cutoff values (1995). This research also found a strong relation between a low BMI and poor socioeconomic status. In present study there is a high frequency of normal weight but centrally obese individuals who are normal by BMI but defined as obese by WC, WHR and WHtR. Thus present study population show a high risk of regional adiposity related co-morbidity and mortalities along with diseases related with low BMI. This nutritional disease is now more common through worldwide which are commonly known as double burden of malnutrition (DBM).

LIST OF ABBREVIATIONS

AFI	Arm Fat Index
ANOVA	One-Way Analysis of Variance
AWC	Adaptations of Water low's Classification
BAI	Body Adiposity Index
BMI	Body Mass Index
BSF	Bicep Skin Fold
CED	Chronic Energy Deficiency
CI	Conicity Index
CVD	Cardiovascular Diseases
FFM	Fat Free Mass
FFMI	Far Free Mass Index
FM	Fat Mass
FMI	Fat Mass Index
HC	Hip Circumference
ICDS	Integrated Child Development System
LBW	low Birth Weight
MUAC	Mid Upper Arm Circumferences
NCBI	National Center for Biotechnology
NFHS	National Family Health Survey
NIH	National Institutes of Health
NLM	National Library of Medicine
NMMP	National Mid-day Meals Program
NNMB	National Nutrition Monitoring Bureau

PBF	Percent Body Fat
PDS	Public Distribution System
PEM	Protein Energy Malnutrition
RI	Rohrer Index
SES	Socio Economic Status
SISF	Supra-iliac Skin Fold
SSF	Sub-Scapular Skin Fold
TEM	Technical Error of Measurements
TSF	Triceps Skin Fold
UAMAH	Upper Arm Muscle Area by Height
UFA	Upper Arm Fat Area
UMA	Upper Arm Muscle Area
UNICEF	United Nations Children's Fund
WC	Waist Circumference
WHO	World Health Organizations
WHR	Waist Hip Ratio
WHtR	Waist Height Ratio

CONTENTS

List of Tables

List of Figures

CHAPTER I

INTRODUCTION

1.1 An Overview

Nutrition can be defined as the process of ingesting food and utilizing it for the purposes of development, metabolism, and repair. It refers to how an organism consumes, absorbs, transports, uses, and excretes dietary substances (Lagua and Claudio, 1996). Nutrition is the study of the nutritional content of various foods, as well as the amount of nutrients required for optimal growth and function, and how this varies for different people. A living organism's ability to grow, maintain, and reproduce is aided by the process of nourishment. Human nutrition research is multidisciplinary, encompassing not only biochemistry, physiology, and molecular biology, but also psychology and anthropology, which investigate the impact of attitudes, beliefs, preferences, and cultural tradition on food consumption. It may be further connect with economics and political science as the world responds to the suffering and death caused by malnutrition. As a result, nutritional science has a considerably broader research field with new technology and social change, which provide new opportunities (Pelletier et al., 2013). One of the most essential variables impacting the quality of human life is nutrition. Nutritional science aims to promote optimal health by lowering the risk of chronic diseases (such as cancer and cardiovascular disease) and preventing nutritional deficient diseases (such as kwashiorkor and pellagra).

Human body needs a good nutrition through a well balanced diet to fulfill body requirements and to maintain body functions. A poor diet can result in a lack of essential nutrients (Causes malnutrition) or excessive calorie consumption (overeating) (Causes overnutrition). Undernutrition and overnutrition are currently two of the main causes of death worldwide. For developing countries like India, both undernutrition and overnutrition are important health issues. Double burden of malnutrition causes nutrition related complications and different diseases with decreasing the power of immunity. Undernutrition impairs physiological function, resulting in low weight, growth retardation, a weakened immune system, which leads to an increase in infections, the emergence of chronic diseases (such as diabetes mellitus, hypertension, and coronary heart disease), and mental health problems (Hoet JJ, 1997; Martins et al., 2002 and Muller and Krawinkle, 2004). Whereas overnutrition (obesity and overweight) is linked to a number of non-communicable diseases, including hypertension, diabetes, cancer, and cardiovascular disease (Ni Mhurchu et al., 2004; Berrington et al., 2010; Zheng et al., 2012). Females are more likely to be underweight, overweight, or obese than their male partners due to biological and behavioral differences. Women with insufficient nutrients suffer from infertility, abortion, preterm birth and neonatal mortality.

1.2 Women Nutrition

Woman plays an important role in the society. They form a major part of our society. As per 2011 census, the total population of India is 1.2 billion out of which 655.8 million are males and 614.4 millions are females and out of that West Bengal state contents 54 million women population. As women constitute half of its population and play crucial role in different field of society like agriculture and livestock production, household economy and reproductive functions. In view of all these India's first Prime Minister rightly said that "You can tell the condition of a nation by looking at the status of women."

Indian women have high mortality rates during their childhood and in reproductive years. From a global perspective, NFHS-3 data, India accounts for 19% off all live birth and 27% of all maternal deaths. India has highest proportion of malnourished women compared to other developing countries. A recent estimate suggests that about 70% of non pregnant women and

75% of pregnant women aged 15-49 years were anemic (Masson et al., 2005). Researchers discovered that Indian women's contributions to society are usually underestimated because they are viewed as economic burden. There is a great desire in Indian society for sons over daughters. Daughters are mistreated as a result of this son preference and exorbitant dowry cost.

Assessment of nutritional status of women still remains a low priority in the public health agenda of most developing countries. Maternal nutritional status is important for a host of reasons. These reasons include: a) For the woman herself b) For her capacity to reproduce c) For the development of her children, with implications for the health and reproductive capacity of the next generation's mothers.

However, for decades, issues in women's nutrition have focussed on nutritional assessment during pregnancy and lactation. The health and well-being of the children has thus been a major source of worry. Women's dietary difficulties have rarely been investigated, and there are few nutritional data available from non-pregnant women. India has developed a framework of programmes to combat undernutrition in recent decades, including a Public Distribution System (PDS), an Integrated Child Development Services (ICDS) programme, a National Mid-day Meals Program (NMMP), and several employment schemes that provide food in exchange for work. Despite these efforts, India continues to suffer from undernutrition, with a high prevalence of chronic energy deficiency (CED) and anaemia among mothers, as well as a growing number of severely malnourished children.

Women’s poor nutritional status, both before and during pregnancy, is the leading contributor to impairment of fetal development and also contributes to low birth weight (LBW) and in turn leads to high rates of stunting or low-height-for-age (Vir, 2016). The percentage of women in South Asia with a low BMI, indicating malnutrition, ranging from 7.5% in the Maldives and one third of women (36%) in India (Vir, 2016). In fact, studies in India have found a significant percentage of women with low BMI, as well as a high percentage of LBW and stunted children (UNICEF, 2014). Studies have consistently found that the link between maternal malnutrition and LBW is a key source of concern (Kader and Perera, 2014; Borah and Agarwalla, 2016; Roy et al., 2016). A global review of region-by-region data from the 1980s to the 2000s, which includes South Asia, finds that an increase in BMI of women aged 15 to 49 years corresponds to a decrease in the rate of LBW (Masson et al., 2012). Women have an impact on their children's nutritional health via influencing pregnancy outcomes as well as child care habits. Poor food intake and availability of nutrients consumed as a result of illness are well-known immediate and direct causes of undernutrition in women, and they play a significant role in undernutrition in children. A multitude of underlying socio-economic factors influence these direct causes, including purchasing power, gender inequality, women's decision-making power at the household level, and investment in nutrition care for self, children, and family.

Nutrition is viewed from an evolutionary and comparative perspective in anthropology. Nutritional Anthropology is the study of food and nutrition from evolutionary, behavioral, social, and cultural perspectives, as well as how these factors interact to produce nutritional status of individuals and communities. Anthropological research on nutrition describing how particular social or cultural factors play people at a higher risk for nutritional diseases or identifying health problem related to nutrition. The study of the interaction between diet and culture, and their mutual influence on one another, is defined as nutritional anthropology (Freedman, 1976). The incorporation of nutritional anthropometry is defined by the application of five direct or indirect methods developed by D.B Jelliffe in 1966 for the evaluation of nutritional status.

Jelliffe (1966) presented five techniques for assessing nutritional status in his outstanding monograph. The available methods of assessing nutritional status have been divided into two categories by WHO (1996):

- Direct methods (e.g. Anthropometry, Biochemical, Clinical and Dietary evaluation method)
- Indirect methods (e.g. ecological variables, Economic factors, vital health statistics particularly infant and under 5 mortality and fertility index.)

Anthropometry is a unique or essential method for examining an individual's nutritional status in Biological Anthropology. Nutritional status is now widely acknowledged as a leading indication of a population's or individuals overall health. The ultimate goal of nutritional assessments, according to the World Health Organization (WHO), is to improve public health (Bogin, 1999).

Anthropometry method was utilized in this study to measure the nutritional status of Rajbanshi populations because it is the most widely used methodology for assessing nutritional status. Here's a brief summary of its development and many aspects:

1.3 Anthropometry

In biological anthropology, anthropometry is one of the most significant research tools. This technique is utilized in the anthropological classification and comparison of human body measurements. The measurements of the body's physical dimensions and underlying composition should allow us not only to accurately characterize our current health but also to give predictions about outcomes such as ability to reproduce and long term survival. Anthropometry has contributed to the investigation of human variation in terms of sex and bodily dimensions such as stature as a research tool. These study techniques have clarified the dimensions and morphological features that characterize sexual dimorphism, as well as the differences in human variation that may have resulted from societal or environmental causes, as well as natural selection. This method requires adherence to specific international rules, started from the International Congress held in Geneva in 1912 when the International Convention for the unification of anthropometric measurements in living was signed. It's been used to measure health and nutritional risk extensively and successfully. It is a good approach for determining a person's nutritional condition and body composition (WHO, 1995; Hamieda and Billot, 2002).

The present study was performed with the help of anthropometric technique. Anthropometry is the most widely applicable, low-cost, and non-invasive approach for determining the height, dimensions, and bone density of humans(Deurenberg et al., 2002; Santosh et al., 2004; Bose et al., 2006; Liu et al., 2010; Sen et al., 2011; Sen and Mondal, 2012; Little et al., 2016; Dutta et al., 2019; Rai et al., 2021). According to recent study, anthropometry is important throughout life, not only for individual assessments but also for reflecting the health and socioeconomic condition of human population (Gorstein and Akre, 1988; Steckel,1995; Komlos and Snowdon, 2005). Cross-sectional examination of the relation between obesity and disease risk will be possible using anthropometric measurements such as skin folds and circumferences, as well as bioelectrical impedance. Height, weight, BMI, body circumferences (waist, hip, and limbs), and skin fold thickness are the most important aspects of anthropometry. These anthropometric measurements are useful for determining an individual's nutritional status as well as their development and growth.

Advantages:

Anthropometric measurements have some advantages over other methods. This approach is easy, safe, affordable, and non-invasive, and it may be used on both big and small samples. The necessary equipment is both affordable and portable. The numerical and gradable readings of these measurements can be efficiently interpreted. This technique can be used to evaluate nutrition programmes as a parameter.

Although this methodology has certain drawbacks, such as being a somewhat insensitive method that cannot detect changes in nutritional status over short periods of time, it does have some advantages. It also contains some observer bias and procedural mistakes.

Anthropometry is used to determine the frequency of undernutrition, which is a significant source of concern in many developing nations where it is a serious public health issue (Corsi et al., 2011; Khambalia et al., 2012; Prasad et al., 2012; Akhter, 2016). The Indian subcontinent is no exception (Khor, 2003; Mukhopadhyay et al., 2009; Debnath and Bhattacharjee, 2016). According to reports, due to the country's vast population and extensive poverty, the majority of its citizens are malnourished and disadvantaged (Nandy et al., 2005; Kapil and Sachdev, 2012; Varadharajan et al., 2013; Bhutia, 2014). Women, both tribal and non-tribal populations, are one of the most nutritionally susceptible groups in the country.

CHAPTER II

LITERATURE REVIEW

PRESENT STUDY

2.1 Literature Review

"A review of literature on the research topic makes the researcher familiar with the existing studies and provides a foundation upon which to base new knowledge. It involves the systematic identification, location, scrutiny and summary of written materials that contain information on a research problem" (Pilot&Hungler, 1999).

The majority of the literature search pertaining to this study was done by utilizing Google and Google Scholar. In some extent literature search was also done by using "PubMed". It is a free resource that includes over 32 million citations and abstracts from scientific research, including life science magazines. The National Center for Biotechnology Information created and maintains PubMed (NCBI).

2.1.1 Studies done on assessment of nutritional status among adults with some socioeconomic, demographic and lifestyle determinants

Adults are the support system of a society. The World Health Organization (WHO, 1995) has defined individuals aged between 18-65 years as adult. As a result, the nutritional assessment of the adult population is vital for societal growth. Malnutrition with a double load is becoming more common and prevalent in the adult population.

2.1.1. a International studies:

Undernutrition is one of the world's most serious public health issues, affecting around 900 million people worldwide. Both undernutrition and overnutrition is now mostly prevalent diseases in developed countries. Several studies were conducted in different parts of the world for assessing nutritional status of adult population. Some of the important works describe bellow:

Deurenberg et al (2002) reported a study on Indonesians (Malays and Chinese ancestry), Singaporean Chinese, Malays and Indians, and Hong Kong Chinese to study the relationship between body mass index (BMI) and body fat per cent (BF%) in different population groups of Asians. The BF % was computed using deuterium oxide dilution, a chemical-for-compartment model, or dual-energy X-ray absorptiometry, and the BMI was calculated using weight and height. In comparison to Caucasians, all Asian ethnicities tested had a higher BF % at a lower BMI. In general, compared to Caucasians, their BF % was 3-5 % points greater for the same BMI. In comparison to Caucasians, their BMI was 3-4 units lower for the same BF %. Variances in body build, such as differences in trunk-to-leg-length ratio and slenderness, can explain some of the high BF % at low BMI.

Coris and Kennedy (2003) reported a research work on 874 adult healthy Irish born individuals. Height, weight, triceps skinfold thickness, mid-arm, and calf circumferences were all measured, BMI, mid-arm muscle circumference, and arm muscle area were computed, and smoothed centile data for each variable was calculated. One-third of these senior people had a BMI of 20-25 kg/m2, nearly two-thirds (68.5 % and 61 % of females) were overweight or obese, and nearly one-fifth had a BMI of over 30 kg/m2 (17 % of men and 20 % of women). Only 3% of the participants were underweight, with a BMI of less than 20 kg/m2. With age, height, weight, BMI and muscle mass all reduced. Lower handgrip strength was linked to a reduction in muscle size. Only females' fat reserves decreased as they grew older.

A study from Japan reported by **Hsieh et al (2003)** for assessing central fat distribution and metabolic disorder among Japanese Man and Women. Height and age have a negative relationship. Only W/Ht linked positively with age for both men and women, while age and other anthropometric indices, except height, correlated strongly with the morbidity index for cardiovascular risk factors.W/Ht>or=0.5 was seen in nearly all overweight men and women (BMI>or=25) (98.5 % of men and 97.5% of women). W/Ht>or=0.5 was seen in 45.5% of men and 28.3 % of women of normal weight (BMI 18.5-25). W/Ht was the best index for signalling metabolic risk in both normal-weight and overweight patients.

A comparative study reported by **Rush et al (2004)** to look into the links between body size and body fat, as well as fat distribution, in young healthy men from New Zealand's European, Pacific Island, and Asian Indian communities. A total of 114 healthy men aged 17 to 30 years old (64 Europeans, 31 Pacific Islanders, and 19 Asian Indians) were measured for height, weight, and body composition using total body dual-energy X-ray absorptiometry (DXA). In comparison to Europeans, Pacific Island men had a 4 % lower % BF while Asian Indian men had a 7-8 % greater % BF for the same BMI. For the same % BF, Pacific Island men's BMI was 2-3 units higher, whereas Asian Indian men's BMI was 3-6 units lower.

Santosh et al (2004) reported a cross-sectional study of 1220 elderly persons (819 women and 411 men; age range, 60-99 y) in the city of Santiago (Chile). This study describe the age and sex differences in weight, height, body mass index, knee height, waist circumference, mid arm circumference, triceps skinfold thickness, arm muscle area, and calf circumference in Chilean elderly subjects. In all age groups, men were much heavier and taller than women, while women's BMI values were significantly higher than men's. In both men and women, the average values of all anthropometric variables decreased as they grew older.

In 2005, Pongchaiyakul et al, reported a study to build and evaluate sex-specific equations for predicting percentage body fat (percent BF) by using BMI and anthropometric measures, in the rural Thai population. Weight, height, BMI, waist circumference, hip circumference, triceps skinfold thickness, biceps skinfold, subscapular skinfold thickness, and suprailiac skinfold thickness were measured.

Pongchaiyakul et al (2006) reported another work on body mass index (BMI) in the definition of obesity in the Thai population to determine cut-off values and evaluate the accuracy of BMI in the classification of obesity. Obesity prevalence in men and women was 18.8% and 39.5 %, respectively, based on body mass index. Only 2.9 % of men and 8.9 % of women were identified as obese using the BMI cut-off of > or =30. BMI was found to be a significant predictor of % BF in the cubic regression model, with a BMI of 27 kg/m2 predicting a % BF of 25% in males and a BMI of 25 kg/m2 predicting a % BF of 35% in women.

Sanchez Gracia et al (2007) conducted a research on 60 years old beneficiaries of Mexican city to evaluate anthropometric measurements and nutritional status. There were 870 women and 1,098 males in the research. The average weights for women were 62.7 kg and for men were 70.3 kg , while the average heights for women were 1.52m and 1.63m. Anthropometric parameters were shown to vary with age. According to BMI measurements, 62.3 % of the population is overweight, with 73.6 % of women and 16.5 % having a high fat tissue distribution.

Another cross-sectional study reported by **Coqueiro et al (2009)** among 1905 elderly Havana people of Cuba. This study was done to assess their anthropometric profile. Body mass index, height or stature, waist, arm, and calf circumferences, triceps skinfold thickness, and arm muscle circumference data were reported as means and percentiles, with differences specified by age and sex. In both men and women, the average values of all anthropometric variables decreased as they got older. The age of 70 years seemed to be the critical point for the most significant anthropometric disparities found. Body mass index and triceps skinfold thickness were both higher in the female group than in the male group. A significant portion of the group analysed had a BMI that was lower than normal.

Liu et al (2010) conducted a cross-sectional study to evaluate the consistency of BMI and body fat percentage (BF%) in detecting obesity and the optimal BMI cut-offs for identifying obesity in Taiwanese women with breast cancer. BMI and BF % had a strong relationship. BMI, on the other hand, had a low sensitivity for detecting obesity (47 %). BMI has a higher sensitivity for detecting obesity in women over 60. The most accurate BMI threshold for obesity was 22.3 kg/m2, which had a sensitivity and specificity of 89 % and 87 % respectively, and a total accuracy rate of 89 %.

An important comparative study reported by **Wulan et al (2010)** between Asian and Caucasians adult people to estimate the differences in body composition and metabolic disorder. According to this study Asians had a larger body fat percentage, conspicuous abdominal obesity, a higher intra molecular lipid, and/or a higher liver fat content than Caucasians. These factors may explain why African-Americans have a higher predisposition to insulin resistance than Caucasians, while having a lower level of obesity. Depending on the locale, the variances in body composition are more pronounced. Asian Indians, followed by Malay and Chinese, have the greatest body fat among three major ethnic groups in Asia with the same BMI.

Sultana et al (2015) presented a study on 650 aged 19-60 years patients of Dhaka Hospital, Bangladesh to assess the use of MUAC as a simpler alternative to the BMI cut-off for detecting adult undernutrition, and to identify a reasonable cut-off value. MUAC and BMI have a highly significant positive correlation (linear), for males and for females. Based on the highest equivalent Youden's index, MUAC cut-offs of 25.1 cm in males (AUC 0.930) and 23.9 cm in females (AUC 0.930) were chosen separately. And these values strongly correlate to the BMI cut-off for undernutrition (BMI <18.5).

A comparative study reported by **Ul Haq et al (2018**) to assess nutritional status of Chinese and International students of Nanjing China. Overweight and obesity were more common among international students than among Chinese students. Male and female international students had significantly higher BMI and percent body fat than Chinese male and female students (p 0.05). Chinese students had considerably higher nutritional KAP scores (p 0.05) than international students. In terms of diet intake, international students consumed more daily milk, whereas Chinese students consumed more daily egg, weekly fish, and meat. International students consumed much more fast food and carbonated drinks on a weekly basis.

Batis et al (2020) reported a research work to compare the prevalence of malnutrition (undernutrition and obesity) in Mexican children and women of reproductive age by wealth, education level, ethnicity, and urban/rural locations. Stunting or short height was negatively linked with non-indigenous households; high income, high education, and living in urban areas in most age groups, and wealth and education were inversely associated with anaemia. However, wealth, non-indigenous household, and urban regions were favourably related among women aged 11 to 19, while education was inversely associated.

Mujica-Coopman et al (2020) conducted a study on adult Chilean population to find the association between malnutrition, socio-economic conditions and ethnicity. In total, over 75% of women and men were overweight. Low SES women had higher excess weight. Obesity was also more common among indigenous women. Excess weight did not differ substantially by SES or ethnicity in men, although short stature was prevalent in low SES and indigenous men.

An important study from Nepal reported by **Thorup et al (2020)** to compare MUAC with BMI and proposes a MUAC cut-off for adults who are underweight. A total of 302 persons, 197 women and 105 men, aged 18 to 86 years, were enrolled in the study. In both women and men, MUAC was substantially linked with BMI. The best statistically generated MUAC threshold for a BMI of less than 18.5 kg/m2 was 24.5 cm (Youdens Index = 0.75; sensitivity 92.86; specificity 82.48), which had a strong predictive value (AUROCC> 0.9). The appropriate MUAC cut off was also 24.5 cm, based on the settings.

Tang et al (2020) conducted an individual participant data meta-analysis (IPDMA) to investigate the sensitivity (SENS) and specificity (SPEC) of various MUAC cut-offs for detecting underweight in adults (defined as a BMI of less than 185 kg/m2). The average MUAC was 25.7

cm, and 28% of the patients had a low BMI (18.5 kg/m2). The pooled dataset had an area under the receiver operating characteristic curve of 0.91 (ranging from 061 to 98). According to the findings, MUAC cut-offs in the range of ≤23.5 to ≤25.0 cm could be used as a screening indicator for underweight.

Van Haute et al (2020) conducted a research work among 190 Filipino young adult. This study compared the performance of the modified BMI formula to the standard one in predicting body fat percentage (percent BF) by using bioelectric impedance measurement and diagnosing overweight/obesity. The BMI quadratic models showed the highest adjusted R2 and the lowest AIC and BIC for both sexes when compared to the linear models using robust polynomial regression analysis (covariates: age, waist circumference, smoking history, and alcohol intake). Although not statistically significant, the AuROCs of the traditional BMI were greater than those of the proposed BMI.

In 2021, Philpott et al, reported a cross-sectional study to assess nutritional status of adult Sub Saharan African male Detainees. MUAC 25.5 cm upper cut-off to exclude healthy detainees would result in 64% fewer detainees requiring BMI screening, with a sensitivity of 77% and specificity of 796 % for BMI 185 kg/m2. For BMI 16 kg/m2, a lower cut-off of MUAC <21.0 cm showed sensitivity 25.4 % and specificity 99.0%. A 50 kg weight requirement increased specificity to 99.6% while maintaining sensitivity.

A recent study given by **Razon et al (2022)** on elderly people of Bangladesh to assess the nutritional status and common health complications by using anthropometric measurements, dietary method and mini nutritional assessment (MNA). According to BMI definition, the percentage of people who are underweight increases with age. For example, the underweight percentage for 60-75 year olds was 30.0 %, while the underweight percentage for 76 to 85 and >85 years olds was 45.0 % and 60.0 %, respectively. 97 elderly respondents were malnourished, according to the MNA score, and 172 respondents had SNAQ scores below 14.

2.1.1. b National studies:

Malnutrition (both underweight and overweight) is a serious public health concern among adult populations in developing nations, including India. Even while the country's overweight and obesity rates continue to grow, India has the greatest proportion of underweight adults. Sedentary lifestyle adaptations, improving economic conditions, urbanisation, and nutritional changes may have contributed to a steady rise in overweight and obesity with the prevalence of undernutrition. Several studies have been conducted in India to solve the problem of under nutrition among adult men and women. The following paragraphs discuss some of the pertinent works.

Tanuja et al., (1995) presented a study on nutritional evaluation of tribal women in Bihar, which reported that 36.0 % of the women were underweight, and the majority of the women were at risk of delivering low birth weight babies and having pregnancy difficulties.

In a cross sectional study (**Mehta and Shringarpur, 2000**), on 320 adult men and women from three income groups (High, middle, low) of urban Baroda, Anthropometric measurements of height, weight, mid upper arm circumference (MUAC), and body mass index were used to determine nutritional status (BMI) along with some socioeconomic variables. In elderly HIG and MIG males, mean anthropometric measurements of weight and BMI were greater than in elderly

LIG men. All anthropometric measurements of old women in LIG were significantly different from those of HIG and MIG. The findings show that as people become older, their nutrition, health, and disease profiles change dramatically.

Gogoi G and Sengupta S, (2002) published a paper to examine the BMI of the Dibongiya Deoris of Assam in order to better understand their nutritional state. In comparison to other North East Indian groups, the bulk of Deori adults have a higher BMI. They also have a relatively low prevalence of chronic energy deficit.

Another study from Meghalaya, North-East India reported by **R Khongsdire (2002)** on Khasi adult males (>18 years) to estimate the relationship between BMI and morbidity in adult individuals. The prevalence of chronic energy deficiency (CED) was found to be 35% and both BMI and morbidity were substantially related to household age and income. Thus, morbidity and low BMI are components of ill health that are influenced by a variety of factors.

Shukla et al., (2002), conducted a study among adult (≥35 years, both men and women) urban population of Western India to describe the height, weight and BMI and to estimate the prevalence and severity of thinness and overweight in this population. The result of this study reported that men's average height, weight, and BMI were 161.0 cm, 56.7 kg, and 21.8 kg/m2, while women's average height, weight, and BMI were 148.0cm, 49.8kg, and 22.7 kg/m2. 19% of men and women were underweight (BMI 18.5 kg/m2), whereas 19% of men and 30% of women were overweight (BMI > 25 kg/m2). An equal prevalence of underweight and overweight is observed in this study.

Another study conducted by **Singh et al (2003)** among Punjabi males aged 12 to 20 years examined the BMI profile and the evaluation of several classes of thinness based on WHO (1995) adult population guidelines. However, at the age of 18, the above guidelines may not be relevant.

Arlappa et al (2005) reported a study by using data from a cross-sectional study conducted by the National Nutrition Monitoring Bureau (NNMB) exclusively in Integrated Tribal Development Project (ITDP) villages of 9 provincial States in India during 1998-1999 to assess the diet and nutritional status of the tribal elderly (> or = 60 years). An anthropometric survey was completed by 3,932 older people. Both men and women's' mean heights and weights declined dramatically as they grew older. In comparison to their male (61.8%) counterparts, females (65.4%) had a higher prevalence of Chronic Energy Deficiency (CED = BMI <18.5). CED was found to be substantially more common among the elderly in kutchaand landless households. When compared to their rural counterparts, a larger proportion of tribal elders are malnourished.

In **2005, Bose and Chakravarty,** presented a paper on Anthropometric characteristics and nutritional status (Based on BMI classification) among adult (>18 years) Bathudis of Keonjhar district, Orissa. Anthropometric measurements including height, weight, circumferences and skinfolds as well as BMI and waist-hip ratio (WHR) were measured. Overall, undernutrition (BMI < 18.5) was found to be very high (57.9%) and there was a significant difference in the prevalence of undernutrition between men (52.7%) and women (64.5%). It means that the prevalence of adult undernutrition was found to be very high among the Bathudis.

In a study reported by **Bose et al., (2006),** among adult Savars, a tribal group in Orissa, India, to evaluate sex differences in mean body mass index (BMI) and nutritional status (based on BMI), as well as the effect of age on BMI and nutritional status. A total of 600 adult (> 18 years) Savars from four villages were selected in Keonjhar District, Orissa, India. Men were significantly taller, heavier, and had a higher BMI. The prevalence of undernutrition was found to be quite high (both sexes combined) (43.5%). Furthermore, there was a significant difference in the prevalence of undernutrition between men (38%) and women (38%). Both sexes had a substantial negative relationship with BMI. Thus undernutrition was shown to be more common as people got older.

Similar year **Bose et al., (2006)** reported another study on 226 male Bathudis from the Keonjhar District of Orissa, India, to look into age differences in anthropometric and body composition characteristics, as well as the prevalence of underweight. Data on height, weight, circumferences, and skinfolds was gathered. Most anthropometric and body composition variables and indices showed substantial negative age changes, according to the findings. It was also discovered that as people became older, the number of those who were underweight increased. This study found that age was significantly inversely connected to anthropometric and body composition variables and indices among Bathudi men. Furthermore, as people became older, the number of underweight people increases.

Adak et al (2006) reported a study where Body mass index (BMI) was used to measure nutritional status in adult (18-60 years) males from seven tribal tribes in Maharashtra, India. The result reveals that they were mostly skinny and lean, with a medium to low stature. The Gond (18.33kg/m2) had the highest mean BMI, followed by Korku (18.30kg/m2) and Mahadeokoli (18.17kg/m2). The Warli had the highest prevalence of Chronic Energy Deficiency (CED), with 30.0% having severe CED, 32.0% having moderate CED, and 26.0 % having light CED. The Korku had a higher incidence of normal nutritional status (36.0 %).

In 2007, Bose and Bisai studied the anthropometric profile of adult male Santals from Orissa and West Bengal, as well as the prevalence of CED. Both populations had high levels of CED (Orissa 26.2 %, West Bengal 31.5 %). The prevalence of CED was high and the condition was severe in both populations, according to WHO (1995) standards.

A cross-sectional study **(Bose et al., 2007)** was conducted on 183 female Bathudis from the Keonjhar District of Orissa, India, to evaluate age differences in anthropometric and body composition variables, as well as nutritional status. Data on height, weight, circumferences, and skinfolds was gathered. The body mass index (BMI) and many body composition variables and indicators were calculated. The findings demonstrated that major anthropometric and body composition measures and indices had substantial negative age changes. The frequency of undernutrition increased with increasing age, according to studies on these women's nutritional condition. Finally, this study found that age was significantly inversely connected to anthropometric and body composition variables and indices among Bathudi women.

Chakraborty and Bose (2008) reported another study to investigate the anthropometric parameters and prevalence of undernutrition in adult male Oraons, a tribal population in Gumla District, Jharkhand by using body mass index (BMI). A total of 205 adult Oraon men (aged 18 and up) from five villages in Jharkhand's Gumla District. Height, weight, circumferences, and skin folds were gathered. The standard equation was used to compute BMI. The severity of chronic energy deficiency (CED) was determined using widely recognised BMI cut-off values. 161.8 cm, 47.3 kg, and 18.0 kg/m2 were the mean value for height, weight, and BMI, respectively. The prevalence of undernutrition is very high and the condition is worse.

Another important study conducted by **Das M, (2010)** on Korku tribe in Betul district of Madhya Pradesh. This study gathers all essential information on the health and nutritional status of the Korku tribes in Madhya Pradesh's Betul region. The findings revealed that both male and female Korku are nutritionally deficient, owing to low intake of pulses, milk and milk products, green leafy vegetables, fruits, fats and oils, and sugar and jaggery. The results contribute to the necessity for Korku tribes to adjust their eating patterns in order to enhance their nutritional status.

In India, the percentage of underweight (BMI 18.5 kg/m2) was found to be 35% among adult men and women (NNMB). According to the **National Nutrition Monitoring Bureau (NNMB),** the percentage of overweight or obesity among adult men and women was 10% and 13.5%, respectively, in **2012.**

M Goswami (2013) conducted a study is to evaluate the overall prevalence of undernutrition among the Juangs, a vulnerable tribal population in Odisha, India, based on body mass index (BMI). An anthropometric study was conducted on 414 adult males and 423 adult females (>18 years) from fifteen villages in the Keonjhar district of Odisha, India. The body mass index (BMI) was calculated using the standard equation after measuring height and weight. There is a significant difference in mean height, weight and BMI between men and women. Overall, the prevalence of undernutrition among the Juangs (57.5%) is very severe, demonstrating their low nutritional state, particularly among women.

Subasinghe et al. (2014) conducted a cross-sectional study among ≥18 years individuals lived in 12 villages, in the Rishi Valley, Andhra Pradesh, India to determine the socioeconomic and lifestyle factors linked to CED (defined as a BMI of 18 kg/m2) and anaemia. The prevalence of CED (38%) and anaemia (25%) was very high. In both women and men farming was linked to CED. Low income was also associated to CED, while not completing high school was linked to anaemia.

According to NFHS-3 statistics, the states of Tripura (39.8%), Rajasthan (39.3%), Chattishgar (37.2%), and Gujarat (35.7%) have the highest rates of underweight men in India (**Patil and Shinde, 2014**).

Das and Bose, (2015) published a review article on Adult Tribal population of India. Based on studies published to date, this review provides an overview of the prevalence of chronic energy deficiency (CED) utilising BMI and various demographic profiles of Indian tribes. A total of 76 papers were examined for mean BMI using the World Health Organization's (WHO) definition of the public health problem of low BMI in adult populations around the world. The overall sex specific prevalence of CED revealed that both tribe females (52.0%) and males (49.3%) were in a critical state with regard to nutritional status, with females being more disadvantaged.

Another important study presented by **Little et al., 2016,** to present the prevalence of underweight, overweight, and obesity among adult aged between 20-80 years in a rural area of south India, as well as the factors that contribute to these conditions. The prevalence of underweight and overweight was 22.7% and 14.9% respectively. In rural areas of southern India, underweight, overweight, and obesity are common, indicating a village-level dual burden. These diseases are related to a number of factors, including physical activity, socioeconomic status, rurality, television viewing, and food.

G K Khatriya and SK Achariya (2016) published a study between adult tribal populations in three Indian states (West Bengal, Odisha, and Gujrat) and found that overall undernutrition among females was 47.4 % to 32.1 %, implying that nearly half of the female population is severely malnourished.

Another cross-sectional study reported by **Kalaiselvi et al (2016)** to investigate the prevalence of undernutrition and its associated factors among rural elderly people of Puduchery. Undernutrition was found to be prevalent among the elderly (24.8%). More than half of the elderly (58.7%) considered their nutritional situation was poor, and 28.9% of them were genuinely malnourished. The average BMI of old women was greater than that of men. Being an elderly male, having reached the age of 70, and having a per capita income of less than 1000 INR were found to be substantially correlated with undernutrition.

M Goswami (2017) conducted a study to examine the socioeconomic profile and anthropometric characteristics of the Mankidias, a semi-nomadic and particularly vulnerable tribe in Northern Odisha's Mayurbhanj District. The study involves 136 married women over the age of 15 and 124 adult men over the age of 20. The subjects were also questioned in order to obtain information about their socioeconomic status. Anthropometric measurements, such as height and weight, were taken and BMI (Body Mass Index) was developed and used to assess nutritional status. The study illustrates the tribe's low socioeconomic standing in terms of literacy and household income. Furthermore, both males and females were found to have very high levels of undernutrition.

India has the most overweight and obese children, who will grow up to be adults and contribute to a larger burden of cardio metabolic disease and mortality (Reilly & Kelly, 2011; LBD Double Burden of Malnutrition Collaborators, 2020).

G K Kshatriya and S K Acharya (2016) reported a study on 2156 adult’s tribe from three states of India. This study measure the triple burden (undernutrition, overweight or obesity, and hypertension) among 9 different tribal populations. The Koras (51.9%), Bathudis (51.3 %), and Oraon all had high prevalence of undernutrition (49.6%). The prevalence of obesity among the Bhumijs (17.7%), Dhodias (23.8%), Kuknas (15.8%), and Santals of West Bengal (12.2%) and Odisha (15%) was particularly alarming. Women were overweight or obese in 10.9 % and 1.5%

of the time, respectively, with 14.0% having hypertension. Both men and women were affected by malnutrition.

Rai et al., (2018) studied the adult population of India and discovered that the frequency of underweight was 46.5% in 2008. Between 2008 and 2012, 25.8% of underweight people transitioned to a normal BMI, 12.9% of normal-weight people became underweight, and 0% of overweight/obese people became underweight.

In a population base cross-sectional study reported by **Dutta et al (2019),** to determine the factors of underweight and overweight/obesity in adult men and women aged 15-49 in India. The findings revealed that in India, there is a persistently high prevalence of underweight, which coexists with an increased prevalence of overweight/obesity. The likelihood of being underweight was highest in the central and western regions, as well as among people who smoked or used smokeless tobacco. Obesity was found to be more common in metropolitan areas, the southern region, and among adults aged 35 to 49.

According to **Rai et al., (2020),** the prevalence of overweight and obesity among Indian men and women is increasing in both urban and rural areas. Obesity prevalence among women (BMI 27.50 kg/m2) was about 3 percentage points higher than among men in 2015–16, and this was considerably greater in metropolitan areas. Except in metropolitan regions, the obesity prevalence (BMI 23.00 kg/m2) was slightly higher in men than in women.

In the year of **2021 Krishnamoorthy et al**, reported a study on 279 adult people from four villages of Puduchery to assess the validity and reliability of Mini-Nutritional Assessment-SF

(MNA-SF) Questionnaire. According to the MNA full-form scale, 17.9% of people were malnourished. Body mass index (BMI) MNA-SF reported a similar prevalence (16.5 %), while calf-circumference (CC) MNA-SF overstated the prevalence (38 %). CC-MNA-SF had a higher sensitivity (92%) than BMI-MNA-SF (72%), whereas BMI-MNA-SF had a higher specificity (95.6%) than CC-MNA-SF (73.8 %).

Gupta et al (2021) carried out a study in a rural area in Ballabgarh, Haryana, to determine the prevalence of underweight, overweight, and anaemia among 420 elderly and its relationship to socio demographic characteristics. 33.6 % were overweight, 13.8 % were obese, 15.6 % were underweight, and 37.0 % had a normal BMI. There was no significant relationship between being underweight and any of the socio demographic characteristics studied. Being a woman was related to being overweight or obese in a substantial way.

2.1.1. c Regional studies:

The health of Indian women is innately linked to their status in society especially for rural areas. Several studied was undertaken in the field of Biological Anthropology in West Bengal. A large number of researches in various districts of West Bengal have been conducted to investigate the adult nutritional status. In the next paragraphs, I'll explore at some of the important work.

Ghosh et al (2001) reported a study of 410 (210 men and 200 women) aged (> 55 years) urban Bengalee Hindu persons living in Calcutta, India. This study used multiple markers of adiposity and central fat distribution. Height, sitting height (SH), weight, body mass index (BMI), minimum waist (MWC), maximum hip (MHC), and mid upper arm (MUAC) circumferences, and triceps skinfold (TSF) all had a significant negative effect on age in both sexes. Thus there is a significant inverse age trend in adiposity among urban elderly Bengalee Hindus.

Bose et al (2006) conducted a research Based on body mass index (BMI) of adult Santals, a tribal population of Jhargram, West Medinipur District, West Bengal, India, to establish anthropometric profile and the prevalence of chronic energy insufficiency (CED). Standard anthropometric measurements such as height, weight, and circumferences, as well as BMI, were taken. The prevalence of CED (BMI <18.5) was found to be extremely high (36.8 %). CED was found to be more common in women (41.8%) than in males (31.5%). The frequency of CED was high and the situation was critical in both men and women, according to the World Health Organization definition (WHO, 1995).

In **2006 (b), Bose et al,** reported another study Based on their body mass index (BMI), to examine the anthropometric profile and nutritional health of adult Kora Mudis, a tribal people of Bankura District, West Bengal, India. Anthropometric measurements were taken including height, weight, circumferences, and skinfolds. The BMI was determined and used to determine nutritional status. The prevalence of undernutrition (BMI< 18.5) was discovered to be extremely high (52.2 %). Women (56.4 %) were much more likely than men to be malnourished (48.0 %). The frequency of undernutrition is classified as 'very high' by the World Health Organization.

In the peri-urban zone of Kolkata, India, a cross-sectional study was done by **Ghosh and Bharati (2006)** to investigate the health status of 387 Munda and 317 Pod adult males and females. For this study, Chronic Energy Deficiency (CED) was determined using the Body Mass Index (BMI) and seven anthropometric parameters. CED was found to be much higher in Munda males and females. The female Munda had a higher percentage of CED than the male Munda. As a result, there was presence of intra- and inter-ethnic health variations between and within the two socioeconomically disadvantaged communities.

Ghosh and Malik (2007) reported a study among 800 adult Santal population of Bankura district of West Bengal to assess the intra population variation with a special reference to a sex differences in a number of body size and shape measurements. According to this study Santals are short-statured, dolihocephalic, mesorrhinic, and euryprosopic people. They have adapted successfully to their physical and climatic environments. Santal males are much taller, heavier, and have bigger bone breadths and circumferences than Santal females, indicating a distinct sex difference.

Another important study presented by **Bose et al (2008)** to evaluate the anthropometric parameters and nutritional status of adult male Lodha and Bhumij tribes from West Bengal's Paschim Medinipur District. A total of 157 Lodha and 161 Bhumij adult men (>18 years old) were examined from four villages. The nutritional status of the participants was assessed using widely recognized BMI criteria. The World Health Organization's standards were used to classify the public health problem of low BMI in these populations. Males from Lodha were much taller, heavier, and had a higher BMI, indicating a serious condition. Because these two communities' nutritional status was very poor and situation is critical.

Bisai and Bose (2009) reported a cross-sectional study on 123 adult tribal women to assess the utility of different anthropometric indices in determining undernutrition. The body mass index (BMI) and mid-upper-arm circumference (MUAC) were used to determine CED. CED was found in 55.3 % with a BMI of less than 18.5 and 51.2 % with a MUAC of less than 22.0 cm. According to World Health Organization standards, both of these prevalence rates belong into the very high-prevalence category (> or = 40%) and signal a critical situation.

Another mentionable study reported by **Das and Bose (2010)** where BMI (kg/m2) was used to assess the general prevalence of undernutrition among the Santal adult tribes of Purulia District, West Bengal, India. A total of 513 people aged 18 and above were measured (196 males and 317 females). The nutritional condition of the participants was assessed using a widely recognized measure, BMI. Females were found to be significantly underweight (30.6 %) and (63.4 %) than their male counterparts. In CED, there are significant gender differences.

In a research of premenopausal and postmenopausal women from Santiniketan, **A Ghosh and M Rakhshit (2010)** discovered a substantial difference in central obesity status between pre-menopausal and post-menopausal women.

Mukhopadhyay A (2010) reported a cross-sectional study where Body mass index (BMI) was used to examine the anthropometric profile and nutritional status of adult Santals of Birbhum District, West Bengal. A total of 400 adult Santals (aged >18 years) from two villages in Birbhum District were researched. Standard anthropometric measurements such as height, weight, circumferences, and skinfolds, as well as BMI, were taken. The prevalence of undernutrition (BMI <18.5) was found to be high (34.5 %). Females had a higher prevalence of undernutrition (38.5 %) than males (30.5 %). The prevalence of undernutrition (based on BMI) is moderately high, and the situation is critical, according to the World Health Organization definition.

In a research of anthropometric evaluation of nutritional status among college women in Midnapore, West Bengal, **Mandal et al. (2011**) discovered that the total prevalence of CED was 28.3%, and the majority of the college students were in a critical state of low BMI.

Bisai and Bose (2012) conducted a cross-sectional study among adult tribal population of West Bengal and Orissa. Bhumijs, Kora Mudis, Lodhas, Santals, Bathudis, and Savars are among the tribes. Using internationally established BMI cut-off values, nutritional status (chronic energy deficiency, CED) was assessed. It is showed that, in general, both sexes had very low BMI values across the tribes tested. There were significant rates of CED, indicating a critical nutritional condition, Women were more nutritionally stressed and the nutritional situation in West Bengal and Orissa is similar.

Das et al (2013) reported a research work on Birhor tribe of Purulia district of West Bengal to assess the nutritional profile among this vulnerable group by using BMI. A total of 147 adults from Bhupatipalli and Bareriya villages were measured (72 men and 75 females). According to the study, 26.5 % of Birhors were undernourished (age and sex combined). Females had a rate of 33.3 % and males had a rate of 19.4 %, respectively. All age categories of Birhor adults were suffering a high (severe) situation, with the women and the oldest among them facing the most serious scenario in terms of their health and nutritional status.

Das and Bose (2014) reported a study on adult Hill Kherias tribes of Purulia district of West Bengal, to find the prevalence of undernutrition by using BMI and MUAC cut off. And result revealed that 45.6% men and 62.00% women were undernourished when undernutrition was measured by MUAC and the prevalence of CED was high in both man and women.

Pal et al., (2014) performed a research among the adult rural population of West Bengal to determine the prevalence of anaemia and the connection between anaemia and BMI.

According to the data presented in the paper "Nutritional and health status of adult women of the Lodha tribal population of Paschim Midnapore, West Bengal, India: compared with nontribal women" (**Bepari et al., 2015**), the prevalence of undernutrition was very high (80%) and the risk of chronic malnutrition was eleven times higher than in general communities.

Ghosh and Bose (2015) presented a research work on adult Bhumij of Midnapore district of West Bengal to evaluate the nutritional status of this population by using BMI and MUAC. CED was found in 52.3 %, while undernutrition based on MUAC 23.0 cm was found in 48.2 %. According to World Health Organization standards, both of these prevalence fall into the extremely high-prevalence category (40 %), signifying a serious situation.

Ghosh J (2016) conducted a study among Santal Munda tribe of North 24 Parganas of West Bengal. In this study, the majority of them had a normal BMI [76.27%], but a significant number of them were overweight [4.23%] and undernutrition was also frequent [19.49%] among these tribal women with a severity of 6.8%. According to the results of this study, undernutrition is still a big concern. Furthermore, a rising trend for overweight/obesity was detected, indicating a twofold burden of malnutrition.

Das et al (2018) reported a study on adult slum dwellers of Midnapore town of West Bengal to assess the potential of using a statistically appropriate value of mid-upper arm circumference (MUAC) to detect severe undernutrition in adult Indian slum dwellers with a very low BMI. The optimum cut-off points to distinguish CED from non-CED were MUAC of 22.7 and 21.9 cm in males and females, respectively.

An important research work reported by **Bhattacharya et al (2019)** by utilizing anthropometric measures to calculate a new Composite Score. The Composite Score was compared to other measures such as body mass index (BMI) and mid-upper arm circumference (MUAC) classification. A total of 700 adult Oraon (both male and female) were participated in this study. According to the BMI category, 45.9% of people were undernourished, 56.7 % were undernourished according to the MUAC category, and 51.8 % were undernourished according to the newly computed Composite Score.

Maity et al (2019) reported a cross-sectional study on 190 adult old women residing in old-age home of Kolkata, West Bengal to assess the association of nutritional status and depression. Mild and severe depression affected 38.3 % and 14.8 % of the patients, respectively. Borderline impairment and impairment in cognitive function were reported in 13.2% and 9.2% of older women, respectively. Nutritional status was revealed to have a significant link with depression and cognitive function.

Ghosh et al. (2020) have undertaken a cross-sectional study on the prevalence and predictors of anaemia among women of reproductive age in a village area of West Bengal, finding that 70.8 % of women had CED, with proportions of mild, moderate, and severe anaemia of 24.16 %, 37.5 %, and 9.16 %, respectively.

S Ghosh and P Ghosh (2021) conducted a research work on 348 adult Santal of Jhargram district of West Bengal to assess their nutritional status by using BMI and MUAC cut-off values. Overall, the prevalence of Chronic Energy Deficiency (CED) was found to be quite high (33.6 %). Females (36.6 %) had a higher prevalence of CED than males (based on BMI) (30.6 %). The prevalence of undernutrition (as determined by MUAC) was found to be quite significant (30.7 %). Males (31.2 %) had a higher prevalence of undernutrition than females (based on MUAC) (30.3 %).The prevalence of undernutrition (based on BMI and MUAC) was significant, and the situation was serious, according to World Health Organization (WHO) criteria (WHO, 1995).

Mandal and Roy (2022) reported an important study on Sabar tribe of Jhargram district of West Bengal to determine the relationship between nutritional status and socio-economic conditions. The prevalence of malnutrition among sabar adolescents and adult is high. The residents of this area had limited access to clean drinking water and sanitary facilities. The health of the sabar people in this area was closely linked to family income and educational attainment. Adult sabars also have a high prevalence of occupational and lifestyle-related illnesses.

The northern part of West Bengal commonly known as North Bengal. A number of tribal, non tribal, indigenous and caste population are found in these area (Rajbanshi, Bengali Hindu caste, Bengali Hindu Muslim, Oraon, Munda, Rabha, Lepcha and Toto). Several studies has undertaken in the field of Biological Anthropology for assessing nutritional status of adult populations of North Bengal. Here I discussed some of important studies:

In 2002, Roy S K conducted a study on Oraon tribes of Jalpaiguri district of North Bengal. This study examines the anthropometric measurements, somatotypes, food intakes, energy expenditures, and work outputs of Oraon agricultural labourers in the Jalpaiguri area of West Bengal in order to discover the characteristics that predict high work productivity.

Mittal and Shrivastava (2006) reported a cross-sectional study on 500 Oraon tribes of New Mal in Jalpaiguri district of North Bengal. Adult Oraons had a healthy basal mass index (BMI), but children were extremely malnourished. Men were malnourished to a lesser extent than women. Wiping cleansed dishes with leaves of a native plant called mirchaiya, preparing herbal tablets called ranoodava to make an alcoholic and a medicinal drink called hadiya were some of the potentially therapeutic customs performed. The Oraons lacked critical knowledge of contraception, immunizations, correct diet, and nutrients required for a good pregnancy.

An important study reported by **Banik et al (2007)** to compare the anthropometric characteristics and prevalence of undernutrition of adult Dhimals, a tribal population of Naxalbari, West Bengal with those of four other tribes in Eastern India: the Bathudis, Kora Mudis, Santals, and Savars, using body mass index (BMI). The prevalence of undernutrition (BMI< 18.5) was extremely high overall (36.4%). Women were shown to have a higher prevalence than men (46.4 % vs. 27.0 %). The prevalence of undernutrition was high, and the situation was serious among men, according to the WHO definition. The rate of undernutrition among women was quite high, and the situation was severe.

Sarkar et al (2009) conducted a research work on Bengali Kayastha population of Alipurduar district North Bengal where obesity was measured by WC, WHR, WHtR, CI and BMI. A total of 150 people (75 men and 75 women) volunteered to take part in the experiment. A mercury sphygmomanometer was used to monitor blood pressure (SBP and DBP) on the left arm using an auscultator approach. Standard techniques were used to record the anthropometric measures. In comparison to females, males have greater mean anthropometric measurements and blood pressure levels. Obesity affected 80.00 % population. All of the anthropometric characteristics play an influence on blood pressure, according to step-wise regression analysis. Obesity is prevalent among the Bengali Kayastha community of Alipurduar town.

Datta Banik (2011) also presented a work on Dhimals of Naxalbari of North Bengal to find the inter-relationship between height and arm span and also assessed nutritional status from arm span. Males were taller than females and had greater arm spans. In both sexes, the height-arm span ratio was 0.98-0.99, indicating that height was somewhat less than arm spread. There was also a strong link between these two dimensions.

Sen et al (2013) reported an excellent work on 600 adult Bengalee Hindu Caste Population of Jalpaiguri district of North Bengal to investigate the prevalence of overweight and obesity along with some associated factors. Overweight and obesity were found to be prevalent among both males (23.67 %) and females (20.33 % and 29.33 %). Obesity was found to have significant effects on sex, age, monthly income, marital status, education, and alcohol consumption. With combined overweight-obesity, sex, age, monthly income, monthly income, and marital status all had significant influences. The frequency of overweight and obesity among BHCP urban adults has been rising in recent years. The prevalence of overweight and obesity among them was found to be more influenced by sex, age, marital status, and monthly income.

According to **Sinha et al. (2018),** the occurrence of overweight and obesity was high among adult Rajbanshi menopausal women of North Bengal aged 45–50 years (30.63 percent, 4.26 percent) and 50–56 years (30.63 percent, 4.26 percent) (32.36 percent ; 18.91 percent).

Tigga et al (2018) reported an important work on adult Bengalee Muslim population of Uttar dinajpur district of North Bengal to investigate the prevalence of undernutrition and overweight or obesity and their association with some socioeconomic and demographic variables. Men were found to have a substantially higher mean height, weight and BMI than women. Undernutrition and overweight or obesity was found to be prevalent in 22.86 % and 12.86 %, respectively. And there was a strong association between undernutrition and lower age groups and occupation.

Deb shrama et al., (2021) undertook a study to analyze the nutritional status of Rajbanshi youngsters in North Bengal using the head circumference measurement. Only a few studies have looked at the health of the people of North Bengal.

Pal and Ghosh (2022) conducted a study on adult Nepalese of Kurseong, Darjeeling district of North Bengal to find the relationship between BMI and Anthropometric measurements and to find the prevalence of obesity. In this study, 10.52 % of women were found to be obese, whereas males were not, and 18.36 % of men were found to be undernourished, compared to 10.52 % of women. The mean disparities in their weight, WC, BMI, and MUAC have been observed.

2.2 Present study

The nutritional status of a woman has significant implications for her health and that of her children. More than half of Indian women are anemic, and more than a third are severely malnourished. India's women, particularly rural women, make major contributions to our country in every field, not only in census counting, but also in agriculture, economy, society, and development. It has been claimed that a country's developmental status should be measured by the development of all aspects of its society. As a result, it is critical to examine how the rural population, particularly women, will be cared for in relation to the health and other facilities.

Females have been marked out due to their significance and involvement in the growth of a family, society, and country as a whole. It is necessary to assess the nutritional state of adult women in order to improve maternity and child health as well as the overall population's nutritional status. With the aforementioned difficulties in mind, the current study uses an anthropometric approach to measure the nutritional health of adult women from a North Bengal ethnic population. The Rajbanshi people have been chosen for this ethnic group. It is also being attempted to discover and assess the effects of various socio- demographic variables on undernutrition and overnutrition.

The findings of this study will also help policymakers to design or develop incentives for this group in terms of health, lifestyle, and other factors.

2.2.1 Research Objectives

The primary goal of this study is to investigate the prevalence of undernutrition and overnutrition among adult female Rajbanshi people in North Bengal. The following are the objectives of present study:

1. To assess the nutritional status and body composition measurement by using internationally accepted cut-off values.
2. To assess the prevalence of undernutrition among Rajbanshi female population.
3. To determine the relationship between nutritional status and body fat distribution along with various socioeconomic, demographic, and lifestyle characteristics.
4. To assess the age related changes in anthropometric characteristics and body fat distribution among this targeted population.
5. To find the mean age at menarche and menopause among this population.
6. To compare the results of the current study with other (national and international) studies.

The current study has provided basic information on reproductive variables (such as age at menarche, age at natural menopause), undernutrition, overweight and obesity, and other socioeconomic characteristics that are often overlooked in adult Rajbanshi women in North Bengal.

2.2.2 Applied aspects of present study

Anthropometric measurements and indicators serve an important role in determining a population's nutritional status in the field of biological anthropology. The current study's assessment of the nutritional status of the adult population has the potential to play a significant role in designing distinct developmental strategies for this target group. This research also provides light on the impact of undernutrition in this community and the effectiveness of health care efforts. It is also possible to consider the effect of many socioeconomic, demographic, and lifestyle components on the prevalence of undernutrition or overnutrition.

CHAPTER III

MATERIALS AND METHODS

3.1 Study Population

The purpose of this study was to determine the nutritional condition of adult Rajbanshi females in Darjeeling District, which is located in the northern section of West Bengal, often known as North Bengal. This vast territory includes the Himalayan and Sub-Himalayan mountain ranges, as well as lowlands. North Bengal is home to a diverse tribal population (Lepcha, Bhutia, Mech Rabha, Oraon, Munda, Santal, and Hajong), as well as religious communities and caste groups. In North Bengal, there are different caste populations (Rajbanshi, Bhumali, Namasudra, Turia, and Bhuiya). The Rajbanshi population is the largest and most extensively distributed among them. They represent the second largest portion of the schedule caste population in West Bengal (3,386,617 total population; 18.40%, data taken from 2001 census of India).

The Rajbanshi are considered as an ethnic group of North Bengal, mainly in the districts of Jalpaiguri, Dinajpur, Cooch Behar, and plain regions of Darjeeling. The Koch-Rajbanshi can now be found all over North Bengal, particularly in Darjeeling, the Dooars (especially Cooch Behar and Jalpaiguri districts), lower Assam, Nepal's eastern region, and Bihar. They are the first pioneer in North Bengal and they were socially homogeneous because there were no sub-castes among them.

Anthropologically it is widely assumed that the Rajbanshi share racial similarities with the Koch people of Assam, and that they are a composite race of Australasians/Dravidians and Mongolians (Risley, 1891). The ethnic groups that make up the Mongoloids/Indo-Mongoloids have arrived in India from various directions at various eras (Das et al., 1981). The community was still known as Koch in the 1830s, according to Risley, and it was until 50 years later that they began calling themselves Rajbongshi. Koch and Rajbongshi were declared to be the same in 1891 by the district Magistrate of Rangpur. After that, upper-class Rajbongshis began to organise: Rajbanshi zamindari, and the middle classes began to identify them as Khatriyas. The Rajbanshi were originally of Dravidian stock, according to Dalton (1872), and later came into touch with the Mongoloid ethnic strain of Assam, Northeast India.

According to Dr. Charu Chandra Sanyal (1965) "Koches are non-Aryan in origin; some of them converted to Hinduism and became Rajbanshi," Later, these Rajbanshi asserted them to be Khatriya. Koch and the Rajbanshi are of Koch origin, and Rajbanshi or Koch is the same population of the state, according to the historical book "The Cooch Behar State and its Land Revenue Settlements" written by the Koch king of "Cooch Behar State" in the year 1903. In West Bengal and Bihar, they are known as " Rajbongshi and Rajbanshi," and in Assam, they are known as " Koch," " Rajbongshi," and " Koch- Rajbanshi." Despite the fact that the community is known by a variety of names in different states, but their origin is same "Koch" (Roy, 2018).

According to genetic markers, the Rajbanshi are a semi-Hinduized caste group located between clusters of Caucasoid caste people and Mongoloid tribal communities (Kumar et al., 2004). The Rajbanshi, Chutiya, and Ahom tribes were discovered to have gone through the tribe-caste continuum process. Swaraj Basu (2003) investigated the Hindu method of tribal absorption, which explained the tribal caste continuity process. During this process, the tribe progressively takes on the characteristics of the caste population, eventually assimilating into the caste system. Similar processes have also reported from the Koch of Cooch Behar by kumar et al., 2004. Thus Rajbanshi is an example of a tribe-caste continuum both in their biological and socio-cultural aspects. The trem Rajbanshi according to A.C Choudhury is supposedly derived from Aryan and

Dravidian word Rajvamsi meaning "Khatriya or people belong to royal race or decendants from the king".

The Koch- Rajbonshi was ethnically and culturally related to the same Koch Dynasty who ruled their land and vice versa, i.e., the Koch dynasty of Assam, North Bengal, Rangpur part. The Rajbanshi who were previously Agamas-Hindu converted to Vedic-Hinduism and termed as Rajbanshi or Koch- Rajbanshi.

The Rajbanshis were traditionally farmers, but their supremacy in North Bengal meant that they had considerable professional disparities. The majority of them were halua (agricultural labourers) or sharecroppers (called adhiar). These were frequently employed by landed farmers known as dar-chukanidars. The chukandiars and jotedars were above them, and the Zamindars were at the top. Rice, lentils, and maize were the principal crops they grew. The bulk of the population eats rice as their primary source of nutrition. Despite the fact that urbanisation is on the rise, a major section of the community continues to live in rural areas.

Their diet is comparable to that of the Assamese, Nepalese, and Meghalayan Koches. They ate rice and pulses every day, as well as veggies and bhajis (mainly potato fries). Dhekir sag and napha sag were the two most frequent green vegetables among them. Stale rice or Panta bhat is commonly consumed by the locals. They ate meat, fish, and eggs as well. In Ghordew puja, pigs were sacrificed, and in Laxmi puja, ducks were sacrificed.

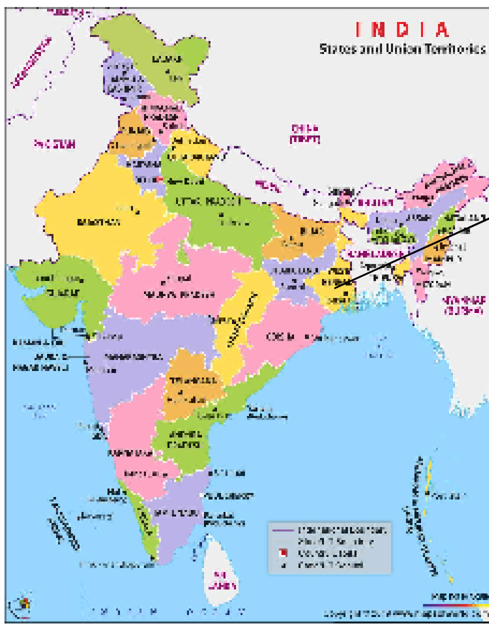
The rectangular layout with an open space in the centre (named egina/aingna) is crucial in the home design of a typical Rajbanshi individual. Every Koch-Rajbanshi home must have a Manasha or Kali Thakur Thakurghor at the entrance.

Patani, Agran, Angsha, Chadar, Lifan, and Phota are some of the Rajbanshis' traditional outfits. Angsha and Jama are the traditional dress for men, while Bukani-patani is the traditional clothing for women. Despite the fact that modern costumes are freely available, the Koch Rajbanshi have maintained their age-old cultural clothing.

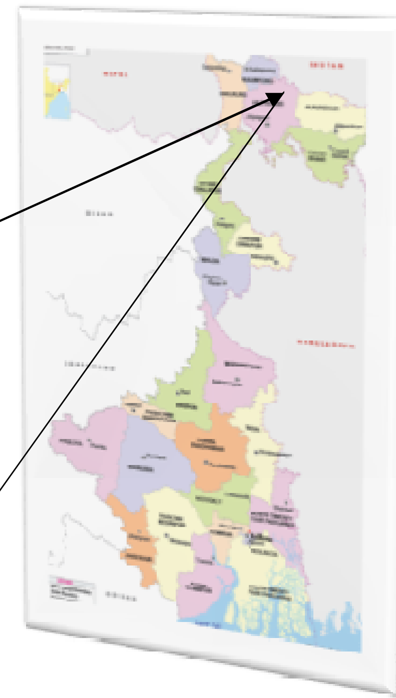
The Rajbanshi presents a variety of musical styles in various cultural programmes. Bhawaiyya, Chatka, Chorchunni, Palatia, Lahankari, and Bishohora pala are among the prominent musical styles of Koch- Rajbanshi culture. Dotora, Sarindra, and Bena were among the instruments employed, as were double membrane instruments such as Dhak, Tashi, Khol, Desi Dhol, and Mridanga, bells such as Kansi and Khartal, and wind instruments such as Sanai, Mukha banshi, and Kupa bansi. The Rajbanshi language is made up of members of the Tibeto-Burman and Indo-Aryan language families.

3.2 Study Area

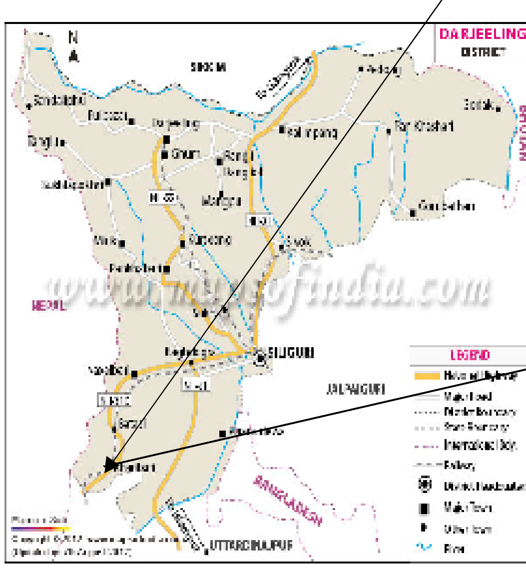
The current research was conducted in the Darjjeling District in North Bengal's rural areas. ***Figure 3.1*** depicts the geographical location of the Darjeeling district. The population was drawn from Rajbanshi-dominated villages in the Kharibari Block (Latitude 26. 34' 19" N, Longitude 88. 08' 51" E), Siliguri Sub-Division, Kharibari Police Station, Darjeeling District, West Bengal, India. This research region is near to the Mechi River, which defines the Indo-Nepal International Border, and is about 32 to 39 kilometres from Siliguri, the sub-divisional town. The Kharibari Block is 144.88 km2 in size. There are 1 panchayat samity, 4 gramme panchayats, 79 gramme sansad, 76 mouzas, and 73 inhabited villages in this area. The information was gathered from approximately 800 Rajbanshi families living in the block's ten Rajbanshi-dominated villages. Kharibari Panishali gramme panchayat, Raniganj Panishali gramme panchayat, and Binnabari gramme panchayat are the three gramme panchayats studied in this study. The block has a total population of 109,251, with 55,671 (51%) males and 53,580 (49%) females [according to India's 2011 census]. There are 53.61 percent Schedule Castes and 19.46 percent Schedule Tribes in the area. According to the 2011 census, the overall literacy rate is 67.37 percent, with 76.00 percent of males and 58.37 percent of females aged 6 and up being literate. West Howdavita, Gurudayaljote, Belbari, Kachaijote, Dohaguri, PWD, Jorpakhuri, Maynaguri, Banchavita, Ramdhan jote are the names of the villages. Rajbanshi people made up more than 85% of the population in every village. ***Figure 3.1*** depicts the location of this research area within the Kharibari block.



INDIA



WEST BENGAL



DARJEELING

KHARIBARI

3.3 Nature of Sampling and sample Size

The current study's population was chosen utilizing multistage stratified sampling processes. The information was gathered between April 2018 and March 2019.

The Rajbanshi-dominated villages were identified and selected from the relevant Block and Gram Panchayats in the first step. This procedure resulted in a list of 12 villages, which were then narrowed down to ten villages that were convenient for data collecting, easy road access, and subject availability. The ten villages were chosen based on the presence of Rajbanshi people, and they were all located between 5 and 10 kilometres from the Kharibari Block.

Only Rajbanshi people were surveyed in these villages in order to gather information. The targeted populations were chosen based on surnames, physical characteristics, and languages. The opinions of the village's most senior and respected members were also taken into account. The ethnicity of the subjects was verified using their identity cards or Gram Panchayat official documents. Non-Rajbanshi people were largely excluded from the research.

Using simple random sampling procedures, data on anthropometric, socioeconomic, demographic, and lifestyle-related characteristics were obtained from adult female Rajbanshi persons aged 18-64 years in the third stage.

950 Rajbanshi females were recruited for participation in this study once initial information about their age and ethnicity was verified. This study did not include pregnant or nursing women. Prior to data collection, the aims of the current investigation were outlined. A total of 150 people were removed from the study out of a total of 950. As a result, the final sample comprises of 800 adult Rajbanshi females between the ages of 18 and 64. Individuals' ages were

determined using their birth certificates, voter cards, or adhar cards. Age at menarche was determined by asking individuals to recall the first time they had menstrual bleeding, and age at menopause was determined by asking participants to recollect the last time they had menstrual bleeding. Prior to data collection, female Rajbanshi individuals gave their informed consent.

3.4 Procedure of data collection

Standard approaches for data collecting from the field setting were taken into consideration to fulfill the goal of this study. The experiment was carried out in conformity with the Helsinki Declaration's ethical criteria for human experimentation (Touitou et al., 2004). The processes for collecting information are briefly discussed here.

3.4.1 Demographic, Socioeconomic, reproductive and lifestyle factors

This study takes into account socioeconomic, demographic, and lifestyle aspects, all of which have a significant impact on a person's nutritional condition. A questionnaire was designed and used to collect data from Rjbanshi females. This established and tested schedule (Annexure I) for the current field with all anthropometric measurements was used to collect data on demographic, socioeconomic, reproductive, and lifestyle-related aspects.

3.4.1.1 Demographic variables

Demographic variables are variables that describe the characteristics and distribution of the population. The effects of both continuous and discontinuous variables on nutrition were examined in this study. Age, marital status, parity, family size, and family type were the demographic variables investigated in this study.

As previously stated, participants' ages were obtained by asking for their dates of birth, if known, or by asking them to provide official papers such as birth certificates, voter cards, or Aadhaar cards. For further analysis, people were divided into three age groups: 18-29 years, 30-49 years, and 50-64 years. The data on marital status and parity was gathered by asking the person whether she is married or not, and if she is, how many children she has. In this study, family size is defined as the number of family members or individuals that share a shared kitchen as a family. The family type in this study is defined as nuclear and joint family with 0-6 members and above 7 members, respectively, for the purposes of analysis. The respondent was explicitly questioned for this information.

3.4.1.2 Socio-economic variables

Socio-economic variables are factors or variables that show the social and economic nature of a community or group. These factors are also vital in determining the impact of dietary status on human health. Education, occupation, and family monthly income were the socioeconomic variables considered in this study.

The modified Kuppuswami scale proposed by Mishra and Singh was then used to determine the socioeconomic status (SES) of the population under consideration (2003). Dr. R. Sharma developed a real-time calculator that was used to update the scale for 2015 and available online at www.scaleupdate.weebly.com (Sharma, 2012). The calculator has been used in a variety of investigations (Reddy et al., 2014; Thakur et al., 2014; Bhansali, 2015). This scale determines an individual's socioeconomic standing based on her level of education, occupation, and monthly income. In ***Table 3.1,*** the updated Kuppuswamy socioeconomic scale is described.

Not only does the socio-economic status (SES) include income, but it also includes educational achievement. As children grow into young people, their educational status helps to develop their appreciation of food, their awareness of the circumstances in which eating occurs, and their ability to make good choices. In this way, education has a direct impact on the population's nutritional health. Individuals who can write her name are considered literate in this survey.

The current study's occupational status is determined by the nature of their work. Occupational status was categorized into four categories: Farmer, Labor, Govt. employee and Business man. The family's monthly income allows us to evaluate their standard of life. Because the majority of the participants were farmers who only sold their agricultural products once a year, it was determined by summing their annual incomes from all sources. The family's monthly income was calculated by dividing the annual sum by 12. People who worked for the government had their monthly salary counted as a family's monthly income.

Table 3.1: Mishra and Singh (2003) developed Kuppuswami SES scale updated for year 2015

Series no	Education	Score
1	Professional	7
2	Graduate or post graduate	6
3	Intermediate or post high school	5
4	High school	4
5	Middle school	3
6	Primary school	2
7	Illiterate	1
	Occupation	
1	Professional	10

2	Semi-professional	6
3	Clerical, shop owner and farmer	5
4	Skilled labour	4
5	Semi- skilled labour	3
6	Unskilled labour	2
7	Unemployment	1
	(C) Income per month in Rs	
1	≥40,315	12
2	20,158-40,314	10
3	15,118-20,157	6
4	10,079-15,117	4
5	6,047-10,078	3
6	2,036-6,046	2
7	≤2,035	1
	SES status	Total score
1	Upper (I)	26-29
2	Upper-middle (II)	16-25
3	Lower- middle (III)	11-15
4	Upper lower	10-5
5	Lower	<5

3.4.1.3 Life style variables

The nutritional status of an individual is also influenced by lifestyle factors. The variables in this study were drinking water sources, toilet facilities, power facilities, and dwelling type.

The majority of Rajbanshi's dwellings were "kachha" type mud plastered buildings with metal sheet roofs. Houses with cement plastered metal sheet roofs were referred to as "semi-pakka" those, whereas houses with concrete structures were referred to as "pakka" houses. Two sources of drinking water were discovered in Rajbanshi's home: a tube well and a well. Rajbanshi household are equipped with kaccha, pakka or semi pakka type pit toilets and most of the toilets are placed within their premises.

3.4.1.4 Reproductive variables

The reproductive variables used in this study were age at menarche and age at menopause.

The participants' age of menarche was determined by asking them to recall the first time they had menstrual blood. The year of a woman's birth was subtracted from the year of her last menstrual period to determine her age at menopause. Years between recalled menopausal age and present age were calculated in completed years.

To complete the structured schedule, face-to-face interviews were undertaken. The interviewer (IS) was fluent in Rajbanshi language and expressions, as well as having previous field experience collecting data on reproductive history.

3.5 Anthropometric Measurements

Before all anthropometric measurements were taken, participants were informed about the study's goals and procedures. First, a verbal consent was obtained, followed by measurements. At the time of the measurements, all of the participants were healthy and free of any disorders. They lacked any physical abnormalities or deformities.

3.5.1 Procedure of taking measurements

Weiner and Lourie (1981) proposed a standard technique which were used to record anthropometric measurements of height, weight, and mid-upper arm circumference (MUAC) (1989). The waist circumference and hip circumference were measured in accordance with WHO recommendations (2008). On the left side of the subject, all measures were obtained in the bare minimum of clothing and bare feet. The measurements were taken three times and the average was calculated.

The skinfolds (BSF, TSF, SSF, and SISF) were measured on the left side of each subject with a Holtain skinfold calliper to the nearest 0.2 mm, as described by Weiner and Lourie (1981). The skinfold calliper is developed to apply a pressure of 10.2 mm during measurements. As a precaution, only a double layer of skin and fatty tissue beneath was incorporated, but no muscles. The calliper was put to the fold at a straight angle. The reading was recorded two seconds after the trigger was released to apply full pressure. The detail procedures are briefly enumerated bellow:

3.5.1.1 Height

An anthropometric rod was used to measure the participant's height to the nearest 0.1 cm. They were designed to stand on a flat surface with both hills in the same place. In the Frankfurt horizontal plane, the head was kept raised upward to its maximum extent. The horizontal arm of the anthropometry was then gently lowered to make touch with the subject's vertex in the mid-sagittal plane.

3.5.1.2 Weight

A portable digital weight machine was used to record the participants' body weight. Before entering the measuring scale, the participants were advised to remove their shoes and excess clothing. They were also told to position their foot correctly on the scale and to stand still in front of it with their hands on their sides. The body weight was calculated to the closest 0.1kg.

3.5.1.3 Mid-Upper Arm Circumference (MUAC)

Each participant's MUAC was measured on the left arm, with arms hanging relaxed and palms facing front. It was found halfway between the acromion's tip and the olecranon process. A marker was used to mark the measurement spots, and the measurement was taken to the nearest 1 mm without squeezing the tissue. The subjects were required to remain upright throughout the procedure.

3.5.1.4 Waist Circumference (WC)

While standing erect, the waist circumference was measured between the lower edge of the last perceptible rib and the top of the iliac crest. The measurement was taken with the arms relaxed on the sides. The measurement was taken to the nearest 1 cm with the support of a flexible nylon tape. The measurements were collected while the subject was dressed comfortably.

3.5.1.5 Hip Circumference (HC)

The maximal circumference of the buttocks was measured when the participants stood straight with their heels touching and their arms relaxed on sides. The measurement was taken to the nearest 1 cm using flexible nylon tape.

3.5.1.6 Biceps Skinfold (BSF)

The BSF measurement were taken when participants were stand straight and relaxed with arm hanging on both sides. The midpoint of upper arm area between acromian and olecranon process was measured and marked. Then the skinfold was pinched vertically and lifted the muscle about 1 cm above the marked line, after that the measurements was recorded.

3.5.1.7 Triceps Skinfold (TSF)

TSF was determined by measuring the back of the left arm. The midpoint between the scapula's acromial process and the ulna's olecranon process was noted. The skinfold was then pinched vertically and lifted 1 cm above the designated line from the muscle. After that, the measurement was recorded.

3.5.1.8 Sub-Scapular Skinfold (SSF)

The inferior angle of the scapula was found and noted by palpating the scapula's posterior spine with fingertips. The skin and subcutaneous tissue fold was plucked obliquely below the inferior angle of the scapula. The calliper was placed 1 cm away from left thumb and index finger on the designated location.

3.5.1.9 Suprailiac Skinfold (SISF)

Only 1 cm above and 2 cm medial to the anterior superior iliac crest was the supailiac skin fold measured. The measurement was taken after the skin fold was pinched vertically.

3.5.2 Technical errors of measurements

The Technical Errors of Measurement (TEM) are commonly calculated to ensure that the anthropometric measurement is valid and reliable. It was calculated by multiplying the sample size by the square root of the difference between two identical measurements (Ulijaszek and Kerr, 1999; Goto and Mascie-Taylor, 2007). The following formula was used to calculate the reliability coefficient, or R. The standard deviation of all measurements is called SD, thus R= 1-[TEM2/SD2]. The reliability coefficient (R) was calculated, which runs from 0 (not trustworthy) to 1 (full dependability). In order to calculate intra-observer TEM, 50 adult females had their height, weight, MUAC, WC, HC, BSF, TSF, SISF and SSF measured.

Table 3.2: For female Investigator (n=50) Intra-observer technical error of measurement (TEM)

Measurements	TEM	Intra-observer Coefficient of Reliability
Height	0.06	0.99
Weight	0.10	0.99
MUAC	0.06	0.99
WC	0.15	0.99
HC	0.20	0.99

BSF	0.13	0.99
TSF	0.13	0.98
SSF	0.01	0.99
SISF	0.24	0.98

The R values are higher than the 0.95 cutoff value given by Ulijaszek and Kerr (1999), indicating that the measurements taken by investigators are reliable and repeatable.

3.5.3 Assessment of Nutritional Status

Standard anthropometric measures and body composition indicators were used to examine the nutritional health of 800 adult female Rajbanshi people ranging in age from 18 to 64 years. The following is a list of them:

3.53.1 Body Mass Index (BMI)

BMI is a useful technique for estimating the severity of malnutrition (CED) and overnutrition (overweight or obesity) in a person or a population. The BMI stands for Body Mass Index, and it is calculated using the WHO algorithm below (1995).

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

The nutritional condition of the participants was assessed using WHO's internationally approved BMI cut-off points (WHO, 1995), ***(Table 3.3)*** and WHO's Asian cut-offs (WHO, 2000), ***(Table 3.4).*** Different CED grades of BMI were employed to screen for undernutrition (WHO, 1995), ***(Table 3.5).*** According to many research, the BMI cutoff point for determining underweight is 18.50 kg/m^2 (James et al., 1988; Ferro-Luzzi et al., 1992; Sengupta et al., 2014; Mondal et al, 2017). Asian adults with a body mass index of 23 kg/m^2 or greater are now considered being at risk. Obese I and II were also identified at 25 kg/m^2 and 30 kg/m^2, respectively.

Table 3.3: Cut-off points for nutritional status of adult populations proposed by WHO (1995)

Class	BMI (kg/m^2)
CED Grade III	<16.00
CED Grade II CED Grade I	16.00-16.99 <17.00-18.49
Normal	18.50-24.99
Overweight	≥25.00-29.99
Obese	≥30.00

Table 3.4: Asian cut-off proposed by WHO (2000)

Devision	BMI (kg/m^2)
Underweight	<18.50
Normal	18.50-22.99
Overweight	>23.00
At risk	23.00-24.99
Obese I	25.00-29.99
Obese II	≥30.00

Table 3.5: Classification of CED based on BMI for adult individuals proposed by WHO (1995)

Prevalence of CED	BMI(< 18.50 kg/m^2)
Low	Warning sign: 5-9%
Medium	Poor situation: 10-19%
High	Serious situation: 20-39%
Very high	Critical situation: > 40%

3.5.3.2 Waist-Hip Ratio (WHR)

The WHR has been calculated by using the measurements of WC and HC. Following equation was used to calculate the value of WHR:

WHR= Waist circumference (cm) / Hip circumference (cm)

The value of >0.8 in females indicated as higher risk of WHR by Web GP. (2002) and Huxley et al. (2008). The amount of greater regional adiposity among population is investigated by using these cut-off values.

3.5.3.3 Rohrer Index (RI)

The Rohrer index (RI) was calculated to assess body composition and nutritional health by using the following equation:

Rohrer index (RI) (kg/m^3) = Weight (kg) / $Height^3$ (m^3)

3.5.3.4 Waist- Height Ratio (WHtR)

The WHtR was determined by using the following equation and the WC and height measurements:

$$WHtR = \text{Waist circumference (cm)} / \text{height (cm)}$$

The cut-off value of 0.5 defined as higher level of adiposity for both sexes developed by Hsieh and Muto (2004). The Kayastha people of North Bengal, have also been subjected to this cut-off (Sarkar and Mukhopadhyay 2009).

3.5.3.5 Conicity Index (CI)

The Conicity Index (CI) is derived from Valdez et al (1993)equation. It is used to evaluate central adiposity.

$$CI = \text{Waist circumference (m)} / 0.109 \times \sqrt{\{\text{Weight (kg)} / \text{Height (m)}\}}$$

This indicator is primarily used to determine the relationship between cardiovascular disease and body obesity. Females with a cut-off point of 1.18 have an increased risk of cardiovascular disease and other risk factors.

3.5.3.6 Mid Upper arm circumference (MUAC)

The nutritional status of the participants was determined by using the internationally established MUAC cut-off standards. Females with MUAC levels below 22 cm were considered undernourished (James et al., 1994).

3.5.3.7 Body Adiposity Index (BAI)

The BAI is a method for measuring a person's body fat percentage without utilising their weight. Bergman and colleagues proposed it (2011). The following is the formula:

$$BAI= \{Hip\ Circumference\ (cm) / Height\ (m)^{1.5}\} - 18$$

3.5.4 Assessment of Body Composition

3.5.4.1 Upper Arm Composition

The upper arm composition of an individual was calculated by using the values of MUAC and TSF, suggested by Frisancho (1974, 1981 and 1989). Total Upper Arm Area (TUA), Upper Arm Muscle Area (UMA), Upper Arm Fat Area (UFA), and Arm Fat Index were all measured (AFI). The equations are given bellow:

$$TUA\ cm^2= (MUAC)^2 / (4\times\pi)$$

$$UMA\ cm^2= \{MUAC - (TSF\times\pi)\}^2 / (4\times\pi)$$

$$UFA\ cm^2= TUA\text{-}UMA$$

$$AFI=(UFA/TUA)\times 100$$

Frisancho's (1989) standard formulae were also used to calculate the adjusted Bone Free Muscle Area (BFMA) in adult female Rajbanshi individuals. The formula is as follows:

$$BFMA_{FEMALE}\ cm^2 = (UMA - 6.5)$$

3.5.4.2 Body Density Assessment

Body density must be calculated in order to calculate PBF using four skinfold thicknesses (BSF, TSF, SSF, SISF). These equations postulated a logarithmic link between obesity and the sum of BSF, TSF, SSF, and SISF skinfolds among populations. Sex specific standard equations were proposed by Durnin and Womersely (1974). Chakrabarty and Bharati (2010), Kaur and Talwar (2011), Chowdhury and Roy (2016), Banik et al. (2016), Ghosh and Bose (2018) have all proven these equations in diverse Indian populations. The following are the equations:

$$\text{Female Body Density} = 1.1567 - 0.0717 \times \log_{10}(\text{BSF+TSF+SSF+SISF})$$

3.5.4.3 Assessment of PBF

Following the estimation of body density, the Siri (1956) standard equation was used to compute the percent body fat (PBF) of female Rajbanshi participants in the current study.

$$\text{PBF} = (4.95/\ \text{Body Density} - 4.50) \times 100$$

Siri's equation has been used by several researchers to assess body fat in various Indian tribes (Dudeja et al., 2001; Das and Bose, 2006; Chakrabarty and Bharati, 2010 b Chowdhury and Roy, 2016; Banik et al., 2016; Ghosh and Bose, 2018).

3.5.4.4 Assessment of Fat mass (FM) and Fat free mass (FFM)

Both fat mass (FM) and fat free mass (FFM) make up the body mass. The level of FM and FFM among Rajbanshi people was determined using a standard formula of Van Itallie et al. (1990) and Eckhardt et al. (2003). Several scholars have applied these formulae to determine the FM and FFM in various Indian ethnic groups (Chakrabarty and Bharati, 2010; Chowdhury and Roy, 2016; Ghosh and Bose, 2018). The equations are as follows:

$$\text{Fat Mass (FM) (kg)} = (\text{PBF}/100) \times \text{Weight (kg)}$$

$$\text{Fat Free Mass (FFM) (kg)} = \text{Weight (kg)} / \text{FM (kg)}$$

3.5.4.5 Assessment of Fat mass index (FMI) and Fat free mass index (FFMI)

The formulae of Van Itallie et al. (1990) were used to determine the fat mass mass index (FMI) and fat free mass index (FFMI). The following are the indices.

$$\text{Fat Mass Index (kg/m}^2\text{)} = \text{FM} / \text{Height}^2 \text{ (m}^2\text{)}$$

$$\text{Fat Free Mass Index (FFMI) (kg/m}^2\text{)} = \text{FFM} / \text{Height}^2 \text{ (m}^2\text{)}$$

3.5.4.6 Assessment of Body fatness status

The fitness levels of the participants in this study were determined using the percentage body fat classifications of Nieman (1995) and Muth (2009). ***Tables 3.6 and 3.7*** provide more information about their classification. Muth (2009) used a sex-specific classification, whereas Nieman (1995) used an universal classification.

3.5.4.7 Assessment of related risk factor with PBF

There are no established cut-offs for determining the level of PBF risk (WHO, 1995; Lavie et al., 2009). The most commonly utilised PBF cut-off points for male and female are 25% and 35%, respectively. Another often used PBF cut-off number is 25 percent for males and 30 percent for females, which was employed in this study (Dudeja et al. 2001; Zeng et al. 2012).

Table 3.6: Percentage Body Fat (PBF) proposed by Nieman (1995)

Weight status	Fat percentage
Lean	<13%
Optimal fat	13-23 %
Fat	24-32 %
Over fat	>33 %

Table 3.7: Sex specific values for related risk factor with PBF (Muth 2009).

Class	Man %	Women %
underweight	2-5	10-13
Normal	6-17	14-24
overweight	18-24	25-31
morbid	25	32

3.6 Statistical Tests

Statistical constants and applicable statistical tests were used to tabulate and analyze the obtained data. The Statistical Package for Social Sciences was used to conduct the statistical tests (SPSS; version 20.00) and p- value <0.05, <0.01 was taken to be statistically significant.

Descriptive statistics (mean± standard deviation) were used to describe the collected anthropometric variables. The anthropometric variables recorded have been described using descriptive statistics (mean ± standard deviation). Age specific differences in the anthropometric variables were analyzed using Descriptive statistics (mean standard deviation) were used to describe the anthropometric variables collected. One-way analysis of variance was used to investigate age-related variations in the anthropometric variables (ANOVA). To further understand the relationship between the anthropometric factors, a Pearson correlation coefficient analysis was performed. A linear regression analysis was used to determine the relationship between age and BMI and the anthropometric factors. Using $\chi 2$ analysis, the differences in BMI, WHR, and WHtR with regard to other socioeconomic, demographic, and lifestyle associated variables were also examined.

In the case of BMI, WC, WHR, and WHtR among Rajbanshi female individuals, to determine the probability of undernutrition and overnutrition, logistic regression models are developed. Underweight, overweight, and obesity were compared to being affected by normal weight using binary logistic regression. The likelihood of being overweight is influenced by high WC, WHR, and WHtR was also compared by using a binary logistic regression analysis. To investigate any differences between people in the categories of undernutrition and overnutrition, a model with Wald χ^2- calculations, corresponding adjusted odds (ORs), and 95 % CI was utilised. Age, educational status, married status, family occupation, income, socio-economic condition (based on Kuppuswamy Scale), family size, family type, dwelling type and drinking water were all predictive variables or independent variables. The regression model allows for the regulation of these factors' effects in order to generate dependency in certain variables.

BMI was categorised as 1, 2, or 3 for undernutrition, overweight, and obesity, respectively, when normal cases were coded as 0. Participants who fell below the cut-offs for central obesity parameters like WC, WHR, and WHtR were given a 0 and those who surpassed them a 1. These variables were used as response variables in the model. Similarly, the predictor variables were coded independently and input as a collection of categorical variables in the regression model. The variables utilized in the logistic regression model as predictors include: age (18-29 years; 30-49 years; 50-64 years), marital report (married; unmarried; widowed/separated), educational status (illiterate; up to primary; secondary and graduate), family occupation (farmar; daily labour; Govt. employee; business/others), women occupation (employee; housewife/Student; daily labour/farmer), family monthly income (≤ ₹5000Rs; ₹5001Rs- ₹10000Rs; ≥ ₹10001Rs), Family type (nuclear; joint/extended), dwelling type (semi-pakka; pakka; kacha), drinking water (well; tube well; Govt. supply), toilet services (kaccha, semi pakka, pakka) and SES status based on Kuppuswamy Scale (higher lower; lower medium; upper middle) .

The words in brackets are each variable's categories, coded with the knowledge that SPSS automatically assigns the last number as reference, As a result, the reference category for logistic regression models is the final category of each of these variables.

CHAPTER IV

RESULTS

4.1 Distribution of socioeconomic, demographic and lifestyle related variables among Rajbanshi women population:

4.1.1 Population size and structure

The participants in this study were 800 adult Rajbanshi women. The chosen age range was 18 to 64 years old. The women in this study were divided into three groups: 18-29 years old, 30-49 years old, and 50-64 years old. There were 231 Rajbanshi women in the first age group (18-29 years), accounting for 28.88% of the total. The second age group (30-49 years) had 444 women (55.50 %), while the third age group (50-64 years) had 15.62 % (125) Rajbanshi women (***Figure: 4.1***).

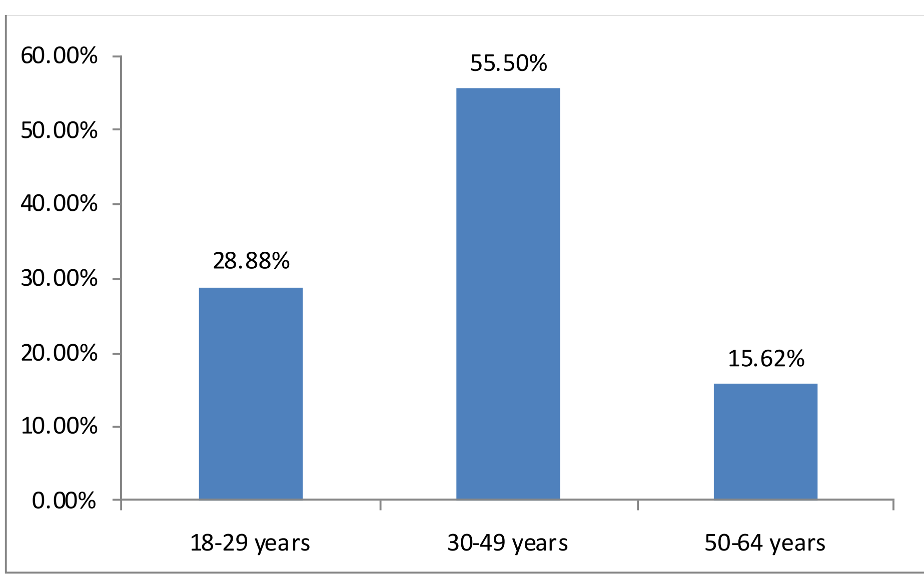
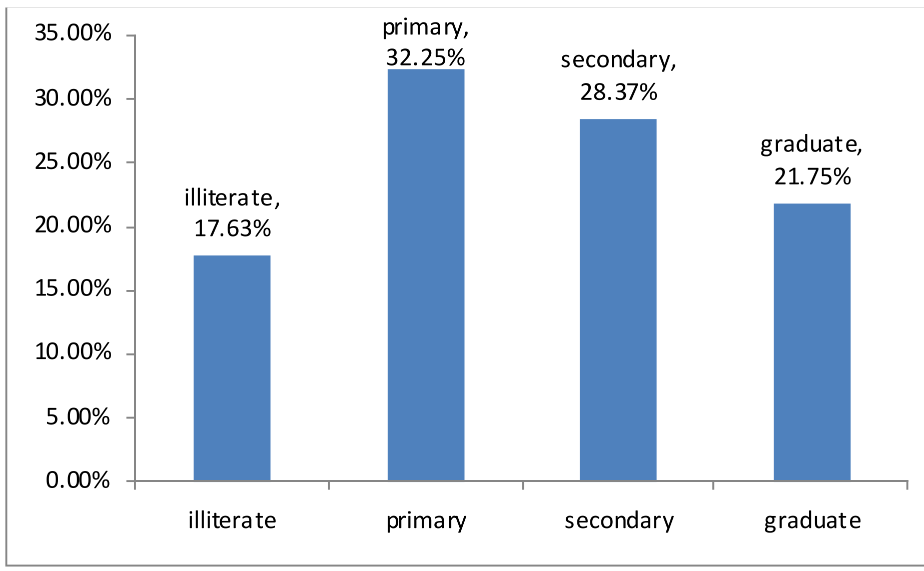


Figure 4.1: Age distribution of the Rajbanshi women population

4.1.2 Educational status

The educational attainment of Rajbanshi individuals is presented in ***figure 4.2***. The result showed that 17.62% women were illiterate and only 21.75% individuals were graduates. Most of the women were studied up to primary level (32.25%) and rests of them were studied up to secondary level (28.37%).



. **Figure 4.2: Distribution of educational attainment of Rajbanshi women population**

4.1.3 Marital status

As presented in ***figure 4.3*** most of the women were married (76.50%). Among them 1.00% were widowed and separated. In present study only 22.50% women were unmarried.

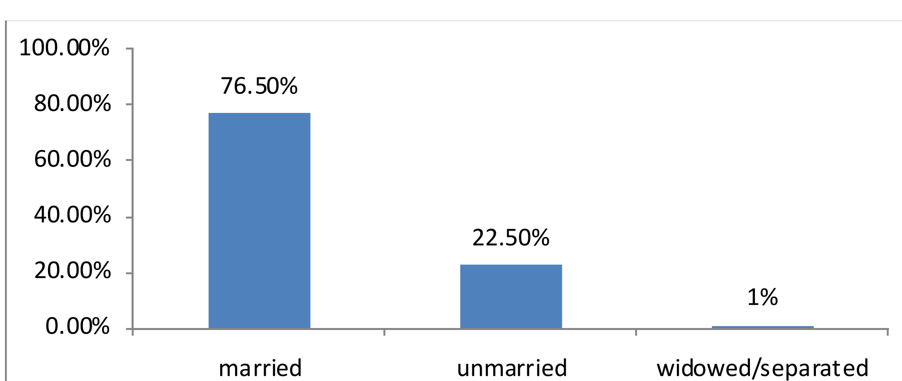


Figure 4.3: Distribution of marital status of Rajbanshi population

4.1.4 Occupational status of family

The occupational status of Rajbanshi individuals were depicted in ***Figure 4.4***. The result showed that main occupation of Rajbanshi individuals was cultivation or agricultural related activities. A majority of them were farmer (58.25%). Only 15.75% were engaged with Govt. services. Rest of them were daily labour (10.00%) and others/ businessman (16.00%). Daily labour was practiced in the agricultural field, tea gardens, wages and skilled labour sectors.

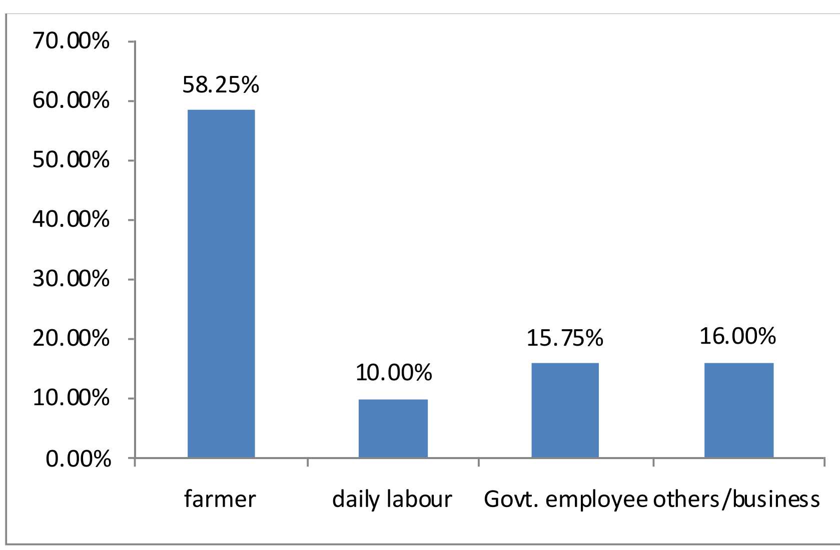


Figure 4.4: Distribution of occupational status of family of Rajbanshi population

4.1.5 Family monthly income

Figure 4.5 shows that 33.25 % individuals belong to the lower income group. The middle income group was 48.00 %. And then individuals with high family monthly income were 18.75%.

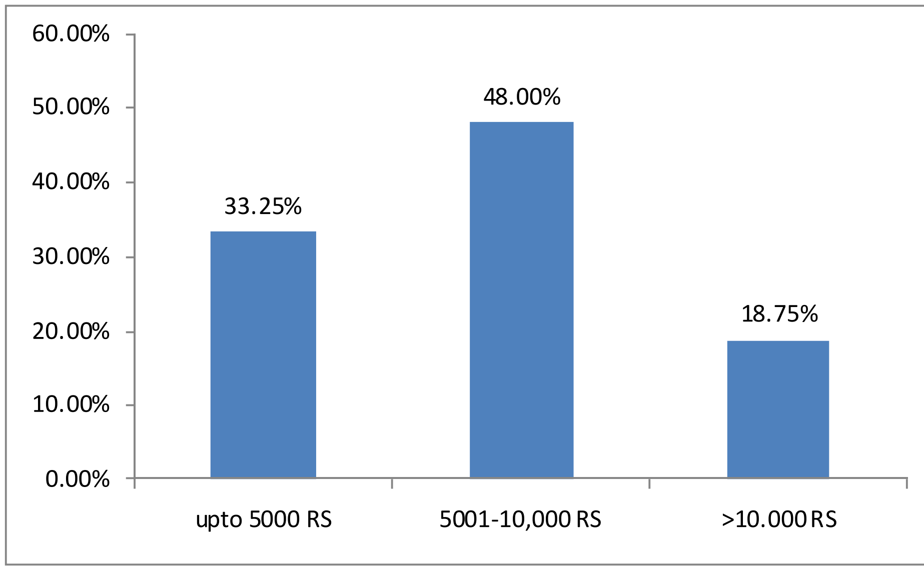


Figure 4.5: Distribution of family monthly income of Rajbanshi individuals.

4.1.6 Women occupational status

The distribution of women occupational status among Rajbanshi women is presented in ***Figure 4.6.*** The result showed that majority of them were housewife or students (62.87%) and only 8.62% women were employed. Rest of the women was either daily labour or farmer (28.50%).

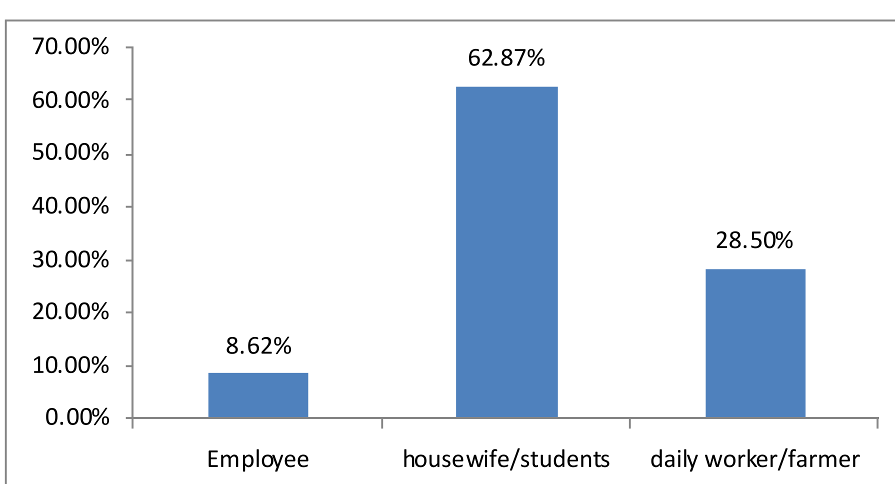


Figure 4.6: Distribution of women occupational status of Rajbanshi population

4.1.7 Socio-economic status (SES)

Only four socioeconomic categories were identified by the Kuppuswamy SES scale among the Rajbanshis in this study. Lower, Middle, Upper-middle (UM), and Upper are the four levels. ***Figure 4.7*** depicts the overall distribution. 47.13% individuals belong to middle SES group and only 1.62% was upper SES group. Rest of the population were either lower (40.50%) SES group or upper-middle (10.75%) SES group.

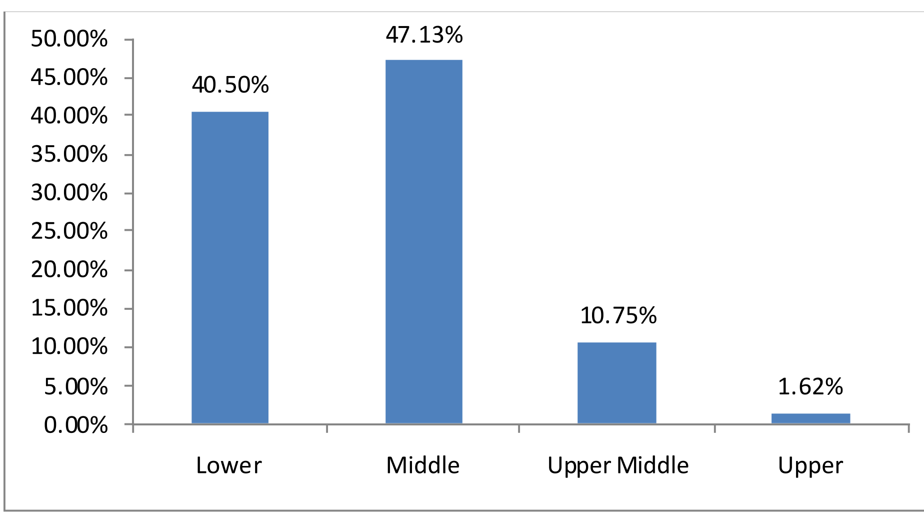


Figure 4.7: Distribution of socio-economic status of Rajbanshi individuals

4.1.8 Family size

The distribution of family size is shown in ***figure 4.8***. The results of the present study indicated that most of the families have to the family size of 5-6 members (43.50%). The less number of individuals comprised the family size of 7-8 members (11.75%). 28.00% individuals have ≤4 members and rest of 16.75 % have ≥9 members.

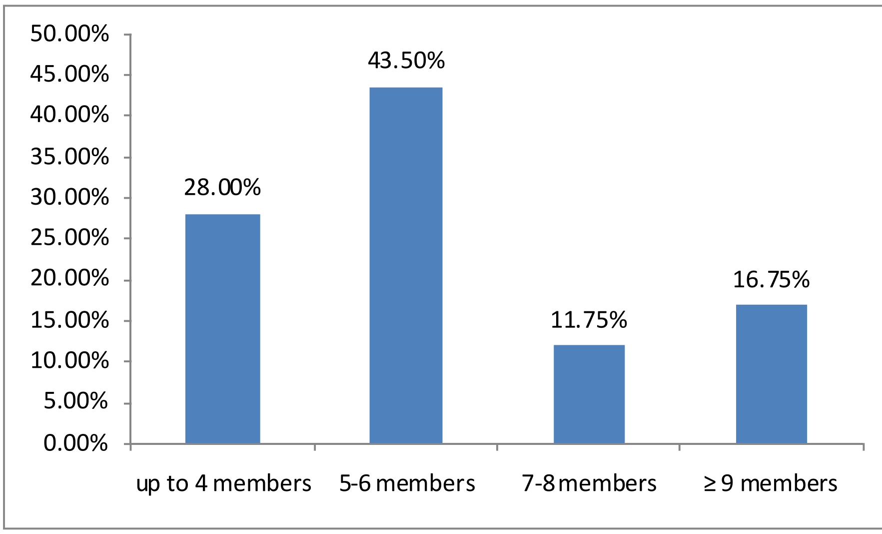


Figure 4.8: Distribution of family size of Rajbanshi population

4.1.9 Family type

Figure 4.9 depicts the distribution of nuclear (1-6 members) and joined (7-9 members) families. There were 390 people from nuclear households (48.75 %) and 410 people from extended families (51.25 %).

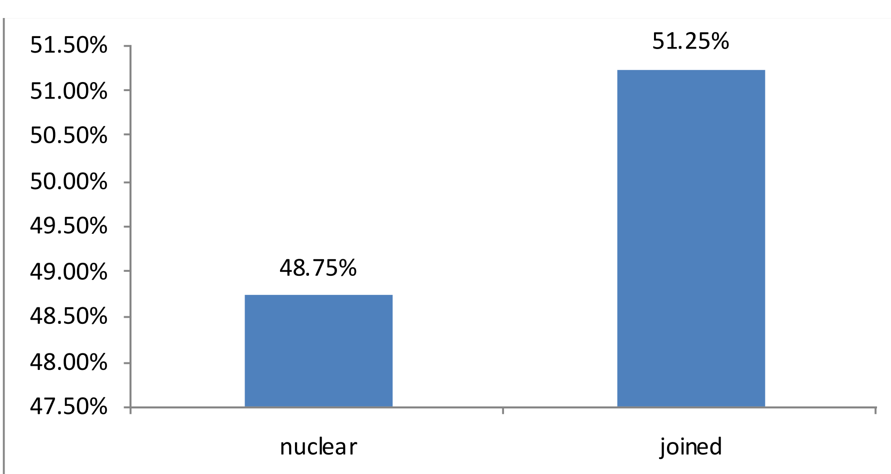


Figure 4.9: Distribution of family type of Rajbanshi individuals

4.1.10 House type

The distribution of house types among the Rajbanshi people is depicted in ***Figure 4.10***. "Semi-pakka" (55.50 %) was the most common type of dwelling, followed by "pakka" (24.38 %) and "kachha" (20.12 %).

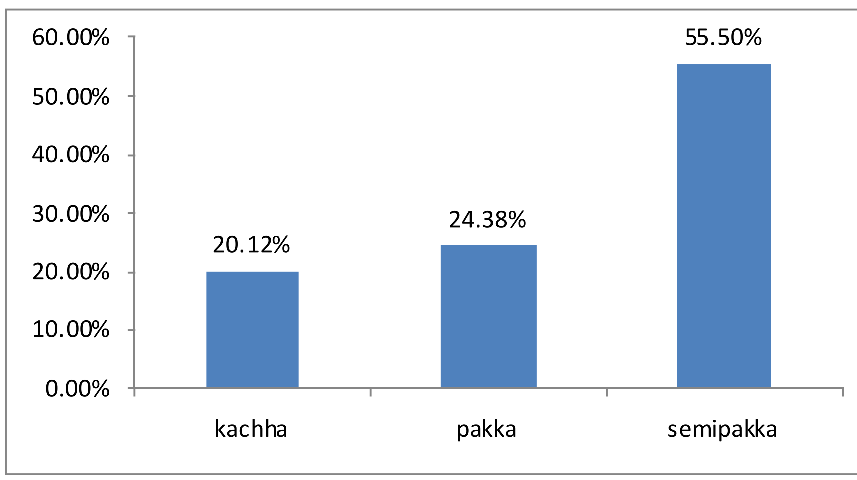


Figure4.10: Distribution of house type of Rajbanshi individuals

4.1.11 Drinking water facilities

There were primarily three types of water sources: government-supplied taps, private wells, and private tube wells. The distribution is depicted in ***figure 4.11***. 577 numbers (72.12%) of individuals have their own tube well and 191 numbers (23.87%) of individuals have their own well at their premises. Only 32 numbers (4.00%) of women took Govt. supply water.

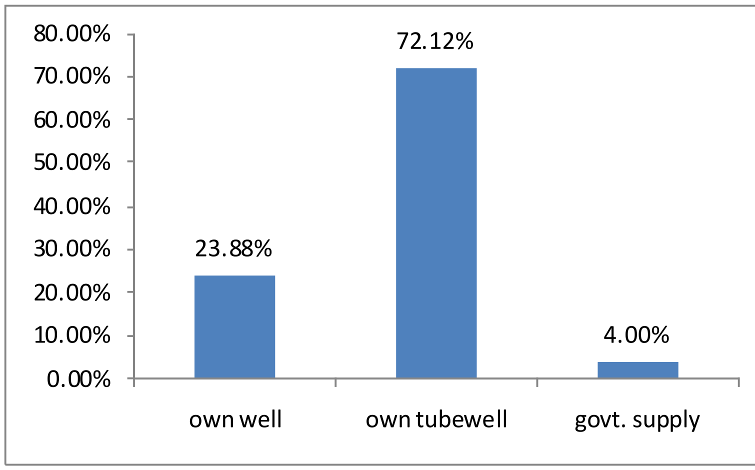


Figure 4.11: Distribution of drinking water facilities of Rajbanshi population

4.1.12 Toilet facilities

There were no households without a toilet in this research. There were 3 types of toilets differ only from structure, not in terms of sanitary conditions. Overall, 339 (42.38%) people lived in households with pakka toilets, whereas 321 (40.12%) lived in households with semi-pakka toilets. Only 17.50% women used kachha type toilet ***(figure 4.12).***

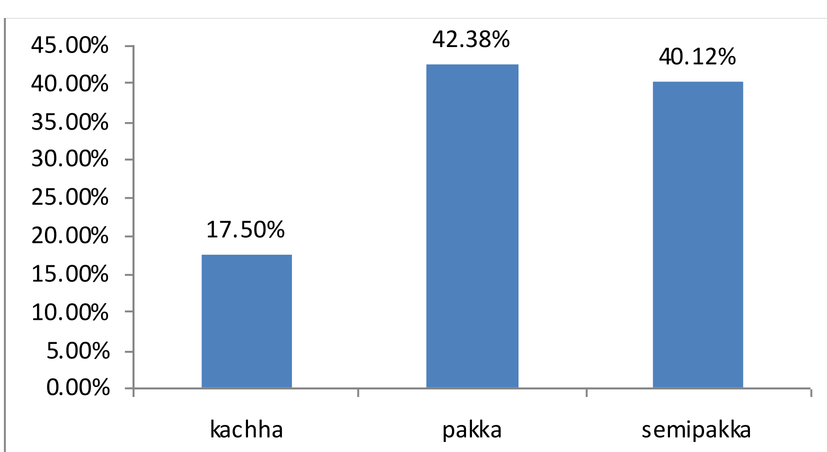


Figure 4.12: Distribution of toilet facilities of Rajbanshi population

Table 4.1: Distribution of socioeconomic, demographic and lifestyle variables of the Rajbanshi women individuals

Variables	Categories	Number and percentage of women
Age (years)	18-29	231 (28.88)
	30-49	444 (55.50)
	50-64	125 (15.62)
Education	Illiterate	141 (17.63)
	Up to primary	258 (32.25)
	Secondary	227 (28.37)
	Graduate	174 (21.75)
Marital status	Married	612 (76.50)
	Unmarried	180 (22.50)
	Widowed/separated	8 (1.00)
Family occupation	Farmer	466 (58.25)
	Labor	80 (10.00)
	Govt. employee	126 (15.75)
	Others/Business	128 (16.00)
Family monthly income	Up to 5000 RS	266 (33.25)
	5001-10,000 RS	384 (48.00)
	>10,000 RS	150 (18.75)
Women occupation	Employee	69 (8.62)
	Housewife	503 (62.88)
	Daily labor/ farmer	228 (28.50)
SES	Lower	324(40.50)
	Middle	377 (47.13)
	Upper-middle	86 (10.75)
	Upper	13 (1.62)
Family size	Up to 4	224 (28)
	5-6	348 (43.5)
	7-8	94 (11.75)
	≥9	134 (16.75)
Family type	Nuclear	390 (48.75)
	Joined/Extended	410 (51.25)
House Type	Kaccha	161 (20.12)
	Pakka	195 (24.38)
	Semi-pakka	444 (55.50)
Water supply	Own well	191 (23.87)

	Own Tubewell	577 (72.12)
	Govt. Tap	32 (4.00)
Toilet type	Kaccha	140 (17.5)
	Pakka	339 (42.37)
	Semi-pakka	321 (40.12)
Age at menarche	11-12 years	430(53.75)
	13-14 years	370(46.25)
Age at menopause	43-47 years	48(27.90)
	48-50 years	124(72.10)

4.2 Nutritional Assessment by Using Anthropometry and Body composition Variables:

4.2.1 *Descriptive statistics of Age and Anthropometric characteristics*

Table 4.2 shows the overall mean and SD of anthropometric parameters and age. The mean age of total population (800) was 37.10 years with age range of 18-64 years. The overall mean of all anthropometric variables like height, weight, MUAC, WC, HC, BSF, TSF, SSF and SISF were 151.01± 3.85, 49.56 ± 5.78, 22.19 ± 2.75, 81.58 ± 9.68, 85.35 ± 10.02, 5.66 ± 2.31, 7.23± 2.95, 8.40 ± 2.20 and 9.84 ± 2.09 respectively.

Table 4.2: Descriptive statistics of age and anthropometric features of Rajbanshi women individuals

Variables	Total population (N=800)
	Mean ± SD
Age (years)	37.10 ± 11.41
Height (cm)	151.01 ± 3.85
Weight (kg)	49.56 ± 5.78
MUAC (cm)	22.19 ± 2.75

WC (cm)	81.58 ± 9.68
HC (cm)	85.35 ± 10.02
BSF (mm)	5.66 ± 2.31
TSF (mm)	7.23 ± 2.95
SSF (mm)	8.40 ± 2.20
SISF (mm)	9.84 ± 2.09

SD= Standard deviation

4.2.2 Descriptive statistics of Derived Indices of Nutritional status and Body composition variables

The overall mean and SD of derived dietary indices and body composition variables are shown in ***Table 4.3***. The derived indices of nutritional and body composition variables are BMI, RI, WHR, WHtR, CI, TUA, UMA, UFA, AFI, BFMA, PBF, FM, FFM, FMI and FFMI. The mean and SD value of BMI (27.7 kg/m^2 ± 2.59), RI (14.39kg/m^3 ± 1.83), WHR (0.95 ±0.03), WHtR (0.53± 0.06), CI (1.31 ± 0.15), TUA (39.80 cm^2 ± 9.70), UMA (32.05 cm^2 ± 7.29), UFA (7.75 cm^2 ± 3.55), AFI (19.30 % ± 6.63), BFMA (25.55 cm^2 ±7.30), PBF (21.1 % 8 ± 3.38), FM (10.61 kg ± 2.12), FFM (38.94 kg ± 3.70), FMI (4.64 kg/m^2 ± 1.17) and FFMI (17.06 kg/m^2 ± 1.73).

Table 4.3: Descriptive statistics of derived nutritional and body composition Indices of the Rajbanshi women individuals

Variables	Total population (N=800)
	Mean±SD
BMI (kg/m^2)	21.75±2.42
RI (kg/m^3)	14.39 ± 1.83
WHR	0.95 ± 0.03

WHtR	0.53 ± 0.06
CI	1.31 ± 0.15
TUA (cm^2)	39.80 ± 9.70
UMA (cm^2)	32.05 ± 7.29
UFA (cm^2)	7.75 ± 3.55
AFI %	19.30 ± 6.63
BFMA (cm^2)	25.55 ± 7.30
PBF%	21.18 ± 3.38
FM (kg)	10.61 ± 2.12
FFM (kg)	38.94 ± 3.70
FMI (kg/m^2)	4.64 ± 1.17
FFMI (kg/m^2)	17.06 ± 1.73

SD= Standard deviation

4.2.3 Age specific Descriptive statistics of anthropometric variables

Total populations have divided into three age groups, viz. 18-29 years, 30-49 years and 50-64 years. The result of ANOVA between age group showed significant effect of age on different anthropometric variables among Rajbanshi women population ($p<0.05$), presented in ***Table 4.4***. From childhood to adulthood, the average height and weight grew. The 30-49 year old women had the highest average height (151.48cm) and weight (54.71 kg). The age-specific mean values of MUAC, BSF, TSF, SSF, and SISF all showed a similar upward trend. In the case of WC and HC among Rajbanshi women, the increasing trend with increasing age was found to be significant ($p<0.001$).

However, post-hoc analysis revealed a significant difference in height, weight, MUAC, BSF, TSF, SSF, and SISF between three age groups (18-29 years, 30-49 years, 50-64years) in post-hoc studies. According to post hoc research, metrics like WC and HC declined in 30-49 years from 18-29 years.

Table 4.4: Age group wise descriptive statistics (mean±SD) of Anthropometric characteristics of Rajbanshi women population

Variables	Total population			F-value
	18-29 years	30-49 years	50-64 years	
Height	150.35±4.36	151.48±3.49	150.61±3.85	7.62**
Weight	45.33±2.84	54.71±5.84	50.38±5.62	172.56**
MUAC	21.87±1.90	22.28±2.57	22.08±2.76	9.96**
BSF	4.25±1.03	5.84±2.14	6.84±1.96	94.18**
TSF	5.76±1.03	7.02±1.97	7.98±1.83	74.38**
SSF	7.45±1.33	8.45±1.88	9.22±1.66	48.23**
SISF	9.02±1.30	9.79±1.63	10.51±1.36	42.21**
WC	71.37±2.84	83.18±7.26	94.40±3.70	77.07**
HC	74.07±2.90	86.46±5.10	95.37±1.50	33.58**

SD = Standard deviation, p**≤0.001, p*≤0.05, d.f. = 2,

4.2.4 Descriptive statistics of derived anthropometric and body composition variables by Age (mean±SD)

Table4.5 shows age group specific descriptive statistics for derived indices of anthropometric and body composition variables among women. The mean value of BMI gradually increased from earlier age to later age. Women aged 30-49 years had the greatest age-specific mean BMI (23.73 kg/m2). In older women, the age-specific mean values of RI (15.64), WHR (0.99), and WHtR (0.62) were found to be high. The age-specific mean values of CI, TUA, UMA, UFA, AFI, and BFMA all showed a similar upward trend. PBF % was increased from 18-29 (19.21%) years to 32-49 years (21.28%) and 50-64 years (22.84%) for each age group. The observed F values with p<0.01 for BMI (41.10), RI (20.74), WHtR (56.77), WHR (15.34), and CI (20.52) were significant among Rajbanshi individuals. FM (12.55), FFM (42.16), FMI (5.44), and FFMI (18.29) had the greatest age-specific mean values among women aged 50-64. Among Rajbanshi populations, the observed F values for FM (F= 36.89; P<0.001), FFM (F= 43.19; P<0.001), FMI (F= 74.18; P<0.001), and FFMI (F= 10.49; P<0.001) were extremely significant. ***Table 4.5*** shows that the ANOVA findings between age groups were significant for these indices.

However, post hoc analysis revealed a significant difference in indices including BMI, RI, WHtR, WHR, CI, FFM, and FFMI among persons aged 18-29 years, 30-49 years, and 50-64 years. Post hoc analysis supported the change in mean BMI values across age groups among individuals.

Table 4.5: Age specific descriptive statistics (mean±SD) of derived anthropometric and body composition variables of Rajbanshi women population

Variables	Total population			F-value
	18-29 years	30-49 years	50-64 years	
BMI	20.03±1.55	23.73±1.83	22.10±2.38	41.10**
RI	13.32±1.27	14.66±1.71	15.64±1.36	20.74**
WHR	0.96±0.03	0.96±0.05	0.99±0.04	15.34**
WHtR	0.47±0.02	0.55±0.05	0.62±0.03	56.77**
CI	1.19±0.06	1.32±0.08	1.44±0.05	20.52**
TUA	38.38±6.72	40.06±9.83	43.00±10.88	10.18**
UMA	32.29±5.69	32.48±7.53	34.14±8.41	3.07*
UFA	6.08±1.44	7.58±2.87	8.86±2.93	52.05**
AFI	15.84±2.25	18.61±3.64	20.42±3.18	94.24**
BFMA	25.79±5.69	25.98±7.53	27.64±8.41	3.07*
PBF	19.21±1.96	21.28±3.03	22.84±2.49	82.98**

FM	8.72±1.15	10.83±2.57	12.55±2.10	36.89**
FFM	36.60±2.26	39.55±3.53	42.16±2.56	43.19**
FMI	3.85±0.54	4.74±1.09	5.44±0.90	74.18**
FFMI	16.17±1.24	17.36±1.53	18.29±1.22	10.49**

** p<0.001; * p<0.05; d.f. = 2, SD = Standard deviation

4.2.5 Correlations of Anthropometric variables among Rajbanshi women populations

The correlations between different anthropometric variables of Rajbanshi female populations are shown in ***Table 4.6***. The age was positively and significantly correlated with weight (.156), MUAC (121), BSF (.236), WC (.204), HC (.124), BMI (.204), RI (.235), WHtR (.228) , CI (146), TUA (.135), PBF (.136), FM (.026), FFM (.253) and FMI (.034) where p<0.05. On other hand the age is negatively significantly (p<0.05) correlated with height (-.121), TSF (-.155), SSF (-.012), SISF (-.125), WHR (-.148), UMA (-.142), UFA (-.052), AFI (-.246), BFMA (-.123) and FFM (-.238) among Rajbanshi female populations.

The height had positive (+r) and significant (p<0.05) correlation with weight (.265), MUAC (.158), SISF (.150), WC (.159), BMI (.025), WHtR (.638), CI (.250), TUA (.156), UMA (.125), UFA (.123), BFMA (.205), PBF (.253), FM (.256), FFM (.373) and FMI (.064). Only HC (.-250) AFI (-.034) and FFMI (-.025,) was negatively(-r) correlated with height.

A positive (+r) and significant (p<0.05) correlation of weight was observed with MUAC (.672,), BSF (.643), TSF (.527), SSF (.631), SISF (.510), WC (.723), HC (.844), BMI (.845), RI (.453,), WHR (.258), WHtR (.710), CI (.356), TUA (.845), UMA (.825), UFA (.575), AFI (.439,), BFMA (.412), PBF (.624), FM (.733), FFM (.843), FM (.808) and FFMI (.867) among Rajbanshi female individuals.

A positive strong correlation was observed of MUAC with BSF (.522), TSF (.513), SSF (.625,), SISF (.513), WC (.594), HC (.647), BMI (.747), RI (.356), WHR (.234), WHtR (.553), CI (.224,), TUA (.847), UMA (.787), UFA (.750), AFI (.423), BFMA (.124), PBF (.743), FM (.721), FFM (.645), FMI (.725), and FFMI (.812) where p<0.05.

BSF had also positive (+r) and significant (p<0.05) correlation with others anthropometric variables. This variables were TSF (.498), SSF (.625), WC (.525), BMI (.658), RI (.341), WHtR (.639,), CI (.251,), TUA (.529), UMA (.536), UFA (.550), AFI (.449,), BFMA (.524), FM (.684), FMI (.698), and FFMI (.582). BSF was negatively (-r) significantly correlated with SISF (r=.526), HC (.621), WHR (.254), PBF (.763), and FFM (.448) among Rajbanshi individuals.

Similarly TSF was positively (+r) significantly (p<0.05) correlated with SSF (.515), SISF (.523), WC (.498), HC (.573), BMI (.578), RI (.145), WHR (.084), WHtR (.456), CI (.258), TUA (.632), UMA (.539), UFA (.875), AFI (.956), BFMA (.356,), PBF (.832), FM (.765), FFM (.462), FMI (.645), and FFMI (.465).

The SSF also had negative (-r) correlation with SISF (-.694), HC (-.692), WHtR (-.634), CI (-.256), UFA (-.632), BFMA (-.205), FFM (-.563), FFMI (-.257) and positive(+r) correlation with WC (.674), BMI (.724), RI (.321), WHR (.314), TUA (.581), UMA (.645), AFI (.448), PBF (.817), FM (.876), FMI (.588).

The result also indicated a strong (p<0.05) positive correlation of SISF with all anthropometric variables. These were WC (.463), HC (.519), BMI (.656), RI (.413), WHR (.259,), WHtR (.524), CI (.412), TUA (.563), UMA (.584), UFA (.592), AFI (496,), BFMA (.301), PBF (.678), FM (.293), FFM (.392), FMI (.639), and FFMI (.329).

WC had positive significant (p<0.05) correlation with HC (.462), BMI (.634), RI (.620), WHR (.642), WHtR (.764), CI (.563), TUA (.507), UMA (.843), UFA (.586), AFI (.620), BFMA (.456), PBF (.723), FM (.842), FFM (.723), FMI (.896), and FFMI (.723).

The HC was strongly positively correlated with BMI (.832), RI (.302), WHtR (.675,), CI (.235), TUA (.724), UMA (.735), UFA (.624), AFI (.409), BFMA (.625), PBF (.639), FM (.842), FFM (.649), FMI (.832), and FFMI (.762). On the contrary HC was negatively correlated with WHR (r=.042) among adult Rajbanshi female populations.

There was a positive significant (p<0.05) correlation of BMI with RI (.120), WHR (.241), WHtR (.849), CI (.328), TUA (.824), UMA (.823), UFA (.646), AFI (.327), BFMA (.578), PBF (.627), FM (.723), FFM (.328), FMI (.844), and FFMI (.901).

RI had significant positive correlation with WHR (.251), WHtR (.320), CI (.124), UMA (.421), PBF (.634), FM (.725), FFM (.431), FMI (.356), and FFMI (.269) among female Rajbanshi individuals.There was no significant correlation between RI and AFI and BFMA.

WHR also showed significant positive correlation with WHtR (.543), CI (.572), TUA (.292), UMA (.192), UFA (.124), AFI (.153), BFMA (.652), PBF (.125), FM (.332), FFM (.342), FMI (.435), and FFMI (.429). The correlation was weakly associated with WHR except BFMA.

WHtR had positive significant correlation with CI (.725), TUA (.152), UMA (.653), UFA (.562), AFI (.413), BFMA (.432), PBF (.264), FM (.545), FFM (.642), FMI (.719), and FFMI (.725) among female Rajbanshi individuals. Similarly CI was lightly correlated with TUA (.256), UMA (.346), UFA (.149), AFI (.046), BFMA (.305), PBF (.257), FM (.324), FFM (.249), FMI (.248), and FFMI (.258).

TUA was significantly (p<0.05) positively correlated with UMA (.848), UFA (.725), AFI (.346), BFMA (.102), PBF (.709), FM (.852), FFM (.708), FMI (.605), and FFMI (.721). The correlation was strong except BFMA and AFI. The others correlation of UMA with UFA (.624), AFI (.257), BFMA (.236), PBF (.542), FM (.724), FFM (.725), FMI (.821), and FFMI (.724) was observed high among Rajbanshi female individuals. Only AFI and BFMA had weak correlation with UMA.

The UFA had significant (p<0.05) strong correlation with AFI (.786), BFMA (.456), PBF (.791), FM (.814), FFM (.452), FMI (.727), and FFMI (.493) among female Rajbanshi individuals. The observed correlation was strong except BFMA, FFM and FFMI. Furthermore AFI was lightly correlated with BFMA (.369), FFM (.124) and FFMI (.253). There was also significant positive correlation of AFI with PBF (.725), FM (543) and FMI (.528) among Rajbanshi female populations.

The BFMA was relatively correlated with PBF (.032), FM (.352), FFM (.562) and FMI (.425). Only FFMI (625) had significant (p<0.05) correlation with BFMA among adult female Rajbanshi population. BFMA also had positive correlation of PBF with FM (.924), FFM (.490) FMI (.925) and FFMI (.513). The correlation of FM with FFM (.645), FMI (.829) and FFMI (.824) were strong and significant. The FFM had strong positive correlation with FMI (629) and FFMI (.825) among Rajbanshi female individuals. The correlation of FMI with FFMI (.687) was strong and positive.

Table 4.6: Pearson correlation (r) of different anthropometric characteristics of female Rajbanshi individuals

Variables	Age	Height	Weight	MUAC	BSF	TSF	SSF	SISF	WC	HC	BMI	RI	WHR	WHtR	CI	TUA	UMA	UFA	AFI	BFMA	PBF	FM	FFM	FMI	FFMI
Age	1																								
Height	-.121*	1																							
Weight	.156**	.256**	1																						
MUAC	.121*	.158**	.672**	1																					
BSF	.236*	.063	.643**	.522**	1																				
TSF	-.155**	.056	.527**	.513**	.498**	1																			
SSF	-.012	.045	.631**	.625**	.625**	.515**	1																		
SISF	-.125*	.15.*	.510**	.513**	.526**	.523**	.694**	1																	
WC	.204**	.159**	.723**	.594**	.525**	.498**	.674**	.463**	1																
HC	.124*	-.250**	.844**	.647**	.621**	.573**	.692**	.519**	.642**	1															
BMI	.204**	.025*	.845**	.747**	.658**	.578**	.724**	.656**	.634**	.832**	1														
RI	.235**	.012	.453**	.356**	3415**	.145**	.321**	.413**	.620**	.302**	.120*	1													
WHR	-.148**	.042	.258**	.234**	.254**	.084*	.314**	.259**	.642**	-.042	.241**	.251**	1												
WHtR	.228**	.638**	.710**	.553**	.639**	.456**	.63**	.524**	.764**	.675**	.849**	.320**	.543**	1											
CI	.146**	.250**	.356**	.224**	.251**	.258**	.256**	.412**	.563**	.235**	.328**	.124**	.572**	.725**	1										
TUA	.135*	.156**	.845**	.847**	.529**	.632**	.581**	.563**	.507**	.724**	.824**	.032	.292**	.152**	.256**	1									
UMA	-.142**	.125**	.825**	.787**	.536**	.539**	.645**	.548**	.843**	.735**	.823**	.421**	.192**	.653**	.342**	.848**	1								
UFA	-.052	.123*	.575**	.750**	.550**	.875**	.632**	.592**	.586**	.624**	.646**	.125**	.124**	.562**	.149**	.725**	.624**	1							
AFI	-.246**	-.034	.439**	.423**	.449**	.956**	.448**	.496**	.620**	.409**	.327**	.012	.153**	.413**	.046*	.346**	.257**	.786**	1						
BFMA	-123*	.205**	.412**	.124**	.524**	.356**	.205**	.301**	.456**	.625**	.578**	.034	.652**	.432**	.305**	.102**	.236**	.456**	.369**	1					
PBF	.136**	.253*	.624**	.743**	.763**	.832**	.817**	.678**	.723**	.639**	.627**	.634**	.125**	.264**	.257**	.709**	.542**	.791**	.725**	.032	1				
FM	.026*	.256**	.733**	.721**	.684**	.765**	.876**	.293**	.842**	.842**	.723**	.725**	.332**	.545**	.324**	.852**	.724**	.814**	.543**	.352**	.924**	1			
FFM	.253**	.373**	.843**	.645**	.448**	.462**	.563**	.392**	.723**	.649**	.328**	.431**	.342**	.642**	.249**	.708**	.725**	.452**	.124**	.562**	.490**	.645**	1		
FMI	.034*	.064*	.808**	.725**	.698**	.645**	.588**	.639**	.891**	.832**	.844**	.356**	.435**	.719**	.248**	.605**	.821**	.727**	.528**	.425**	.925**	.829**	.692**	1	
FFMI	-.238**	-.025*	.867**	.812**	.582**	.465**	.275**	.329**	.723**	.762**	.901**	.269**	.429**	.725**	.258**	.721**	.72**	.493**	.253**	.625**	.513**	.824**	.825**	.687**	1

** p<0.01; * p<0.05

4.2.6 Linear regression of age on anthropometric and body composition factors among Rajbanshi female populations

Age was used as a dependent variable and other anthropometric variables or indices were used as independent variables in a linear regression study to see how age affected other anthropometric variables or indices (***Table 4.7)***.

The result of the analysis showed that age had a negative effect on RI (t=- -0.518), BSF (t= -1.07), TSF (t= -1.07), SSF (t= -0.384), HC (t= -0.486), WHtR (t= -0.204), CI (t= - 0.043), AFI (t= -0.610), PBF (t= -0.228) and FMI (t= -0.024). Age also had a positive effect on Height (t= 2.303), weight (t= 1.125), BMI (t= 0.029), MUAC (t= 0.884), SISF (t= 0.817), WC (t= 0.279), WHR (t= 1.457), TUA (t= 1.021),UMA (t= 1.249),UFA (t= 0.189), BFMA (t= 1.249), FM (t= 0.510), FFM (t= 1.424) and FFMI (t= 0.054). The age was statistically significant with weight, WHR, TUA, UMA, BFMA and FFM ($P \leq 0.05$). While it was not statistically significant with height, BMI, RI, MUAC, BSF, TSF, SSF, SISF, WC, HC, WHtR, CI, UFA, AFI, PBF, FM, FMI and FFMI ($P > 0.05$) (***Table 4.7***).

Table 4.7: Linear Regression of age on anthropometric and body composition Measurements among Rajbanshi women populations

Variable	B	SE	Beta	Adjusted R^2	t	P Value
Height	0.241	0.105	0.081	0.005	2.303	0.022*
Weight	0.080	0.071	0.040	0.001	1.125	0.051*
BMI	0.005	0.166	0.001	-0.001	0.029	0.977
RI	-0.121	0.234	-0.018	-0.001	-0.518	0.604
MUAC	0.145	0.164	0.031	0.001	0.884	0.377
BSF	-0.210	0.196	-0.038	0.010	-1.07	0.284
TSF	-0.046	0.215	-0.008	-0.001	-0.212	0.832
SSF	-0.086	0.224	-0.014	-0.001	-0.384	0.701
SISF	0.209	0.256	0.029	0.010	0.817	0.414
WC	0.012	0.042	0.010	0.021	0.279	0.780
HC	-.0.023	0.048	-0.017	-0.012	-0.486	0.627
WHR	12.91	8.859	0.052	0.001	1.457	0.050*
WHtR	-1.318	6.454	-0.007	-0.231	-0.204	0.838
CI	-0.158	3.709	-0.002	-0.012	-0.043	0.966
TUA	0.044	0.043	0.036	0.012	1.021	0.050*
UMA	0.070	0.056	0.044	0.032	1.249	0.052*

UFA	0.028	0.149	0.149	-0.234	0.189	0.850
AFI	-0.069	0.113	-0.022	-0.010	-0.610	0.542
BFMA	0.070	0.056	0.044	0.014	1.249	0.052*
PBF	-0.031	0.137	-0.008	-0.024	-0.150	0.820
FM	0.082	0.160	0.018	-0.324	0.510	0.610
FMM	0.161	0.113	0.050	0.024	1.424	0.055*
FMI	-0.009	0.376	-0.001	-0.001	-0.024	0.981
FFMI	0.014	0.257	0.002	-0.012	0.054	0.957

4.2.7 Linear regression analysis of BMI on different anthropometric and body composition variables among female Rajbanshi populations

Linear regression analysis was done to assess the dependency of BMI on different anthropometric and body composition variables. In this analysis BMI was taken as dependent variable where other anthropometric and body composition variables considered as independent variables. The result was depicted in ***Table 4.8***.

The result of the analysis showed that BMI was positively dependent on most of the variables. These variables were weight (t= 55.276), RI (t= 26.738), MUAC (t= 15.459), BSF (t= 22.511), TSF (t= 21.771), SSF (t=17.792), SISF (t=16.301), WC (t= 27.875), HC (t=21.829), WHR (t=13.255), WHtR (t= 32.440), CI (t= 10.540), TUA (t= 15.897), UMA (t= 13.329), UFA (t= 22.516), AFI (t= 17.265), BFMA (t= 12.329),PBF (t= 21.972), FM (t= 39.499), FFM (t= 43.17), FMI (t= 51.170) and FFMI (t= 80.782). Only height (t= -6.242) was negatively dependent on BMI. The result also indicated that most of the regression coefficient was statistically significant ($p<0.05$) (***Table 4.8***).

Table 4.8: Linear Regression of BMI on anthropometric and body composition measurements among Rajbanshi populations

Variables	B	SE	Beta	Adjusted R^2	t	P
Height	-0.136	0.022	-0.216	0.045	-6.242	0.050
Weight	0.382	0.007	0.890	0.793	55.276	0.000
RI	1.372	0.011	0.0976	0.953	126.738	0.000
MUAC	0.475	0.031	0.480	0.229	15.459	0.000
BSF	0.734	0.033	0.623	0.388	22.511	0.000

TSF	0.789	0.036	0.610	0.372	21.771	0.000
SSF	0.717	0.040	0.533	0.283	17.792	0.000
SISF	0.768	0.047	0.500	0.249	16.301	0.000
WC	0.179	0.006	0.702	0.493	27.875	0.000
HC	0.177	0.008	0.611	0.373	21.829	0.000
WHR	22.651	1.709	0.425	0.179	13.255	0.050
WHtR	29.259	0.902	0.754	0.568	32.440	0.000
CI	7.794	0.739	0.350	0.121	10.540	0.050
TUA	0.128	0.008	0.490	0.240	15.825	0.032
UMA	0.135	0.011	0.400	0.159	13.329	0.000
UFA	0.559	0.025	0.623	0.384	22.516	0.000
AFI	0.353	0.020	0.521	0.271	17.265	0.000
BFMA	0.135	0.011	0.400	0.159	12.329	0.000
PBF	0.507	0.032	0.614	0.376	21.972	0.000
FM	0.783	0.020	0.813	0.661	39.499	0.000
FMM	0.569	0.013	0.837	0.700	43.171	0.000
FMI	1.977	0.039	0.875	0.766	51.170	0.000
FFMI	1.455	0.018	0.944	0.891	80.782	0.001

4.2.8 Assessment of Nutritional Status using BMI among Rajbanshi female individuals

4.2.8.1 Based on WHO's BMI classification (1995)

Table 4.9 shows the prevalence of underweight, overweight, and obesity as defined by WHO (1995).The results suggested that 39.50 % population were undernourished and 0.38% individuals were at risk group of CEDII. The findings also revealed that the overall prevalence of overweight (BMI≥ 25.00 kg/m2) and obesity (BMI≥ 30.00 kg/m2) was 67 (8.38%) and 7 (0.88%), respectively. The result also showed that half of individuals (50.88%) were normal. ***Figure 4.13*** visually depicts the general distribution of nutritional status among Rajbanshi female people.

Table 4.9: Prevalence of underweight, overweight and obesity measured by WHO (1995) classification among Rajbanshi female individuals

Class	BMI (kg/m^2)	N=800
CED II	16.00 – 16.99	3 (0.38)

CED I	17.00 – 19.99	316 (39.50)
Normal	20.00 -24.99	407 (50.88)
Overweight	≥25.00 – 29.99	67 (8.38)
Obese	≥ 30.00	7 (0.88)
Total		800 (100.00)

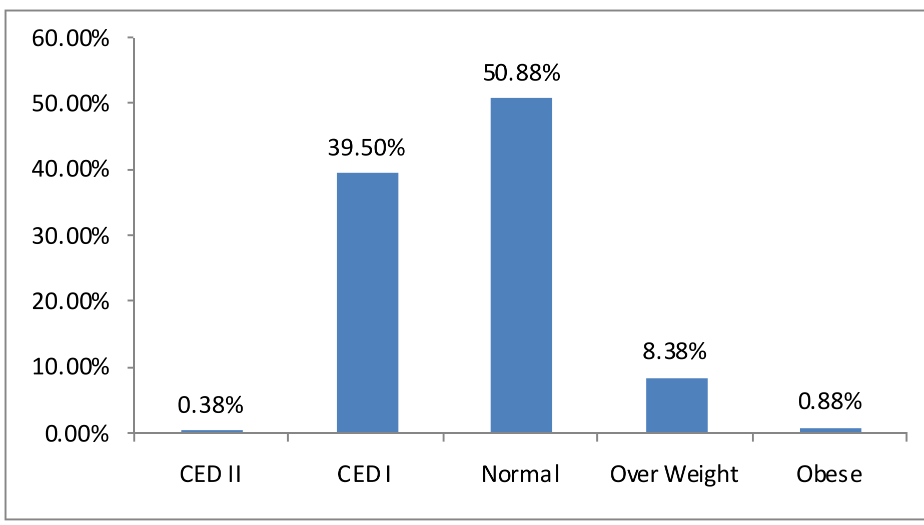


Figure 4.13: The overall prevalence of underweight, overweight, and obesity using WHO (1995) classification among Rajbanshi female individuals.

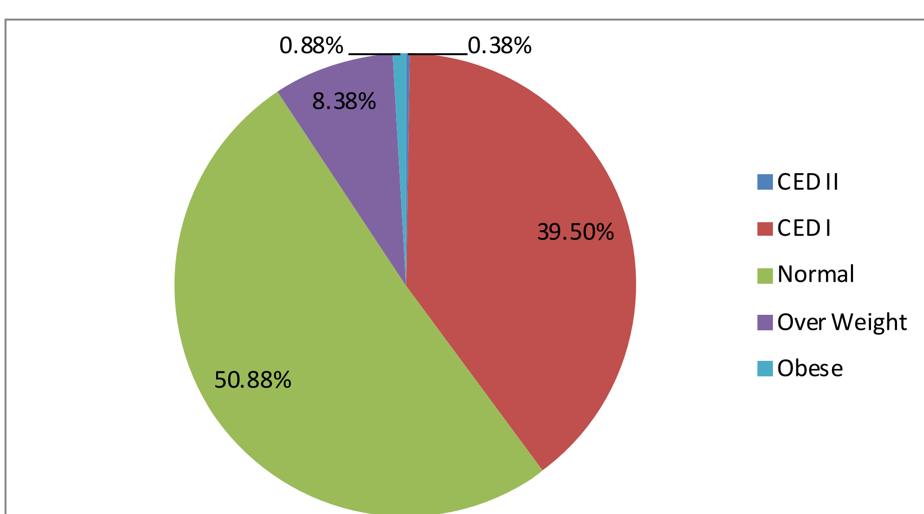


Figure 4.14: Distribution of underweight, overweight and obese using WHO (1995) classification among Rajbanshi female populations

The population was separated into three age groups: 18-29 years old, 30-49 years old, and 50-64 years old (***Table 4.10***). The overall frequency of CED I was high among women aged 50 to 64 years. CED II was found to be 0 % in 18-29 year olds and 02 % in 30-49 year olds. In the earlier age group (18-29 years) the prevalence of CED I was 122 (52.81 %) and in middle-aged group (30-49 years), the CED I was found in 110 (24.78 %).

Table 4.10: Age group wise prevalence of underweight, overweight and obesity measured by WHO (1995) classification among Rajbanshi populations

BMI class	18-29 years	30-49 years	50-64 years
CED I	122(52.81)	110 (24.78)	84 (67.20)
CED II	00 (00)	02 (0.45)	01 (0.80)
Normal	91 (39.39)	288 (64.87)	28 (22.4)
Overweight	15 (6.49)	40 (9.00)	12 (9.6)
Obese	03 (1.29)	04 (0.90)	00 (0.0)
Total	231 (100.00)	444 (100.00)	125 (100)

Figures in the parenthesis are percentage

Overweight was prevalent among middle (30-49 years) and older (50-64 years) aged women, with 40 (9.00 %) and 12 (9.00 %) respectively (9.6 %). However, among people aged 18 to 29, the rate of obesity were 15 (6.49 %). Obesity prevalence, on the other hand, was higher among younger women (118-29 years) and lower among older women (50-64 years) with 03 (1.29 %) and 0 (0.0 %) respectively. Obesity was found to be 0.90 % in the middle age group (30-49 years), with 4 people. ***Figure 4.15*** depicted the overall results graphically.

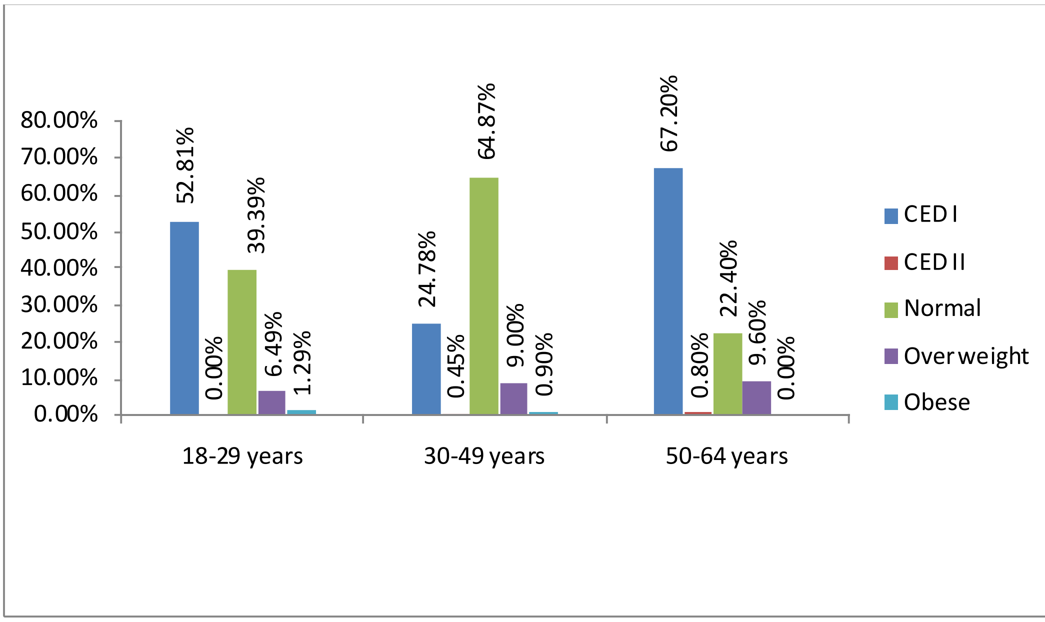


Figure 4.15: Age group wise distribution of underweight, overweight and obese measured by WHO (1995) classification among Rajbanshi female populations

4.2.8.2 Nutritional status of Rajbanshi women according to WHO (2000) BMI classification

According to WHO (2000) classification, 37.50 % are underweight ***(Table 4.11)***. According to the results, 37.62 % of the population was normal, whereas 15.62 % of the people were overweight. Obesity prevalence was further separated into obese I and obese II groups. Obese I and II people made up 8.38 % (67) and 0.88 % (7) of the group, respectively. ***Figure 4.16*** graphically depicts the general prevalence of underweight, overweight, and obesity among Rajbanshi people.

Table 4.11: Prevalence of undernutrition, overweight and obesity using WHO (2000) classification among Rajbanshi female population

Class	BMI (kg/m^2)	Individuals (N=800)
Underweight	<19.50	300 (37.50)
Normal	19.50-22.99	301 (37.62)
Overweight	≥23.00	125(15.62)
Obese I	25.00-29.99	67(8.38)

Obese II	≥30.00	7 (0.88)
Total		800 (100.00)

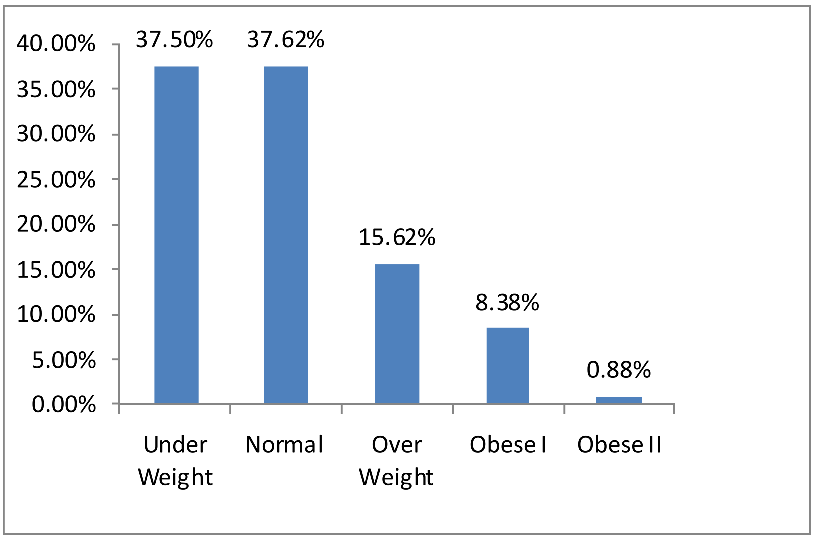


Figure 4.16: The prevalence of underweight, overweight, and obesity Measured by WHO (2000) classification among Rajbanshi female individuals

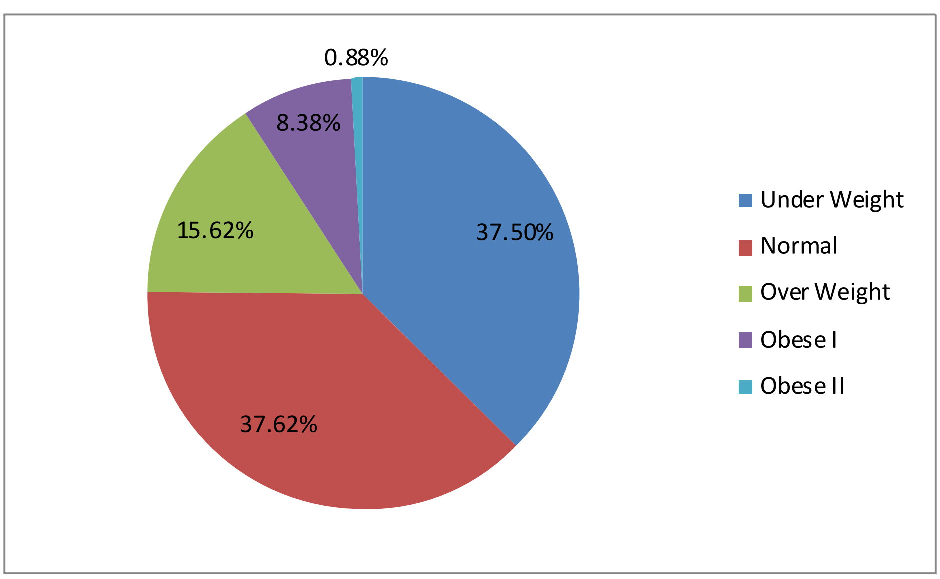


Figure 4.17: Distribution of underweight, overweight, normal and obesity measured by WHO (2000) classification among Rajbanshi adult female individuals

According to the WHO's BMI categorization from 2000, the percentage of underweight was 56 % in the 50-64 year old group, 51 % in the 18-29 year old group, and 25.22 % in the 30-49 year old group. Overweight was found in 16.45 percent of 18-29 year old women and 16.21 percent of 30-49 year old women. Overweight prevalence was found to be low (12.00%) among elderly women (50-64 years). Obesity I, on the other hand, was found to be prevalent in 9 % of 40 women and 9.60 % of 12 women aged 30-49 and 50-64 years, respectively. Obesity I was uncommon in the 18-29 year old age group. In the same way, the frequency of obese II was 1.29 % and 0.90 % with 3 and 4 individuals in the 18-29 and 30-49 age groups, respectively. Obesity II was not common among older women, with a frequency of 0%. ***Figure 4.18*** depicts the consequences of this description graphically.

Table 4.12: Age group wise prevalence of undernutrition, overweight and obesity measured by WHO (2000) classification among Rajbanshi female population

BMI grades	18-29 years	30-49 years	50-64 years
Underweight	118(51.08)	112 (25.22)	70 (56.00)
Normal	57 (24.68)	216 (48.64)	28 (22.40)
Overweight	38 (16.45)	72 (16.21)	15 (12.00)
Obese I	15 (6.49)	40 (9.00)	12 (9.60)
Obese II	03 (1.29)	04 (0.90)	00(0.00)
Total	231 (100.00)	444 (100.00)	125 (100.00)

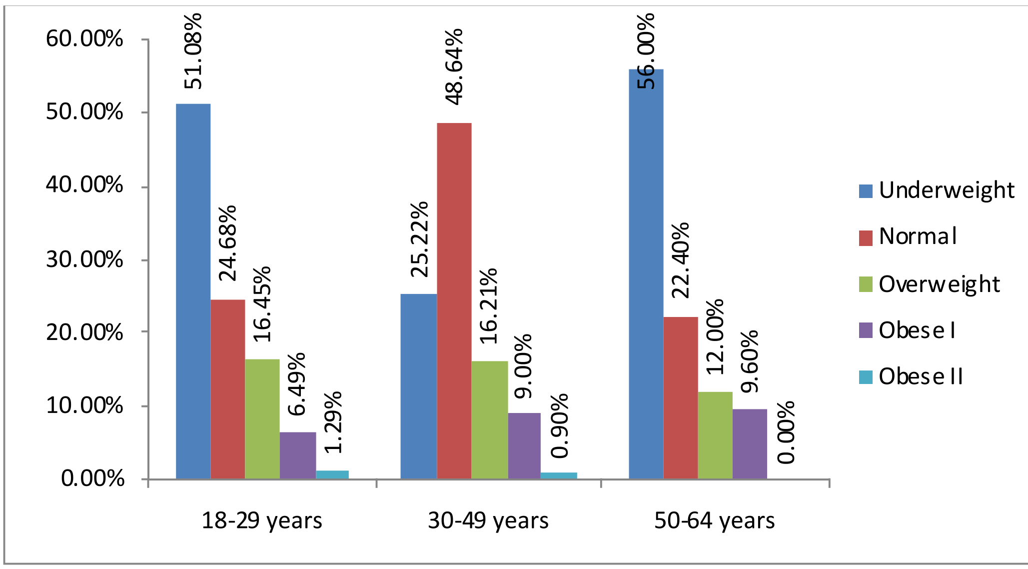


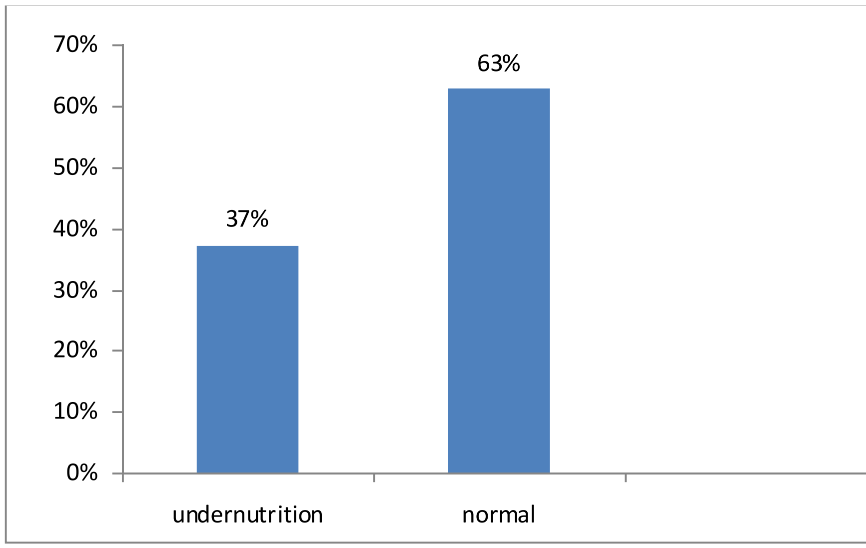
Figure 4.18: Age group wise prevalence of underweight, overweight and obesity using WHO (2000) classification among Rajbanshi female populations

4.2.9 Assessment of Nutritional Status using MUAC among Rajbanshi female individuals

James et al., 1994 established sex-specific cut-off values for MUAC for under-nutrition (beneath 23 for male, bellow 22 for female) to measure nutritional status. ***Table 4.13*** shows the frequency of undernutrition among Rajbanshi female populations. With 298 people, the general frequency of undernutrition was 37 %, whereas 63 % of 502 women were normal. **Figure 4.19** shows the graphical distribution.

Table 4.13: Prevalence of under-nutrition based on MUAC cut off (By James et al, 1994) among Rajbanshi female populations

Nutritional status	Population
Under-nutrition	298 (37.00%)
Normal	502 (63.00%)
Total	800 (100.00%)



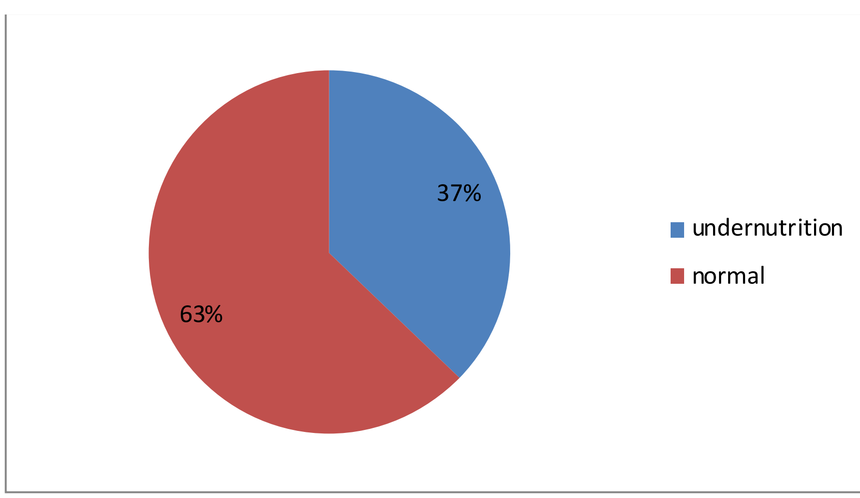


Figure 4.19: Distribution of under-nutrition using MUAC among Rajbanshi female individuals

The age specific prevalence of under-nutrition was high (43.20%) among older aged women (50-64 years). The prevalence was 40.70% with 94 women among 19-29 years aged populations. In middle aged women (30-49 years), the prevalence was 33.80% with 150 individuals. Similarly women among 30-49 years had 294 normal individuals then 50-64 years females (56.80%). The results are shown in ***Table 4.14*** and graphical distributions are presented in ***Figure 4.20.***

Table 4.14: Age group wise prevalence of under-nutrition measured by MUAC among Rajbanshi female individuals

MUAC class	18-29 years	30-49 years	50-64 years
Under-nutrition	94(40.70%)	150(33.80%)	54(43.20%)
Normal	137(59.31%)	294(66.22%)	71(56.80%)
Total	231(100%)	444(100%)	125(100%)

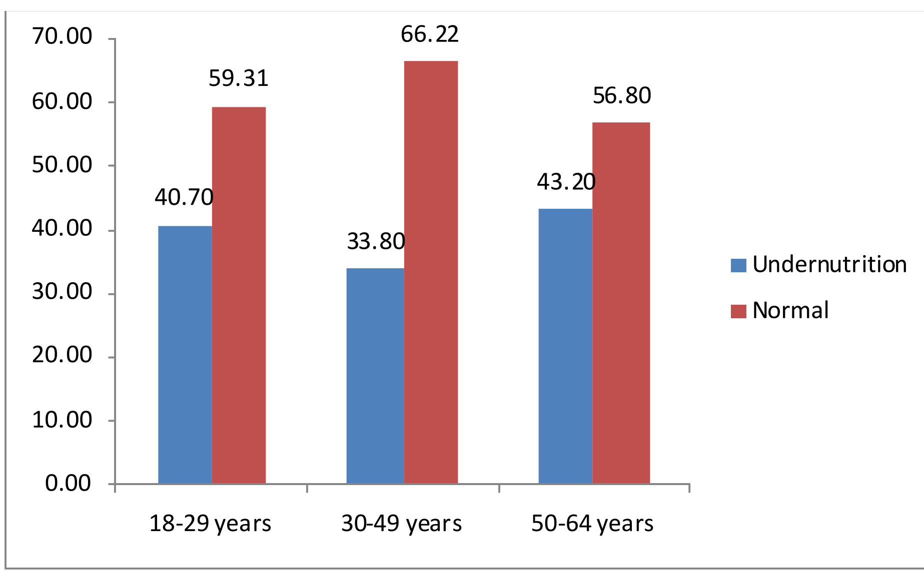


Figure 4.20: Age group wise distribution of under-nutrition measured by MUAC among Rajbanshi female individuals

4.2.10 Assessment of Nutritional Status using combination of BMI and MUAC among Rajbanshi female individuals

Rajbanshi persons' nutritional status was also measured using a combination of BMI and MUAC (***Table 4.15*)**. The results revealed that 298 (37.25%) people were undernourished, with 190 (23.75%) women falling into the normal category and 105 (13.12%) women falling into the CED I category. CED II, overweight, and obesity were assigned to the remaining 1 (0.13 %), 2 (0.25 %), and 0 (0.0 %) people, respectively. It was also discovered that 330 people (41.25 %) had normal BMI and MUAC readings. In addition, 62.75 % of the women had normal MUAC levels, with 12.25 % having CED I, 0.25 % having CED II, 8.12 % being overweight, and 0.88 % being obese. ***Figure 4.21*** depicted the outcome graphically as well.

Table 4.15: Prevalence of under-nutrition measured by in combination with BMI and MUAC among theRajbanshi female individuals

MUAC	CED I	CED II	Normal	Overweight	Obese	Total
<22 cm	105(13.12%)	1(0.13%)	190(23.75%)	2(0.25%)	0(0.00%)	298(37.25%)
≥22 cm	98(12.25%)	2(0.25%)	330(41.25%)	65(8.12%)	7(0.88%)	502(62.75%)
Total	203(25.37%)	3(0.38%)	520(65.00%)	67(8.37%)	7(0.88%)	800(100%)

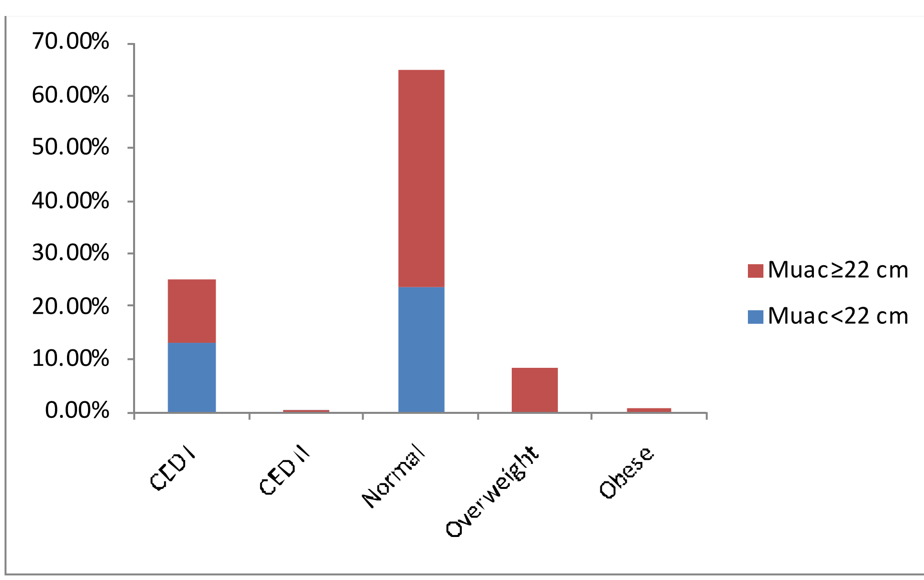


Figure 4.21: Prevalence of under-nutrition measured by combination of BMI and MUAC among Rajbanshi female individuals

4.2.11 Prevalence of Central Adiposity and Overall adiposity among Rajbanshi female individuals

The prevalence of central adiposity and overall adiposity was also identified by using the cut-offs for WC, WHR (WHO, 2000), WHtR (WHO, 2008) along with BMI for overweight (WHO, 1995, 2000). Based on

BMI ($\geq$25 kg/m^2)) criteria (WHO, 1995), the overall prevalence of overweight and obesity was 9.25% (74 women). On the other hand the prevalence of overweight was 24.87% (199 women) according to WHO (2000) BMI ($\geq$23 kg/m^2) criteria among Rajbanshi female individuals. These results are presented in ***Table 4.16***.

WC was also used to evaluate regional adiposity; it was discovered that the overall prevalence of regional obesity was 52.37 %, with 419 women. These women were at risk for adiposity-related health problems. Similarly, when we used WHR as a measure of adiposity index, we found that 96.63 percent of women were obese and had a higher risk of fat-related health issues. Another indicator of central obesity was WHtR, which revealed that 547 Rajbanshi people (68.37 percent) were at risk of adiposity-related disorders. ***Figure 4.22*** depicts the results.

Among different indices used to identify the adiposity related health problems, WHR had highest percentage of individuals (96.63%) compare then WHtR (68.37%), WC (52.37%), BMI, 2000 (24.87%) and BMI, 1995 (9.25%) among Rajbanshi female individuals.

Table 4.16: The prevalence of central obesity and abdominal adiposity in Rajbanshi women

Categories		Total population
BMI (1995) ≥ 25 kg/m^2	Normal	726 (90.75%)
	Obese	74 (9.25%)
BMI (2000) ≥ 23kg/m^2	Normal	601 (75.13%)
	Obese	199 (24.87%)
WC	Normal	381 (47.63%)
	Obese	419 (52.37%)
WHR	Normal	27 (3.37%)
	Obese	773 (96.63%)
WHtR	Normal	253 (31.63%)
	Obese	547 (68.37%)

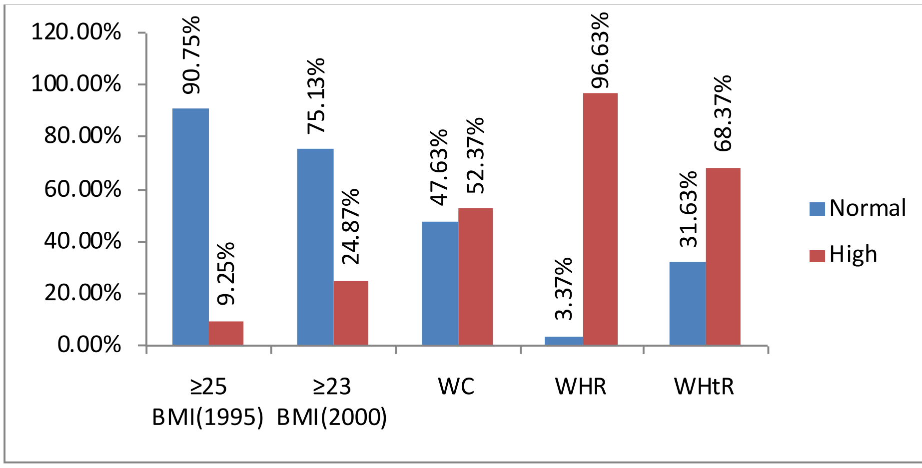


Figure 4.22: The prevalence of central obesity and abdominal adiposity in Rajbanshi women

4.2.11.1 Age specific prevalence of central adiposity among Rajbanshi female individuals

The age specific central obesity was identified by using WC, WHR and WHtR among Rajbanshi female individuals. Utilizing WC, the prevalence was high (53.38%) among middle aged group (30-49 years). Among Rajbanshi populations, 121 (52.38 %) women in their early years (18-29 years) and 61 (48.80 %) women in their later years (50-64 years) were found to be at increased risk of central obesity-related comorbidities. It was also observed that 110 (47.62%) women from 18-29 years, 207 (46.62%) women from 30-49 years and 64 (51.20%) women from 50-64 years were under normal category. The details description of this result was presented in ***Table 4.17*** and ***Figure 4.23.***

4.17: Age group wise prevalence of central adiposity measured by WC among Rajbanshi individuals

WC	18-29 years	30-49 years	50-64 years
High	121(52.38%)	237(53.38%)	61(48.80%)
Normal	110(47.62%)	207(46.62%)	64(51.20%)
Total	231(100%)	444(100%)	125(100%)

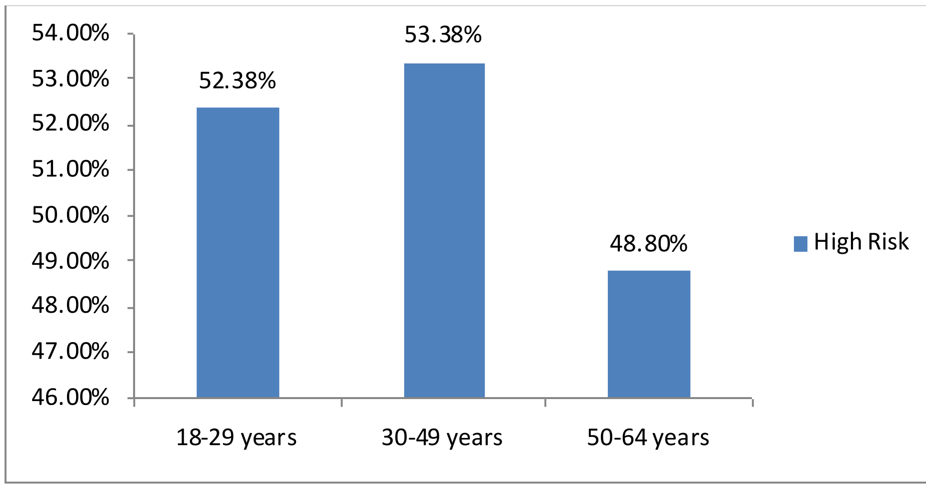


Figure 4.23: Age specific prevalence of WC related health risk among Rajbanshi female individuals

Similarly, using WHR, Rajbanshi female populations showed a wide range of central adiposity ***(Table 4.18).*** Women aged 18-29 years and 30-49 years had a frequency of central obesity of 94.24 % (220) and 97.07 % (431) respectively. Using WHR as a measure of central adiposity, Rajbanshi women aged 52-64 years had a greater (97.60%) risk of central obesity-related morbidity. ***Figure 4.24*** depicts the graphical distribution. The findings also demonstrated that normal WHR ranges were found in lesser women in each age group (18-29 years = 4.76 %, 30-49 years = 2.93 %, 50-64 years = 2.40 %).

4.18: Age group wise prevalence of central adiposity measured by WHR among Rajbanshi individuals

WHR	18-29 years	30-49 years	50-64 years
High	220(94.24%)	431(97.07%)	122(97.60%)
Normal	11(4.76%)	13(2.93%)	03(2.40%)
Total	231(100%)	444(100%)	125(100%)

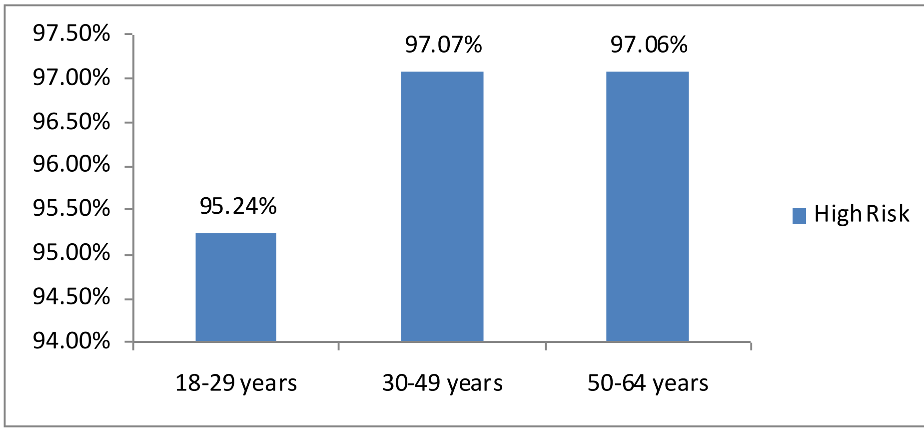


Figure 4.24: Prevalence of central adiposity using WHR among Rajbanshi female individuals

Table 4.19 shows the age-specific distribution of central obesity in Rajbanshi female people using WHtR. When utilizing WHtR as a measure of central obesity, the results showed that 72.29 % (167) of women in the 18-29 age range had an increased risk of obesity-related morbidity. Obesity was also prevalent in the 30-49 year old (66.89 %) and 50-64 year old (66.40 %) age groups. ***Figure 4.25*** illustrates the overall distribution. In addition, fewer women in each age group (18-29 years= 27.71 %, 30-49 years= 33.11 %, 50-64 years= 33.60 %) had a reasonable range of adiposity-related health problems.

Table 4.19: Age group wise prevalence of central adiposity measured by WHtR among Rajbanshi individuals

WHtR	18-29 years	30-49 years	50-64 years
High	167(72.29%)	297(66.89%)	83(66.40%)
Normal	64(27.71%)	147(33.11%)	42(33.60%)
Total	231(100%)	444(100%)	125(100%)

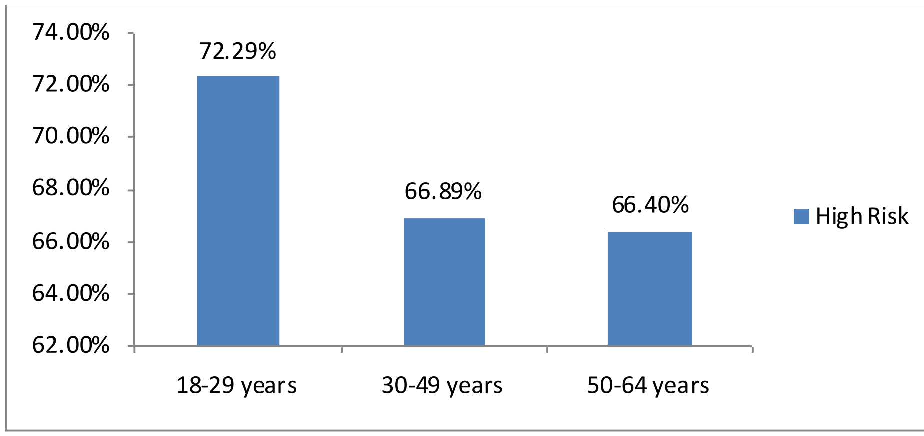


Figure 4.25: Prevalence of central adiposity using WHtR among Rajbanshi female individuals

4.2.12 Assessment of Central Adiposity and Overall adiposity using BMI in combination with WC, WHR, WHtR among Rajbanshi female individuals

The central adiposity and overall adiposity was also identified by using BMI in combination with WC, WHR, WHtR among Rajbanshi female individuals. Excess adiposity was linked to a higher risk of health problems, as indicated by a bridge of BMI and WC, WHR, and WHtR. By WC, the individuals were considered normal, but by BMI, they were considered underweight. According to the findings, 26.38 percent of women were classified as normal by BMI but had significant adiposity by WC. According to the WC and BMI, 181 women exhibited a significant amount of obesity.

BMI was used to identify persons who were normal weight but centrally obese, and WHR was highest (47.13 %) among Rajbanshi female populations. The Rajbanshi people were shown to be more influenced by a combination of BMI and WHR (47.13%) than by a combination of WC (26.38%) and WHtR (36.13%). According to a combined assessment of BMI with WC (22.63 %), WHR (24.38%), and WHtR (24.13 %), a substantial proportion of Rajbanshi women had excess central adiposity linked to morbidities, followed by normal individuals (WC= 2.25%, WHR= 0.50 %, WHtR= 0.75 %). Individuals with a high prevalence of regional adiposity in terms of WHR (>0.9) (N=201, 25.13 %) and WHtR (0.5) (N= 65, 8.13%) were also found to have a high prevalence of regional adiposity in terms of WHR (>0.9)

(N=201, 25.13 %) and WHtR (0.5) (N= 65, 8.13 %). A low level of regional obesity (WHtR<0.5) but higher BMI was found among only 6 num.ber (0.75%) of Rajbanshi women. The details description of this results are depicted in ***Table 4.20*** and graphical distribution is presented in ***Figure 4.26.***

Table 4.20: Adiposity prevalence among Rajbanshi females using BMI in connection with WC, WHR, and WHtR

BMI	WC		WHR		WHtR	
	Normal	High	Normal	High	Normal	High
Underweight (<19.5kg/m^2)	177 (22.30%)	27 (3.38%)	03 (0.38%)	201 (25.13%)	139 (17.38%)	65 (8.13%)
Normal (19.5-23 kg/m^2)	185 (23.25%)	211 (26.38%)	20 (2.50%)	377 (47.13%)	108 (13.50%)	289 (36.13%)
Overweight (>23 kg/m2)	18 (2.25%)	181 (22.63%)	04 (0.50%)	195 (24.38%)	06 (0.75%)	193 (24.13%)

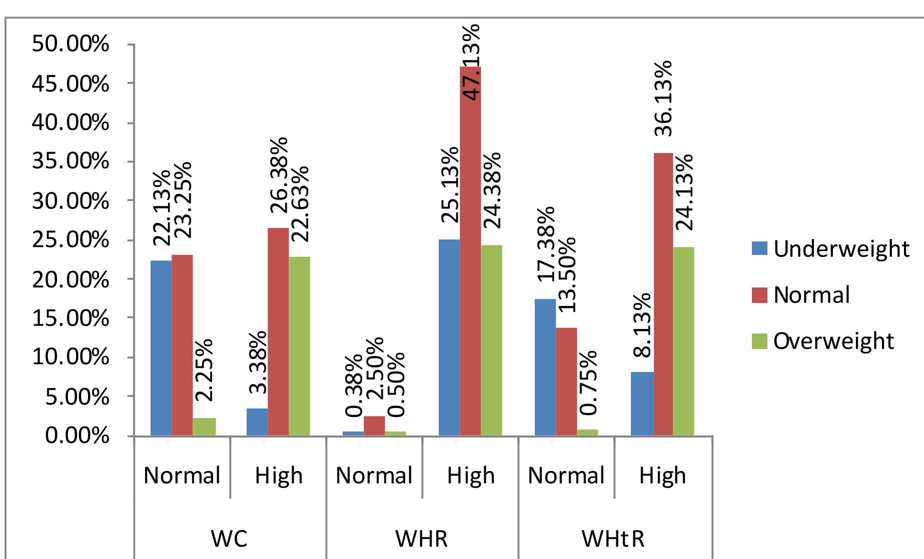


Figure 4.26: Adiposity prevalence among Rajbanshi females using BMI in connection with WC, WHR, and WHtR

4.3 Body Fat and Fitness among Rajbanshi female populations

The body fitness state of Rajbanshi females was also measured, based on PBF and the fitness scale given by Neiman (1995) and Muth (2009).

Table 4.21 shows the body fitness state of Rajbanshi females according to the Neiman categorization. The results showed that ideal fat was found in 83.75% (670) of the women, followed by fat in 16.25% (130) of the women. This is depicted in ***Figure 4.27*** as well. The prevalence of lean and obese women was not discovered in this investigation.

Table 4.21: Distribution of PBF using Nieman (1995) classification among the Rajbanshi female individuals

Body fitness status	Population
Optimal	670 (83.75%)
Fat	130 (16.25%)
Total	800 (100.00%)

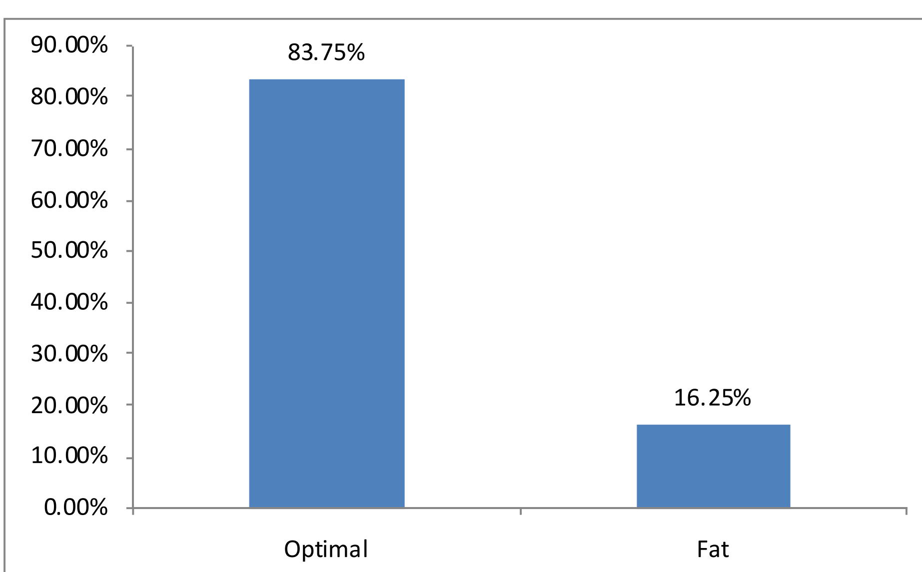


Figure 4.27: Distribution of Body fitness using Nieman (1995) classification among Rajbanshi female individuals

The age specific body fatness among Rajbanshi female individuals according to Neiman classification is presented in ***Table 4.22***. The prevalence of optimal fat is highest among 50-64 years aged women (89.60%) followed by 18-29 years (83.98%) and 30-64 years (81.98%) aged individuals. On the other hand a lower prevalence of body fat was found among 50-64 years (10.40%) of age group. The prevalence of body fat was also low among 18-29 years (16.02%) and 30-49 years (18.02%) of aged populations. The overall age specific prevalence of PBF among Rajbanshi female individuals are graphically presented in ***Figure 4.28***.

Table 4.22: PBF distribution by age groups using Nieman (1995) classification among Female Rajbanshi persons

Age group	Optimal fat	Fat
18-29 years	194 (83.98%)	37 (16.02%)
30-49 years	364 (81.98%)	80 (18.02%)
50-64 years	112 (89.60%)	13 (10.40%)

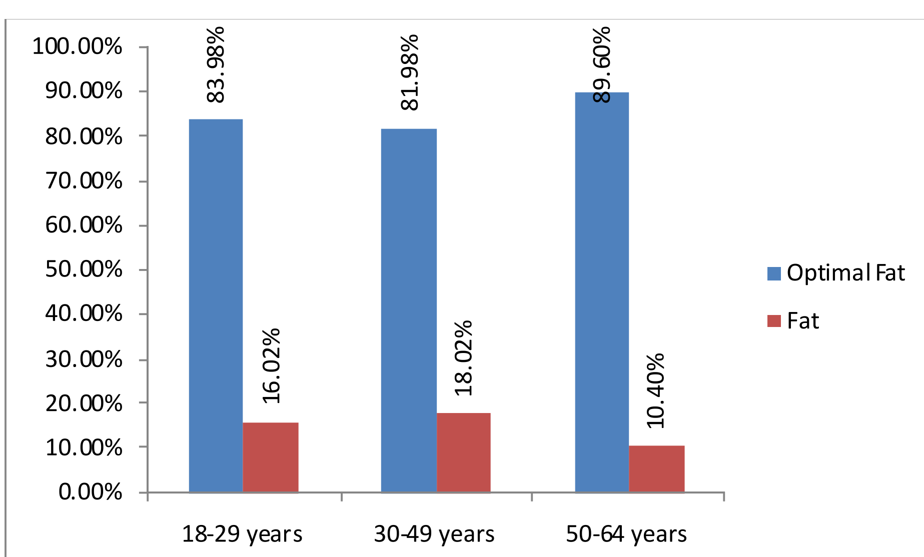


Figure 4.28: Distribution of Body fitness using Nieman (1995) classification among Rajbanshi female individuals

Table 3.23 shows the distribution of PBF in Rajbanshi female populations according to Muth (2009) classification. Normal, underweight, at risk, and obese are the four categories in this classification. In the current study, 87.12 % (697) of the participants were classified as normal, whereas 12.88 % (103) of the women were classified as at risk. ***Figure 4.29*** also illustrated the graphical distribution.

Table 4.23: PBF distribution by using Muth (2009) classification among the Rajbanshi female individuals

Body weight status	Population
Normal	697(87.12%)
Overweight/ at risk	103 (12.88%)
Total	800 (100.00%)

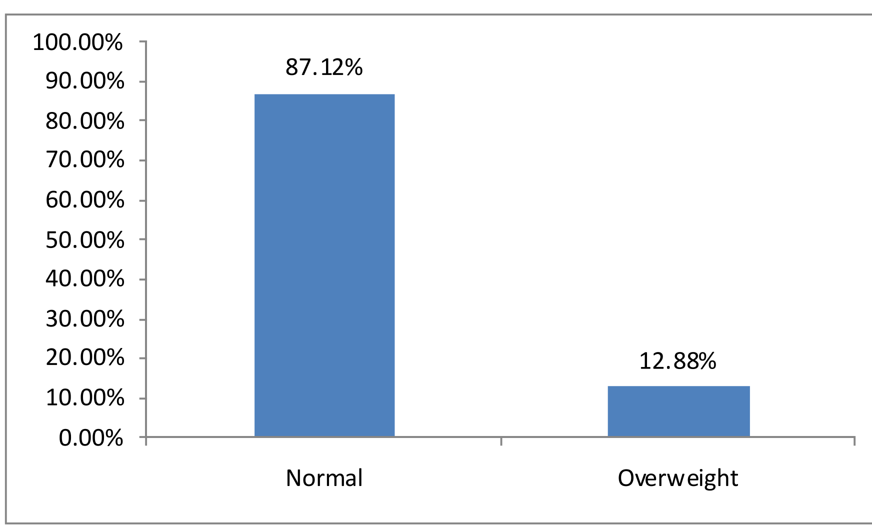


Figure 4.29: Distribution of Body fitness using Muth (2009) classification among Rajbanshi female individuals

Table 4.24 also shows the age-specific percentage of PBF among Rajbanshi females according to Muth (2009) classification. According to the findings, 103 (12.87 %) of women in each age group (18-29 years = 12.12 %, 30-49 years = 14.19 %, and 50-64 years = 9.60 %) were found to be at risk. In this investigation, there was no evidence of underweight or obesity. ***Figure 4.30*** depicted the findings of this investigation graphically.

Table 4.24: PBF distribution by age groups using Muth (2009) classification among Female Rajbanshi persons

Age group	Normal	At high risk
18-29 years	203 (87.38%)	28 (12.12%)
30-49 years	381 (85.81%)	63 (14.19%)
50-64 years	113 (90.40%)	12 (9.60%)
Total	697 (87.13%)	103 (12.87%)

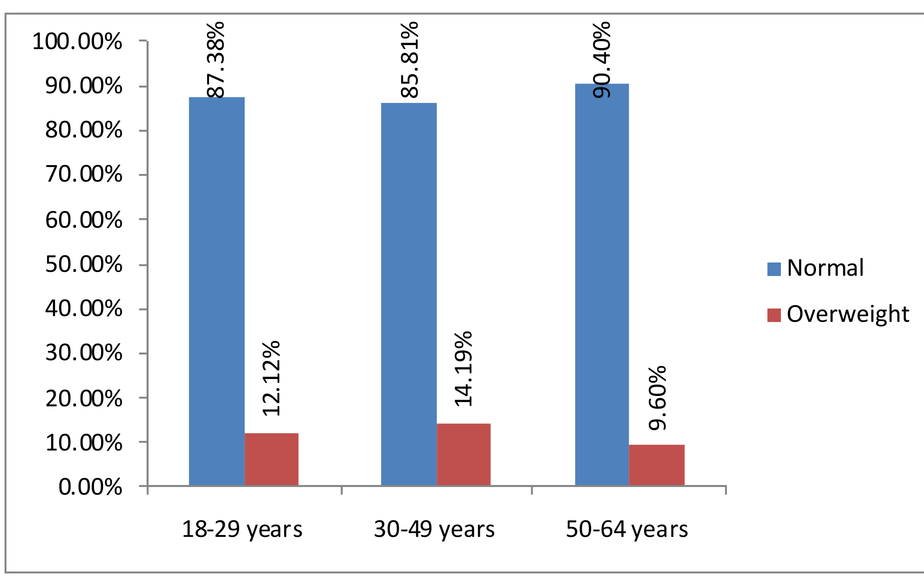


Figure 4.30: PBF distribution by age groups using Muth (2009) classification among Female Rajbanshi persons

4.4 Determinants of underweight, overweight and obesity among Rajbanshi female population

The χ^2 test was used findings to determine the relationship between socioeconomic, demographic, and lifestyle factors and underweight, overweight, and obesity. General adiposity was measured using BMI (23 kg/m^2 and 25 kg/m^2), whereas regional adiposity was measured using WC, WHR, and WHtR in Rajbanshi female populations. The next paragraphs go through the specifics of these.

4.4.1 Socio-economic, demographic and life style factors associated with high BMI (≥ 23 kg/m^2) among Rajbanshi female individuals

The highest frequency of high BMI (23 kg/m2) was found among Rajbanshi persons aged 30-49 years (14.50 %), followed by 18.29 years (7.00 %) and 50-64 years (3.38 %). It should be highlighted that age did not have a significant relationship with BMI (P>0.05). Similarly, high BMI was not observed to be linked with 20.38 % married women and 4.38 % unmarried women (P>0.05). The educational status of Rajbanshi females was connected with BMI values in a meaningful way (p<0.05). High BMI (25 kg/m2) was associated with a lower percentage of illiterate 23 (2.88 %), primary 74 (9.25 %), secondary 71 (8.88 %), and graduate 31 (3.88 %) women. There was also a significant link (p<0.05) between women's occupational position and high BMI values. Overweight and obesity were found in 3.50 % of employed women and 6.25 % of daily worker women. Furthermore, high BMI values were not observed to be connected with family size, family type, or water supply (p>0.05). BMI (25 kg/m^2) was found to be substantially linked with toilet type, monthly family income, family occupation, and SES status. With a high BMI, the toilet type kachha house showed 2.50 %, followed by 14.25 percent for pakka type and 8.13 percent for semi-pakka type. Individuals with a monthly income of up to 5000 are represented by 2.13 percent of the population, followed by those with a monthly income of 5001- 10000Rs (10.00 %) and 10001Rs (12.75 %). The occupational status of family like farmer consists of 11.50% women followed by 1.63% labor, 6.13% govt. service and 5.63% of businessman and other workers. The female individuals falling under upper SES scale of Kuppuswamy was 0.75%, followed by lower (4.88%), upper middle (6.13%) and middle (13.13%) ($p<0.05$). The χ^2 value is presented in ***Table 4.25.***

Table 4.25: Socioeconomic, demographic and lifestyle variables associated with high BMI (≥23 kg/m^2) among Rajbanshi female individuals

Factors	categories	BMI (High)	BMI (Normal)	χ^2 value
Age group	18-29 years	56(7.00)	175(21.88)	1.139;
	30-49 years	116(14.50)	328(41.00)	df=2;
	50-64 years	27(3.38)	98(12.25)	p>0.05
Marital status	Married	163(20.38)	449(56.13)	4.509;
	Unmarried	35(4.38)	149(18.63)	df=2;
	Widowed/separated	01(0.13)	03(0.38)	p>0.05
Education	Illiterate	23(2.88)	118(14.75)	17.24;
	Primary	74(9.25)	185(23.13)	df=3;
	Secondary	71(8.88)	155(19.38)	p<0.05
	Graduate	31(3.88)	143(17.88)	
Women occupation	Employee	28(3.50)	41(5.13)	10.346;
	House wife	121(15.13)	382(47.75)	df=2;
	Daily worker	50(6.25)	178(22.25)	p<0.05
Family Size	Upto4 members	59(7.38)	165(20.63)	2.27;
	5-6	91(11.38)	257(32.13)	df=3;
	7-8	22(2.75)	72(9.00)	p>0.05
	≥9	27(3.38)	107(13.38)	
Family type	Nuclear	106(13.25)	284(35.50)	2.163;
	Joint	93(11.63)	317(39.63)	df=1; p>0.05
Water supply	Well	41(5.13)	149(18.63)	4.994;
	Tube well	154(19.25)	423(52.88)	df=2; p>0.05
	Govt. supply	04(0.50)	29(3.63)	

House type	Kachha	23(2.88)	138(17.25)	35.40;
	Pakka	78(9.75)	117(14.63)	df=2;
	Semipakka	98(12.25)	346(43.25)	p<0.05
Toilet type	Kachha	20(2.50)	120(15.00)	25.972;
	Pakka	114(14.25)	225(28.13)	df=2;
	Semipakka	65(8.13)	256(32.00)	p<0.05
Monthly income	Up to 5000	17(2.13)	110(13.75)	29.116;
	5001-10,000RS	80(10.00)	304(38.00)	df=2;
	>10001 RS	102(12.75)	187(23.38)	p<0.05
Family occupation	Farmer	92(11.50)	374(46.75)	30.235;
	Labor	13(1.63)	67(8.38)	df=3;
	Govt. service	49(6.13)	77(9.63)	p<0.05
	Others/Business	45(5.63)	83(10.38)	
SES (Kupposwamy)	Lower	39(4.88)	185(23.13)	23.238;
	Middle	105(13.13)	332(41.50)	df=3;
	Upper middle	49(6.13)	77(9.63)	p<0.05
	Upper	06(0.75)	07(0.88)	

4.4.2 Association of socio-economic, demographic and life style variables with High BMI (≥ 25 kg/m2) among Rajbanshi female individuals

Among Rajbanshi female individuals the prevalence of overweight and obese women was less compare then normal individuals (obese vs normal: 2.25%/26.63%; 5.50%/50.00%; 1.50%/ 14.13%). The result showed that there was no significant association between age group and BMI (≥25 kg/m^2) (P>0.05). However 8.13% married women and 1.00% unmarried women showed significant relation with high BMI values (p<0.05). High BMI was not shown to be connected with women's educational status, employment status, or family size (p>0.05). Family type, like nuclear family (5.50%) and joint family (3.75%) was significantly associated with high BMI (p<0.05). House style, toilet type, monthly family income, family occupation, and SES level were also found to be significantly linked. 1.25% women showed kachha house with high BMI followed by semi-pakka (3.38%) and pakka (4.63%). The pakka toilet type showed

5.38% women with high BMI (≥25 kg/m^2) then semi-pakka (2.28%) and kachha (1.00%). The monthly family income >10001Rs consist of 4.75% individuals followed by the monthly income of 5001-10,000 Rs (3.38%) and up to 5000 Rs (1.13%). Similarly 3.88% farmer and 2.63% govt. services family members showed significant association with high BMI (P<0.05). The SES status of Rajbanshi women showed a significant association with BMI (p<0.05). 4.25% Rajbanshi women were under middle SES status of Kuppuswamy followed by 2.88% upper middle, 2.00% lower and 0.13% upper. The χ^2 values of this result are depicted in ***Table 4.26***.

Table 4.26: Socioeconomic, demographic and lifestyle variables associated with high BMI (≥25 kg/m^2) among Rajbanshi female individuals

Factors	categories	BMI (High)	BMI (Normal)	χ^2 value
Age group	18-29 years	18(2.25)	213(26.63)	0.833;
	30-49 years	44(5.50)	400(50.00)	df=2;
	50-64 years	12(1.50)	113(14.13)	p>0.05
Marital status	Married	65(8.13)	547(68.38)	6.432;
	Unmarried	08(1.00)	172(21.50)	df=2;
	Widowed/separated	01(0.13)	07(0.88)	p<0.05
Education	Illiterate	12(1.50)	129(16.13)	4.195;
	Primary	26(3.25)	233(29.13)	df=3;
	Secondary	26(3.25)	200(25.00)	p>0.05
	Graduate	10(1.25)	164(20.50)	
Women occupation	Employee	08(1.00)	61(7.63)	3.787;
	House wife	52(6.50)	451(56.38)	df=2;
	Daily worker	14(1.75)	214(26.75)	p>0.05
Family Size	Upto4 members	25(3.13)	199(24.88)	2.775;
	5-6	33(4.13)	315(39.38)	df=3;
	7-8	08(1.00)	86(10.75)	p>0.05
	≥9	08(1.00)	126(15.75)	

Family type	Nuclear	44(5.50)	346(43.25)	3.743; df=1; p<0.05
	Joint	30(3.75)	380(47.50)	
Water supply	Well	15(1.88)	175(21.88)	0.559; df=2; p>0.05
	Tube well	56(7.00)	521(65.13)	
	Govt. supply	03(0.38)	30(3.75)	
House type	Kachha Pakka	10(1.25) 37(4.63)	151(18.88) 158(19.75)	29.049; df=2; p<0.05
	Semipakka	27(3.38)	417(52.13)	
Toilet type	Kachha	08(1.00)	132(16.50)	8.51; df=2; p<0.05
	Pakka	43(5.38)	296(37.00)	
	Semipakka	23(2.88)	298(37.25)	
Monthly income	Up to 5000Rs	09(1.13)	118(14.75)	8.193; df=2; p<0.05
	5001-10,000 RS	27(3.38)	357(44.63)	
	>10001 RS	38(4.75)	251(31.38)	
Family occupation	Farmer	31(3.88)	435(54.38)	12.95; df=3; p<0.05
	Labor	07(0.88)	73(9.13)	
	Govt. service	21(2.63)	105(13.13)	
	Others/Business	15(1.88)	113(14.13)	
SES (Kupposwamy)	Lower	16(2.00)	208(26.00)	14.516; df=3; p<0.05
	Middle	34(4.25)	403(50.38)	
	Upper middle	23(2.88)	103(12.88)	
	Upper	01(0.13)	12(1.50)	

4.4.3 Socio-economic, demographic and life style factors associated with high WC (≥ 80 cm) among Rajbanshi female individuals

The percentage of central adiposity-related risk factors as defined by WC (≥80 cm) was highest in people aged 30-49 years (25.87%) of age group, which was followed by 13.75% among 18-29 years and 8.00% among 50-64 years of age. There was not any significant association between BMI and age divisions (p>0.05). The result showed that women occupational status was found associated significantly with High

WC (>80cm). 31.62% house wife and 13.62% daily labourer were significantly associated with high central adiposity related health problems ($p<0.05$). Women's marital status and educational position were not shown to be linked to WC-related health issues. 28.12% individuals had semi-pakka house with 21.37% semi-pakka toilet showed significant association with high WC related adiposity($p<0.05$). Similarly family monthly income, family occupation and SES status were found to be highly associated with high WC among female Rajbanshi populations ($p<0.05$). 27.12% individuals of middle SES group, 30.37% individuals of farmer, 24.87% individuals of monthly income of 5001-10000 Rs were observed to be associated with high WC related adiposity ($p<0.05$). The remaining variables like family size, family type and water supply were not found to be associated with WC related central adiposity among Rajbanshi female populations. The result of χ^2 tests was presented in ***Table 4.27***.

Table 4.27: Socioeconomic, demographic and lifestyle factors associated with high WC (≥80cm) among Rajbanshi female individuals

Factors	categories	WC (Normal)	WC(High)	χ^2 value
Age group	18-29 years	110(13.75)	121(15.12)	0.820; df=2, P>0.05
	30-49 years	207(25.87)	237(29.62)	
	50-64 years	64(8.00)	61(7.62)	
Marital status	Married	286(35.75)	326(40.75)	1.312 ;df=2 P>0.05
	Unmarried	90(11.25)	90(11.25)	
	Widowed/separated	05(0.62)	03(0.37)	
Education	Illiterate	72(9.00)	69(8.62)	6.903; df=3, P>0.05
	Primary	121(15.12)	138(17.25)	
	Secondary	94(11.75)	132(16.5)	
	Graduate	94(11.75)	80(10.00)	
Women occupation	Employee	19(2.37)	50(6.25)	12.607; df=2, P<0.05
	House wife	253(31.62)	250(31.25)	
	Daily worker	109(13.62)	119(41.87)	

Family Size	Upto4 members	108(13.5)	116(14.5)	0.805; df=3, P>0.05
	5-6	170(21.25)	178(22.5)	
	7-8	42(5.25)	52(6.5)	
	≥9	61(7.62)	73(9.12)	
Family type	Nuclear	187(23.37)	203(25.37)	0.032; df=1, P>0.05
	Joint	194(24.25)	216(27.00)	
Water supply	Well	93(11.62)	97(12.12)	1.677; df=2, P>0.05
	Tube well	267(33.37)	308(38.50)	
	Govt. supply	19(2.37)	14(1.75)	
House type	Kachha	98(12.25)	63(7.87)	37.97; df=2, P<0.05
	Pakka	58(7.25)	137(17.12)	
	Semipakka	225(28.12)	219(27.37)	
Toilet type	Kachha	90(11.25)	50(6.25)	40.00; df=2, P<0.05
	Pakka	120(15.00)	219(27.37)	
	Semipakka	171(21.37)	150(18.75)	
Monthly income	Up to 5000 Rs	76(9.5)	51(6.37)	24.19; df=2, P<0.05
	5001-10,000RS	199(24.87)	185(23.12)	
	>10001 RS	106(13.25)	183(22.87)	
Family occupation	Farmer	243(30.37)	223(27.87)	27.23; df=3, P< 0.05
	Labor	47(5.87)	33(4.12)	
	Govt. service	36(4.50)	90(11.25)	
	Others/Business	55(6.87)	73(9.12)	
SES (Kupposwamy)	Lower	130(16.25)	94(11.75)	40.83; df=3, P<0.05
	Middle	217(27.12)	220(27.50)	
	Upper middle	32(4.00)	94(11.75)	
	Upper	02(0.25)	11(1.37)	

4.4.4 Socio-economic, demographic and life style factors associated with high WHtR (> 0.5cm) among Rajbanshi female individuals

A high prevalence of WHtR related adiposity was found among Rajbanshi female populations. In middle age (30-49 years), 37.12% women were found to have high WHtR related regional adiposity followed by 20.87% among 18-29 years and 10.37% among 50-64 years. But there were not any significant relation between age groups and BMI (P>0.05). Similarly, neither marital nor educational status were found to be related to BMI (p>0.05). 51.75% married women and 22.62% primarily educated women showed high WHtR related regional adiposity then normal women (married= 24.75%, primary education= 9.75%). Women occupational status was found to be highly associated with high WHtR related adiposity (p<0.05). It was observed that 41.87% housewife and 19.87% daily worker were significantly associated with high WHtR related risk factors. However family size, family type and water supply were found not to be associated with high WHtR related adiposity (p>0.05). Semi-pakka house residents had a greater risk of WHtR, followed by pakka (20.75 %) and kachha (11.50 %) house residents. 34.37% individuals with pakka toilet had higher WHtR related regional adiposity followed by semi-pakka (25.50%) and kaccha type (8.50%). 38.50% farmer were observed with high WHtR in present study (p<0.05). The densities of Rajbanshi females were found to be highest in the middle (37.00 %) SES group, followed by lower (17.00 %), upper-middle (12.87 %), and upper (1.50%) SES categories . High WHtR readings were reported in 31.50 % with a monthly salary of 5001-10000 Rs, compared to 16.50 % of normal women. ***Table 4.28*** displays the results of the χ^2test as well as the distribution of the other variables.

Table 4.28 Association of socioeconomic, demographic and lifestyle determinants on high WHtR (>0.5 cm) among Rajbanshi female individuals

Factors	categories	WHtR(Normal)	WHtR(High)	χ^2 value
Age group	18-29 years	64(8.00)	167(20.87)	2.318;
	30-49 years	147(18.37)	297(37.12)	df=2,
	50-64 years	42(5.25)	83(10.37)	P>0.05

Marital status	Married	198(24.75)	414(51.75)	1.723; df=2, P>0.05
	Unmarried	54(6.75)	126(15.75)	
	Widowed/separated	01(0.12)	07(0.87)	
Education	Illiterate	54(6.75)	87(10.87)	5.432; df=3, P>0.05
	Primary	78(9.75)	181(22.62)	
	Secondary	62(7.75)	164(20.50)	
	Graduate	59(7.37)	115(14.37)	
Women occupation	Employee	12(1.5)	57(7.12)	7.214, df=2, P<0.05
	House wife	168(21.00)	335(41.87)	
	Daily worker	73(9.12)	155(19.37)	
Family Size	Upto4 members	73(9.12)	151(18.87)	2.498; df=3, P>0.05
	5-6	117(14.62)	231(28.87)	
	7-8	25(3.12)	69(8.62)	
	≥9	38(4.75)	96(12.00)	
Family type	Nuclear	132(16.5)	258(32.25)	1.736,df=1 P>0.05
	Joint	121(15.12)	289(36.12)	
Water supply	Well	70(8.75)	120(15.00)	3.138, df=2, P>0.05
	Tube well Govt. supply	173(21.62) 10(1.25)	404(50.00) 23(2.87)	
House type	Kachha	71(8.87))	90(11.25)	38.546; df=2, P<0.05
	Pakka	29(3.62)	166(20.75)	
	Semipakka	153(19.12)	291(36.37)	
Toilet type	Kachha	72(9.00)	68(8.50)	54.315; df=2, P<0.05
	Pakka	64(8.00)	275(34.37)	
	Semipakka	117(14.62)	204(25.50)	
Monthly income	Up to 5000 Rs	52(6.50)	75(9.37)	14.411; df=2, p<0.05
	5001-10,000RS	132(16.50)	252(31.50)	
	>10001 RS	69(8.62)	220(27.50)	
Family occupation	Farmer	158(19.75)	308(38.50)	11.169; df=3, p<0.05
	Labor	31(3.87)	49(6.12)	
	Govt. service	25(3.12)	101(12.62)	

	Others/Business	39(4.87)	89(11.12)	
SES (Kupposwamy)	Lower	88(11.00)	136(17.00)	20.023; df=3, p<0.05
	Middle	141(17.62)	296(37.00)	
	Upper middle	23(2.87)	103(12.87)	
	Upper	01(0.12)	12(1.50)	

4.4.5 Socio-economic, demographic and life style factors associated with high WHR (> 0.8 cm) among Rajbanshi female individuals

A high frequency of WHR-related obesity was discovered among Rajbanshi people. WHR was found to be prevalent among Rajbanshi female populations in 74.50 % of married women and 53.87 % of those aged 30-49. In addition, educational and occupational status were not shown to be substantially linked with WHR in Rajbanshi populations (p>0.05). 60.75% housewife was observed a high WHR values in present study (p>0.05). Furthermore, among Rajbanshi people, family size and family type were found to have a significant connection with high WHR (p<0.05). The fact that 50.37 % of women had a joint family of 5-6 individuals (42.75 %) was associated with a high WHR (p<0.05). Female Rajbanshi individuals living in semi-pakka houses (54.37 %) with pakka toilets (40.62 percent) were found to have elevated WHR linked regional obesity. However, high WHR was found to be substantially linked with monthly family income and family occupation (p<0.05). There were high WHR related morbidities among Rajbanshi female populations in 56.87 % of farmers with monthly incomes of 5001-10001 Rs (46.75 %). The distribution of female individuals were identified as high in middle (53.00%) SES category followed by lower (27.25%), upper-middle (15.00%) and upper (1.37%). The details description of this result and χ^2 values are depicted in ***Table 4.29.***

Table 4.29: Association of socioeconomic, demographic and lifestyle determinants on high WHR (>0.8 cm) among Rajbanshi female individuals

Factors	categories	WHR(Normal)	WHR (High)	χ^2 value
Age group	18-29 years	11(1.37)	220(27.50)	2.00;

	30-49 years	13(1.62)	432(53.87)	df=2,
	50-64 years	03(0.37)	122(15.25)	p>0.05
Marital status	Married	18(2.25)	594(74.5)	2.09;
	Unmarried	09(1.12)	171(21.37)	df=2,
	Widowed/separated	00(0.00)	08(1.00)	p>0.05
Education	Illiterate	06(0.75)	135(16.87)	3.35;
	Primary	07(0.87)	252(31.50)	df=3,
	Secondary	05(0.62)	221(27.62)	p>0.05
	Graduate	09(1.12)	165(20.62)	
Women occupation	Employee	05(0.62)	64(8.00)	4.144;
	House wife	17(2.12)	486(60.75)	df=2,
	Daily worker	05(0.62)	223(27.87)	p>0.05
Family Size	Upto4 members	18(2.25)	206(25.75)	21.117;
	5-6	06(0.75)	342(42.75)	df=3,
	7-8	02(0.25)	92(11.50)	p<0.05
	≥9	01(0.12)	133(16.62)	
Family type	Nuclear	20(2.50)	370(46.25)	7.173;
	Joint	07(0.87)	403(50.37)	df=1, p<0.05
Water supply	Well	08(1.00)	182(22.75)	1.571;
	Tube well	19(2.37)	558(69.75)	df=2,
	Govt. supply	00(0.00)	33(4.12)	p>0.05
House type	Kachha	05(0.62)	156(19.50)	8.989;
	Pakka	13(1.62)	182(22.75)	df=2,
	Semipakka	09(1.12)	435(54.37)	p<0.05
Toilet type	Kachha	05(0.62)	135(16.87)	1.376;
	Pakka	14(1.75)	325(40.62)	df=2,
	Semipakka	08(1.00)	313(39.12)	p>0.05
Monthly income	Up to 5000 Rs	02(0.25)	125(15.62)	4.882;
	5001-10,000Rs	10(1.25)	374(46.75)	df=2,
	>10001 Rs	15(1.87)	274(34.25)	p<0.05

Family occupation	Farmer	11(1.37)	455(56.87)	11.349; df=3, p<0.05
	Labor	00(0.00)	80(10.00)	
	Govt. service	07(0.87)	119(14.87)	
	Others/Business	09(0.50)	119(14.87)	
SES (Kupposwamy)	Lower	06(0.75)	218(27.25)	7.041; df=3, p>0.05
	Middle	13(1.62)	424(53.00)	
	Upper middle	06(0.75)	120(15.00)	
	Upper	02(0.25)	11(1.37)	

4.5 Logistic regression analysis to ascertain the determinants of underweight, overweight and obesity among Rajbanshi female population

A binary logistic regression analysis was done to determine significant causes of underweight and overweight in Rajbanshi women from North Bengal. This exam was used to classify the factors that contribute to being underweight, overweight, or obese (BMI classification given by WHO 1995, 2000 and measure central adiposity by WC, WHR, WHtR).

4.5.1 Logistic regression for females with a high WC (> 80 cm)

The effect of socioeconomic, demographic, and lifestyle variables on adiposity-related morbidities and mortalities on high WC among Rajbanshi female populations was investigated using binary logistic regression ***(Table 4.30).***

In the regression analysis, family size, family type, water supply, housing type, bathroom type, monthly salary, and family profession were all highly significant for being at risk of increased WC (p<0.05). Females from nuclear families (odd= 1.82, 95% CI= 1.37-2.41) with 1-4 members (odd= 1.87, 95% CI= 1.27-2.89) were more likely than normal people to suffer from high WC-related health problems. Nuclear families, tube wells and wells, kachha and pakka houses with pakka toilets, monthly family income up to 10,000 Rs, SES status of upper middle and govt. services personnel all had substantial differences. The individuals residing in kachha (odd= 1.79, 95% CI= 1.23-2.60) and pakka house (odds== 0.69, 95% CI=

0.49-0.96) with pakka toilet (odds= 0.48, 95% CI= 0.35-0.66) were likely to be at risk of high WC related adiposity than individuals living in semipakka house with semipakka and kaccha toilet. Females who drank water from a well (odds= 2.63, 95% CI= 1.20-5.73) and a tube well (odds= 2.16, 95 %CI= 1.03-4.54) had higher significant values than those who drank water from the government supply. Individuals in government services (odds= 1.83, 95%CI=0.61-1.63) had greater significant odds than farmers and daily labourers when compared to other profession categories. With odds= 1.47 (95% CI= 1.08-2.00), the higher monthly income group with a family monthly income of 10,000Rs was observed. ***Table 4.30*** shows the remaining variables that have lower odds values and a non-significant influence.

Table 4.30: Logistic regression model on socioeconomic, demographic and lifestyle determinants and nutritional status based on WC measure (high vs normal) among Rajbanshi female individuals

Factors	categories	WC (High vs Normal)		
		Wald	**Odds**	**95% CI**
Age group	18-29 years	0.02	0.96	0.62-1.49
	30-49 years	0.12	0.93	0.62-1.38
	50-64 years	-	-	-
Marital status	Married	0.08	1.06	0.26-4.30
	Unmarried	0.07	1.22	0.29-5.04
	Widowed/separated	-	-	-
Education	Illiterate	0.09	0.97	0.62-1.52
	Primary	0.04	1.01	0.68-1.47
	Secondary	0.32	1.04	0.68-1.51
	Graduate	-	-	-
Women occupation	Employee	1.88	0.68	0.39-1.76
	House wife	0.22	0.92	0.67-1.26
	Daily worker	-	-	-
Family Size	Upto4 members	8.10	1.87**	1.21-2.89

	5-6	0.75	1.19	0.80-1.77
	7-8	1.31	0.73	0.42-1.24
	≥9	-	-	-
Family type	Nuclear	17.60	1.82**	1.37-2.41
	Joint	-	-	-
Water supply	Well	5.94	2.63**	1.20-5.73
	Tube well	4.16	2.16*	1.30-4.54
	Govt. supply	-	-	
House type	Kachha	9.30	1.79**	1.23-2.60
	Pakka	4.60	0.69*	0.49-0.96
	Semipakka	-	-	-
Toilet type	Kachha	0.78	1.20	0.79-1.81
	Pakka	20.88	0.48**	0.35-0.66
	Semipakka	-	-	-
Monthly income	Up to 5000Rs	2.69	1.42*	0.93-2.16
	5001-10,000Rs	6.09	1.47**	1.08-2.00
	>10001 Rs	-	-	-
Family occupation	Farmer	1.24	1.25	0.84-1.84
	Labor	0.31	1.83	1.03-3.23
	Govt. service	4.01	1.85**	0.61-1.63
	Others/Business	-	-	-
SES (Kupposwamy)	Lower	0.30	1.37	0.44-4.20
	Middle	0.29	1.35	0.44-4.10
	Upper middle	0.04	0.96	0.30-3.03
	Upper	-	-	-

4.5.2 Binary logistic regression for being at high WHR (>0. 80 cm).

The binary logistic regression was used to see if specific socioeconomic, demographic, and lifestyle variables had a significant impact on WHR-related obesity in Rajbanshi female populations. Age, marital status, family size, family type, toilet type, family occupation, and family SES level all had highly significant odds values, as shown in ***Table 4.31.*** Individuals aged 18-29 years (odds= 2.22, 95 % CI= 0.73-6.77) had significantly higher odds than those aged 30-49 years (odds= 1.82, 95 %CI= 0.71-4.16). Unmarried women (odds= 4.14, 95% CI= 0.43-39.22) showed a highly significant effect on high risk of WHR related adiposity than married women (odds= 3.22, 95% CI= 0.49-33.01) among Rajbanshi female populations. Educational status of Rajbanshi female individuals observed a non significant effect with lower odds on WHR related high adiposity (p>0.05). Females in nuclear families (odds= 1.94, 95% CI= 0.86-4.38) with up to 4 members (odds= 3.41, 95%CI= 0.61-18.90) had greater odds and a significant influence on increased risk of WHR than those in joint families with more than 5 members, according to the findings. Among female Rajbanshi individuals, there was no significant connection between water supply and housing type and high WHR related morbidity (p>0.05). The individuals belonging to upper middle (odds= 2.83, 95% CI=0.68-1.54) SES status and having govt. services (odds= 1.15 , 95% CI=0.01-1.12) with bearing pakka toilet (odds= 2.58, 95% CI= 0.25-1.33) had higher odds compare to those individuals living in lower SES status (odds= 0.32, 95% CI= 0.69-3.25) category with kaccha (odds=2.25 , 95% CI= 0.64-7.65) and semi pakka toilet among farmer (odds= 1.15 , 95% CI= 0.01-1.32) and labor groups (odds= 0.11 , 95% CI= 0.01-1.03) of Rajbanshi female populations. Monthly income of family showed a non significant effect on WHR related adiposity among Rajbanshi individuals ***(Table 4.31).***

Table 4.31: Logistic regression model on socioeconomic, demographic and lifestyle determinants and nutritional status based on WHR measure (high vs normal) among Rajbanshi female individuals

Factors	categories	WHR (High vs Normal)		
		Wald	Odds	95% CI
Age group	18-29 years	1.98	2.22*	0.73-6.77
	30-49 years	1.59	1.82	0.71-4.61
	50-64 years	-	-	-
Marital status	Married	1.74	3.22	0.49-36.01

	Unmarried	1.53	4.14*	0.43-39.22
	Widowed/separated	-	-	-
Education	Illiterate	0.44	0.68	0.22-2.08
	Primary	0.47	1.50	0.47-4.72
	Secondary	0.02	0.97	0.33-2.87
	Graduate	-	-	-
Women occupation	Employee	0.02	0.90	0.23-3.43
	House wife	0.45	1.33	0.57-3.10
	Daily worker	-	-	-
Family Size	Upto4 members	1.97	3.41*	0.61-18.90
	5-6	0.82	0.59	0.19-1.81
	7-8	0.26	0.69	0.16-2.84
	≥9	-	-	-
Family type	Nuclear	2.57	1.94*	0.86-4.38
	Joint	-	-	-
Water supply	Well	1.52	1.65	0.21-2.35
	Tube well	0.64	0.58	0.36-1.23
	Govt. supply	-	-	-
House type	Kachha	1.60	2.22	0.64-7.65
	Pakka	0.35	1.33	0.52-3.40
	Semipakka	-	-	-
Toilet type	Kachha	0.76	1.99	0.42-9.33
	Pakka	1.62	2.58*	0.25-1.33
	Semipakka	-	-	-
Monthly income	Up to 5000Rs	0.58	0.87	0.29-2.61
	5001-10,000Rs	0.59	1.11	0.47-2.60
	>10001 Rs	-	-	-
Family occupation	Farmer	1.92	0.23	0.03-1.80
	Labor	3.73	0.11	0.01-1.03
	Govt. service	2.88	1.15*	0.01-1.32
	Others/Business	-	-	-

SES (Kupposwamy)	Lower	1.25	0.32	0.69-3.25
	Middle	0.58	0.96	0.35-2.36
	Upper middle	2.98	2.38**	0.68-1.54
	Upper	-	-	-

4.5.3 Binary logistic regression for being at high WHtR (>0.5cm).

A binary logistic regression analysis was used to determine the relationship between socioeconomic, demographic, and lifestyle variables on the WHtR. The results of the research revealed that among Rajbanshi females, marital status, women's occupational status, house type, toilet type, monthly family income, family occupation, and family SES level had significant odds on WHtR ($p<0.05$). Age, educational status, family size, family type, and water supply were also not shown to be significantly correlated with WHtR related adiposity ($p>0.05$). Unmarried women (odds= 1.74, 95% CI= 0.40-7.60) showed significant effect with higher odds compare to married women (odds= 1.20, 95% CI= 0.28-5.07). Similarly employed women (odds=1.64, 95% CI= 0.73-1.53) had high significant effect on high WHtR related adiposity than house wife (odds= 0.95, 95% CI= 0.70-1.39) and daily worker women. Age group categories 18-29 years (odds= 1.52, 95% CI= 0.71-1.84) and 30-49 years (odds= 0.96, 95% CI= 0.62-1.46) had no significant association with WHtR among Rajbanshi female individuals. Similarly nuclear family (odds= 1.00, 95% CI= 0.74-1.35) with 5-6 members (odds= 0.99, 95% CI= 0.64-1.53) were not found to be associated with high WHtR related adiposity problems. The female individuals living in pakka house (odds= 2.53, 95% CI= 2.37-4.75) with pakka toilet (odds=2.58, 95% CI= 1.41-2.80) had higher odds compare to people living in kaccha house (odds= 1.65, 95% CI= 1.07-2.55) with kachha toilet (odds= 1.46 , 95% CI= 0.91-2.36). The result indicated that monthly income of family more than 5000 (odds= 1.66, 95% CI= 1.50-4.30) with middle (odds= 2.50, 95% CI= 1.66-6.13) SES status had higher odds value compare to lower (odds=2.19, 95% CI= 0.70-6.77) SES status with farmer (odds= 1.71 , 95% CI= 1.13-2.57) individuals. The result of this analysis is presented in ***Table 4.32.***

Table 4.32: Regression analysis on socioeconomic, demographic and lifestyle variables and nutritional status based on WHtR (high vs normal) among Rajbanshi female individuals

Factors	categories	WHtR (High vs Normal)		
		Wald	Odds	95% CI
Age group	18-29 years	0.34	1.52	0.71-1.84
	30-49 years	0.03	0.96	0.62-1.46
	50-64 years	-	-	-
Marital status	Married	0.61	1.20	0.28-5.07
	Unmarried	0.55	1.74*	0.42-7.60
	Widowed/separated	-	-	-
Education	Illiterate	0.10	0.92	0.57-1.48
	Primary	0.08	0.94	0.62-1.42
	Secondary	0.30	1.12	0.73-1.73
	Graduate	-	-	-
Women occupation	Employee	2.32	1.64*	0.73-1.53
	House wife	0.01	0.95	0.70-1.39
	Daily worker	-	-	-
Family Size	Upto4 members	0.93	0.93	0.58-1.47
	5-6	0.01	0.99	0.64-1.53
	7-8	0.51	0.81	0.46-1.42
	≥9	-	-	-
Family type	Nuclear	0.03	1.08	0.74-1.35
	Joint	-	-	-
Water supply	Well	0.82	0.66	0.27-1.61
	Tube well	1.95	0.54	0.23-1.27
	Govt. supply	-	-	-
House type	Kachha	5.24	1.65	1.07-2.55
	Pakka	12.73	2.53**	2.37-4.75
	Semipakka	-	-	-
Toilet type	Kachha	2.49	1.46*	0.91-2.36
	Pakka	10.76	2.58**	1.41-2.80

	Semipakka	-	-	-
Monthly income	Up to 5000 Rs	8.92	1.33**	1.38-3.57
	5001-10,000Rs	9.59	1.66**	1.50-4.30
	>10001 Rs	-	-	-
Family occupation	Farmer	6.68	1.71	1.13-2.57
	Labor	3.96	1.86**	1.41-3.42
	Govt. service	0.10	0.97	0.59-1.60
	Others/Business	-	-	-
SES (Kupposwamy)	Lower	1.85	2.19	0.70-6.77
	Middle	2.55	2.52**	1.66-6.15
	Upper middle	0.52	1.14	0.36-3.59
	Upper	-	-	-

4.5.4 Binary logistic regression for being underweight and overweight based on BMI classification WHO (1995)

The effect of socioeconomic, demographic, and lifestyle variables on underweight and overweight based on BMI classification (WHO, 1995) among female Rajbanshi populations was investigated using binary logistic regression analysis. Water supply, dwelling type, and family occupation were all found to be substantially linked with being underweight among Rajbanshi females ($p<0.05$). Females aged 18-29 years (odds= 0.98, 95 % CI= 0.38-2.50) and 30-49 years (odds= 1.03, 95 % CI= 0.53-2.03) had lower odds values and no link to being underweight. Some females who live in pakka houses (odds= 2.51, 95 % CI= 1.29-3.88) and get their water from tube wells (odds=1.31, 95 % CI=0.10-0.95) and wells (odds= 0.30, 95 % CI=0.09-0.96) had a higher significant effect on underweight than those who live in semipakka houses (odds= 1.14, 95 % CI= 0.5-2.34) The other characteristics, such as marital status, educational status, and women's employment position, had no effect on being underweight ($p>0.05$). Similarly, there was no significant association between underweight and family size, family type, toilet type ($p>0.05$). ***Table 4.33*** summarizes the findings.

Similarly, only the family type and house type had significant odds ratios for being overweight (p0.05). Females from nuclear families (odds= 1.53, % CI= 1.24-1.16) and those who lived in pakka houses (odds= 2.31, % CI= 1.14-2.69) had a stronger significant effect on being overweight than normal people. The probabilities of being overweight are non-significant (p>0.05) in all other variables. There is no link between being overweight and being married or single between the ages of 18 -29 years and 30-49 years. Similarly, among Rajbanshi female populations, women's occupational status, family size, water supply, toilet style, monthly family income, family occupation, and family SES status had no significant effect on high BMI or overweight. ***Table4.33*** summarizes the results.

4.5.5 Binary logistic regression for being underweight and overweight based on BMI classification WHO (2000)

The results of the logistic regression revealed that water supply, dwelling type, family occupation, and family SES status all have a significant effect on being underweight (p<0.05). Females who live in kachha (odds=1.01, 95 % CI=0.48-2.14) and pakka houses (odds=2.53, 95 % CI= 1.30-2.94) and get their water from tube wells (odds= 1.27, 95 % CI= 0.08-0.88) and wells (odds= 1.27, 95 % CI= 0.08-0.80) have a high risk of being underweight among Rajbanshi. Similarly, those with a lower socioeconomic position (odds= 2.93, % CI= 0.35-24.17) and those from a farming family (odds= 1.62, % CI= 0.83-3.14) have a higher risk of being underweight (p<0.05). Age, marital status, educational status, women's employment status, family size, family type, toilet type, and family monthly income had no significant association with low BMI (underweight) among Rajbanshi female populations (p>0.05).

For women's occupational status, family size, and toilet type, the regression analysis for being overweight compared to normal BMI individuals was very significant (p>0.05). The working women with 7-8 family members (odds= 2.32, % CI= 1.12-4.80) had a highly significant effect on being overweight (odds= 3.35, % CI= 1.01-11.07). Similarly, housewife women (odds= 1.70, % CI= 0.98-3.12) had a higher risk of being overweight than healthy people. Individuals who live in a kachha house with a kachha toilet (odds=

1.86, % CI= 1.29-2.08) have a higher significant risk of being overweight than those who live in a semipakka house with a semipakka toilet (odds= 1.83, 95 % CI= 1.55-1.93). The other remaining variables like, age group, marital status, educational status, family type, family monthly income and SES status of family showed no significant association with high BMI (overweight) among Rajbanshi female populations ($p>0.05$). The result of this analysis is presented in ***Table 4.34.***

Table 4.33: Regression analysis on socioeconomic, demographic and lifestyle variables and nutritional status based on BMI (WHO, 1995) (under vs normal and over vs normal) among Rajbanshi female individuals

Factors	categories	BMI,1995(Underweight vs Normal)			BMI,1995 (Overweight vs Normal)		
		Wald	Odds	95% CI	Wald	Odds	95% CI
Age group	18-29 years	0.02	0.98	0.38-2.50	0.70	1.19	0.31-4.55
	30-49 years	0.09	1.03	0.53-2.03	1.14	1.70	0.64-4.55
	50-64 years	-	-	-	-	-	-
Marital status	Married	0.42	0.47	0.09-4.57	0.16	1.61	0.15-16.67
	Unmarried	0.12	0.65	0.62-6.91	0.93	3.50	0.27-44.54
	Widowed/separated	-	-	-	-	-	-
Education	Illiterate	0.07	0.95	0.31-2.86	0.30	0.64	0.13-3.12
	Primary	0.03	1.07	0.49-2.34	0.31	0.71	0.22-2.29
	Secondary	0.63	1.28	0.69-2.40	0.46	0.72	0.28-1.84
	Graduate	-	-	-	-	-	-
Women occupation	Employee	1.32	0.54	0.19-1.53	0.19	0.71	0.16-3.48
	House wife	0.08	0.95	0.55-1.63	1.28	0.61	0.26-1.43
	Daily worker	-	-	-	-	-	-
Family Size	Upto4 members	0.30	0.93	0.42-2.04	0.32	0.70	0.20-2.38
	5-6	0.13	0.96	0.53-1.74	0.21	0.79	0.29-2.10
	7-8	0.31	1.06	0.53-2.11	0.27	0.77	0.25-2.31
	≥9	-	-	-	-	-	-
Family type	Nuclear	1.16	0.75	0.44-1.26	2.52	1.53*	1.24-1.16

	Joint	-	-	-	-	-	-
Water supply	Well	4.07	0.30*	0.09-0.96	0.90	0.79	0.19-3.24
	Tube well	4.32	1.31*	0.10-0.93	0.36	0.88	0.24-3.18
	Govt. supply	-	-	-	-	-	-
House type	Kachha	0.13	2.51**	1.42-3.24	0.29	0.74	0.26-2.13
	Pakka	5.85	1.14	0.29-0.88	8.16	2.31**	1.14-2.69
	Semipakka	-	-	-	-	-	-
Toilet type	Kachha	0.20	1.01	0.49-2.07	0.85	1.64	0.57-4.80
	Pakka	1.20	0.77	0.49-1.22	0.16	1.16	0.55-2.44
	Semipakka	-	-	-	-	-	-
Monthly income	Up to 5000	0.51	1.35	0.58-3.13	0.16	0.76	0.19-2.89
	5001-10,000RS	0.10	0.96	0.54-1.72	0.42	0.71	0.26-1.94
	>10001 RS	-	-	-	-	-	-
Family occupation	Farmer	2.15	1.60*	0.85-3.01	0.32	0.91	0.32-2.57
	Labor	1.12	1.66	0.64-4.299	0.35	0.64	0.14-2.76
	Govt. service	0.39	1.33	0.61-2.90	0.84	0.60	0.20-1.76
	Others/Business	-	-	-	-	-	-
SES (Kupposwamy)	Lower	0.08	1.30	0.21-7.90	0.25	0.79	0.04-14.14
	Middle	0.10	1.01	0.19-5.19	0.17	0.56	0.04-8.07
	Upper middle	0.60	1.20	0.27-5.28	0.29	0.51	0.04-5.77
	Upper	-	-	-	-	-	-

Table 4.34: Regression analysis on socioeconomic, demographic and lifestyle variables and nutritional status based on BMI (WHO, 2000) (under vs normal and over vs normal) among Rajbanshi female individuals

Factors	categories	BMI,2000(Underweight vs Normal)			BMI,2000 (Over weight vs Normal)		
		Wald	Odds	95% CI	Wald	Odds	95% CI
Age group	18-29 years	0.14	1.20	0.44-3.27	0.22	0.78	0.29-2.11
	30-49 years	0.30	1.22	0.59-2.50	0.90	1.03	0.51-2.09
	50-64 years	-	-	-	-	-	-
Marital status	Married	0.57	0.40	0.04-4.17	0.06	0.79	0.12-4.90
	Unmarried	0.25	0.53	0.04-6.05	0.10	0.98	0.14-6.74
	Widowed/separated	-	-	-	-	-	-
Education	Illiterate	0.62	0.32	0.31-3.17	0.23	1.34	0.41-4.35
	Primary	0.23	0.93	0.41-2.12	1.01	1.53	0.66-3.54
	Secondary	0.74	1.32	0.69-2.53	0.89	0.90	0.48-1.70
	Graduate	-	-	-	-	-	-
Women occupation	Employee	1.29	0.52	0.17-1.58	3.96	3.35*	1.01-11.07
	House wife	0.07	0.92	0.52-1.63	3.59	1.75*	0.98-3.12
	Daily worker	-	-	-	-	-	-
Family Size	Upto4 members	0.50	0.74	0.32-1.69	0.10	1.14	0.51-2.54
	5-6	0.37	0.82	0.45-1.52	0.57	1.23	0.71-2.14
	7-8	0.84	0.89	0.43-1.84	5.14	2.32**	1.12-4.80
	≥9	-	-	-	-	-	-
Family type	Nuclear	1.69	0.69	0.40-1.20	0.90	1.02	0.59-1.75
	Joint	-	-	-	-	-	-

Water supply	Well	4.68	1.27**	0.08-0.88	0.23	0.78	0.29-2.08
	Tube well	5.53	2.26**	0.08-0.80	0.48	0.72	0.29-1.78
	Govt. supply	-	-	-	-	-	-
House type	Kachha	1.24	2.53**	1.30-2.94	2.94	1.31	0.71-2.08
	Pakka	4.70	1.01	0.48-2.14	0.76	1.86*	1.29-2.44
	Semipakka	-	-	-	-	-	-
Toilet type	Kachha	0.25	1.20	0.58-2.51	3.13	1.83**	1.55-1.93
	Pakka	0.13	0.91	0.57-1.46	2.68	1.47*	0.92-2.35
	Semipakka	-	-	-	-	-	-
Monthly income	Up to 5000	0.74	1.47	0.64-3.51	0.50	1.03	0.45-2.35
	5001-10,000RS	0.50	0.97	0.53-1.78	0.33	0.82	0.44-1.56
	>10001 RS	-	-	-	-	-	-
Family occupation	Farmer	2.05	2.62*	1.83-4.14	0.35	1.23	0.61-2.46
	Labor	0.89	1.60	0.60-4.25	1.55	0.55	0.22-1.39
	Govt. service	0.65	1.40	0.61-3.23	0.96	0.63	0.25-1.58
	Others/Business	-	-	-	-	-	-
SES (Kupposwamy)	Lower	1.35	2.93*	0.35-24.17	0.17	0.58	0.04-7.40
	Middle	0.56	2.12	0.29-15.11	0.25	0.53	0.04-5.99
	Upper middle	0.92	2.31	0.37-14.28	0.58	0.41	0.04-3.95
	Upper	-	-	-	-	-	-

CHAPTER V

DISCUSSION

5.1 An evaluation of socioeconomic, demographic, reproductive and lifestyle variables among adult Rajbanshi female populations

Women's nutritional status is a reflection of an individual's or a population's nutritional health. Women's nutritional health is a key component in determining the outcome of pregnancy and their general health. The findings of this study's nutritional evaluation allowed for the development of several intervention programmes in this community, as well as the design and implementation of specific nutritional care by the government. Several studies have been carried out in different parts of India to discover the factors that contribute to malnutrition in Indian women (Kupputhai and Mallika, 1993; Tanuja et al., 1995; Mohapatra A et al., 2001; Gosh J, 2006; Laxmaiah A et al., 2007; Kamath et al., 2013; Choudhury and Dashora, 2015; Darl et al., 2017; Manjunath TL et al., 2017; Namita Singh, 2019). Although studies have indicated that rural populations are more likely to be malnourished, there is a similar trend in the nutritional status of women in rural India. The current study was carried out among adult Rajbanshi females in North Bengal. In order to analyses the nutritional condition of this population, 800 adult females were chosen for this study. Socioeconomic, demographic, reproductive, and lifestyle data, as well as anthropometric and body composition measurements, were collected for this study.

North Bengal has a population of 17.21 million people (2011census). According to the 2011 Indian census, Darjeeling district had a population of 1846,823, with 937,259 males and 909,564 females. The Rajbanshi population (3,386,617) is the second highest in West Bengal (Sen and Gosh, 2008), and they live in the districts of Coochbehar, Jalpaiguri, North Dinajpur, and Darjeeling. Darjeeling is divided into 12 blocks, with the most Rajbanshi people living in

Kharibari, Phanshidawa, and Naxalbari. According to the 2011 Indian census, Kharibari block has 109,251 residents, including 55,671 men and 53,580 women, as well as 23,352 families. Kharibari block has a Schedule caste population of 53.25 percent, which is higher than Schedule tribe populations (21.71%). The district's urban population is 727,963 (39.40 %) and its rural population is 1, 118,860 (60.60 %). In this study, the whole population is drawn from the Kharibari block's rural areas. Rural regions in Kharibari block have a sex ratio of 363 %, while urban areas have a sex ratio of 961 %. In the current research, 76.50 % are married, while 22.50 % are unmarried**.** Unmarried and married people made up 48.49 % and 45.9% of the overall scheduled caste populations, respectively (Census. 2011)

The literacy rate in West Bengal has been increasing, and as of the 2011 census, it was 76.26 percent. In West Bengal, 54.70 percent of Schedule caste residents were literate, which was lower than the national average (59.00%). Similarly, the literacy rate in the Darjeeling district is 79.92 percent, with 86 percent of males and 74 percent of females. Darjeeling was placed 6th in terms of literacy rate among West Bengal's 19 districts and 257th among India's 640 districts. Between 1981 and 2001, the disparity between male and female literacy rates declined from 26.62 percent to 21.69 percent (Sharmila & Dhas, 2010), and it was further reduced to 16.6 percent in 2011 (Sharmila & Dhas, 2010). Similarly, the female literacy rate in West Bengal has risen dramatically in recent years, today standing at 70.54 percent of the overall population. 597,912 females in the Darjeeling district were literate. Kharibari block has a total literacy rate of 67.37 percent, with male literacy at 76.00 percent and female literacy at 58.37 percent (2011 census). However, in the current survey, 82.38 % of females were literate, while 17.62 % were illiterate ***(Fig:4.2***). The total number of illiterates in the Kharibari block is 45,711, with 19,106 males and 26, 605 females. The current study's findings revealed a higher literacy rate than

India's overall literacy rate of 74%. (2011, Census). When it comes to education, just 21.75 % of females have higher education levels (e.g., graduation), which is lower than the other schedule caste groups in West Bengal (2011, census). With 4.3 million students enrolled in 196 universities, India's higher education system is big and structurally diverse. According to the All India Survey on Higher Education (AISHE, 2016), the percentage of women eligible for higher education increased from 47.74 percent in 2011-2012 to 48.21 percent in 2015-2016. In India for 2015-2016, the results revealed that 5% of women are professional (medical, agriculture, law, technical, and veterinary) and 95 % are general education. In 2015-2016, 48.21% of Indian women were ready to pursue higher education, up from 47.74% in 2011-2012. (Ghara k T, 2016). More than half of the women in West Bengal, as well as Kerala, Chhattisgarh, Odisha, Tripura, Assam, and Andhra Pradesh, are willing to pursue higher education. In Goa, the percentage of women enrolled is the lowest (44.85 %). Tushar Kanti Ghara (2016) revealed that just 15.64 percent of women have higher-level education, 66.22 percent have middle-level education and only 18.09 percent have lower-level education. In West Bengal, 43.30 percent of women work in the intermediate category, while only 15.04 percent work in higher professions, according to the survey (Census report, 2011. In the current study, 21.75 % of women had a graduate degree, 28.37 % had a secondary education, and 32.25 % of the population had only an elementary education ***(Fig: 4.2*****)**. Literacy has a significant impact on human population standards, both in rural and urban areas, and has a significant impact on human health and nutrition.

In the current study, 33.25 % of women were classed as having a monthly household income of less than 5001/=. This indicates that a high number of people are in poor socioeconomic circumstances, making it difficult to meet their basic necessities. According to the 2016 state budget report, 19.98 % of the population lives below the poverty line (BPL). In West Bengal, a family with a monthly income of less than 5000/= is termed BPL, whereas a family with a monthly income of more than 10,000/= is called middle income. In the current study, 48.00 % was classified as middle income, while 18.75 % was classified as upper income ***(Fig:4.5).*** According to income estimates, North Bengal's per capita income is significantly lower than the state average. However, it was the highest in Darjeeling compared to all other districts in North Bengal. The economy of North Bengal is primarily dependent on agriculture. However, in recent years, we have seen a significant development in industrial industries, making the area a thriving economic centre. In addition, tea plantations are one of the country's most important sources of revenue. The district has played an important part in the state's economic development due to some tea and food processing enterprises. Because of its geographical location and diverse population, the Siliguri subdivision has seen an economic development in the organized retail, hospitality, and real estate industries.

In Indian families with toilet facilities, there is a growing trend. According to the 2015 census, 96 % of Indian households have toilet facilities (census of India, 2011, retrieved again 2015). Swachh Bharat Mission (SBM, 2nd October 2014) was launched by the Ministry of Housing and Urban Affairs (MoHUA) with the goal of achieving comprehensive sanitation in India. It is known as Mission Nirmal Bangla in West Bengal, and it has provided appropriate sanitation to 125 cities and villages. Kerala, Mizoram, and Lakshadweep had the highest number of toilet-equipped homes in both 2001 and 2011. In West Bengal, toilet facilities are available to 75.70 percent of rural families and 89.64 percent of urban households (2011 census), which is greater than the 2001 census (rural= 62.93 %, urban= 64.85 %). According to an NSO survey done between July and December 2018, around 58.70 % of West Bengal households have toilets. In terms of rural sanitation, West Bengal has built 50 lakh toilets in rural districts, the biggest number of toilets created in any state in the eastern region. In the current survey, 100 % had toilet facilities, with 20.12% reporting kachha toilets, 24.38 % reporting pakka toilets, and 55.50 % reporting semi-pakka toilets. In rural India, 88.50 % have access to drinking water, compared to 95.3 % in urban India. In India, around 19 % in West Bengal do not have access to safe drinking water. In West Bengal, 84 % relies on ground water sources, but roughly 83 blocks have an arsenic problem, and 43 blocks have fluoride in their drinking water. According to the data, just about 56% of urban residents in West Bengal have access to safe drinking water, which is far lower than national standards. In the current survey, 72.12 % have their own tube well, 23.87 % of women have their own well, and just 4.0 % get their drinking water from the government supply tube well. However, in comparison to other districts in West Bengal, these places must make efforts in water treatment, as 40.23 % used untreated water for drinking, which is backed up by the findings of the current study.

In India, 65.80 % families and 93.60 % of urban families live in a pakka structure, whereas 24.6 % of rural households and 5% of urban families live in a semi-pakka structure. The proportions of kachha house, pakka house, half kachha, and semi pakka house in rural Northeast India were 29.05 %, 20.53 %, 47.55 %, and 1.30 %, respectively. Houses in rural West Bengal were distributed as follows: 50.03 % kachha houses, 8.02 % pakka houses, 20.00 percent partly kachha houses, and 27.03 % semi pakka houses (Census, 2011). Three types of houses were recognised in this study: kachha, pakka, and semi-pakka. Semipakka house (55.50 %) was the most common, followed by pakka house (24.38 %) and kachha house (20.12 %). According to the 2011 census, India's workforce totals approximately 40 million people, accounting for 39.1% of the country's population. The labour force consists of 312 million basic specialists (those who have not worked for at least 183 days in the preceding 12 months prior to the census), with a significant gender gap between male and female workers. Males account for 275 million of the 402 million labourers, while females account for 127 million. The fact that labourers make up 51.7 percent of the male population and 25.6 percent of the female population is terrible. Female labourers account for approximately half of all workers. Males account for 68.4% of labourers, while females account for 31.6 percent (census report, 2011). In West Bengal, 34,756,355 people were working out of a total population of 34,756,355 people. 73.9 percent of the workers were primary, while 26.1 percent were marginal. 4,203,767 cultivators (owners or co-owners) and 5, 869,498 agricultural workers were among the 34,756,355 labourers enslaved in basic labour. Work activities were carried out by 42,825 people in Kharibari block. Cultivators numbered 6,147, while agricultural labourers numbered 6,012. According to the census of 2011, there are 431 female cultivators and 1457 female agricultural labourers in the United States. However, the number of female workers is lower than that of male workers. In the current survey, 58.25 % are farmers, followed by 16.00 % who own a shop or run a business, 15.75 % who work for the government, and 10% who work as daily labourers. In the current study, the most common occupations for women were housewife or student (28.50 %), followed by daily worker/farmer (28.50 %), and employee (8.62 %). These results are superior to those of other tribal and caste populations in North Bengal. Instruction and competency, as well as the journey toward self-sufficiency in the future, continue to be vital driving forces.

The Rajbanshi women's average age of menarche was 12.42 years, which was lower than the average for other Indian groups. It was found to be 16.38 years among Bhootia girls in Uttar Pradesh (Singh and Thapar, 1983), 14.7 years among Rajbanshi girls in North-east India (Chakravarty, 1994), 15.00 years among Aao Naga in Nagaland (Purungla and Sengupta, 2002), and 14.00 years among mountain girls in Himachal Pradesh (Sharma and Bansal, 2018). But present study value was closely related to the value of New Zealand girls (12.9 years) (St George et al., 1994) and Korean girls (12.70 years) (Lee et al., 2016). Ethiopian girls (13.90 years) (Ayele and Berhan, 2013), Tibetan women (16.20 years) (Beall, 1983) and Bhootia girls (16.38 years) (Singh and Thapar, 1983) have higher mean value of age at menarche compare than present study. ***Table 5.1*** shows a comparison of the mean age at menarche observed in this study with those reported from other populations.

Table5.1: Comparative table of mean age at menarche among different populations

Indian Studies	year	Region	Age at menarche (years)
Present study	2021	North Bengal,	12.74 (mean)
Sinha et al Omidvar et al	2020 2018	Rajbanshi women of North Bengal South Indian girls	12.52 (mean) 13.00 (mean)
Sharma and Banshal	2018	Mountain girls of Himachal pradesh	14.00 (mean)
Goyal et al	2016	Punjabi girls, Punjab	12.30 (median)
Deb	2009	Assamese girls, Assam	12.45 (mean)
Sidhu	2002	Punjabi girls of Punjab	12.51 (mean)
Purungla and Sengupta	2002	Aao naga of Nagaland	15.00 (mean)
Chakravarty	1994	Rajbanshi girls of Assam	14.70 (mean)
Tyagi et al	1983	Mundas of India	12.76 (mean)
Studies from outside India			
Lee et al	2016	Korean girls	12.70 (mean)
Ayele and Berhan	2013	Ethiopian girls	13.90 (mean)
Chodik et al	2005	Israel girls	13.31 (mean)
St George et al	1994	New Zealand girls	12.9 (mean)
Singh and Thapar	1983	Bhootia women	16.38 (mean)
Beall	1983	Tibetan women	16.20 (mean)

The current study found that the average age of menopause for Rajbanshi women was 48 years, which was similar to other Indian women's studies (e.g. Kripalani and Banerjee, 2005; Sharma et al., 2007; Dasgupta and Ray, 2013). The mean age at natural menopause in the present study was close to the values of other menopausal women in India: such as Aao nagas from Nagaland was 51.33 years (Purnungla and Sengupta., 2002), Lohar Gahadiy from Madhya Pradesh was 46.34 years (Yadav et al., 2002), Bengali Hindu Women from West Bengal, Kolkata was 45.00 years (Dasgupta and Ray, 2013) and women from Himachal Pradesh was 45 years (Sharma and Banshal, 2018). In developing nations, the age of 40 is commonly utilised as an artificial cutoff point for menopause, with menopause considered premature below this age (WHO, 1996). The mean age at menopause was lower than in industrialized nations such as Japan (51 years) (Gold et al., 2001), England (52 years) (Hardy and Kuh, 2005), and France (52 years) (Cassou et al., 2007). ***Table 5.2*** shows data on mean age at menopause from different populations.

Table5.2: Comparative table of mean age at Menopause among different populations

Indian studies	year	Region	Menopausal age (years)
Present study	2021	Bengali women of North Bengal ,West Bengal	48 .00 (median)
Sinha et al	2020	Rajbanshi women of North Bengal	50.00 (median)
Shukla et al	2018	Gujrati women, Gujrat	44.90 (mean)
Sharma and Bansal	2018	Women from Himachal pradesh	45.00 (median)
Ahuja	2016	women	46.20 (mean)
Monika Satpathy Sarkar et al	2016 2014	Urban women of western Odisha Urban women from Jamnagar	44.82 (mean) 45.3 (mean)
Dasgupta and Ray	2009	Bengali women of Kolkata, West Bengal	45.00 (median)
Sharma et al	2007	Urban women from	47.53 (mean)

		Jammu	
Kripalani and Banerjee	2005	North Indian women	48.00 (median)
Yadav et al	2002	Madhya pradesh	46.34(median)
Purnungla and Sengupta	2002	Aao naga women of Nagaland	51.33 (median)
Sengupta and Gagoi	1993	Kaibarta (Assam)	42.95 (mean)
Singh and Ahuja	1980	Women of Assam	40.32 (mean)
Studies from outside India			
Ghimire et al	2015	Nepali women of Nepal	47.00 (median)
Ceylan and Ozerdogan	2014	Turkish women	46.40 (median)
Cassou et al	2007	French women	52.00 (median)
Ozdemir and Coi	2004	Women from Turky	47.00 (median)
Vehid et al	2006	Turkish women	47.00 (median)
Hardy & Kuh	2005	English women	52.10 (median)
Kim YH et al	2003	Urban area of Korea	48.29 (mean)
Gold et al	2001	Japanese women	51.40 (median)
Kato et al	1998	American women	51.00 (median)

Modernization's impact and local and regional culture's engagement may have an impact on human lives. Initially, industrialization had a favourable impact on human well-being, but this is no longer the case. Local and regional cultures, as well as current thought, have an impact on a population's health and nutrition. Positive trends in this population's demographic and reproductive factors revealed that civilization and modernity are having a positive impact on this population. It signifies that the population has progressed as a result of accepting modern thought. Changes in the prevalence of various diseases linked to human behaviors and food habits accompany such economic and demographic transitions (Popkin et al., 2012; Baker and Friel, 2014). Genetically inherited diseases are more common among Rajbanshis than other communicable diseases. Non-communicable diseases such as Thalasemia, Hemophilia, and diabetes have become increasingly common among Rajbanshis as a result of changing eating patterns and the impact of modernization. Thus, anthropometric evaluation of nutritional status is necessary to detect changes in the human body that lead to the occurrence of such disorders.

5.2 Anthropometric measurements and nutritional status of adult Rajbanshi female populations

5.2.1 Effect of Age on Anthropometric and Body composition variables

Age has been found to have a direct or indirect impact on anthropometric and body composition variables in both Indian and non-Indian research (Bose et al., 2007; Sadhukan et al., 2007; Bisai et al., 2008; Sarkar and Mukhopadhya, 2008a; Das and Roy, 2010; Hull et al., 2011; Das et al., 2012; Rao et al., 2012; Peter et al., 2014; Mondal et al., 2016; Singh et al., 2017). These alterations reflect the fundamental changes in body size and composition that occur as people get older. Several studies in India have documented age-related changes in anthropometric characteristics among various ethnic communities (Bose et al., 2006; Mittal and Srivastava, 2006; Gosh and Bharati, 2006; Banik et al., 2007; Bose et al.,2008; Das and Roy, 2010; Kaur and Talwar, 2011; Bagga, 2013; K Das et al., 2020).

Aging is a significant issue that is correlated to body changes caused by the accumulation and loss of body cells in various sections of the body. Wulan et al. (2010) found that body composition and its age-related variations have a considerable hereditary component in a comparative study of Asians and Caucasians. Aging might be viewed as a pre-diagnostic tool for preventing high-risk mortality and morbidity in young adults.

Table 4.5 shows the age-related variation in anthropometric and body composition characteristics. Adult females' anthropometric measurements, such as height, weight, and MUAC, were found to be higher in middle age. Several studies have found similar outcomes in various adult populations (Rosmond et al., 1998: Arlappa et a., 2005; Pardo Silva et a., 2006; Chakrabarty and Bharati. 2010). BSF, TSF, SSF, and SISF were shown to be increased in the elderly. This indicates that in the current investigation, most of the variables were detected increasing with age, and all of the measures indicated a significant increase with age ($p<0.01$). Reduced physical activity, higher calorie intake, and lower energy expenditure, as reported by Das and Bose (2006) and Mungreiphy and Kapoor (2010) lead to an increase in adiposity measures (such as BSF, TSF, SSF, and SISF). In the current investigation, a favorable relationship between age and several metrics was discovered. Several studies have found that the ageing process is linked to changes in body composition such as MUAC, WC, HC, and some derived variables such as BMI, FFM, and FFMI, as well as the loss of subcutaneous adipose tissue and the buildup of adipose tissue (Shimokata et al., 1989; Schwartz et al., 19991; Wulan et al., 2010; Caso et al., 2013).

In this study, BMI was considerably higher in middle-aged women (30-49 years) ($p<0.01$) and significantly lower in women 50-64 years. ***Table:4.5*** shows the age-related variation in derived anthropometric factors. Another study conducted by Bose et al. (2006b) with Savar people in the Keonjhar district of Odisha found a similar outcome. These findings were reported in several research (Kyle et al. 2003; Bose et al., 2006; Bisai et al., 2008; Mukhopadhyay A 2010; Kim et al. 2011; Rao et al. 2012; Rao et al., 2015; K, Das et al., 2020). Other anthropometric indices, such as RI, WHR, WHtR, TUA, UMA, UFA, AFI, BFMA, FM, FMI, and FFMI, revealed a little positive relationship with age in adult females. Hull et al., (2011) discovered a downward tendency in FFMI among Caucasians, African Americans, Hispanics, and Asians after a particular age, in both males and females. Another study conducted by Das and Roy (2010) among the Bishnupriya Manipuris of Cachar district, Assam, found an increasing tendency of PBF and FM with age among the Bishnupriya Manipuris. In a research of Kheria Sabar boys, K. Das et al. (2020) discovered that FFM and FFMI had a negative connection with age due to early alcohol usage.

Several studies conducted among the indigenous communities of Keonjhar, Odisha, India, however, demonstrated the impact of age on anthropometric and body composition characteristics (Bose et al., 2006a, 2007). Other Indian groups, such as the West Bengal Kora-Mudis (Bisai et al., 2008), the adults of Hyderabad (Rao et al., 2012), the Kheria-Sabar males of West Bengal (K, Das et al., 2020), and the adult population of Punjab, have revealed similar findings (K. Singh et al., 2020). Rao et al., 2012; Peter et al., 2014; López-Ortega and Arroyo, 2016; K. Das et al., 2020 found a downward trend in anthropometric and body composition characteristics, as well as increased undernutrition, among the elderly. There is a significant association between age and certain anthropometric factors in the current investigation. It means that with normal and high body weight, total fat tissues grow with age due to an increase in FM and PBF. The main causes of these alterations in body composition could be their residence in various geographical locations or a higher frequency of undernutrition than other Indian communities.

5.2.2 Comparison of mean Anthropometric and Body composition variables

Mean Height:

Rajbanshi females reached at an average height of 151.01 cm. Women considered taller in industrialized countries (such as the United States, the United Kingdom, and Germany) ranged in height from 166 to 170 cm (Bjelica et al., 2012). The average height of this target demographic is higher than the average height of other world populations. ***Table5.3*** shows a comparison of mean heights of different populations around the world.

Bangladeshi women (Sultana et al., 2015) had a lower average height (148.8± 5.8) than Rajbanshi women (151.01± 3.85). British (Rosell et al., 2005), European (Rush et al., 2009), and Hispanic women (Hull et al., 2011) were higher heights than the current study. It means that the height of people in developed countries is higher than in developing countries. The growth of human height can be measured by examining dietary status during childhood and adolescence. Height is mostly determined by genetics, although it is also impacted by diet and environmental variables. A large number of Indian tribal and non-tribal people were found to have a slightly greater average height than Rajbanshi women (***Table 5.3***). In comparison to the current study, a tribal community, particularly the Santal from West Bengal's Purulia area, reported a lower mean height (Bose et al., 2006). The average height of Rajbanshi girls was greater than the average height of Sabar females in West Bengal (Ghosh et al., 2018). As a result, the position of Rajbanshi mean height in this table is unsatisfactory, and the cause of this scenario could be a variety of variables including age, poor environmental and socioeconomic conditions, genotype, and a lack of nutrition expertise (Khongsdire 2001; Kues, 2010; Wells 2012).

Mean weight

Rajbnashi females had an average weight of 49.56± 5.78 kg/m2. A huge number of studies have been published on the average weight of India's various ethnic groups. Santal women had a lower average weight (39.5± 5.79) than other Indian women (Das and Bose 2012). The current population's mean weight (49.5± 5.7) is lower than that of Mech women (51.3± 0.8) in Darjeeling, West Bengal. In comparison to the current study, the people of Darjeeling, particularly Dhimal (44.6 ± 7.5), had a lower mean weight. ***Table 5.4*** shows the comparison of the current study's mean weight with that of other Indian populations**.**

Mean BMI

The change in nutritional status will be measured using the BMI, which is calculated using body height and weight (Hiermeyer, 2009). The average BMI of Rajbanshi females was 21.7± 52.42 kg/m2 (***Table 5.5***). The current population's mean BMI is compared to that of other non-Indian populations in the world (***Table 5.5***). Asian Indian women (26.3± 4.6), European women (31.9±6.4), African American women (28.5±5.7), and Indonesian women (28.1±3.63) had higher mean BMIs than other populations. In comparison to Rajbanshi women, Asian countries such as the Philippines, Korea, Mongolia, Thailand, and Sri Lanka have high mean BMI. Orag Asli (Yousof et al., 2007), Asian women (Hull et al., 2011), Korean elder women (Kim et al., 2011), Polish women from Polad (Lutoslawska et al., 2014), and Bengladeshi women from Bangladesh (Sultana et al., 2015) all had approximately same mean BMI. In contrast to the current study, Maasai women (18.58 2.83) from Kenya showed a lower mean BMI (Galvin et al., 2015).

In India several studies has given the mean BMI for various ethnic population (Sahani, 2004; Bose and Chakravarty, 2005; Mungreipy et al., 2011; Varte et al., 2014; Regnma et al., 2015; Mohan et al., 2016; Bharali et al., 2017; Dorjee B, 2018). The National Nutrition Monitoring

Bureau (NNMB, 2012) published a report among rural populations in 10 Indian states, with a mean BMI that was lower than the current study's figure. Comparative evaluation of mean BMI of different Indian population is presented in ***Table 5.5***.

The Mech and Sabar of West Bengal were found to have a lower BMI (Banik et al., 2009; Gosh et al., 2018). Recent research in South Indian urban middle-class women (Mohan et al., 2016) and Sikkim's Limboo (Dorjee B., 2018) found a higher mean BMI than the current study. The mean BMI of Darjeeling's Dhimals, Mech, and Oraon, as well as the Jalpaiguri district, was comparatively lower. In comparison to the current study, North East Indian women had a higher mean value. According to Mandal et al., 2016 and Bharali et al., 2017, Karbi and Nyishi women had mean BMI values of 22.03± 3.31 kg/m2 and 21.30± 2.44 kg/m2, respectively, which are slightly higher than the current study. In comparison to the current study, the mean BMI of Nicobarese (Sahani et al., 2010) and rural Indian girls (Mohan et al., 2016) was found to be higher. South Indian females have a high mean BMI, according to Rao et al (2012). In comparison to other recorded Indian populations, Rajbanshi ladies had a lower mean BMI.

When compared to other non-Indian studies, the present study population had a lower mean BMI, while when compared to Indian populations; the mean BMI was slightly higher. The current study's mean BMI was quite close to Nepal's average and higher than Bangladesh and Pakistan (NCD-Risc, 2016). The current research area is close to the Nepal-Bihar border. In India, tribes from North East India have a high BMI, whereas tribes from Central India have a low BMI. Environmental or external variables, socioeconomic, regional, genotypic, and dietary aspects may all play a role in the fluctuation of this mean BMI value.

For the current study, the mean MUAC value was 22.19 ±2.75 cm. This number is slightly higher than James et al., 1994's cut-offs for undernutrition (22cm). MUAC is now a widely used technique for measuring undernutrition among many populations around the world (Fero-•luzzi and James, 1996; Assefa et al., 2012; Wilkinson et al., 2015; Benitez Brito et al., 2016; Benitez Brito et al., 2016; Mei et al., 2016). In comparison to the current study, a study from Spain found that the mean MUAC among women (26.26±4.72) was greater. According to Sultana et al. (2015), Bangladeshi women had a higher mean MUAC (25.3 ±3.3). The mean value of BMI and MUAC for present study was slightly above the cut-off value of undernutrition, it means that this population is above the risk of underweight related health issues.

For the current study, the mean values of WC, HC, WHR, WHtR, and CI were 81.58± 9.68, 85.35± 10.02, 0.95± 0.03, 0.53± 0.06, and 1.31± 0.15, respectively. All of the observed values were higher than the underweight cutoffs. It meant that female Rajbanshis were at risk of developing adiposity-related disorders (Gosh A 2004). In comparison to the current study, Lindarto et al. (2016) found that mean WC was higher among Indonesian females (90.1± 9.42). In comparison to the current study, a study conducted among Orang Asli women in Malaysia found lower WC (70.2± 6.76) and higher HC (88.4± 6.81). (Yusof et al., 2007). In comparison to Rajbanshi females, the rural Bengalee female population had a larger mean HC value (90.27 ± 9.68 cm) (Chanak and Bose, 2018). The mean WHtR (0.54± 0.07) and CI (1.31± 0.010) among Bengalee females in West Bengal were slightly lower and similar to the current population (Chanak and Bose, 2018). Furthermore, when compared to the current study, the WHR (0.79± 0.06) and CI (1.17± 0.08) of Marwari women in Kolkata were lower (Das and Bose, 2006). Santal (81.49± 6.03) and Sabar (83.1± 9.2) females in West Bengal had lower mean WC and HC than the current Rajbanshi population in North Bengal (Mukhopadhyay, 2010; Ghosh et al., 2018). In contrast to the current study, the mean value of WC, HC, WHR, and WHtR among other rural females was lower (Mungreiphy et al., 2012; Pradeepa et al., 2015; Mondal et al., 2016). Thus people of India mainly urban areas are at risk of central adiposity related health problems, present study observed mean values are above the cut-off points with fewer adiposity related problems.

Skin fold measurements was also used to assess body fat distribution in different population. In this target population, the mean BSF, TSF, SSF, and SISF were 5.66±2.31mm, 7.23±2.95mm, 8.40±2.20mm, and 9.84±2.09. In comparison to the current study, the Bengalee adult female population of West Bengal had higher BSF (14.2±3.7mm), TSF (22.3±5.9mm), and SSF (36.2±11.0mm) (Bhadra et al., 2002). Marwaris of Kolkata also showed higher mean values of BSF (18.8±5.6 mm) and TSF (25.7±6.3 mm) compared than present study (Das and Bose, 2006). According to Patel et al. (2017), the mean TSF (21.41± 7.41mm) and SSF (23.60±7.92 mm) among women in South Asian cities such as Chennai, Delhi, and Karachi were greater than the current study. Therefore it means that increased subcutaneous adiposity rather than peripheral adiposity which is high among this studied population. In comparison to the current population, the Santal and Sabar tribes of West Bengal had lower mean values of BSF, TSF, SSF, and SISF (Mukhopadhyay, 2010; Ghosh et al., 2018).

The mean PBF of Rajbanshi female individuals was 21.18% ±3.38. PBF was found to be greater among Caucasian (28.7%± 6.4) and Mexican American (35.6 % ±11.5) women than in the current study (Kyle et al., 2003; Peltz et al., 2010). A Korean and Chinese women also had high mean PBF in opposed to present study (Kim et al., 2011; Zhao et al., 2013). The high mean PBF were observed among the Marwaris of Kolkata and urban adults of Hyderabad, India (Das and Bose, 2006; Rao et al., 2012). Mungreiphy et al, (2012) conducted a study among females of

Delhi and Manipur showed that lower mean PBF compared to Rajbanshis of present study. Several studies conducted among different tribes of West Bengal like Bhumij, Oraon, Sabar and Bathudi reported lower mean PBF than present study (Bose et al., 2006; Khastriya and Acharya, 2016; Ghosh et al., 2018). The body composition indices FMI and FFMI, in particular, are thought to be higher over BMI and PBF. These indices have been used in several researchers to evaluate the nutritional status of adult populations (Peltz et al., 2010; Hull et al., 2011; Rao et al., 2012; Das and Bose, 2015). The mean values of FM, FFM, FMI and FFMI of present study were 10.61kg±2.12, 38.9kg±3.70, 4.64kg/m^2±1.17 and 17.06kg/m^2 respectively (***Table 3.3***). In comparison to the current study, Rush et al, (2009) found high mean FM and FFM values among European, Maori, Pacific, and Asian women. FM, FFM, FMI, and FFMI also were high among Marwaris and adult women in India (Das and Bose, 2006; Rao et al., 2012). Similarly in comparison to the current study, the majority of the listed studies have higher body composition values. As a result, an individual was classified as obese not only by BMI but also by lower lean mass or FFM. Individuals with high adiposity have a higher risk of cardiovascular disease, which is exacerbated by the prevalence of undernutrition (Jaswant and Nitish, 2014; Khatriya and Acharya, 2016).

Table 5.3: Comparative table of mean height of different population of the world.

Non Indian	N	Area	Mean value	References
British	9963	UK	163.7±5.9	Rosell et al.,2005
European	124	Newzealand	164.2±6.1	Rush et al.,2009
Hispanic	147	USA	155.5±6.5	Hull et al., 2011
Bengladeshi	260	Bengladesh	148.8±5.8	Sultana et al.,2015

Indian				
Oraon	200	West Bengal	144.0±6.1	Mittal & Srivastava 2006
Santal	213	West Bengal	149.8±5.9	Bose et al.,2006a
Mech	142	Darjeeling	152.7±0.4	Banik et al.,2009
South Indian	436	South India	153.7	Rao et al.,2012
Sabar	111	West Bengal	149.0±5.0	Ghosh et al.,2018
Limboo	496	Sikkim	148.81±5.11	Dorjee B 2018
Rajbanshi	800	West Bengal	151.01±3.85	Present study

Table 5.4: Comparative table of mean weight of different population of the world.

Indian	N	Area	Mean value	References
Bathudi	226	Odisha	39.8±6.2	Bose & Chakraverty, 2005
Dalit women	220	South India	40.9±5.7	Schmid et al., 2007
Mech	142	Darjeeling	51.3±0.8	Banik et al.,2009
Dhimal	146	Darjeeling	44.6±7.5	Banik et al.,2007
Santal	186	Birbhum	44.18±6.9	Mukhopaghya,2010
Santal	317	Purulia	39.5±5.9	Das & Bose,2012
Limboo	496	Sikkim	52.5 ±2.3	Dorjee B,2018
Rajbanshi	800	West Bengal	49.56±5.78	Present study

Table 5.5: Comparative table of mean BMI of different population of the world.

Non Indian	**N**	**Area**	**Mean value**	**References**
Asian Indian	117	Newzealand	26.3±4.6	Rush et al.,2009
European	200	Newzealand	31.9±6.4	Taylor et al.,2010
African Amarican	73	USA	28.5±5.7	Hull et al.,2011
Indonesian	554	Indonesia	28.1±3.63	Lindarto et al.,2016
Indian				
Mech	141	West Bengal	22.0±0.30	Banik et al.,2009
Nicobarese	259	Nicobar Island	23.5±4.1	Sahani et al.,2010
Rural Indian	2616	India	24.6±0.1	Mohan et al.,2016
Sabar	111	West Bengal	18.1±2.3	Gosh et al.,2018
Limbo	496	Sikkim	23.21±3.83	Dorjee B,2018
Rajbanshi	800	West Bengal	21.75±	Present study

5.2.3 Prevalence of underweight using BMI

The nutritional status of Rajbanshi women was classified using WHO (1995) standard cut-off criteria, as shown in ***Table 4.9***. In the current study, 39.88 % individuals were underweight. According to the NCD-RisC (2016) research, developing Asian and African countries have a high prevalence of underweight. In comparison to the current study, the prevalence of underweight was significant (59.0 %) among Maasai of Nilotic African women (Galvin et al., 2015). The prevalence of underweight among women was 26.7 % in Bangladesh Health Survey

(2014), which was lower than the current study. According to the NCD-RisC report (2016), India had the highest rate of underweight compared to other Asian countries.

According to the NFHS-5 (2019-2021) study, the prevalence of underweight women in India has decreased from 22.9 % to 18.7 %, although it remains a serious concern. Jharkhand has the greatest prevalence (31.6 %), while Sikkim has the lowest (6.4 %). Gujrat (41.8 %) has the highest prevalence of underweight women, followed by Odisha (41.5 %) and West Bengal (37.00 %) (Meshram et al., 2016a). The prevalence of underweight among Bengali females in Kolkata was 31.70 %, which was lower than the current study (Bose et al., 2009). Females in the Sabar community were found to have a higher frequency of underweight (56.50%) than males (46.8%) (Ghosh et al., 2018). Several studies (Das and Bose, 2010; Ghosh and Bose, 2015, 2017; Bhattacharya et al., 2019; Das et al., 2020) have found a significant prevalence of underweight among West Bengal women, Mahali (63.6%) , Birhor (33.3%), Santal (52.5%) and Oraon (51.70%) . On the other hand, the highest occurrence was 60.9 % among Hill Kheria in West Bengal (Das and Bose, 2015).

The prevalence of underweight among others populations of North East India was high, Ahom (52%), Kochs (50%), Jogis (50%) (Khonsdier, 2001). However, when compared to Rajbanshi females (39.88%) from North Bengal, Assamese Rajbanshis had a somewhat greater rate of undernutrition (42%). Boro Kacharis (11.2%), Mech (6%), and Panars (1428%), on the other hand, revealed a low prevalence of underweight in comparison to the current study. In comparison to the current study, Datta et al. (2015) found lower rates of underweight among tribal (20.45%) and non-tribal (7.43%) Manipur residents. In comparison to the current study, Naga females showed a lower prevalence of underweight (16.2%) (Mungriephy et al., 2011).

In comparison to the current study, another study among Nyishi women in Arunachal Pradesh found a lower frequency of underweight (10.50 percent) (Bharali et al., 2017). According to data from the 2015-16 National Family Health Survey, 22.90% of Indian women were considered underweight. West Bengal, Odisha, and Jharkhand were at the bottom of the list with the greatest levels of undernutrition ever and earlier, according to a survey done by Bharati et al (2007). The Hill Kheria tribe of West Bengal, on the other hand, has the highest frequency of undernutrition (Das and Bose, 2015). CED I and CED II were found in 39.50 % and 0.38 % of Rjbanshi females, respectively. CED I was shown to be more common (67.20 %) in older women (50-64 years) and less common (24.78 %) in middle-aged women (30-49 years) ***(Table 4.10, Figure 4.15*****).** According to a research conducted among Oraon and Sharak women in the Ranchi district of Jharkhand, the prevalence of CED rose with age (Banik, 2011).

It means that apparently healthy people with low weight were afflicted by CED I. Several researches have also indicated that persons living in tropical and subtropical regions have a lean linear body with low weight (Roberto Schreider, 1974). In India, a high prevalence of underweight is referred to as chronic energy deficit (CED), which has a negative impact on a person's life. In India, the increasing tendency of underweight can be explained by Chronic Energy Deficiency (CED), which impacts an individual's day-to-day productivity. Women who had a higher prevalence of CED had a higher risk of cardiovascular and reproductive health problems, according to the study. Due to poor importance in Indian society, more than half of women in India suffered from malnutrition (Barker et al., 2006; Misra 2011; Kshtriya and Acharya 2016b; Peters SAE et al., 2016; Sinha et al., 2020).

5.2.4 Prevalence of undernutrition using MUAC

Individuals with undernutrition had a prevalence of 37 %, according to MUAC. MUAC is currently widely utilized for determining nutritional status (WHO,1995; Mei et al., 2016). Several studies have used cutoff thresholds to assess the nutritional condition of various populations around the world (Gartner et al.,2001; Khadivzadeh, 2002; Bose et al 2006a; Bisai and Bose, 2009; Chakraborty el al., 2009. 2011; Dorjee B, 2018; Kumar et al., 2019). According to Hambidge et al. (2013), 40% of rural Indians are malnourished. In comparison to Limboo females in Sikkim (13.91 %), the current study population had a high prevalence of undernutrition based on MUAC (Dorjee B, 2018). In comparison to the current study, Bangladeshi adult women had a lower rate of undernutrition (34.8%). (Chen et al., 2014). Adult women in West Bengal had a greater prevalence of malnutrition (Bhumij 48.2 %, Kora-Mudi 52 %, and Santal 64.7 %) than in the current study (Bhumij 48.2 %, Kora-Mudi 52 %, and Santal 64.7 %) (Chakrabarty et al., 2009; Bisai and Bose, 2009; Das abd Bose, 2012; Ghosh and ose, 2015). These studies have also established a substantial link between mortality and MUAC in Indian people. According to MUAC, the prevalence of undernutrition was highest (43.20 %) among people aged 50-60, followed by 18-29 years (40.70 %), and 30-49 years (33.80%). ***Figure 5.1*** shown the comparative evaluation of MUAC based nutritional status of different population of India.

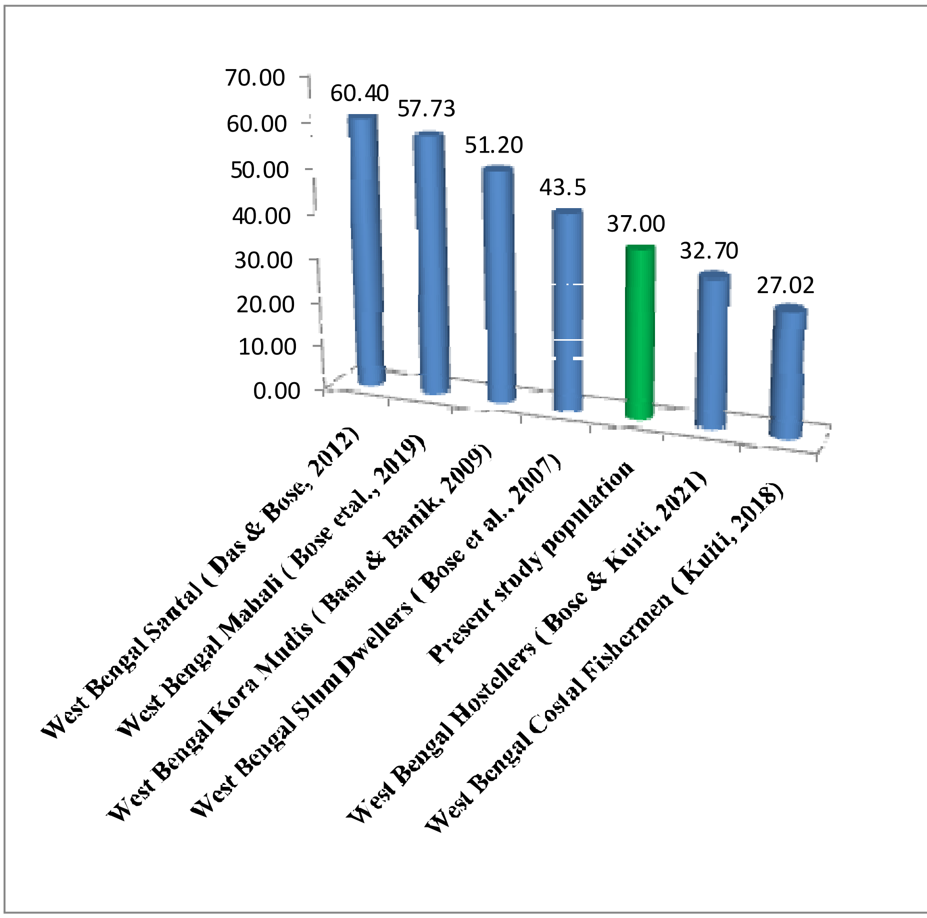


Fig 5.1: Comparison of MUAC based nutritional status among different population

5.2.5 Prevalence of undernutrition measured by BMI and MUAC

A combination of BMI and MUAC can also enhance CED evaluation. The prevalence of CED measured by BMI with MUAC was 13.12% among Rajbanshi female populations. Individuals classified as normal by BMI but undernourished by MUAC comprised for 23.75 % populations. This prevalence of undernutrition was very low compared than other studies of India (Misra et al., 2011; Gosh and Bose, 2015; Little et al., 2016; Chantler et al., 2016; Little et al., 2020). A study on 1561 patients of America reported 13.8% undernutrition assessed by BMI with MUAC

(Powell and Hennessy, 2003). A recent study among South African adult population observed 21% participants were malnourished simultaneously using MUAC and BMI (Tonder et al., 2019). Several studies also used BMI with MUAC for assessing nutritional status of different populations (Fero luzi and James, 1996; Chakravarty et al., 2011; Sultana et al., 2015; Fakier et al., 2017). The prevalence of undernutrition generated by the combination of MUAC and BMI was significant, so it is a warning sign that should be observed, according to WHO guidelines. From the preceding discussion, many studies have concluded that the prevalence of underweight in India ranges from high (20% - 39%) to very high (above 40%) (NNMB, 2012; NFHS-4, 2015-2016; NCDRisC, 2016).

According to WHO's classification (1995) of CED prevalence, the situation in the country is serious to critical. Similarly, the rate of underweight prevalence recorded among the participants in this study can be regarded ***high*** and requires monitoring in accordance with WHO criteria (20 % -39 %). When compared to the prevalence rates reported by other Indians, this rate was higher. This means that rural women in North Bengal are not immune to the dangers of malnutrition.

5.2.6 Prevalence of overweight and obesity

Overweight and obesity are becoming more common throughout the world. Overweight and obesity were measured in this study using BMI, WC, WHR, and WHtR. In Table 4.16 and Figure 4.22, the prevalence of overweight and obesity among Rajbanshi females is illustrated. The observed prevalence of overweight was 9.25 percent using the BMI (1995) threshold. Women in China (12.4 %) and the United States (12.3 %) were the most obese, followed by

India (5.3 %), Brazil (4.8 %), Mexico (3.7 %), Germany (2.1 %), Italy (1.8 %), and Poland (1.1 %). In comparison to the current study, the prevalence of overweight (36.90%) and obesity (26.40%) among Mongolian women was greater (Chimeddamba et al., 2016).

According to NNBM (2017), the prevalence of overweight and obesity has risen in practically all states (with the exception of Gujrat and Maharastra). Nearly one-third of men and women (15-49 years old) in Andhrapradesh, Goa, Karnataka, Telengana, Kerala, and Himachal Pradesh are overweight or obese. South Indian states have the highest frequency of overweight people, whereas north-eastern states have the lowest.

Overweight was found to be common among Marwari women in West Bengal (Das and Bose, 2006). According to Bharati et al., Indian ladies have a lower prevalence of overweight (9.4%) and obesity (2.6%) than males. Obesity prevalence was high in Chandigarh (15.9%) and Tamilnadu (15.2%), compared to Jharkhand (7.8%) and Maharastra (11.3%), which were greater in comparison to the current study. Few studies in India have found a greater rate of overweight among the tribal community (Sahani et al., 2010). Between the 1960s and 1999, the frequency of overweight female Nicobarese increased by 4 % to 21.78 %. These findings indicate that obesity has invaded every segment of Indian society, from urban to rural (Sahani et al., 2018).

A study reported by Khatriya and Acharya (2016) observed lower prevalence of overweight and obesity among Indian tribes. The highest prevalence was observed among Dhodia females (23.3%) followed by Santal of Odisha (15.1%), Kukna (15.00%), Santal of West Bengal (12.3%), Bhumij and Chaudhari (10.7%). In comparison to the current study, a recent study among Hamar in Manipur found increased overweight (24.4 % for rural, 40.0 % for urban) (Lalnuneng and Khongsdier, 2017). The prevalence of overweight/obesity among Marwaris of

Kolkata and BHCP population of Jalpaiguri, West Bengal, India has been recorded in two major studies from West Bengal (Das and Bose, 2006; Sen et al., 2013). In comparison to the current study, the prevalence of was found to be high among female Marwaris (71.8%) and BHCP of Jalpaiguri (female 29.3%). It also remains true for prevalence (female: 20.33 percent) based on Asia Pacific cut-offs, particularly among BHCPs (Sen et al., 2013).

Overweight and obesity were found to be 8.38% and 0.88 % in the current study, respectively. In comparison to the current study, the prevalence of overweight and obesity was higher in the previously mentioned Asian, African, and European studies. However, as compared to other studies in India, the prevalence of overweight and obesity in this study was significantly lower. Obesity was prevalent in India's urban, rural, and traditional communities, according to published studies, as seen in the preceding paragraphs. In various societies, the degree of occurrence may differ. Obesity was found to be prevalent in both rural and urban areas of south Indian states. Obesity was, however, much more common among city dwellers than among rural dwellers. The prevalence of overweight/obesity among Rajbanshi in this study was lower than the statewide incidence for south India. Obesity was reported to be higher among the BHCP and Marwari communities of Jalpaiguri and Kolkata, respectively, than in the current study. Overweight and obesity were shown to be more prevalent among women in their middle years.

5.2.7 Prevalence of central obesity

The prevalence of central obesity was higher in this study than obesity as defined by BMI. The prevalence of central adiposity as measured by WC, WHR, and WHtR was 52.37 %, 96.63 %, and 68.37 %, respectively, among Rajbanshi females. Several studies have found that Asian and Indian women had a greater frequency of central adiposity (Deurenberg-Yap et al., 2000; Rush et al., 2004; Tylor 2010; Bajaj et al., 2014). According to WC, 73.08 % of Turkish women are obese, with a high prevalence of obesity (Oguz et al., 2008). When compared to the current study, the prevalence of obesity measured by WHtR was greater among European (84.9%) and Maori female (89.8%). (Taylor, 2010). In comparison to the current study, the prevalence of obesity as defined by WC and WHR among Pakistani women was lower (10.90% and 44.4%). (Khan et al., 2017).

In India, rural women had a higher incidence of central obesity than males, with the prevalence being highest in the southern region and lowest in the north-eastern region (Meshram et al., 2016b). In comparison to the current study, the prevalence of WHR-related obesity among Delhi females was lower (0.4 percent). In comparison to the current study, Limboo females in Sikkim had a greater prevalence of central obesity as measured by WC (59.07 %), WHR (95.36 %), and WHtR (82.26 percent) (Dorjee B, 2018). Cardiovascular illness and other noncommunicable diseases were linked to a high frequency of central obesity (Prospective Studies Collaboration, 2009; Kaplan et al., 2014; Sahakyan et al., 2015). As a result, the Rajbanshi female participants in this study were at risk of death due to central obesity.

5.2.8 Body fat and body fitness among Rajbanshi individuals

Several researches observed the relation between excessive body fat and some non communicable diseases (like, cardiovascular diseases, diabetes and cancer) (Bose et al., 2003; Gosh et al., 2006; Gosh and Bandopadhya, 2007; Kim et al., 2011; Khatriya and Acharya, 2016). Lee and Neman (2002) reported that body composition and anthropometric characteristics play vital role in determination of body fatness among individuals. The observations in the present study reflected lower body fatness among Rajbanshi female individuals. The prevalence of PBF among Mexican Americans female and Korean female were 53.5% and 42.4% respectively (Peltz et al., 2010; Kim et al., 2011). The proportion of PBF was 0.80% among Orang Asli, which was smaller than current study.

It's ironic that high PBF is typically related with undernutrition in Indian tribes. PBF was shown to be high among Kolkata slum dwellers (75.68 %), Marwari women (97.3 %), and Asian Indian women (33.3 %) in several investigations (Dudeja et al., 2001; Das and Bose, 2006; Chakrborty et al., 2009c). In the current study, the fat or obese persons diagnosed using Niemen (1995) and Muth (2009) categories were 16.25 % and 12.88 %, respectively. However, as compared to research from Mexican Americans (Peltz et al., 2010), Ghana (Obirikorang et al., 2015), and Indian tribes, the enhanced PBF found in the current study using different criteria was still lower (Kshatriya and Acharya, 2016). As a result, in comparison to the Indian and non-Indian populations outlined above, a high proportion of the current population have less diseases related with high PBF.

5.3 Effect of socioeconomic demographic and lifestyle determinants on undernutrition

Socioeconomic, demographic, and lifestyle factors all have an impact on a person's life, either directly or indirectly. To assess a good quality of life, it is necessary to have excellent health and a suitable environment, both of which can be attained by appropriate diet (Subramanian and Smith, 2006; Chakravarti and Bharat, 2010; Sanou et al., 2014; Azim et al., 2015; Al Kibria et al., 2019; Bishwajit M, 2020). In this study, logistic regression analysis was used to determine the impact of various socioeconomic, demographic, and lifestyle factors on undernutrition among Rajbanshi people (***Table 4.33 and Table 4.34***). Various studies have reported that females were more prone to be underweight compare than male (Teller and Yimar, 2000; Arlappa et al., 2005; Patil and Shinde, 2014). Age, sex, marital status, education, domicile, family size, family type, housing style, toilet facility, family occupation, and income are all correlated to the prevalence of undernutrition among adults in India (Khongsdier, 2005; Arlappa et al., 2005, 2009; Barker et al., 2006; Bose et al., 2007, 2009; Chakraborty et al., 2009a; Das and Bose, 2010; Das et al., 2013; Patil and Shinde, 2014; Subasinghe et al., 2014; Sengupta et al., 2015; Dorjee B, 2018; Al Kibria et al., 2019). In comparison to other Indian research, the prevalence of CED was greater (39.50 %) in this study. Low BMI was strongly associated with lower socioeconomic level, drinking water facilities, dwelling type, family occupation, and family type ($p<0.05$). In this study, middle-aged women (30-49 years) had a lower risk of being underweight (odds: 1.03, 95 % Ci: 0.53-2.03, $P>0.05$) than younger (18-29 years) or older women (odds: 1.03, 95 % Ci: 0.53-2.03, $P>0.05$) (50-64 years). According to a Bangladeshi study, rural females over the age of 35 had a higher BMI score than young girls (Ahmed et al., 1998). Kabir et al (2006) found that age had a negative impact on nutritional status among young individuals in another investigation.

A beneficial relationship between nutrition and socioeconomic status has been reported in several research (Subhramanian and Smith, 2006; Subhramanian et al., 2009; Mondal and Sen, 2010; Popkin et al., 2012; Kamal et al., 2015; Biswas et al., 2016; Biswas T et al., 2017; Biswajit M, 2020). The results of the present study also support this fact that lower SES individuals were significantly undernourished compared than middle and higher SES individuals (odds: 2.93; 95%CI: 0.35-24.17, $P<0.05$). In India rural women from lower SES group were more prone to be underweight with less educated status (Bose et al., 2007; Prusty RK, 2014; Joy et al., 2015b; ul Haq et al., 2017; Ai Kibria et al., 2019). The result of the logistic regression analysis showed that lower monthly income was significantly associated with high CED among Rajbanshi women (***Table 4.33 and Table 4.34***). Adult slum dwellers in Kolkata (Chakrabarty et al., 2009) and Indian adults showed similar results (Ai Kibria et al., 2019). Undernutrition is more common among women with lower socioeconomic status, maybe because they consume fewer calories and eat less nutritious meals than women with greater socioeconomic status.

According to the regression analysis, family occupation had a greater impact on undernutrition among Rajbanshi women. Individual cultivators or farmers (odds: 2.62, 95 % CI: 1.83-4.14, P0.05) were shown to be more influenced by undernutrition than service holder families (odds: 1.40, 95% CI: 0.61-3.23). Cultivators, or everyday workers, demand more energy for their labour than service workers, and as a result, cultivators are more nutritionally sensitive (Gautam and Thakur 2009; Arlappa et al., 2009). Several studies in India found that women from farming households were slimmer than women from other occupations (Barker et al., 2006; Rao et al., 2012).

The Rajbanshi people's living patterns were also examined in this study. According to Chakravarty et al (2009), the frequency of CED was high among adult slum dwellers in Kolkata's non-bricked dwellings. Individuals living in kachha houses (odds: 2.51; 955 CI: 1.42-3.24) had a higher risk of being underweight in this study than those living in pakka houses (odds: 1.14; 95% CI: 0.29-0.88). Individuals who get their water from a well (odds: 0.30; % CI: 0.09-0.96) or a tube well (odds: 1.31; 95 % CI: 0.10-0.93) had a high significant odds value for being underweight, according to the findings. Thus, the style of dwelling, living conditions, and water availability all played a role in the frequency of undernutrition.

5.4 Effect of socioeconomic demographic and lifestyle determinants on overweight and obesity

Overweight and obesity is now major health consequences among adult population. In India the influence of overweight and obesity was discussed by several researchers (Prasad et al., 2013; Varadharajan et al., 2013; Som et al., 2014; Pengpid and Peltzer, 2014; Gouda and Prusty, 2014;Rai 2015; Little et al. 2016; Dorjee B, 2018). Sveral factors like age, sex, income, education and food habits were directly or indirectly effect the prevalence of obesity (Agarwall et al., 2014;Rai 2015; Little et al., 2016; Dorjee B, 2018; Das et al., 2019). In numerous south Indian populations, the influence of caste on the proportion of overweight and obesity was explored (Arlappa et al., 2009; Little et al., 2016).

Using χ2test, efforts were made to analyse the relationship between high BMI and relevant socio-economic, demographic, and life style characteristics of Rajbanshi individuals in the current study. Age, married status, occupation, and SES (as measured by χ2test) were the most likely related socioeconomic, demographic, and life style variables. Similarly, logistic regression was used to examine the further relationship. In present study females living in nuclear family and having pakka house and pakka toilet had higher odds for being overweight (Odds: 1.53; 95% CI: 1.24-1.16). Present study also reported that house wife individuals had higher odds compared than daily labor women for being overweight. Individuals with high odd ratios are more likely to be obese than those with low odd ratios in this study. The most consistent characteristics influencing the prevalence of overweight and obesity among the Rajbanshi in this study were age, living conditions, occupation, and socioeconomic level. The prevalence of overweight and obesity in India is considered to be influenced by the country's high socioeconomic status (Subramanyam and Subramanian, 2011). The findings of the current investigation back up this assertion. Other Indian research have made similar conclusions, implying that Rajbanshi people in North Bengal were also influenced in the same way (Das and Bose, 2006; Pradeepa et al., 2015; Dorjee B, 2018). In this study, as in the NHFS-2 group, a high level of SES was linked to a higher risk of being overweight (Griffiths and Bently, 2005). Overweight and obesity were substantially related with several components of SES, such as being non-poor, having a high income, and having a high degree of education among Indian urban women (Sen et al., 2013; Gouda and Prusty, 2014; Rengma et al., 2015;). Overweight and obesity were found to be correlated to dwelling style, family income, occupation, and socioeconomic level in the current study.

The WC, WHtR, and WHR measures of central adiposity or regional adiposity used in this investigation. In female Rajbanshi persons, high adiposity was found to be connected with house type, toilet type, women's occupation, family occupation, monthly income, and SES. Women's occupation, family type, and water supply were the socioeconomic, demographic, and lifestyle variables linked to high adiposity, according to WHtR. In the current study, family size, family type, dwelling type, monthly income, and family occupation were all observed among female Rajbanshi individuals with high WHR. χ^2 test was used to find the above-mentioned relationships.

The association was subsequently investigated using logistic regression, which provided similar results to those obtained using χ^2test. In present study, individuals living in pakka house with nuclear family and taking drinking water from well and tube well have higher odds value for high WC. Participants who have a monthly family income of more than 10,000 RS and are members of a government service family have a higher odds value than daily work or farmer households. Early-aged and unmarried women from a government-services family, on the other hand, had a considerable chance of having a high WHtR ($P<0.01$). Furthermore, women's occupational position, housing type, toilet type, high monthly income, family occupation, and middle and upper SES status were all strongly related to high WHR ($P<0.01$). As a result, factors like age, marital status, occupation, and high SES were found to be significant predictors of high regional or central adiposity in the current study.

Middle age group (40–59 years), old age group (>60 years), highly educated persons, employed women and service/business holder were shown to be connected with regional adiposity measured by WC, WHtR, and WHR among the population of different states of India (Pradeep et al., 2015; Meshram et al., 2016b). In the populations of Tamil Nadu, Chandigarh, and Maharashtra, age and high SES were found to have substantial odd ratios for being at risk of high WC (Pradeepa et al., 2015). In the populations of Tamil Nadu, Chandigarh, Maharashtra, and Sikkim, similar results were found for being overweight or obese as determined by WC and BMI (Pradeepa et al., 2015; Dorjee B, 2018). The reasons of central obesity were more in consistent with the findings of the previous studies.

CHAPTER VI

CONCLUSION

6.1 General summary

The current study was carried out on adult Rajbanshi females in North Bengal. Anthropometry and body composition characteristics were used in the study to measure nutritional status. Present study also finds the association of demographic, socioeconomic and life style factors with nutritional status. The participants of the study were the residents of villages of Darjeeling district, selected through multistage sampling method. According to a Pubmed search, the evaluation of nutritional status in a specific population of this area has never been done before. BMI and MUAC were used to determine the prevalence of underweight. The prevalence of overweight and obesity was determined using the WHO BMI classification (1995, 2000).

6.1.1 Summary findings:

- In the current study, 82.37 % women were literate, whereas only 17.63 % women were illiterate. It indicates that a significant proportion of Rajbanshi people have received education and acquired their education.
- The mean value of anthropometric measurements like height, weight and MUAC were considerably lower compared than other Indian and non-Indian studies.
- The mean value of HC, WC, BSF, TSF, SSF and SISF were slightly higher than other Indian population.
- Age specific variations in different anthropometric variables were also observed in present study.
- Some derived indices like WHR, WHtR, TUA and UFA were slightly higher among Rajbanshi female individuals.

- In present study body composition indices like PBF%, FM, FFM and FFMI had lower value compared to other studies.
- The mean height of Rajbanshi women was comparatively lower than other Indian population and the reason behind this situation is poor knowledge about nutrition and diseases environment during childhood.
- The mean BMI in this study was lower than in other Indian studies, although the observed mean BMI of India's rural tribal population was lower than in this study.
- The central adiposity measured by WC, WHR and WHtR were above the cutoff values. It is indicated that some people had higher risk of adiposity related health issues.
- The result of Pearson correlation analysis between different anthropometric variables showed that all variables were significantly correlated with each other ($p<0.05$).
- The result of linear correlation of age on different anthropometric variables reported that age is significantly co-related with height, weight, WHR, TUA, UMA, BFMA and FMM ($P<0.05$).
- The result of linear regression of BMI on different anthropometric variables indicated that all variables were significantly co-related with BMI.
- The prevalence of undernutrition based on BMI classification (WHO,1995) among Rajbanshi women was high (39.88%) and most of the individuals were suffered from CED grade I level of undernutrition. And the prevalence was high among early (18-29 years) and later (50-94 years) aged women.
- When nutritional status assessed by MUAC (James et al., 1995), the observed prevalence was 37.00%.

- In present study the prevalence of undernutrion was 23.75%, based on BMI measure in combination with MUAC.
- The overall prevalence of overweight and obesity was 15.62% and 9.78% respectively based on BMI classification (WHO, 1995). This rate was lower compare than other Asian populations.
- The prevalence of regional adiposity or central obesity was 52.37%, 96.63% and 68.37% respectively when obesity measured by WC, WHR and WHtR. The prevalence of regional adiposity was high among middle aged women (30-49 years).
- Fat individuals were less in present study. Only 16.23% population (based on Neiman classification, 1995) and 12.88% individuals (based on Muth classification, 2009) have identified with over fat status. Thus amount of risk factors associated with PBF% was less in number in present study.
- A logistic regression analysis was performed to find the effect of different socioeconomic, demographic and lifestyle variables on underweight and over-weight among Rajbanshi women population. The association of BMI,WHR and WHtR with different variables showed a significant influence on being underweight and overweight. The result of this analysis indicated that family type, source of water supply, toilet type, house type, family occupation, living conditions and low socioeconomic status of family were significantly associated with underweight ($p<0.05$).
- The association of high level of BMI, WHR, WHtR with different socioeconomic, demographic and life style variables showed a significant effect on high adiposity among Rajbanshi female population.

- Present study also reported the mean ages at menarche and menopause among Rajbanshi individuals were 12.42 years and 48 years respectively. These values were lower in comparison to other Indian populations.

6.2 Limitations:

There were some drawbacks in this investigation. The following are some of them: To begin with, growing rates of undernutrition and high regional adiposity among these groups could be attributed to a shift in food patterns and a lack of physical activity. These two features, however, were not present in the current investigation. For a population's nutritional status to be assessed, more research is needed in addition to these two aspects. Second, the current research is cross-sectional.

6.3 Conclusion:

The result of the present study revealed that a large portion of adult Rajbanshi women of North Bengal were suffered from undernutrition. The prevalence of undernutrition among this population was above the cutoff values of WHO standard (1995). This study is also provide a strong correlation between low BMI and poor socioeconomic conditions. Several factors like family type, house type, toilet type, family monthly income and family occupation were significantly associated with underweight and overweight ($p<0.05$) and the prevalence of undernutrition was high among early and later aged women. Young women are more prone to underweight than men in the poorest sectors of the population. As a result of this fact, low BMI's negative health effects have increased the risk of low birth weight newborns in Indian communities. In this cohort, there was a strong correlation between the prevalence of overweight and obesity (as evaluated by BMI) and greater occupational status. However, as compared to other Asian and European countries, the prevalence of overweight and obesity was lower in this study. Low BMI increases the risk of non communicable diseases in Indian people. And low PBF or high PBF with same BMI was considered as a high prevalence of central adiposity. There was a high frequency of normal weight but centrally obese persons in the current study, who were normal by BMI but obese by WC, WHR, and WHtR. Thus present study population showed a high risk of regional adiposity related co-morbidity and mortalities along with diseases related with low BMI. This nutritional disease is now more common through worldwide which are commonly known as double burden of malnutrition (DBM). Thus this population gives an opportunity to formulate different policies for improvement of overall health of a population. Among adult women who are at a higher risk of complications related with non-normal BMIs, It is essential to raise awareness of the importance of maintaining a healthy weight through good nutrition education and understanding of the factors that are linked to a higher incidence of double burden of malnutrition.

6.4 Recommendations

- Individuals should be acknowledged about proper health and good nutrition.
- Health workers and policy maker should organize a good awareness camp through which individuals can get a proper knowledge about nutrition.
- A basic use of anthropometric indicators such as BMI and WC should be introduced by the local health centre.
- To address the issue of undernutrition among adult Rajbanshi people in North Bengal, the government and non-governmental organisations (NGO's) should work together to develop specific plans and strategies to improve nutritional status.

- For improvement of nutritional status a suitable health and nutritional intervention programmes is urgently needed.

REFERENCES

Adak DK, Gautam RK, Gharami AK. 2006. Assessment of nutritional status through Body Mass Index among adult male of 7 tribal populations Maharashtra, India. *Mal J Nutr*. 12 (1): 23–31.

Adhi M, Hasan R, Shoaib S, Tauheed S . 2007. Age and symptomatology of menopause in Karachi. *Pak J Physiol*. 3:41-4.

Agrawal S, Millett CJ, Dhillon PK, Subramanian SV, Ebrahim S. 2014. Type of vegetarian diet, obesity and diabetes in adult Indian population. *Nutr J*. 13:89.

Ahmed SM, Adams A, Chowdhury AM, Bhuiya A. 1998. Chronic energy deficiency in women from rural Bangladesh: some socioeconomic determinants. *J Biosoc Sci*. 30(3):349-58.

Ahuja M. 2016. Age of menopause and determinants of menopause age: APAN India survey by IMS. *J Mid-life Heal*. *7*(3), 126–131.

Ajit PS, Pushpa S, Rupinder K , Singh SP. 2003. Assessment of Malnutrition in Punjabi Urban Males According to Body Mass Index (BMI) and Weight for Height Criteria. *Anthropologist*. 5 (3):189-191.

Ahmed A. 2017. Strategic Review of Food Security and Nutrition in Bangladesh. *World food Programme*. DOI: 10.13140/RG.2.2.24673.71529

Al Kibria GM. 2019. Prevalence and factors affecting underweight, overweight and obesity using Asian and World Health Organization cutoffs among adults in Nepal: Analysis of the Demographic and Health Survey 2016. *Obes Res Clin Pract*. 13(3):328.

All India Survey on Higher Education (AISHE).2011. Data for the year 2010-11 was collected.

Arlappa N, Balakrishna N, Brahmam GN, Vijayaraghavan K. 2005. Nutritional status of the tribal elderly in India. *J Nutr Elder*. 25(2):23-39.

Arlappa N, Balakrishna N, Brahmam GN, Vijayaraghavan K. 2005. Nutritional status of the tribal elderly in India. *J Nutr Elder*. 25(2):23-39.

Arlappa N, Balakrishna N, Brahmam GN, Vijayaraghavan K. 2005. Nutritional status of the tribal elderly in India. *J Nutr Elder*. 25(2):23-39.

Arlappa N, Venkaiah K, Rao KM, Reddy ChG, Kumar SS, Ravindranath M, Brahmam GN, Vijayaraghavan K. 2009. Prevalence of chronic energy deficiency in rural-dwelling older Indian adults during a period of severe drought. *J Nutr Elder*. 28(3):301-12

Assefa N, Berhane Y, Worku A. 2012. Wealth status, mid upper arm circumference (MUAC) and antenatal care (ANC) are determinants for low birth weight in Kersa, Ethiopia. *PLoS One*. 7(6):e39957.

Ayele E, Berhan Y. 2013. Age at menarche among in-school adolescents in Sawla Town, South Ethiopia. *Ethi J Health Scie*. 23(3), 189–200

Azeem S, Gillani SW, Siddiqui A, Jandrajupalli SB, Poh V, Syed Sulaiman SA. 2015. Diet and Colorectal Cancer Risk in Asia--a Systematic Review. *Asian Pac J Cancer Prev*.16(13):5389-96.

Bagga A. 2013. Age changes in some linear measurements and secular trend in height in adult Indian women. *Acta Biol Szege.* 57: 51-58

Bajaj HS, Pereira MA, Anjana RM, Deepa R, Mohan V, Mueller NT, Rao GH, Gross MD. 2014. Comparison of relative waist circumference between Asian Indian and US adults. *J Obes*. 2014:461956

Baker P, Friel S. 2014. Processed foods and the nutrition transition: evidence from Asia. *Obes Rev*. 15(7):564-77.

Banik SD, Bose K, Bisai S, Bhattacharya M, Das S, Jana A, Purkait P. 2007. Undernutrition among adult Dhimals of Naxalbari, West Bengal: comparison with other tribes of eastern India. *Food Nutr Bull*. 28(3):348-52.

Banik SD, Ghosh M, Bose K. 2016. Anthropometric and body frame size characteristics in relation to body mass index and percentage body fat among adult Bengalee male brick-kiln workers from Murshidabad, West Bengal, India. *Anthropol Anz*. 73(4):313-321.

Barker M, Chorghade G, Crozier S, Leary S, Fall C. 2006. Gender differences in body mass index in rural India are determined by socio-economic factors and lifestyle. *J Nutr*. 136(12):3062-8.

Basu SK, Banik SD. 2009. Environmental Pollution and Conservation: Global Issues and Policies. New Delhi: *APH Publication Corporation.*

Batis C, Denova-Gutiérrez E, Estrada-Velasco BI, Rivera J. 2020. Malnutrition prevalence among children and women of reproductive age in Mexico by wealth, education level, urban/rural area and indigenous ethnicity. *Public Health Nutr*. 23(S1):s77-s88.

Benítez Brito N, Suárez Llanos JP, Fuentes Ferrer M, Oliva García JG, Delgado Brito I, Pereyra-García Castro F, Caracena Castellanos N, Acevedo Rodríguez CX, Palacio

Abizanda E. 2016. Relationship between Mid-Upper Arm Circumference and Body Mass Index in Inpatients. *PLoS One.* 11(8):e0160480.

Bergman RN, Stefanovski D, Buchanan TA, Sumner AE, Reynolds JC, Sebring NG, Xiang AH, Watanabe RM. 2011. A better index of body adiposity. *Obesity (Silver Spring).* 19(5):1083-9.

Berrington de Gonzalez A, Hartge P, Cerhan JR, Flint AJ, Hannan L, MacInnis RJ, Moore SC, Tobias GS, Anton-Culver H, Freeman LB, Beeson WL, Clipp SL, English DR, Folsom AR, Freedman DM, Giles G, Hakansson N, Henderson KD, Hoffman-Bolton J, Hoppin JA, Koenig KL, Lee IM, Linet MS, Park Y, Pocobelli G, Schatzkin A, Sesso HD, Weiderpass E, Willcox BJ, Wolk A, Zeleniuch-Jacquotte A, Willett WC, Thun MJ.2010. Body-mass index and mortality among 1.46 million white adults. *N Engl J Med.* 2;363(23):2211-9.

Bhadra M, Mukhopadhayay A, Bose K. 2002. Adiposity, central body fat distribution and blood pressure among young Bengalee adults of Kolkata, India: Sexual dimorphism. *J Physiol Anthropol.* 21 (6): 273-276

Bhansali A, Dhandania VK, Deepa M, Anjana RM, Joshi SR, Joshi PP. 2015. Prevalence of and risk factors for hypertension in urban and rural India: the ICMR–INDIAB study. *J Human Hyp*. 29(3):204-9.

Bharali N, Mondal N, Singh Kh N. 2017. Prevalence of Under nutrition, Overweight and Obesity among Nyishi tribal women of Arunachal Pradesh, Northeast India. *Hum Biology Rev*. 6 (1), 63-78.

Bharati S, Pal M, Bhattacharya BN, Bharati P. 2007. Prevalence and causes of chronic energy deficiency and obesity in Indian women. *Hum Biol.* 79(4):395-412.

Bhattacharya A, Pal B, Mukherjee S, Roy SK. 2019. Assessment of nutritional status using anthropometric variables by multivariate analysis. *BMC Public Health.* 5;19(1):1045.

Bhutia DT. 2014. Protein energy malnutrition in India: the plight of our under five children . *J Family Med Prim Care.* 3:63-67.

Bisai S, Bose K, Ghosh A. 2008. Nutritional status of Lodha children in a village of Paschim Medinipur district, West Bengal. *Indian J Publ Health*. 52(4):203-6.

Bisai S, Bose K. 2012. Critical nutritional stress among adult tribal populations of West Bengal and Orissa, India. *Nature Precedings*.

Bisai S, Bose K. 2009. Undernutrition in the Kora Mudi tribal population, West Bengal, India: a comparison of body mass index and mid-upper-arm circumference. *Food Nutr Bull.* 30(1):63-7.

Biswajit Mahapatra. 2020. Prevalence of Anemia and Socio demographic factors associated with Anemia among Barwar tribe of Gonda district, Uttar Pradesh. *JMSCR* Volume 08 Issue 07. 404-411.

Biswas T, Garnett SP, Pervin S, Rawal LB. 2017. The prevalence of underweight, overweight and obesity in Bangladeshi adults: Data from a national survey. *PLoS One.* 16;12(5):e0177395.

Bjelica D, Popovic S, Kezunovic M, Petkovic J, Jurak G, Grasgruber P. 2012. Body Height and Its Estimation Utilizing Arm Span Measurements in Montenegrin Adults. *Anthropol Noteb.* 18.69–83.

Bogin B. 1999. Patterns of human growth. Cambridge University Press, Cambridge.

Borah M, Agarwalla R. 2016. Maternal and socio-demographic determinants of low birth weight (LBW): A community based study in a rural block of Assam. *J Postgrad Med.* 62:178-181.

Bose K, Banerjee S, Bisai S, Mukhopadhyay A, Bhadra M. 2006c. Anthropometric profile and chronic energy deficiency among adult Santal tribals of Jhargram, West Bengal, India: Comparison with other tribal populations of Eastern India. *Ecol Food Nutr.* 45(3): 1–11.

Bose K, Bisai S, Chakraborty F.2006. Age variations in anthropometric and body composition characteristics and underweight among male Bathudis--a tribal population of Keonjhar District, Orissa, India. *Coll Antropol*. 30(4):771-5.

Bose K, Bisai S, Mondal PS, Ghosh M. 2008. Body mass index and chronic energy deficiency among adult male Lodhas and Bhumijs: A comparison with other tribal populations of West Bengal, India. *J Pub Health*. 16(2): 117–21.

Bose K, Bisai S, Sadhukhan S, Mukhopadhyay A, Bhadra M. 2009. Undernutrition among adult Bengalees of Dearah, Hooghly District, West Bengal, India: relationship with educational status and food habit. *Anthropol Anz.* 67(2):121-8.

Bose K, Chakraborty F, Bisai S, Khatun A, Bauri H. 2006. Body mass index and nutritional status of adult Savar tribals of Keonjhar District, Orissa, India. *Asia Pac J Public Health.* 18(3):3-7.

Bose K, Chakraborty F, Bisai S. 2007. Age variations in anthropometric and body composition characteristics and undernutrition among female Bathudis: a tribal population of Keonjhar District, Orissa, India. *Anthropol Anz*. 65(3):285-91.

Bose K, Chakraborty F. 2005. Anthropometric characteristics and nutritional status based on body mass index of adult Bathudis: a tribal population of Keonjhar District, Orissa, India. *Asia Pac J Clin Nutr.* 14(1):80-2.

Bose K, Ganguli S, Mamtaz H, Mukhopadhyay A, Bhadra M, 2006B. High prevalence of under-nutrition among adult Kora Mudi tribals of Bankura District, West Bengal, India. *Anthropol Sci.* 114: 65–68.

Bose K, Ghosh M, Bhandari S, Kuiti BK. 2019. Mid-upperarm based nutritional status and body fat pattern among adult mahalis of bankura district, West Bengal, India. *Man In India*. 99(3-4), 189- 203.

Caso G, McNurlan MA, Mileva I, Zemlyak A, Mynarcik DC, Gelato MC. 2013. Peripheral fat loss and decline in adipogenesis in older humans. *Metabolism.* 62(3):337-40.

Cassou B, Mandereau L, Aegerter P, Touranchet A and Derriennic F. 2007. Work-related factors associated with age at natural menopause in a generation of French gainfully employed women. *Amer J Epide.*166(4),429–438.

Census of India. 2011. Provisional Tables, Paper 2, Office of the Registrar General and Census Commission, India, New Delhi.

Ceylan B, Özerdoğan N. 2014. Menopausal symptoms and quality of life in Turkish women in the climacteric period. *Climacteric.* 17(6), 705–712.

Chakrabarty S, Bharati P. 2010. Adult body dimension and determinants of chronic energy deficiency among the Shabar tribe living in urban, rural and forest habitats in Orissa, India. *Ann Hum Biol.* 37(2):149-67.

Chakrabarty S, Bharati P. 2010. Adult body dimension and determinants of chronic energy deficiency among the Shabar tribe living in urban, rural and forest habitats in Orissa, India. *Ann Hum Biol.* 37(2):149-67.

Chakraborty R, Bose K. 2008. Anthropometric characteristics and nutritional status of adult Oraon men of Gumla District, Jharkhand, India. 2008. Inter J Bio Anthr. 2(1).

Chakravarty K. 1994. Age at menarche among the Rajbanshi women of North Bengal. *J Assam Sci Soci. 36*(1),49–52.

Chanak M, Bose K. 2018. Sexual dimorphism in central obesity among rural adults of Ghatal Block, Paschim Medinipur, West Bengal, India. *Hum Biol Rev*. 7 (2), 183-204.

Chantler S, Dickie K, Micklesfield LK, Goedecke JH. 2016. Determinants of change in body weight and body fat distribution over 5.5 years in a sample of free-living black South African women. *Cardiovasc J Afr*. 27(6):367-374.

Chen Y, Ge W, Parvez F, Bangalore S, Eunus M, Ahmed A, Islam T, Rakibuz-Zaman M, Hasan R, Argos M, Levy D, Sarwar G, Ahsan H. 2014. A prospective study of arm circumference and risk of death in Bangladesh. *Int J Epidemiol.* 43(4):1187-96.

Chimeddamba O, Gearon E, Stevenson C, Liviya Ng W, Baasai B, Peeters A. 2016. Trends in adult overweight and obesity prevalence in Mongolia, 2005-2013. *Obesity (Silver Spring).* 24(10):2194-201.

Chodick G, Huerta M, Balicer RD, Davidovitch N, Grotto I. 2005. Secular trends in age at menarche, smoking, and oral contraceptive use among Israeli girls. *Prev Chronic Dis*. 2(2):A12.

Choudhary AC. 2011. Koch Rajbangshi Jonogosthir Itihas aru Sanskriti. Bongaigaon: *Unique Publication*.

Choudhary M, Dashora R. 2015. Effect of nutritional status on prevalence of anemia among females. *Food sci Research J.* 6(1): 1-7.

Chowdhury TK, Roy SK. 2016; Blood pressure and body composition of rural Oraons of North 24 Parganas, West Bengal, India. *Anthropol Anz.* 73(2).

Coqueiro Rda S, Barbosa AR, Borgatto AF. 2009. Anthropometric measurements in the elderly of Havana, Cuba: age and sex differences. *Nutrition*. 25(1):33-9.

Corish CA, Kennedy NP. 2003. Anthropometric measurements from a cross-sectional survey of Irish free-living elderly subjects with smoothed centile curves. *Br J Nutr*. 89(1):137-45.

Corsi DJ, Kyu HH, Subramanian SV. 2011. Socioeconomic and geographic patterning of under and overnutrition among women in Bangladesh. *J Nutr*. 141:631-638.

Dalton ET. 1872. The Descriptive Ethnology of Bengal. Government Printing, Calcutta, India.

Darl TA, Bharathiraja D, Pandit. 2017. A comparative study on nutritional and health status of tribal and nontribal reproductive women in anantnag district, Jammu and Kashmir. *Inter j inno resea in multidiscipli fie*. 3(2): 146- 159.

Das BM, Roy SK. 2010. Age changes in the anthropometric and body composition characteristics of the Bishnupriya Manipuris of Cachar district, Assam. *Advan in Biosc Biotech*. 1 (2). 122-130.

Das M, Bose K. 2006. Presence of high rates of overweight and obesity among adult Marwaris of Howrah, West Bengal, India. *Coll Antropol*. 30(1):81-6.

Das S, Bose K. 2010. Body Mass Index and Chronic Energy Deficiency among Adult Santals of Purulia District, West Bengal, India. *Internat J Hum Sci*.7 (2): 488–503.

Das S, Bose K. 2012. Nutritional assessment by mid-upper arm circumference of santal adults of Purulia, West Bengal, India. *Coll Antropol.* 36(2):581-4.

Das S, Ghosh M, Mitra S, Chatterjee R, Bhattacharyya S, De AK, Chakraborty S. 2012. Developing nomogram to estimate birth weight from head circumference and midupper arm circumference. *J Trop Pediatr*. 58(4):307-10.

Das Gupta P, Mukherjee BN, Das SK, Pakrasi K, Mukherjee D. 1981: A thropometry and genetic markers amongst the Kaoras of West Bengal. - *Ind throp. Hum. Genet.*

Das M. 2010. Study of Nutritional Status of Korku Tribes in Betul District of Madhya Pradesh. *Studi Tribes & Tribals*. 8(1):31-36.

Das P, Khatun A, Bose K, Chakraborty R. 2018. The validity of mid-upper arm circumference as an indicator of low BMI in population screening for undernutrition: a study among adult slum dwellers in eastern India. *Public Health Nutr.* 21(14):2575-2583.

Das S, Bose K. 2014. Anthropometric assessment of nutritional status of adult Hill kherias of Purulia district, West Benga. In: AK Sinha and Krishan Sharma , editors. Human Ecology in an Era of Globalization and Urbanization: Anthropological Dimension, New Delhi: *Serials Publications PVT. Ltd.* 381–90.

Das S, Bose K. 2015. Adult tribal malnutrition in India: an anthropometric and socio-demographic review. *Anthropolog Revi.* 78(1): 47-65.

Das S, Mahata M, Bose K. 2013. Nutritional profile of adult Birhors of Purulia: A Particularly Vulnerable Tribal Group of, West Bengal, India. *Asian Acad Res J Mult* . 1(5): 262–276.

Das A, Saimala G, Reddy N, Mishra P, Giri R, Kumar A, Raj AK, Chaturvedi S, Babu S, Srikantiah S M. 2019. Mid-upper arm circumference as a substitute of the body mass index for assessment of nutritional status among adult and adolescent females: learning from an impoverished Indian state. *Public health.* 179: 68-75.

Dasgupta D, Ray S. 2009. Menopausal problem: a study on the rural and urban women of Eastern India. *J Soci Behav Health Sci.* 3(1), 20–23.

Dasgupta D, Ray S. 2013. Attitude toward menopause and aging: a study on postmenopausal women of West Bengal. *J Women & Aging.* 25(1), 66–79.

Datta Banik S. 2011. Arm span as a proxy measure for height and estimation of nutritional status: a study among Dhimals of Darjeeling in West Bengal India. *Ann Hum Biol*. 38(6):728-35.

Datta S, Chattopadhyay S, Das AS, Mitra C. 2015. Health and Nutritional status of College students of different ethnic backgrounds of Tripura, a North-east State of India. *Advances in Rese*. 3(3): 319-333.

Deb R. 2009. Variation in the age at menarche of the Assamese and Bengali girls of Guwahati, Assam. *Anthropologist*. 11(4):259–264.

Debnath A, Bhattacharjee N .2016. Understanding Malnutrition of Tribal Children in India: The Role of Women's Empowerment. *Ecol Food Nutr*. 55:508-527.

Sarkar D, Mondal N, Sen J. 2009. Obesity and Blood Pressure Variations among the Bengali Kayastha Population of North Bengal, India. *J Life Sciences*. 1:1,35-43.

Deurenberg P, Deurenberg-Yap M, Guricci S. 2002. Asians are different from Caucasians and from each other in their body mass index/body fat per cent relationship. *Obes Rev*. 3(3):141-6.

Deurenberg-Yap M, Schmidt G, van Staveren WA, Deurenberg P. 2000. The paradox of low body mass index and high body fat percentage among Chinese, Malays and Indians in Singapore. *Int J Obes Relat Metab Disord*. 24(8):1011-7.

Dorjee, Binu . 2018. Nutritional status among the Limboo of Sikkim, India. Thesis.

Dr. Charu Chandra Sanyal. 1965. The Rajbansis of North Bengal. *A Study of a Hindu Social Group. Calcutta*. p.13

Dudeja V, Misra A, Pandey RM, Devina G, Kumar G, Vikram NK. 2001. BMI does not accurately predict overweight in Asian Indians in northern India. *Br J Nutr*. 86(1):105-12.

Durnin JV, GA, Womersley J. 1974. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 Years. *Br J Nutr*. 32: 77-97.

Dutta M, Selvamani Y, Singh P, Prashad L. 2019. The double burden of malnutrition among adults in India: evidence from the National Family Health Survey-4 (2015-16). *Epidemiol Health*. 41:e2019050.

Fakier A, Petro G, Fawcus S. 2017. Mid-upper arm circumference: A surrogate for body mass index in pregnant women. *S Afr Med J*.107(7):606-610.

Ferro-Luzzi A, Sette S, Franklin M, James WP. 1992. A simplified approach of assessing adult chronic energy deficiency. *Eur J Clin Nutr*. 46(3):173-86.

Ferro-Luzzi, Anna & James, William. Ferro-Luzzi A, James WPT. 1996. Adult malnutrition: simple assessment techniques for use in emergencies. *Br J Nutr*. 75: 3-10.

Freedman RL. 1976. Nutritional Anthropology in Action: An Overview. In: T.K.Fitzgerald (ed.), *Nutri Anthropology in Action,* pp. 1-23.

Frisancho AR. 1981. New norm of upper limb fat and muscle areas for assessment of nutritional status. *Am J Clin Nutr*. 34: 2540-5.

Frisancho AR. 1989. Anthropometric standard for the assessment of growth and nutrition status. *Ann Arbor. USA: University of Michigan Press.*

Frisancho AR. 1974. Triceps skin fold and upper arm muscle size norms for assessment of nutrition status. *Am J Clin Nutr.* 27:1052–1058.

Galvin KA, Beeton TA, Boone RB, BurnSilver SB. 2015. Nutritional Status of Maasai Pastoralists under Change. *Hum Ecol.* 43:411–424.

Galvin KA, Beeton TA, Boone RB, BurnSilver SB. 2015. Nutritional Status of Maasai Pastoralists under Change. *Hum Ecol.* 43:411–424.

Gartner A, Maire B, Kameli Y et al. 2001. Body composition unaltered for African women classified as 'normal but vulnerable' by body mass index and mid-upper-armcircumference criteria. *Eur J Clin Nutr*. 55, 393–399.

Gautam RK, Thakur R. 2009. Biosocial Correlates of Nutrition and Chronic Energy Deficiency among Adult Females of two Ecological Zones in Madhya Pradesh and Uttarakhand, India. *Malays J Nutr*. 15(2):137-53.

Ghara TK. .2016. Ranking of the States of India based on higher education development indicators. *The Internal J Humanities & Social Stud.* 4 (6):1-5.

Ghimire N, Dhakal P, Norrish D, Dangal G, Sharma D, Dhimal M. 2015. Menopausal health status of women of Kapilvastu District of Nepal. *J Nepal Healt Res Counc.* 13(31):182–187.

Ghosh M and Bose K. 2018. Relationship between Anthropometric Measures and Body Composition Parameters in Adult Brick Kiln Workers of Murshidabad District, West Bengal. *J Life Science*. 10(2): 107-115.

Ghosh A, Bose K, Chaudhuri AB. 2001. Age and sex variations in adiposity and central fat distribution among elderly Bengalee Hindus of Calcutta, India. *Ann Hum Biol.* 28(6):616-23.

Ghosh A. 2004. Age and sex variation in measures of body composition among the elderly Bengalee Hindus of Calcutta, India. *Coll Antropol.* 28(2):553-61.

Ghosh J. 2016. Nutritional status of tribal women: An epidemiological study among Santal – Munda tribes of North 24th parganas district of west Bengal, India. *Int J sci Res.* 5:229-32.

Ghosh M and Bose K. 2015. Assessment of undernutrition among male Bhumijs of West Bengal, India: A comparison of body mass index and mid-upper arm circumference. *Hum Biol Rev.* 4 (2), 140-149.

Ghosh M, Bhandari S, Bose K. 2018. Anthropometric Characteristics and Nutritional Status of Adult Sabars of Bankura District, West Bengal. *Hum Biol Rev*. 7 (1), 71-83.

Ghosh R, Bharati P. 2006. Nutritional status of adults among Munda and Pod populations in a peri urban area of Kolkata City, India. *Asia Pac J Public Health.* 18(2):12-20.

Ghosh S and Ghosh P. 2021. Nutritional Assessment by Body Mass Index and Mid Upper Arm Circumference of Adult Santals of Jhargram, West Bengal, India. *Hum Biol Rev.* 10 (2), 114-128.

Ghosh S, Malik S. L. 2007. Sex Differences in Body Size and Shape among Santhals of West Bengal. *Anthropologist*. 9(2): 143–149.

Ghosh J. 2006. Nutritional Status of Tribal Women: An Epidemiological Study Among Santal-Munda Tribes of North 24Th Parganas District of West Bengal, India. *International j scient rese.*7: 48-51.

Gogoi G, Sengupta S. 2002. Body Mass Index Among The Dibongiya Deoris of Assam, India. J huma ecol. 13:4.

Gold EB, Bromberger J, Crawford S, Samuels S, Greendale GA, Harlow SD. 2001. Factors associated with age at natural menopause in a multiethnic sample of midlife women. *American J Epidem.* 153(9), 865−874.

Gorstein J, Akre J. 1988. The use of anthropometry to assess nutritional status. *World Health Stat Q.* 41(2): 48-58.

Goswami M. 2013. Prevalence of Under-nutrition among the Juangs A study on a particularly vulnerable tribal group of Odisha, India. *Antro Onl J Anthropol.* 9(1): 1973 – 2880.

Goto R, Mascie-Taylor CG. 2007. Precision of measurement as a component of human variation. *J Physiol Anthropol.* 26(2):253-6.

Gouda J, Prusty RK. 2014. Overweight and obesity among women by economic stratum in urban India. *J Health Popul Nutr.* 32(1):79-88.

Gouda J, Prusty RK. 2014. Overweight and obesity among women by economic stratum in urban India. *J Health Popul Nutr.* 32(1):79-88.

Goyal P, Singh Z, Sethi GK. 2016. Association of age at menarche with anthropometric measures in Punjabi Bania girls. *J Clini Diagn Rese.* 10(11), IC01–IC05.

Griffiths P, Bentley M. 2005. Women of higher socio-economic status are more likely to be overweight in Karnataka, India. *Eur J Clin Nutr*. 59(10):1217-20.

Gupta S, Kumar R, Kalaivani M, Nongkynrih B, Kant S, Gupta SK. 2021. Underweight, Overweight, and Anemia among Elderly Persons in a rural area of Ballabgarh, Haryana. *Indian J Community Med*. 46(3):511-514.

Hambidge KM, Krebs NF, Garcés A, Westcott JE, Figueroa L, Goudar SG, Dhaded S, Pasha O, Ali SA, Tshefu A, Lokangaka A, Thorsten VR, Das A, Stolka K, McClure EM, Lander RL, Bose CL, Derman RJ, Goldenberg RL, Bauserman M. 2013. Anthropometric indices for non-pregnant women of childbearing age differ widely among four low-middle income populations. *BMC Public Health*. 18: 45.

Hameida J, Billot L. 2002. Nutritional status of Libyan children in 2000 compared with 1979. *East Mediterr Health J*. 8(2-3):261-71.

Hardy R, Kuh D. 2005. Social and environmental conditions across the life course and age at menopause in a British birth cohort study. *British J Obstet Gynaeco*.112(3), 346–354.

Hiermeyer M. 2009. Height and BMI values of German conscripts in 2000, 2001 and 1906. *Econ Hum Biol*. 7(3):366-75.

Hoet JJ, Hanson MA. 1999. Intrauterine nutrition: its importance during critical periods for cardiovascular and endocrine development. *The Journal of physiology*. *514 (Pt 3)*(Pt 3), 617–627.

Hsieh SD, Muto T. 2004. A simple and practical index for assessing the risk of metabolic syndrome during routine clinical checkups. *Nippon Rinsho*. 62: 1143-9.

Hsieh SD, Yoshinaga H, Muto T. 2003. Waist-to-height ratio, a simple and practical index for assessing central fat distribution and metabolic risk in Japanese men and women. *Int J Obes Relat Metab Disord*. 27(5):610-6.

Hull HR, Thornton J, Wang J, Pierson Jr RN, Kaleem Z, Pi-Sunyer X, Heymsfield S, Albu J, Fernandez JR, VanItallie TB, Gallagher D. 2011. Fat-free mass index: changes and race/ethnic differences in adulthood. *Int J Obes (Lond)*. 35(1): 121–127.

Huxley R, James WP, Barzi F. 2008. Obesity in Asia Collaboration. Ethnic comparasion of the cross-sectional relationships between measures of body size with diabetes and hypertension. *Obes Rev*. 1: S53-S61.

James WP, Ferro-Luzzi A, Waterlow JC. 1988. Definition of chronic energy deficiency in adults. Report of a working party of the International Dietary Energy Consultative Group. *Eur J Clin Nutr*. 42(12):969-81.

James WP, Mascie-Taylor GC, Norgan NG, Bistrian BR, Shetty PS, Ferro-Luzzi A. 1994. The value of arm circumference measurements in assessing chronic energy deficiency in Third World adults. *Eur J Clin Nutr*. 48(12):883-94.

Jaydip Sen, Shila Ghosh. 2008. Estimation of stature from foot length and foot breadth among the Rajbanshi: An indigenous population of North Bengal. *Forens Sci International*. 181:1–3.

Joy EJM, Kumssa DB, Broadley MR, Watts MJ, Young SD, Chilimba ADC, Ander EL. 2015b. Dietary mineral supplies in Malawi: spatial and socioeconomic assessment. BMC nutrition. 1:42.

Kabir ZN, Ferdous T, Cederholm T, Khanam MA, Streatfied K, Wahlin A.2006. Mini Nutritional Assessment of rural elderly people in Bangladesh: the impact of demographic, socio-economic and health factors. *Public Health Nutr*. 9(8):968-74.

Kader M, Perera NK .2014. Socio-economic and nutritional determinants of low birth weight in India. Ame. *J Med Sci*. 6:302-308.

Kalaiselvi S, Arjumand Y, Jayalakshmy R, Gomathi R, Pruthu T, Palanivel C. 2016. Prevalence of under-nutrition, associated factors and perceived nutritional status among elderly in a rural area of Puducherry, South India. *Arch Gerontol Geriatr*. 65:156-60.

Kamal SM, Hassan CH, Alam GM. 2015. Dual Burden of Underweight and Overweight among Women in Bangladesh: Patterns, Prevalence, and Sociodemographic Correlates. *J health, popul nutrition*. 33(1):92.

Kamath R, Majeed JA, Chandrasekaran V, Pattanshetty SM. 2013. Prevalence of Anemia among Tribal Women of Reproductive Age in Udupi Taluk, Karnataka. *J Famil Medic Prim Care*. 2(4): 345–348.

KC Roy. 2018. Demand for Schedule tribe status by Koch Rajbongshis. *Economic & Polit weekly*.

Kapil U, Sachdev HP. 2012. Urgent need to orient public health response to rapid nutrition transition. *Indian J Community Med*. 37:207-210.

Kaplan RC, Avilés-Santa ML, Parrinello CM, Hanna DB, Jung M, Castañeda SF, Hankinson AL, Isasi CR, Birnbaum-Weitzman O, Kim RS. 2014. Body mass index, sex, and cardiovascular disease risk factors among Hispanic/Latino adults: Hispanic community health study/study of Latinos. *J Am Heart Assoc*. 3(4). e000923.

Kato I, Toniolo P, Akhemedkhanov A, Koenig KL, Shore R, Zeleniuch-Jacquotte A. 1998. Prospective study of factors influencing the onset of natural menopause. *J Clinical Epidem.* 51(12), 1271−1276.

Kaur M, Talwar I. 2011. Body composition and fat distribution among older Jat females: a rural-urban comparison. *Homo.* 62(5):374-85.

Kaustav Das, Koel Mukherjee, Sayak Ganguli, Somosree Pal, Subrata Sankar Bagchi. 2020. Aging, Anthropometry and Body Composition among Kheria Sabar Males, Coll. Antropol. 44(2): 73–80.

Khadivzadeh T. 2002. Mid upper arm and calf circumferences as indicators of nutritional status in women of reproductive age. *East Mediterranean heal j.* 8: 612-618.

Khambalia AZ, Lim SS, Gill T, Bulgiba AM. 2012. Prevalence and sociodemographic factors of malnutrition among children in Malaysia. *Food Nutr Bull.* 33:31-42.

Khan I, Ul-Haq Z, Taj AS, Iqbal AZ, Basharat S, Shah BH. 2017. Prevalence and Association of Obesity with Self-Reported Comorbidity: A Cross-Sectional Study of 1321 Adult Participants in Lasbela, Balochistan. *Biomed Res Int.* 1076923.

Khongsdier R. 2001. Body mass index of adult males in 12 populations of northeast India. *Ann Hum Biol.* 28(4):374-83.

Khongsdier R. 2002. Body mass index and morbidity in adult males of the War Khasi in Northeast India. Eur J Clin Nutr. 56(6):484-9.

Khor GL. 2008. Food-based approaches to combat the double burden among the poor: Challenges in the Asian context. *Asia Pac J Clin Nutr.* 17:S111–S115.

Kibria, Gulam Muhammed Al, Swasey, Krystal, Hasan, Md Zabir, Sharmeen, Atia D Brendan. 2019. Prevalence and factors associated with underweight, overweight and obesity among women of reproductive age in India. *Glob Heal Rese Policy*. 4. 10.1186.

Kim CH, Chung S, Kim H, Park JH, Park SH, Ji JW, Han SW, Lee JC, Kim JH, Park YB, Nam HS, Kim C. 2011. Norm references of fat-free mass index and fat mass index 351 and subtypes of obesity based on the combined FFMI-%BF indices in the Korean adults aged 18-89 yr. *Obes Res Clin Pract*. 5(3):e169-266.

Kim Y, Je Y. 2019. Early menarche and risk of metabolic syndrome: a systematic review and Meta analysis. *J Women's Heal*. 28(1), 77–86.

Komlos J, Snowdon B. 2005. Measures of Progress and Other Tall Stories. *World Economics*. 6(2) 87-135.

Kriplani A, Banerjee K. 2005. An over view of age of onset of menopause in northern India. *Maturitas*. 52(3–4), 199–204.

Krishnamoorthy Y, Vijayageetha M, Saya GK. 2021. Validation and Reliability Assessment of the Mini-Nutritional Assessment-Short Form Questionnaire among Older Adults in South India. *Indian J Community Med*. 46(1):70-74.

Kshatriya GK, Acharya SK. 2016. Triple Burden of Obesity, Undernutrition, and Cardiovascular Disease Risk among Indian Tribes. *PLoS One*. 11(1):e0147934.

Kshatriya GK, Acharya SK. 2016. Triple Burden of Obesity, Undernutrition, and Cardiovascular Disease Risk among Indian Tribes. *PLoS One*. 25;11(1):e0147934.

Kues AB. 2010. Taller - Healthier - more equal? The biological standard of living in Switzerland in the second half of the 20th century. *Econ Hum Biol*. 8(1):67-79.

Kuiti BK. 2018. Assessment of diet and nutritional status and prevalence of morbidity among coastal fishermen of Purba Medinipur district in West Bengal. PhD thesis, Department of Anthropology, Vidyasagar University. Retrieved from: http://hdl.handle.net/10603/295392

Kumar P, Sinha R, Patil N, Kumar V. 2019. Relationship between mid-upper arm circumference and BMI for identifying maternal wasting and severe wasting: a cross-sectional assessment. *Public Health Nutr*. 1–5.

Kumar V, Basu D, Reddy BM. 2004. Genetic heterogeneity in northeastern India: reflection of tribe–caste continuum in the genetic structure. *American Journal of Human Biology*. 16(3): 334–345.

Kupputhai U, Mallika N. 1993. Nutritional status of adult women belonging to khond, Gadaba and Porja tribes of Andhra Pradesh. *The Indian J Nutr Diet*. 30: 173-179.

Kyle UG, Schutz Y, Dupertuis YM, Pichard C. 2003. Body composition interpretation. Contributions of the fat-free mass index and the body fat mass index. *Nutrition*.19(7-8):597-604.

Lagua RT, Claudio VS. 1996. Nutrition and diet therapy reference dictionary. New York. *Chapman & Hall*.

Lalnuneng A, Khongsdier R. 2017. Rural-Urban Differences in Hypertension among the Hmars of Manipur in Northeast India. *The Anthropologist.* 28(3):173-183.

Lavie CJ, Milani RV, Artham SM, Dharmendrakumar PA, Ventura HO. 2009. The obesity paradox, weight loss, and coronary disease. *Am J Med.* 122:1106-14.

Laxmaiah A. 2007. Diet and Nutritional Status of Tribal Population in ITDA project areas of Khammam District, Andhra Pradesh. *J Hum Ecol*. 21 (2): 79-86.

LBD Double Burden of Malnutrition Collaborators. Mapping local patterns of childhood overweight and wasting in low- and middle-income countries between 2000 and 2017. 2020. *Nat Med*. 26(5):750-759.

Lee MH, Kim SH, Oh M, Lee KW, Park MJ. 2016. Age at menarche in Korean adolescents: trends and influencing factors. *Reproductive Health*. 13, 121.

Lee R, Nieman DC. 2002. Anthropometry. In: Lee R, Nieman DC, editors. Nutritional Assessment. New York, NY: *McGraw-Hill*. 223–288.

Lindarto D, Shierly, Syafril S. 2016. Neck Circumference in Overweight/Obese Subjects who Visited the Binjai Supermall in Indonesia. *Open Access Maced J Med Sci.* 4(3):319-323.

Little M, Humphries S, Patel K, Dewey C. 2016. Factors associated with BMI, underweight, overweight, and obesity among adults in a population of rural south India: a cross-sectional study. *BMC Obes*. 20: 3-12.

Little M, Humphries S, Dodd W, Patel K, Dewey C. 2020. Socio-demographic patterning of the individual-level double burden of malnutrition in a rural population in South India: a cross-sectional study. *BMC Public Health.* 20 (1):675.

Liu LN, Miaskowski C, Wang JS, Chen SC, Chen ML. 2010. Accuracy of body mass index to determine obesity in women with breast cancer: an observational study of Taiwanese sample. *Int J Nurs Stud*. 47(8):994-1000.

López-Ortega M, Arroyo P. 2016. Anthropometric characteristics and body composition in Mexican older adults: age and sex differences. *Br J Nutr.* 115(3):490-9.

Lutoslawska G, Malara M, Tomaszewski P, Mazurek K, Czajkowska A, Kęska A, Tkaczyk J. 2014. Relationship between the percentage of body fat and surrogate indices of fatness in male and female Polish active and sedentary students. *J Physiological Anthropo*. 33:10

Mahajan N, Aggarwal M, Bagga A. 2012. Health issues of menopausal women in North India. *J Midlife Health*. 3(2):84-7.

Maity B, Chaudhuri D, Saha I, Sen M. 2019. Association of Nutritional Status with Depression and Cognitive Function of Older Women Residing in Old-age Homes of Kolkata, India. *Indian J Community Med.* 44(4):328-331.

Mandal A, Roy D. 2022. Assessment of nutritional status in relation to socio economic determinants among Sabar tribes of Jhargram district of West Bengal, India. *Int J Community Med Public Health*. 9:1479-91.

Manjunath TL, Zachariah SM, Venkatesha M, Muninarayana C, Lakshmi A. 2017. Nutritional assessment of women in the reproductive age group (15-49 years) from a rural area, Kolar, Kerala, India. *Int J Community Med Public Health*. 4:542-6.

Martins I, DantaS A. Guimnar S. Amorim Cruz JA. 2002. Vitamin and mineral intakes elderly. *J Nutr Health Aging*. 6: 63-65.

Mason JB, Saldana LS, Ramakrishnan U, Lowe A, Noznesky E.A, Girard A.W. Girard AW, McFarland DA, Martorell R. 2012. Opportunities for improving maternal nutrition and mirth outcomes: synthesis of country experiences. *Food Nutr Bull.* 33: S104–S137.

Mehta P, Shringarpure B. 2000. Diet nutrition and health profile of elderly population of urban Baroda. *Indian J Public Health*. 44(4):124-8.

Mei KL, Batsis JA, Mills JB. 2016. Sarcopenia and sarcopenic obesity: do they predict inferior oncologic outcomes after gastrointestinal cancer surgery. *Perioper Med* **5** **:**30.

Meshram II, Balakrishna N, Sreeramakrishna K, Rao KM, Kumar RH, Arlappa N, Manohar G, Reddy ChG, Ravindranath M, Kumar SS, Brahmam GN, Laxmaiah A. 2016a.Trends in nutritional status and nutrient intakes and correlates of overweight/obesity among rural adult women (≥18-60 years) in India: National Nutrition Monitoring Bureau (NNMB) national surveys. *Public Health Nutr*. 19(5):767-76.

Mishra D, Singh H. P. 2003. Kuppuswamy's Socioeconomic Status Scale – A Revision. A letter to editor. *Indian J Pediatr*. 70(3):273-4.

Misra A, Singhal N, Sivakumar B, Bhagat N, Jaiswal A, Khurana L. 2011. Nutrition Transition In India: Secular Trends In Dietary Intake and Their Relationship to Diet Related Non Communicable Diseases. *J Diabetes.* 3: 278-292.

Mittal PC, Srivastava S. 2006. Diet, nutritional status and food related traditions of Oraon tribes of New Mal (West Bengal), India. *Rural Remote Health.* 6(1):385.

Mohan I, Gupta R, Misra A, Sharma KA ,Agrawal A, Vikram NK, Sharma V, Shrivastava U, Pandey RM. 2016. Disparities in Prevalence of Cardio-metabolic Risk Factors in Rural, Urban-Poor, and Urban Middle Class Women in India. *PLoS One.* 11(2):e0149437.

Mohapatra A. 2001. Nutritional status of rural Oriya women from drought affected Kalahandi District of Orissa. *The Indian J Nutrition Dietetics.* 38: 403-411.

Monali G. 2015. Anthropometric Characteristics and Chronic Energy Deficiency of the Mankidias - A PTG of Northern Odisha, India. *Stud Tribes Tribals.* 13:1, 88-93.

Mondal N, Sen J, Bose K, Timungpi R, Kathar M, Hanse S. 2016. Neck circumference as a screening measure of overweight/obesity among Indian adults. *Anthropological Rev.* 79 (3): 347-365.

Mondal N, Timungpi R, Kathar M, Hanse S, Teronpi S, Timung A, Bose K. 2017. Cut-off point estimation of Neck circumference to determine Overweight and Obesity among Asian Indian adults. *Epidemiology, Biostatistics and Pub Heal.* 14 (2).

Mujica-Coopman MF, Navarro-Rosenblatt D, López-Arana S, Corvalán C. 2020. Nutrition status in adult Chilean population: economic, ethnic and sex inequalities in a post-transitional country. *Public Health Nutr*. 23(S1):s39-s50.

Mukhopadhyay A. 2010. Anthropometric characteristics and under-nutrition among adult Santal tribe of Birbhum District, West Bengal, India. *Anthropol Sci*.118(1): 57–60.

Mukhopadhyay DK[1], Biswas R, Chakraborty M, Sadhukhan SK, Banik KK. 2009. Anthropometric failure, a new approach to measure undernutrition: an experience from a rural community of West Bengal, India. *J Indian Med Assoc*.107:211-4, 236.

Müller O, Krawinkel M. 2005. Malnutrition and health in developing countries. *CMAJ 173*(3): 279–286.

Mungreiphy NK, Kapoor S. 2010. Socioeconomic changes as covariates of overweight and obesity among Tangkhul Naga tribal women of Manipur, north-east India. *J Biosoc Sci*. 42(3):289-305.

Mungreiphy NK, S Kapoor, R Sinha. 2011. Association between BMI, blood pressure, and age: study among Tangkhul Naga tribal males of Northeast India. Article ID 748147, 6 pages.

Muth ND. 2009. What are the guidelines for percentage of body fat loss? ACE BlogonDecember02.https://www.acefitness.org/educationandresources/lifestyle/blog/112/what-are-the-guidelines-for-percentage-of-body-fat-loss (Accessed on 05-07-2018)

Namita Singh. 2019. Nutritional Status of Tribal Women of Reproductive Age Group in Naugarh Block, Chandauli District. *Int.J.Curr.Microbiol.App.Sci*. 8(07): 953-966.

Nandy S, Irving M, Gordon D, Subramanian SV, Smith GD .2005. Poverty, child undernutrition and morbidity: New evidence from India. *Bull World Health Organ*. 3:210-216.

National Family Health Survey (NFHS 4). 2015–16: International Institute for Population Sciences & Macro International (IIPS), Mumbai, India. http://rchiips.org/nfhs/factsheet_NFHS-4.shtml State level Factsheets were accessed on 06.03.2018.

National Nutrition Monitoring Bureau. 2012. Diet and Nutritional Status of Rural Population, Prevalence of Hypertension & Diabetes among Adults and Infant & Young Child Feeding Practices -Report of Third Repeat Survey. Technical Report no. 26. Hyderabad: National Institute of Nutrition, Indian Council of Medical Research.

National Nutrition Monitoring Bureau. 2017. Diet and Nutritional status of urban population in India and prevalence of obesity, hypertension, diabetes and hyperlipidemia in urban men and women. NNMB Brief Report on Urban Nutrition. Technical report No: 27. Hyderabad: National Institute of Nutrition, Indian Council of Medical Research.

NCD Risk Factor Collaboration (NCD-RisC). 2016. Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19.2 million participants. Lancet 387:1377-1396.

Ni Mhurchu C, Rodgers A, Pan WH, Gu DF, Woodward M; Asia Pacific Cohort Studies Collaboration. 2004. Body mass index and cardiovascular disease in the Asia-Pacific

Region: an overview of 33 cohorts involving 310 000 participants. *Int J Epidemiol.* 33(4):751-8.

Nieman DC. 1995. Fitness and Sport Medicine: A Health-Related Approach. *Bull Publishing Co, Palo Alto*.

Obirikorang C, Osakunor DN, Anto EO, Amponsah SO, Adarkwa OK. 2015. Obesity and Cardio-Metabolic Risk Factors in an Urban and Rural Population in the AshantiRegion-Ghana: A Comparative Cross-Sectional Study. *PLoS One*. 10(6):e0129494.

Oguz A, Temizhan A, Abaci A, Kozan O, Erol C, Ongen Z, Celik S. 2008. Obesity and abdominal obesity; an alarming challenge for cardio-metabolic risk in Turkish adults. *Anadolu Kardiyol Derg*. 8(6):401-6.

Omidvar S, Amiri FN, Bakhtiari A, Begum K. 2018. A study on menstruation of Indian adolescent girls in an urban area of South India. *J Family MedicinePrimary Care.* 7(4), 698–702.

Özdemir O, Coi M. 2004. The age at menopause and associated factors at the health center area in Ankara, Turkey. *Maturitas*. 49(3), 211–219.

Pal P, Ghosh J. 2022. A Study of Nutritional Status and Obesity among the Adult Nepalese of Karseong, Darjeeling District, West Bengal, India. *Advances in Anthropo*. **12**:18-28.

Pardo Silva MC , De Laet C. , Nusselder WJ , Mamun AA , Peeters A. 2006. Adult obesity and the number of years lived with and without cardiovascular disease. *Obesity*. 14:1264-1273.

Patil YP, Shinde RL. 2014. Undernutrition among Indian men: a study based on NFHS-3. *Am J Mens Health.* 8(6):492-502.

Pelletier LG, Rocchi MA, Vallerand RJ, Deci EL, Ryan RM. 2013. Validation of the revised sport motivation scale (SMS-II). *Psychology Sport Exerc.* 14(3), 329e341.

Peltz G, MD, MPH, Aguirre MT, MS, Sanderson M, Fadden MK, MPH, PA. 2010. The role of fat mass index in determining obesity. *Am J Hum Biol.* 22(5): 639–647.

Peltz G, MD, MPH, Aguirre MT, MS, Sanderson M, Fadden MK, MPH, PA. 2010. The role of fat mass index in determining obesity. *Am J Hum Biol*. 22(5): 639–647.

Pengpid S, Peltzer K. 2014. Prevalence of overweight/obesity and central obesity and its associated factors among a sample of university students in India. *Obes Res Clin Pract.* 8(6):e558-70.

Peter RS, Fromm E, Klenk J, Concin H, Nagel G. 2014. Change in height, weight, and body mass index: longitudinal data from Austria. *Am J Hum Biol.* 26(5):690-6.

Peters SAE, Woodward M, Jha V. 2016.Women's health: a new global agenda. *BMJ Global Health.* 1:e000080.

Philpott DC, Belchior-Bellino V, Ververs M. 2021. Use of mid-upper arm circumference to screen for thinness among sub-Saharan African male detainees. *Public Health Nutr.* 24(15):4777-4785.

Pongchaiyakul C, Kosulwat V, Rojroongwasinkul N, Charoenkiatkul S, Thepsuthammarat K, Laopaiboon M, Nguyen TV, Rajatanavin R. 2005. Prediction of percentage body fat in rural thai population using simple anthropometric measurements. *Obes Res.* 13(4):729-38.

Pongchaiyakul C, Nguyen TV, Kosulwat V, Rojroongwasinkul N, Charoenkiatkul S, Pongchaiyakul C, Sanchaisuriya P, Rajatanavin R. 2006. Defining obesity by body mass index in the Thai population: an epidemiologic study. *Asia Pac J Clin Nutr*. 15(3):293-9.

Popkin BM, Adair LS, Ng SW. 2012. Global nutrition transition and the pandemic of obesity in developing countries. *Nutr Rev*. 70(1):3-21.

Powell-Tuck, Hennessy EM .2003. A Comparison of mid upper arm circumference, body mass index and weight loss as indices of undernutrition in acutely hospitalised patients. *Clil Nutr*. 22 :307–312.

Pradeepa R, Anjana RM, Joshi SR, Bhansali A, Deepa M, Joshi PP, Dhandania VK, Madhu SV, Rao PV, Geetha L, Subashini R, Unnikrishnan R, Shukla DK, Kaur T, Mohan V1, Das AK; ICMR-INDIAB Collaborative Study Group. 2015. Prevalence of generalized & abdominal obesity in urban & rural India--the ICMR-INDIAB Study (Phase-I) [ICMR- NDIAB-3]. *Indian J Med Res*. 142(2):139-50.

Pilot, D. F., & Hungler, B. P. (1999). Nursing research: principles and methods. Phildelphia: JB Lippincott Company.

Prasad DS, Kabir Z, Dash AK, Das BC. 2013. Effect of obesity on cardiometabolic risk factors in Asian Indians. *J Cardiovasc Dis Res*. 4(2):116-22.

Prospective Studies Collaboration, Whitlock G, Lewington S, Sherliker P, Clarke R, Emberson J, Halsey J, Qizilbash N, Collins R, Peto R. 2009. Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. *Lancet*. 373(9669):1083-96.

Prusty RK, Kumar A. Socioeconomic dynamics of gender disparity in childhood immunization in India, 1992-2006. *PLoS One.* 15;9(8):e104598.

Purnungla S, Sengupta S. 2002. Menarche and menopause among Ao Naga women of Nagaland, India. *J Human Ecol.*13(4), 327–328.

Rai RK, Fawzi WW, Bromage S, Barik A, Chowdhury A. 2018. Underweight among rural Indian adults: burden, and predictors of incidence and recovery. *Public Health Nutr.* 21(4):669-678.

Rai RK. 2015. Factors associated with nutritional status among adult women in urban India, 1998-2006. *Asia Pac J Public Health.* 27(2):NP1241-52.

Rao KM, Arlappa N, Radhika MS, Balakrishna N, Laxmaiah A, Brahmam GN. 2010. Correlation of Fat Mass Index and Fat-Free Mass Index with percentage body fat and their association with hypertension among urban South Indian adult men and women. *Ann Hum Biol.* 39(1):54-8.

Rao KM, Kumar RH, Krishna KS, Bhaskar V, Laxmaiah A. 2015. Diet & nutrition profile of Chenchu population - A vulnerable tribe in Telangana & Andhra Pradesh, India. *Indian J Med Res.* 141(5):688-96.

Rao VG, Gopi PG, Bhat J, Yadav R, Selvakumar N, Wares DF. 2012. Selected risk factors associated with pulmonary tuberculosis among Saharia tribe of Madhya Pradesh, central India. *Eur J Public Health.* 22(2):271-3.

Razon AH, Haque MI, Ahmed MF, Ahmad T. 2022. Assessment of dietary habits, nutritional status and common health complications of older people living in rural areas of Bangladesh. *Heliyon.* 11;8(2):e08947.

Reddy UN, Priya V, Chacham S, Khan SS, Rao JN, Mohiuddin MN. 2014. Impact of maternal risk factors on the incidence of low birth weight neonates in southern India. *International J Medical Rese Health Sciences*. 3(4):813-818.

Reilly JJ, Kelly J. 2011. Long-Term Impact of Overweight and Obesity in Childhood and Adolescence on Morbidity and Premature Mortality in Adulthood: Systematic Review. *InternationalJObesity*.35:891-898.

Rengma MS, Sen J, Mondal N. 2015. Socio-Economic, Demographic and Lifestyle Determinants of Overweight and Obesity among Adults of Northeast India. *Ethiop J Health Sci*. 25(3):199-208.

Risley, H.H. 1891/ 1992 (reprint). The Tribes and Castes of Bengal – Ethnographic Glossary. 2-volumes. *Firma K L Mukhopadhyay*, Calcutta.

Roberto ES, MD Fernando E, Viteri MD, DSC. 1974. Luminal events of lipid absorption in protein-calorie malnourished children; relationship with nutritional recovery and diarrhea. I. Capacity of the duodenal content to achieve micellar solubilization of lipids, *The American J Clinical Nutri*. 27 (8):777–787.

Rosell M, Appleby P, Key T. 2005. Height, age at menarche, body weight and body mass index in life-long vegetarians. *Publ Healt Nutri.* 8(7):870–875.

Rosmond R, Dallman MF, Bjorntorp P. 1998. Stress-related cortisol secretion in men: relationships with abdominal obesity and endocrine, metabolic and hemodynamic abnormalities. *J Clin Endocrinol Metab*. 83:1853-1859.

Roy S, Barman S, Mondal N, Sen J. 2016. Prevalence of Stunting and Thinness Among Adolescent Girls Belonging to the Rajbanshi Population of West Bengal, India. *J Nepal Paedia Soci.* 36(2):147- 155.

Roy SK. 2002. Factors affecting the work productivity of Oraon agricultural laborers of Jalpaiguri district, West Bengal. *Am J Phys Anthropol.*117(3):228-35.

Rush EC, Plank LD, Mitchelson E, Laulu MS. 2002. Central obesity and risk for type 2 diabetes in Maori, Pacific, and European young men in New Zealand. *Food Nutr Bull.* 23(3):82-6.

Rush E, Plank L, Chandu V, Laulu M, Simmons D, Swinburn B, Yajnik C. 2004. Body size, body composition, and fat distribution: a comparison of young New Zealand men of European, Pacific Island, and Asian Indian ethnicities. *N Z Med J*. 117(1207):U1203.

Sadhukan SK, K Bose, A Mukhopadhya, M Bhadra. 2007. Age variations in overweight men and women in rural areas of Hooghly District, West Bengal. *Indian Joural of Public Health.* 51(1): 59-61.

Sahakyan KR, Somers VK, Rodriguez-Escudero JP, Hodge DO, Carter RE, Sochor O, Coutinho T, Jensen MD, Roger VL, Singh P, Lopez-Jimenez F. 2015. NormalWeight Central Obesity: Implications for Total and Cardiovascular Mortality. *Ann Intern Med.* 163(11):827-35.

Sahani R, Chakrabarty S, Bharati P. 2010. Temporal trends in overweight and obesity among Nicobarese adults in Nicobar Islands, India, 1960s-1999. *Obes Res Clin Pract.*4(2):e83-e162.

Sahani R, Gautam RK, Golnabi AH, Vedwan N. 2018. Comparative study of chornic energy deficiency among adult males of Andaman and Nicobar Islands and their counterparts. *Anthropol Rev.* 81(1): 1-17.

Sahani R. 2004. Seasonal variation in nutritional status of the Jarwas. *J Anthrop Survey India*. 53:99-117.

Sánchez-García S, García-Peña C, Duque-López MX, Juárez-Cedillo T, Cortés-Núñez AR, Reyes-Beaman S. 2007. Anthropometric measures and nutritional status in a healthy elderly population. *BMC Public Health*. 3:7-2.

Sanou D, O'Reilly E, Ngnie-Teta I. 2014. Acculturation and Nutritional Health of Immigrants in Canada: A Scoping Review. *J Immigrant Minority Health*. **16:**24–34.

Santos JL, Albala C, Lera L, García C, Arroyo P, Pérez-Bravo F, Angel B, Peláez M. 2004. Anthropometric measurements in the elderly population of Santiago, Chile. *Nutrition*. 20(5):452-7.

Sarkar A, Pithadia P, Goswami K, Bhavsar S, Makwana NR, Yadav S, Parmar DV. 2014. A Study on Health Profile of Post-menopausal Women in Jamnagar district, Gujarat. *J Res Med Den Sci*. 2(2):25-29.

Sarkar SB, Mukhopadhyay. 2009. Seasonal variation in blood pressures and hypertension among the Bhutias of Sikkim, India. *Stud on Biomedl Anthropol*. INCAA Occasional Paper No. 8. Edited By A. K. Danda, Vikash Bhatt and R. K. Mutatkar. *Aryan International Publishing House,* New Delhi.

Sarkar S, Mukhopadhyay B. 2008a. Perceived psychological stress and cardiovascular risk: observation among the Bhutias of Sikkim, India. *Stre & Heal*. 24(1). 23-34.

Satpathy M. 2016. A Study on Age at Menopause , Menopausal Symptoms and Problems among Urban Women from Western Odisha , India. *International J Scien Research Publicas.* 6(3):2250-3153.

Schmid MA, Salomeyesudas B, Satheesh P, Hanley J, Kuhnlein HV. 2007. Intervention with traditional food as a major source of energy, protein, iron, vitamin C and vitamin A for rural Dalit mothers and young children in Andhra Pradesh, South India. *Asia Pac J Clin Nutr.* 16(1):84-93.

Schwartz RS, Shuman WP, Larson V. 1991. The effect of intensive endurance exercise training on body fat distribution in young and older men. *Metabolism.* 40:545–51.

Sen J, Mondal N. 2012. Socio-economic and demographic factors affecting the Composite Index of Anthropometric Failure (CIAF). *Ann Hum Biol.* 39(2):129-36.

Sen J, Mondal N, Dey S. 2011. Assessment of the nutritional status of children aged 5 12 years using upper arm composition. *Ann Hum Biol.* 38(6):752-9.

Sen J, Mondal N, Dutta S. 2013. Factors affecting overweight and obesity among urban adults: A cross-sectional study. *Epidemiol Biostat Pub Health*. 10: e8741–1-8.

Sengupta S, Gogoi G. 1993. Menarche and menopause among the Kaibarta women of Dibrugarh, Assam. *J Assam Sci Soc.* 35:113-9.

Sengupta A, Angeli F, Syamala TS, Dagnelie PC, van Schayck CP. 2015. Overweight and obesity prevalence among Indian women by place of residence and socio-economic status: Contrasting patterns from 'underweight states' and 'overweight states' of India. *Soc Sci Med.* 138:161-9.

Sengupta A, Angeli F, Syamala TS, Van Schayck CP, Dagnelie P. 2014. State-wise dynamics of the double burden of malnutrition among 15-49 year-old women in India: how much does the scenario change considering Asian population-specific BMI cut-off values? *Ecol Food Nutr*. 53(6):618-38.

Sharma R. 2016. Online interactive calculator for real-time update of the Kuppuswamy's socioeconomic status scale.Available from: www.scaleupdate.weebly.com (Accessed on 2016-05-10)

Sharma K, Bansal M. 2018. Association of age at menopause with post-menopausal symptoms, menarche age and other reproductive factors among rural females in Shimla, Himachal Pradesh. *J Biosocial Scie*. 50(1):19–25.

Sharma S, Tandon VR, Mahajan A. 2007. Menopausal symptoms in urbanwomen. *JK Sci.* 9:13-7.

Sharmila N, Dhas CA. 2010. Development of women education in India, InMunichPersonalRePEcArchive.Retrievedfrom:http://mpra.ub.unimuenchen.de/20680/MPRAAll India Survey on Higher Education, MHRD, Govt. of India: www.aishe.gov.in

Shimokata H, DC Muller, R Andres. 1989. Studies in the distribution of body fat. *J Am Med Assoc.* 261:1169-1173.

Shukla HC, Gupta PC, Mehta HC, Hebert JR. 2002. Descriptive epidemiology of body mass index of an urban adult population in western India. *J Epidemiol Community Health*. 56(11):876-80.

Shukla R, Ganjiwale J, Patel R. 2018. Prevalence of postmenopausal symptoms, its effect on quality of life and coping in rural couple. *J Midlife Heal.* 9(1): 14–20.

Sidhu S. 2002. Age at menarche among scheduled caste girls of Punjab. *J Human Ecol*. 13(4), 327–328.

Singh L, Thapar M. 1983. Age at menarche among the Bhotias of Mana Valley. *Anthropol Anz*. 41(4):259–262.

Singh L, Ahuja S. 1980. Trend of menopause among the women of Punjab. *Anthropol Anz*. 38:297-300.

Singh V, Ahmed S, Dreyfuss ML, Kiran U, Chaudhery DN, Srivastava VK, Ahuja RC, Baqui AH, Darmstadt GL, Santosham M, West KP Jr. 2017. Non-governmental organization facilitation of a community-based nutrition and health program: Effect on program exposure and associated infant feeding practices in rural India. *PLoS One*. 12(9)

Singh J, Nitish M. 2014. Use of Upper-Arm Anthropometry as Measure of Body-Composition and Nutritional Assessment in Children and Adolescents (6–20 Years) of Assam, Northeast India. *Ethiopian j health scie*. 24. 243-52.

Singh K, Singh S, Kaur G, Bose K. 2020. Comparison of Age-Related Anthropometric Changes Among Elderly Punjabi Males Residing in Old-Age Homes with Those Residing with Their Families. *J Anthropological Surv India*. 69.

Sinha I, Tigga P, Mondal N, and Sen J. 2020.Association between age at menarche and age at menopause amongwomen of an indigenous population of North Bengal, India. *J Biosoc Sci*. https://doi.org/10.1017/S002193202000019X

Som S, Ulijaszek S, Pal M, Bharati S, Bharati P. 2014. Variation in height and BMI of adult Indians. *J Biosoc Sci.* 46(1):47-65.

Steckel RH. 1995. Stature and the Standard of Living. J. *Econ Lit*. 33:1903-40.

St George IM, Williams S, Silva PA. 1994. Body size and the menarche: the Dunedin Study. *J Adolesc Health*. 15(7):573-6.

Subasinghe AK, Walker KZ, Evans RG, Srikanth V, Arabshahi S, Kartik K, Kalyanram K, Thrift AG. 2014. Association between farming and chronic energy deficiency in rural South India. *PLoS One*. 27;9(1):e87423.

Subasinghe AK, Walker KZ, Evans RG, Srikanth V, Arabshahi S, Kartik K, Kalyanram K, Thrift AG. 2014. Association between farming and chronic energy deficiency in rural South India. *PLoS One*. 9(1):e87423.

Subramanian SV, Smith GD. 2006. Patterns, distribution, and determinants of under- and overnutrition: a population-based study of women in India. *Am J Clin Nutr*. 84(3):633-40.

Subramanyam MA, Subramanian SV. 2011. Low socio-economic groups are not overweight in India. *Indian J Med Res*. 133:119-20.

Sultana T, Karim MN, Ahmed T, Hossain MI. 2015. Assessment of under nutrition of Bangladeshi adults using anthropometry: can body mass index be replaced by mid-upper-arm-circumference? *PLoS One*. 10(4):e0121456.

Swaraj Basu. 2003. Dynamics of a caste Movement, The Rajbansis of North Bengal, 1910-1947.

Tang AM, Chung M, Dong KR, Bahwere P, Bose K, Chakraborty R, Charlton K, Das P, Ghosh M, Hossain MI, Nguyen P, Patsche CB, Sultana T, Deitchler M, Maalouf-Manasseh Z. 2020. Determining a global mid-upper arm circumference cut-off to assess underweight in adults (men and non-pregnant women). *Public Health Nutr*. 23(17):3104-3113.

Tanuja D, Karmakar V, Sampathkumar S, Jeyalakshmi S, Abel R. 1995. Nutritional status of tribal women in Bihar. *Man in India*. 75: 209–214.

Taylor RW, Brooking L, Williams SM, Manning PJ, Sutherland WH, Coppell KJ, TipeneLeach D, Dale KS, McAuley KA, Mann JI. 2010. Body mass index and waist circumference cutoffs to define obesity in indigenous New Zealanders. *Am J Clin Nutr*. 92(2):390-7.

Teller H, Yimar G. 2000. Levels and Determinants of Malnutrition in Adolescent and Adult Women in Southern Ethiopia. *Ethiopian J Heal Develop*. 14:57-66.

Thakur N, Chandra J, Pemde H, Singh V. 2014. Anaemia in severe acute malnutrition. *Nutrition*. 30(4): 440-442.

Thorup L, Hamann SA, Kallestrup P, Hjortdal VE, Tripathee A, Neupane D, Patsche CB. 2020. Mid-upper arm circumference as an indicator of underweight in adults: a cross-sectional study from Nepal. *BMC Public Health*. 20(1):1187.

Tigga PL, Debnath S, Das M, Mondal N, Sen J. 2018. Prevalence of undernutrition and overweight or obesity among the Bengali Muslim population of West Bengal, India. *Anthropol Open J*. 3(1): 1-10.

Touitou Y, Portaluppi F, Smolensky MH, Rensing L. 2004. Ethical principles and standards for the conduct of human and animal biological rhythm research. Chronobiol Int. 21:161-70.

Tyagi D, Pal G, Tewari PK. 1983. Menarcheal age among Oraon and Munda girls of Ranchi. *J Indian Med Associ.* 80(9–10): 133–134.

Ul Haq I, Mariyam Z, Li M, Huang X, Jiang P, Zeb F, Wu X, Feng Q, Zhou M. 2018. A Comparative Study of Nutritional Status, Knowledge Attitude and Practices (KAP) and Dietary Intake between International and Chinese Students in Nanjing, China. *Int J Environ Res Public Health*. 15(9):1910.

ul Haq I, Wasila H, Nawsherwan, Khan A, Chawla KR. 2017. Maternal Formal Education in Association with Nutritional Status of Children (Less-than Two Years). *Indian J Nutri.* 4(2): 162.

Ulijaszek SJ, Kerr DA. 1999. Anthropometric measurement error and the assessment of nutritional status. *British J Nutr*. 2: 165-77.

UNICEF. 2014. Every child counts. United Nations Children's Fund. https://www.unicef.org/gambia/SOWC_report_2014.pdf

Valdez R, Seidell CJ, Ahn YI. 1993. A new index of abdominal adiposity as an indicators of risk of cardio vascular disease. A cross population study. *Int J Obes*. 17:77-82.

Van Haute M, Rondilla E 2nd, Vitug JL, Batin KD, Abrugar RE, Quitoriano F, Dela Merced K, Maaño T, Higa J, Almoro JG, Ternida D, Cabrera JT. 2020. Assessment of a proposed BMI formula in predicting body fat percentage among Filipino young adults. *Sci Rep*. 10(1):21988.

Varadharajan KS, Thomas T, Rajaraman D, Kurpad AV, Vaz M. 2013. Overweight and obesity among internal migrants in India. *Asia Pac J Clin Nutr*. 22(3):416-25.

Varadharajan KS, Thomas T, Kurpad AV. 2013. Poverty and the state of nutrition in India. *Asia Pac J Clin Nutr* . 22:326-39.

Varte, Lalhmunlien, Sahani, Ramesh. 2014. A Comparative Study of Anthropometry and Obesity of Hmars of Mizoram and Shillong and blood Pressure Level Among the Hmars of Shillong.

Vehid S, Aran SN, Köksal S, Işiloglu H and Senocak M. 2006. The prevalence and the age at the onset of menopause in Turkish women in rural area. *Saudi Med J*. 27(9), 1381−1386.

Vir SC. 2016. Improving women's nutrition imperative for rapid reduction of childhood stunting in South Asia: coupling of nutrition specific interventions with nutrition sensitive measures essential. *Matern Child Nutr*. 12(1):72-90.

Web GP. 2002. Nutrition: A Health Promotion Approach, 2nd eds. London: *Arnold Publishers*.

Weiner JS, Lourie JA. 1981. Practical human biology. London: *Academic Press*.

Wells JC. 2012. Sexual dimorphism in body composition across human populations: associations with climate and proxies for short- and long-term energy supply. *Am J Hum Biol*. 24(4):411-9.

WHO. 1995. Physical Status: the Use and Interpretation of Anthropometry. Technical Report Series no. 854. World Health Organization, Geneva

WHO. 1996. Report of WHO Scientific Group on Menopause in 1990s. WHO Technical Report Series 866. World Health Organization, Geneva, pp.12–13.

WHO. 1995. Physical status: The use and interpretation of anthropometry. Technical Report series. Geneva: World Health Organization. 854: 1-452

WHO. 2000. International Association for the Study of Obesity & International Obesity Task Force. The Asia-Pacific Perspective: Redefining Obesity and Its Treatment. World Health Organization, Sydney: Health Communications.

WHO. 2008. Waist circumference and waist–hip ratio: report of a WHO expert consultation, Geneva, 8–11

Wilkinson AL, Pedersen SH, Urassa M, Michael D, Todd J, Kinung'hi S, Changalucha J, McDermid JM. 2015. Associations between gestational anthropometry, maternal HIV, and fetal and early infancy growth in a prospective rural/semi-rural Tanzanian cohort, 2012-13. *BMC Pregnancy Childbirth*. 15:277.

Wulan SN, Westerterp KR, Plasqui G. 2010. Ethnic differences in body composition and the associated metabolic profile: a comparative study between Asians and Caucasians. Maturitas. 65(4):315-9.

Wulan SN, Westerterp KR, Plasqui G. 2010. Ethnic differences in body composition and energy expenditure: A comparison between Asians and Caucasians. *NWO werkgemeenschap voiding*. Deurne, The Netherlands. Oral presentation.

Yadav A, Jain A, Sharma AN. 2002. Menarche and menopause among seminomadic Lohar Gadhiyas of Malthon Town of Sagar District, Madhya Pradesh. *J Human Ecol.* 13(4), 325–326.

Yusof HM, Ching TS, Ibrahim R, Lola S. 2007. Anthropometric indices and life style practices of the indigenous Orang Asli adults in Lembah Belum, Grik of Peninsular Malaysia. *Asia Pac J Clin Nutr.* 16(1):49-55.

Yusof HM, Ching TS, Ibrahim R, Lola S. 2007. Anthropometric indices and life style practices of the indigenous Orang Asli adults in Lembah Belum, Grik of Peninsular Malaysia. *Asia Pac J Clin Nutr.* 16(1):49-55.

Zhao D, Li Y, Zheng L, Yu K. 2013. Brief communication: Body mass index, body adiposity index, and percent body fat in Asians. *Am J Phys Anthropol.* 152(2):294-9.

+HT

Name	age	m.s	Ed.s	b.o	f.s	f-t	w.s	e.s	t.f	m.i	H.h	W.t	muac	bsf	tsf	Ssf	sif	csf	wc	hc
A	19	un	H.S	2	6	N	T	Y/PT	SPT	50t/10K	152	59	29	11	15	13	18	19	99	102
B	36	M	BA	2	6	N	T	Y/SPT	SPT	50t/15K	155	57	28.2	12.4	15	20	17	15	82	96
C	39	M	12	3	8	N	T	Y/SPT	SPT	B/10K	153	60	29	11	14.8	19	17	19	99	106
D	18	un	H.S	1	8	N	T	Y/PT	SPT	B/10K	153.6	51	27	14	18.4	19	18.4	14	94	99
E	41	M	4	2	6	N	BT	Y/PT	PT	30t/20K	152	55	30	14.3	13	18	20	12	82	96
F	48	M	6	3	4	N	T	Y/SPT	SPT	B/6K	149	51	24	13	18	20	18.2	12	94	99
G	46	M	9	2	4	N	BT	Y/SPT	SPT	B/8K	157	66	36	10	12	13	14	22	102	108
H	55	M	illit	1	10	J	T	Y/SPT	KT	DL/6K	153	65	26	12	15	22	19	17	104	108
I	60	M	ill	3	11	J	T	Y/SPT	SPT	F/4K	150	62	30	10	14	21	17	18.6	96	101
J	53	M	illit	2	10	J	W	Y/KT	PT	Dt/6K	154	66	26	10	12	11	13	21	106	110
K	60	M	ill	3	12	J	T	Y/KT	PT	DL/6K	152	60	27	11	15	14	16	19	99	104
L	61	M	illit	4	8	N	BT	Y/KT	KT	DL/6K	150	48	24	7.8	13	11	18	16	82	90
M	24	M	ill	2	6	N	T	Y/KT	KT	DL/6K	142	47	25	9.3	12	15.6	18	17.2	80	99
N	36	M	MP	3	6	N	W	Y/KT	KT	DL/5K	150	50	26	15	15.6	18	20	13	82	94
O	38	un	MP	2	6	N	T	Y/SPT	SPT	F/5K	146	49.3	24	10.3	13.2	14.3	18.2	19	86	98
Q	42	M	8	4	5	N	W	Y/KT	SPT	F/5K	149	60	30	13	16	13.6	19	22	106	110

List of Papers And Two Attended National Seminar

Antrocom Online Journal of Anthropology vol. 17. n. 1 (2021) 155-167– ISSN 1973 – 2880

Antrocom Journal of Anthropology

journal homepage: http://www.antrocom.net

Anthropometric characteristics of rural Bengali adolescent girls from North Bengal, India

Isita Sinha[1], Neha Rani Pal[1], Nitish Mondal, [2]Jaydip Sen[1]

[1]Department of Anthropology, University of North Bengal, Raja Rammohanpur, P.O.:NBU Campus, District: Darjeeling, 734013, West Bengal, India; [2]Associate Professor, Department of Anthropology,Sikkim University, Gangtok-737102, Sikkim, India; corresponding author Dr. Jaydip Sen <jaydipsen@rediffmail.com>

KEYWORDS

Adolescence; Anthropometry; Physical growth; Bengali; India

ABSTRACT

Adolescence is the developmental period through which children grow into adults. Adolescents are the future generations of any country and their physical growth and nutritional needs are important for overall development of a society. The present cross-sectional investigation was undertaken to determine anthropometric characteristics of rural Bengali adolescent girls residing in North Bengal, India. The present investigation has observed that the adolescent girls exhibited low rates of physical growth when compared with the standard growth reference population but higher than those reported for other rural adolescent girls from India.

Introduction

Adolescence is the transitional phase between childhood and adulthood, and characterized by high growth acceleration, which is closely linked with nutritional status, and both are influenced by the process of sexual maturation. Nutrition plays a vital role during adolescence period because inadequate nutrition leads to malnutrition, growth retardation, reduced physical capacity, and poor mental and social development (Awasthi *et al.*, 2000; Chhatwal *et al.*, 2004; Sharma *et al.*, 2007; Mondal *et al.*, 2017; O' Brien *et al.*, 2018). In South-east Asia a large number of children and adolescents suffer from chronic undernutrition, which adversely effects their health and development (Venkaiah *et al.*, 2002; Olivieri *et al.*, 2008; Patanwar and Sharma 2013; Konwar *et al.*, 2019). The growth and nutritional status of adolescent girls, who are the future mothers bears special importance as they contribute to the overall nutritional status and health of the total population (Venkaiah *et al.*, 2002; Deshmukh *et al.*, 2006; Medhi *et al.*, 2007; Mondal and Sen, 2010; Roy *et al.*, 2016; Debnath *et al.*, 2017; Pal and Bose, 2017; Nandi *et al.*, 2018; O'Brien *et al.*, 2018). Currently, it is estimated that there are about 69.7 million adolescents' girls constituting about 7% of the total population in India. The adolescents are potentially and nutritionally vulnerable in view of their rapid physical growth and maturation (Das and Bose 2011; Khatun et al., 2016; Debnath et al., 2019). Inadequate diet and unfavorable environmental, socio-economic conditions and demographic variables can adversely affect the physical growth and nutritional status. Better nutritional environment of adolescents in the higher socio-economic groups accelerates, while poor socio-economic status retards the physical growth pattern (Bose and Mukhopadhyay, 2004; Bose *et al.*, 2005; Banik *et al.*, 2007; Rengma *et al.*, 2016; Joshi *et al.*, 2019; Vaishnaw *et al.*, 2020). Malnutrition is also one of the principal causes of premature mortality and morbidity among children and adolescents in India. World Health Organization (WHO) the ultimate

Please cite this article as: Isita Sinha, Neha Rani Pal, Nitish Mondal, Jaydip Sen. Anthropometric characteristics of rural Bengali adolescent girls from North Bengal, India. *Antrocom J. of Anthropology 17-1 (2021) pp. 155-167.*

intention of the nutritional assessment is to improve human health and improvement nutritional status is also one of the goals of SDGs (Sustainable Development Goals). Several research investigations of both undernutrition and overnutrition have significant clinical and public health implication for developing health promotion strategies to prevent chronic diseases in adulthood. However, a handful studies have been reported on the assessment of nutritional status among adolescents' girls in India (Rao *et al.*, 2000; Mitra *et al.*, 2002; Mondal and Sen, 2010; Patanwar and Sharma, 2013; Mondal, 2014; Dhingra and Bhatt, 2017; Konwar *et al.*, 2019).

Anthropometry has been widely used to assess physical growth and nutritional status (WHO 1995; Mondal and Sen 2010; Mondal *et al.*, 2017; Debnath *et al.*, 2018). It is well recognized worldwide that anthropometric measurements are indispensible in diagnosing of both undernutrition and overnutrition. Due to its simplicity, reliability and low cost, anthropometric measurements are widely used to evaluate physical growth and nutritional status (Venkaih *et al.*, 2002; Bose and Mukhopadhyay, 2004; Hall *et al.*, 2007; Bisai and Bose 2009; Das and Bose 2012; Mondal *et al.*, 2017; O'Brien *et al.*, 2018; Konwar *et al.*, 2019; Bharali and Mondal 2019; Debnath *et al.*, 2019). Anthropometric examination still remains a widely utilized tool in any research related with health and nutrition condition in childhood or adolescence stages (Bose and Mukhopadhyay, 2004; Medhi *et al.*, 2007; Mondal and Sen, 2010b; Sen and Mondal, 2013; Mondal *et al.*, 2017). Several studies have investigated physical growth status of children and adolescents belonging to various ethnic groups in India using this technique (Deshmukh *et al.*, 2006; Medhi *et al.*, 2007; Bisai and Bose, 2009; Basu *et al.*, 2014; Sing and Mondal, 2014; Rengma *et al.*, 2016; Debnath *et al.*, 2017; Konwar *et al.*, 2019; Vaishnaw *et al.*, 2020). Several researchers have also assessed growth and nutritional status of school going children and adolescents from West Bengal (Bose *et al.*, 2008; Chakraborty and Bose, 2009; Mondal and Sen, 2010; Das and Bose, 2011; Mondal and Bose, 2014; De, 2017; Debnath *et al.*, 2017; Pal *et al.*, 2017; Bhadra *et al.*, 2018; Bharali and Mondal., 2019; Debnath *et al.*, 2019). Moreover, it is attributed to poor socio-economic status can lead to poor nutrition and diseases which in turn can influence height of a growing child (e.g., de Onis 2001; Dasgupta *et al.*, 2005). The proponents of strategic growth adjustment in human consider presence of adequate nutrition, health, and living condition as prerequisites and not true regulators of physical growth (e.g., Bogin *et al.* 2017; Hermanussen *et al.* 2018). Given the above, the present investigation tries to ascertain the growth patterns of rural adolescent girls aged 10 to 14 years belonging to the Bengali Hindu Caste Population (BHCP) of Darjeeling district of West Bengal.

Materials and Methods

Area and Subjects

The present cross-sectional investigation was carried out in the northern part of West Bengal, India, a region which is popularly known as North Bengal. This region comprises the districts of Darjeeling, Kalimpong, Jalpaiguri, Alipurduar, Coochbehar, North dinajpur, South Dinajpur and Malda. A large number of tribal (e.g., Oraon, Munda, Rabha, Lepcha, Toto, Santal) and non-tribal (Rajbanshi, Bengali speaking Hindu Caste and Bengali Muslim) populations inhabit in this region. Existing literature have shown that these populations remained very vulnerable to undernutrition (Banik *et al.*, 2007; Mondal and Sen, 2010; Sen *et al.*, 2011; Mondal, 2014; Roy *et al.*, 2016; Debnath *et al.*, 2017; Pal *et al.*, 2017; Konwar *et al.*, 2019). The girls selected to participate in the present investigation were the residents of a rural area of Naxalbari block (Upper Bagdogora) of Darjeeling district, which is situated around 14 km away from the sub-divisional town of Siliguri. This area is the homeland of diverse populations such as Nepali, Lepcha, Santali, Bengali Hindu Caste and Bengali Muslim. They speak different languages, having different ethnic origins and cultural traditions. All the girls belonged to the Bengali Hindu Caste Population (BHCP) and enrolled in the Bagdogora Balika Vidyalaya (BBV). Ethnically, the BHCP is a

Bengali-speaking endogamous caste group of West Bengal and faithful to Hinduism. They are probably a blend of Dravidian and Mongoloid ethnic groups with a strain of Indo-Aryan blood among the higher caste groups (Das Chaudhuri *et al.*, 1993). The BBV school was primarily selected based on the twin factors of easy road accessibility and dominance of students belonging to the BHCP.

The girls were selected using a multistage stratified random sampling method. Initially 320 girls were approached to take part in this investigation. Forty-nine (49) of them were subsequently excluded from the study as either they did not belong to the age group selected or they did not belong to the BHCP. Age and ethnicity of the girls were subsequently verified from the school records. Hence the final sample size consisted of 271 girls in the age group 10-14 years. All the girls were observed to be free from any physical deformities, nutritional deficiency symptoms and did not suffer from any disease at the time of data collection. The data collection was conducted from March 2018 to April 2018. The work was conducted in accordance with the ethical guidelines for human experiments as laid down in the Helsinki Declaration of 2000 (Touitou *et al.*, 2004). The objectives and protocol of the present investigation were informed to the Head Mistress of the school before commencement of the study.

Anthropometric measurements recorded

Altogether seven anthropometric measurements were recorded from each participant following standard techniques (Hall *et al.*, 2007). These measurements were height, weight, sitting height, arm span, waist circumference, hip circumference and mid-upper-arm-circumference (MUAC). Height and sitting height of the girls were recorded using an anthropometer rod to the nearest 0.10 cm. Weight of the participants wearing minimum clothing and with bare feet was taken using a portable weighing machine to the nearest 0.10 kg. Arm span was measured by an anthropometer rod. The circumferences were recorded by using a non-stretchable plastic-coated measuring tape to the nearest 0.1mm.

The intra-observer and inter-observer technical errors of measurements (TEM) were calculated using a standard method (Ulijaszek and Kerr, 1999) and the coefficient of reliability (R) were calculated for testing the reliability of the measurements. For analysis of TEM, a total 50 girls were randomly selected from the BBV school. Their height, WC, HC and NC were measured by two of the authors (NRP and IS). The values of 'R' were subsequently determined from TEM. Very high values of 'R' (>0.975) were obtained for all four anthropometric measurements. As these values were appreciably higher than the cut-off value of 0.95 as suggested by Ulijaszek and Kerr (1999), the measurements recorded by the two authors were considered to be reliable, reproducible and free from any observer bias. All the measurements in the present study were subsequently recorded by NRP.

Body Mass Index (BMI) and Waist Hip Ratio (WHR) were derived using the following standard equations:

$$BMI\ (kg/m^2) = Weight\ (kg) / Height^2\ (m^2)$$
$$WHR = WC\ (cm) / HC\ (cm)$$

Statistical analysis

Descriptive statistics like mean and standard deviation of all anthropometric variables by age were computed. One-way analysis of ANOVA was performed to test the significant differences in mean anthropometric characteristics by age of the girls. The age- specific percentiles (5^{th}, 10^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th} and 95^{th}) values of height, weight and BMI have also derived using appropriate statistical procedure.

All statistical analysis was performed using the Statistical Packages for Social Sciences (SPSS; version 20.0). Statistical significance level was set at $p<0.05$.

Results

The age-specific descriptive statistics of anthropometric variables among the girls are depicted in Table 1. The mean height and weight increased with age from early adolescence to late adolescence. The age-specific mean height (149.46 cm) and weight (41.69 kg) were highest among 14 years aged girls. Girls belonging to the ages of 10 to 14 years have experienced greater acceleration in growth in height and weight. The age-specific highest positive attainment of growth spurt was observed in height (6.27 cm) and weight (5.99 cm) among girls aged 11 years. A similar increasing trend was observed in age specific mean values of MUAC, WC, HC, arm span and sitting height. Using ANOVA statistically significant ($p<0.05$) differences were observed in all anthropometric variables with respect to age (Table1). The BMI gradually increased from 11 to 14 years, with a slight decrease observed from 10 to 11 years and then values continued to rise reaching its highest peak in age of 14 years (18.76 kg/m^2). The age-specific mean values of WHR did not show any general increase with respect to age. The highest positive attainment of growth spurt was observed in BMI (1.83 kg/m^2) among girls aged 11 years. Using ANOVA statistically significant differences were observed in derived anthropometric and body composition variables with respect to age ($p<0.05$) (Table1). Age-specific selected percentile of 5th, 10th, 25th, 50th, 75th, 90th and 95th values for height, weight and BMI were derived separately among the girls are shown in Table 2. There appears to be an existing significant age-specific variation in anthropometric measurements of height, weight and BMI among adolescent girls as the girls approached in higher ages.

Comparison with the Reference Population

Age-specific mean values of height and BMI of adolescent's girls were compared with the WHO (2007) reference population. It was observed that the girls were generally below the 50th percentile of the reference values (Figures 1 and 2). The mean age-specific heights were well above the 5th and considerably below the 25th percentile of the reference values of girls aged 13 to 14 years. The age-specific mean values of BMI were observed to be below the 50th percentile, while age-specific mean BMI values were observed to be high in the 5thpercentile and to be same of 25th percentile in the ages of 12 and 14 years.

Discussion

Children and adolescents remain vulnerable due to their rapid physical growth rate and they require more attention for their physical and mental development which remains directly related to adequate level of nutrition (Bose *et al.*, 2005; Deshmukh *et al.*, 2006; Dhingra and Bhat 2017; Vaishnaw *et al.*, 2020). Height and weight are the two basic measures that are mainly used to assess the physical growth of children and adolescence. The present investigation observed that age-specific mean value of anthropometric measures showed the growth spurt during the period of adolescence. The overall means and standard deviations of height and weight of the adolescence girls were 144.3 cm ($\pm$8.39) and 37.1 kg ($\pm$9.0), respectively. Mean height and weight increased progressively from 10 to 14 years (Table 1), which was observed to be similar to the results obtained from other Indian studies among rural and urban girls (Mondal and Sen, 2010; Roy *et al.*, 2016; Pal and Bose, 2017; Nandi *et al.*, 2018; Joshi *et al.*, 2019; Khopkar *et al.*, 2014). The nature of the percentile curves showed that the mean values of different anthropometric measurements represent more or less an increasing trend with the advancement of age. The age-specific increase was however not observed to be uniform for all the measurements because of the influence of genetic and environmental conditions (Medhi *et al.*, 2007; Rengma *et al.*, 2016;

Debnath *et al.*, 2017; Nandi *et al.*, 2018; Bharali *et al.*, 2019; Konwar *et al.*, 2019; Debnath *et al.*, 2019).

In the present investigation, age at peak height was observed with the increase of age (e.g., 10-14 years) which was similar to the results of other studies reported on adolescent girls from India (Rao *et al.*, 2000; Bisai and Bose, 2009; Sen *et al.*, 2011; Khatun *et al.*, 2016; Bharati *et al.*, 2017; Nandi *et al.*, 2018). A majority of the body measurements in the present investigation have shown a high rate of increase in the age group of 10-12 years that corresponded to the adolescent growth spurt, which was earlier than the average age of onset among adolescence for other Indian girls. The Figure 3 shows the comparison of the girls in the current investigation with other rural girls. It indicated that increase in height of the girls in the present investigation was significantly higher ($p<0.01$) than other that of Indian girls as reported by other studies (e.g., Das and Bose, 2011; Mondal and Terangpi, 2014; Roy *et al.*, 2016; Bharathi *et al.*, 2017; Bhadra *et al.*, 2018) with their height increasing mostly in the age group of 10-14 years. Bengali adolescence girls of urban area of Kolkata (De, 2017) were observed to be significantly taller than girls in the present investigation. The results of the present investigation also showed that the girls under study had higher values for all anthropometric measurements when compared to other Indian studies. On the other hand, Figure 4 showed that the body weight of the rural girls were found to be significantly heavier than other Indian girls (e.g., Assamese, Rajbanshi and Santali) and significantly lighter than Bengali adolescence girls of urban area of Kolkata (De, 2017). With regard to BMI-for-age, a high proportion of population investigations showed high range of BMI when compared with other Indian adolescents girls (Figure-5) (Das and Bose, 2011; Mondal and Terangpi, 2014; Roy *et al.*, 2016; Pal and Bose, 2017). The comparison of BMI of the girls with the reference population (WHO, 2007) showed that the mean BMI of the studied girls were found to be significantly lower than this population (Figure 2). However, the overall means of height, weight and other anthropometric measures in this present investigation showed higher values when compared with other Indian studies. One reasons for this could be better living conditions, improved nutrition and medical facilities and changes in socioeconomic and environmental conditions (Mascie-Taylor and Lasker, 2005; Olivieri *et al.*, 2008; Roy *et al.*,2016; Mondal *et al.*, 2017; Nandi *et al.*, 2018; O'Brien *et al.*, 2018; Joshi *et al.*, 2019).

The present investigation observed that the girls showed higher levels of physical growth acceleration in comparison with other rural Indian girls (Das and Bose, 2011; Mondal and Terangpi, 2014; Roy *et al.*, 2016; Pal and Bose, 2017) and lower levels of physical growth pattern when compared with the reference population (WHO, 2007). The poor attainment of physical growth among these girls can be primarily attributed to poor socio-economic conditions, large family size and lack of knowledge of mothers about adequate nutritional requirement (Rengma *et al.*, 2015; Roy *et al.*, 2016; Tigga *et al.*, 2018; Debnath *et al.*, 2018; Levin *et al.*, 2019). The present investigation is similar to several other research investigations that indicated high prevalence of chronic undernutrition and anemia in adolescence girls in the country (Bisai and Bose, 2009; Maiti *et al.*, 2012; Nandi *et al.*, 2018; Konwar *et al.*, 2019; Upadrasta *et al.*, 2019; Reshmi *et al.*, 2020). Those adolescents suffering from undernutrition or malnutrition are more likely to develop into thin or obese adult with low or high BMI that would have an impact on their physical work capacity, poor reproductive outcomes which leads to their greater morbidity and mortality in the population (Mondal and Sen 2010a; Rengma *et al.*, 2015; Kunwar *et al.*, 2018; Tigga *et al.*, 2018; Debnath *et al.*, 2019).

Conclusion

In the present investigation the authors have assessed the physical growth pattern of rural adolescents and compared the findings with other Indian studies. It may be concluded that these girls were heavier and taller than compared with other Indian studies. Age-specific variability in physical growth may be attributed by several factors (e.g., socioeconomic, environmental, genetic and exposed to diseases) which may be directly or indirectly affect the overall development of a population. This study would also help to reveal the enhanced usefulness and effectiveness of the different intervention programs at targeted populations. One of the main limitations of this investigation was the small size. A longitudinal study using anthropometry, dietary intake and socio-economic and socio-demographic data would be helpful for planning of a proper nutritional intervention for rural populations to overcome the problem of undernutrition and/or malnutrition.

Recommendations

Nutrition related knowledge and awareness programmes are needed among parents and community level to reduce the future possibility of undernutrition. Further studies with interdisciplinary approach and comprehensive methods are required to examine nutrition intake, dietary pattern, disease prevalence and their association with nutritional status among adolescents.

Funding sources: *University Grant Commission (RGNF-SC), Government of India*

Acknowledgements: *The authors acknowledge the help and cooperation of the authorities and Head Mistress of Bagdogora Balika Vidayalaya, Darjeeling, West Bengal, India. They also thank the students for their patience, cooperation and their voluntary participation in the study. The help of the Department of Anthropology, North Bengal University is also acknowledged.*

Conflict of interest: *Authors have no conflict of interest*

References

Awasthi, C. P., Kumar, S., Tiwari, P. P., Singh, A. B. (2000). "Nutritional status of preschool and school children in rural area of Sultanpur district". *Journal of Dairying Foods & Home Science* 19:16-21.

Banik, S. D., Bose, K., Bisai, S., Bhattacharya, M., Das , S., Jana, A., Purkait, P. (2007). "Undernutrition among adult Dhimals of Naxalbari, West Bengal: comparison with other tribes of eastern India". *Food Nutrition Bulletin* 28:348-352.

Basu, D., Islam, G., Gogoi, R., Dey, S., Deori, J.(2014). "Child's growth and nutritional status in two communities –Mishing tribe and Kaibarta caste of Assam, India". Inernational. *Journal of Sociology and Anthropology* 6:59-69.

Bhadra, M., Paul, P., Das, T. (2018). "Physical growth pattern and Nutritional status among adolescents Bhumij boys of Khatra block, Bankura District, West Bengal, India". *International Journal of Experimental Research Review* 16: 1-6.

Bharali, N., Mondal, N. (2019). "Double bourdan of malnutrition among SonowalKachari preschool children (<5 years) of North Lakhipur District of Assam, India". *Human Biology Review* 8: 233-240.

Bharthi, K., Ghritlahre, M., Das, S., Bose, K. (2017). "Nutritional status among children and adolescents aged 6–18 years of Kolam tribe of Andhra Pradesh, India". *Anthropology review* 80: 13–23.

Bisai, S., Bose, K. (2009). "Leanness among early adolescents in two rural schools of two districts in West Bengal". *Indian Journal of Public Health* 53:235-236.

Bogin, B., Scheffler, C., Hermanussen, M. (2017). " Global effects of income and income 820 inequality on adult height and sexual dimorphism in 821 height". *American Journal of Human Biology*. 00:e22980. https://doi. 822 org/10.1002/ajhb.2298

Bose, K., Mukhopadhyay, A. (2004). "Nutritional status of adolescent Bengalee Boys". *Indian Pediatrics* 41:633.

Bose, K., Bhattacharya, S., Basu, K., Ghosh, K., Mukhopadhyay, A., Bhadra, M. (2005). "Age trends in anthropometric characteristics among 6-9 years old Bengalee Hindu school girls of Kolkata, India". *Anthropologischer Anzeiger* 63:439-448.

Bose, K., Bisai, S., Mukherjee, S. (2008). "Anthropometric characteristics and nutritional status of rural school children". *International Journal of Biological Anthropology* 2:1.

Chakraborty, R., Bose, K. (2009). "Very high prevalence of thinness using new international body mass index cut off points among 5-10 year old school children of Nandigram, West Bengal, India". *Journal of Research Medicine Science* 14:129-133.

Chhatwal, J., Verma, M., Riar, S. K. (2004). "Obesity among preadolescent and adolescents of a developing country(India)". *Asia Pacific Journal of Clinical Nutrition* 13: 231-235

Das, Chaudhuri, A. B., Basu, S., Chakraborty, S. (1993). "Twinning rate in the Muslim population of West Bengal". *Acta Geneticae Medicae Gemellologiae (Roma)* 42:35-39.

Das, G. M., Lokshin, M., Grangolati, M., Lvaschenko, O. (2005). "Improving child nutrition outcomes in India: Can the integrated child development services program be more effective?". *World bank policy research working paper* 3647 doi: 10.1596/1813-9450-3647.

Das, S., Bose, K. (2011). "Prevalence of thinness using new international cut-off points among Santal tribal children and adolescents of Purulia District, West Bengal, India". *Sri Lanka Journal of Child Health* 40:105-110.

Das, S., Boe, K. (2012). "Nutritional assessment by mid-upper arm circumference of Santal adults of Purulia, West Bengal,". *Collegium Antropologicum* 36:581-584.

de Onis, M. (2001). "Child Growth and Development. In: Semba R.D., Bloem M.W. (eds) Nutrition and Health in Developing Countries. Nutrition and Health". *Humana Press*, Totowa, NJ. https://doi.org/10.1007/978-1-59259-225-8_4

De, K. (2017). "Anthropometric status of adolescent girls of rural India". *Journal of Traditional Medicine Clinical Naturopathy* 6: 205

Debnath ,S., Mondal, N., Sen, J. (2017). "Use of upper arm anthropometry, upper arm muscle area-by-height (UAMAH) and midupper-arm-circumference (MUAC)-for-height as indicators of body composition and nutritional status among children". *Anthropology Review* 80:85–102.

Debnath, S., Mondal, N., Sen, J. (2019). "Double burden of malnutrition among adolescents in India". *Human Biology Review* 8: 155-178.

Deshmukh, P. R., Gupta, S. S., Bharambe, M. S., Dongre, A. R., Maliye, C., Kaur, S., Garg, B. S. (2006). "Nutritional status of adolescents in rural Wardha". *Indian Journal of Pediatrics* 73:139-141.

Dhingra, R., Bhat, A. (2017). "Association of body mass index and lifestyle variables among adolescent in urban Jammu". *International Journal of Health Science Research* 7:276-284.

Hall, J. G., Allanson, J. E., Gripp, K. W., Slavotinek, A. M. (2007). "Handbook of Physical Measurements". *New York: Oxford University Press.*

Joshi, N., Kumar, M., Chatterjee, K. (2019). "Study of sociodemographic factors and their relationship with the morbidity among adolescent girls of Pune slum area". *International Journal of Research Medicine Science* 7:1399-1405.

Khatun, A., Mukhopadhyay, A., Bose, K. (2016). "Age and sex variations in anthropometric characteristics of Muslim adolescents of North 24 Parganas, West Bengal". *Human Biology Review* 5:456-464.

Khopkar, S. A., Virtanen, S. M., Kulathinal, S.(2014)."Anthropometric characteristics of underprivileged adolescents: A study from urban slums of India". *Journal of Anthropology* http;// dx. Doi.org/ 10.1155/2014/197048.

Konwar, P., Vyas, N., Hossain, S. S., Gore, M. N., Choudhury, M. (2019). "Nutritional status of adolescent girls belonging to the tea garden estates of Sivasagar district, Assam, India". *Indian Journal of Community Medicine* 44:238-242.

Levin, C., Hale, J., Hutchison B. (2019). "Economic effects of the double burden of malnutrition." *Lancet* 395(10218):156-164.

Mascie-Taylor, C. G. N., Lasker, G. W. (2005). " Biosocial correlates ofstature in a British National cohort". *Journal of Biosocial Science* 37:245-251.

Medhi, G. K., Hazarika, N. C., Mahanta, J. (2007)."Nutritional status of adolescents among tea garden workers". *Indian Journal of Pediatrics* 74:343-347.

Mondal, N., Sen, J.(2010). " Prevalence of stunting and thinness among rural adolescents of Darjeeling district, West Bengal, India". *Italian Journal of Public Health* 7: 54-61.

Mondal, N., Sen, J. (2010b). "Prevalence of undernutrition among children (5-12 years) belonging to three communities residing in a similar habitat in North Bengal, India". *Annals of Human Biology* 37:198-216.

Mitra, M., Kumar, P. V., Ghosh, R. (2002). "Growth pattern of the Kamars- A primitive tribe of Chhattisgarh, India". *Collegium Anthropolicum* 26: 485-499.

Mondal, N. (2014). "Thinness as Major Underlying Problem among Adolescents of Northeast India". *Journal of Nepal Paediatric Society* 34:39-47.

Mondal, N., Terangpi, M. (2014). "Prevalence of undernutrition among tribal adolescents of Karbi Anglong district of Assam, Northeast India". *Sri Lanka Journal of Child Health* 43:154-157.

Mondal, N., Ghosh, P., Sen, J. (2017). "Physical growth patterns and body composition of Rajbanshi adolescent boys of Eastern India". *Human Biology Review* 6: 263-283.

Nandi, A., Behrman, J. R., Kinra, S., Laxminarayan, R. (2018). "Early-life nutrition is associated positively with schooling and labor market outcomes and negatively with marriage rates at age 20–25 years: Evidence from the Andhra Pradesh Children and Parents Study (APCAPS) in India". *The Journal of Nutrition* 148: 140–146.

O'Brien, E. C., Alberdi, G., McAuliffe, F. M. (2018). "The influence of socioeconomic status on gestational weight gain: a systematic review". *Journal of Public Health* 40:41–55.

Olivieri, F., Semproli, S., Pettener, D., Toselli, S. (2008). " Growth and malnutrition of rural Zimbabwean children (6-17 years of age)". *American Journal of Physical Anthropology* 136:214-222.

Pal, A., Pari, A. K., Sinha, A., Dhara, P. C. (2017). "Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India". *International Journal of Pediatrics Adolesccence Medicine* 4:9-18.

Pal, S., Bose, K. (2017). " Anthropometric characteristics of rural primary school children of Hooghly District, West Bengal, India". *Human Bioloy Review* 6: 30-46.

Patanwar, P., Sharma, K. K. N. (2013). "Nutritional Status of Kurmi Adolescent Girls of Raipur City Chhattisgarh, India". *International Journal of Scientific Research Publication* 3:1-6.

Rao, S., Joshi, S., Kanade, A. (2000). "Growth in some physical dimensions in relation to adolescent growth spurt among rural Indian children". *Annals of Human Biology* 27:127-138.

Rengma, M. S., Bose, K., Mondal, N. (2016). "Socio-economic and demographic correlates of stunting among adolescents of Assam, North-east India". *Anthropology Review* 79:409–425.

Reshmi, P.S., Takalkar, A. A. (2020). "Prevalence of anemia in adolescent girls and its association with certain demographic variables: our experience from rural Telangana". *International Journal of Community Medicine Public Health* 7:1007-1011.

Roy, S., Barman, S., Mondal, N., Sen, J. (2016). "Prevalence of Stunting and Thinness AmongAdolescent Girls Belonging to the Rajbanshi Population of West Bengal, India". *Journal of Nepal Paediatric Society* 36:147-155.

Sharma, A., Sharma, K., Mathur, K. P. (2007). "Growth pattern and prevalence of obesity in affluent schoolchildren of Delhi". *Public Health Nutrition* 10: 485-491.

Sen, J., Mondal, N., Dey, S. (2011). "Assessment of the nutritional status of children aged 5-12 years using upper arm composition". *Annals of Human Biology* 38:752-759.

Sen, J., Mondal, N. (2013). "Fat mass and fat-free mass as indicators of body composition among Bengalee Muslim children". *Annals of Human Biology* 40:286-293.

Singh, J., Mondal, N. (2014) "Use of upper-arm anthropometry as measure of body-composition and nutritional assessment in children and adolescents (6-20 years) of Assam, Northeast India". *Ethiopian Journal of Health Science* 24:243-52.

Tigga, P. L., Debnath, S., Das, M., Mondal, N., Sen, J. (2018). "Prevalence of undernutrition and overweight or obesity among the Bengali Muslim population of West Bengal, India,". *Anthropology Open Journal* 3(1): 1-10.

Touitou, Y., Portaluppi, F., Smolensky, M. H., Rensing, L. (2004). "Ethical principles and standards for the conduct of human and animal biological rhythm research". *Chronobiology International* 21:161-70.

Ulijaszek, S. J., Kerr, D. A. (1999). "Anthropometric measurement error and the assessment of nutritional status". *British Journal of Nutrition* 82:165-177.

Upadrasta, V.P., Ponna, S.N., Bathina, H., Bharathi, S., Kapu, A.K.R., Sadasivuni, R.. (2019) "Knowledge, attitudes and practices of adolescent school girls regarding prevention of iron deficiency anaemia". *International Journal of Community Medicine Public Health* 6:2694-2699

Vaishnaw, T., Das, M. C., Kumar, V. P. (2020). "Nutritional status of school age children in urban slum area in Vijayawada and Guntur". *Journal of Clinical Diagnostic Research* 14: OC01-OC04

Venkaiah, K., Damayanti, K., Nayak, M. U., Vijayaraghavan, K. (2002). "Diet and nutritional status of rural adolescents in India". *European Journal of Clinical Nutrition* 56:1119-1125.

World Health Organization (WHO). (1995). "Physical Status: The Use and Interpretation of Anthropometry". Technical Report Series No. 854. Geneva.

World Health Organization (WHO). (2007). child growth standards: head circumference for-age, arm circumferenceforage, triceps skinfold-for-age and subscapular skinfold-for-age: methods and development. Geneva.

Tables and Figures

Table1: Age wise mean±standard deviation (SD) of the anthropometric variables and within age differences among the girls

Variable (N=271)	10 Year (N=52)	11 Year (N=56)	12 Year (N=56)	13 Year (N=57)	14 Year (N=50)	F-Value
Height(cm)	135.70±8.07	140.97±7.63	146.73±6.77	148.50±5.72	149.46±4.57	58.11**
Weight(kg)	29.55±6.75	35.54±8.53	37.21±7.54	41.30±8.70	41.69±7.91	26.81**
Arm span(cm)	127.46±24.52	132.78±24.96	146.91±7.58	146.28±13.57	149.29±6.33	18.03**
Sitting Height(cm)	70.68±4.38	73.39±4.54	75.50±10.43	76.96±5.76	78.52±2.95	18.45**
WC(cm)	59.75±7.32	65.32±9.19	66.40±9.09	70.76±7.79	71.44±7.11	19.36**
HC(cm)	68.43±7.83	71.91±8.83	79.21±7.17	79.78±7.30	81.61±7.32	37.64**
MUAC(cm)	18.44±2.14	19.98±2.88	19.46±2.85	21.11±2.74	21.58±2.98	11.52**
BMI(kg/m²)	15.88±2.41	17.71±3.22	17.19±2.81	18.70±3.78	18.66±3.51	7.07**
WHR	0.87±0.09	0.91±0.12	0.84±0.12	0.89±0.11	0.88±0.10	2.82*

*Significance at the level of *p<0.05; **p<0.01*

Table2: Age wise percentile values for height(HT), weight(WT) and body mass index (BMI) among the girls

Age (Year)	5th			10th			25th			50th		
	HT	WT	BMI	HT	WT	BMI	HT	WT	BMI	HT	WT	BMI
10	124.99	20.97	12.55	126.78	22.00	13.33	129.05	24.00	14.12	134.05	29.75	15.71
11	125.21	24.00	12.96	129.70	24.85	14.22	137.02	28.75	15.03	141.85	34.25	16.95
12	132.89	25.00	13.68	136.64	28.95	14.03	142.85	32.12	15.32	147.15	36.50	16.52
13	138.77	28.80	14.17	140.46	32.40	14.91	145.50	37.00	16.24	148.50	40.00	18.06
14	141.94	31.27	14.71	143.58	33.15	15.18	146.92	35.80	16.04	149.05	40.75	18.21

Age (Year)	75th			90th			95th		
	HT	WT	BMI	HT	WT	BMI	HT	WT	BMI
10	141.15	3.75	16.63	147.58	39.60	19.82	150.00	43.33	21.87
11	146.15	40.75	20.60	150.19	49.00	22.36	153.15	50.15	23.92
12	150.57	40.00	18.53	154.60	48.60	21.01	158.86	51.15	22.97
13	153.00	45.00	20.22	155.00	50.40	22.83	156.63	55.05	25.80
14	152.12	46.00	20.33	154.00	53.90	23.50	159.34	58.42	24.02

Figure 1: Age-specific comparison of mean height of the girls with the WHO (2007) reference population

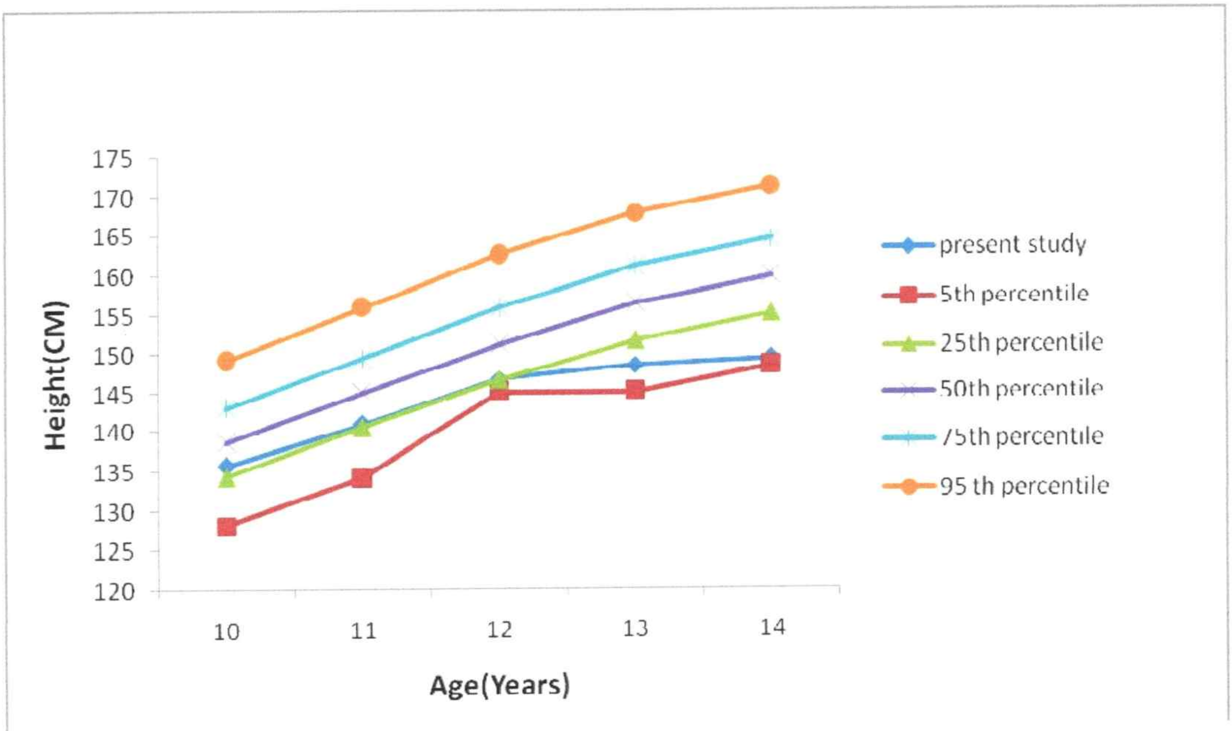


Figure 2: Age-specific comparison of mean BMI of the girls with the WHO (2007) reference population

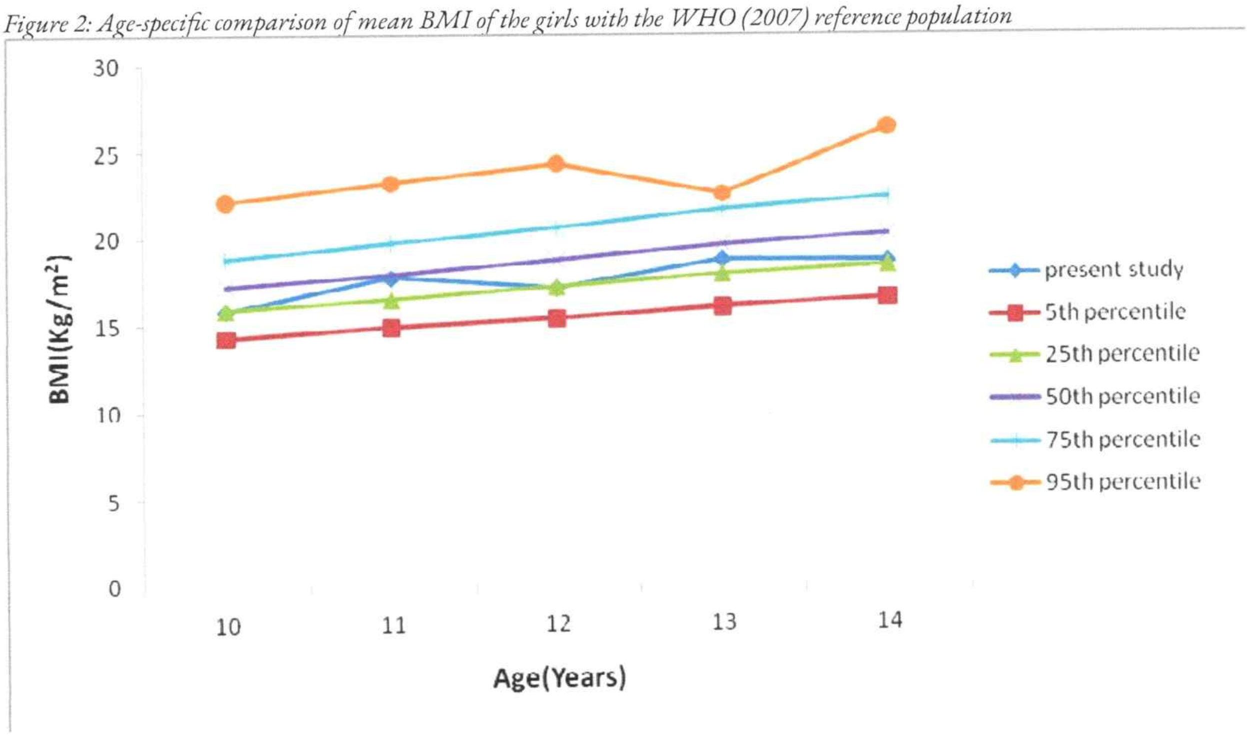


Figure 3: Age-specific comparison of mean height of the girls with other Indian studies (Das and Bose 2011;Mondal and Terangpi 2014; Roy et al., 2016; De 2017)

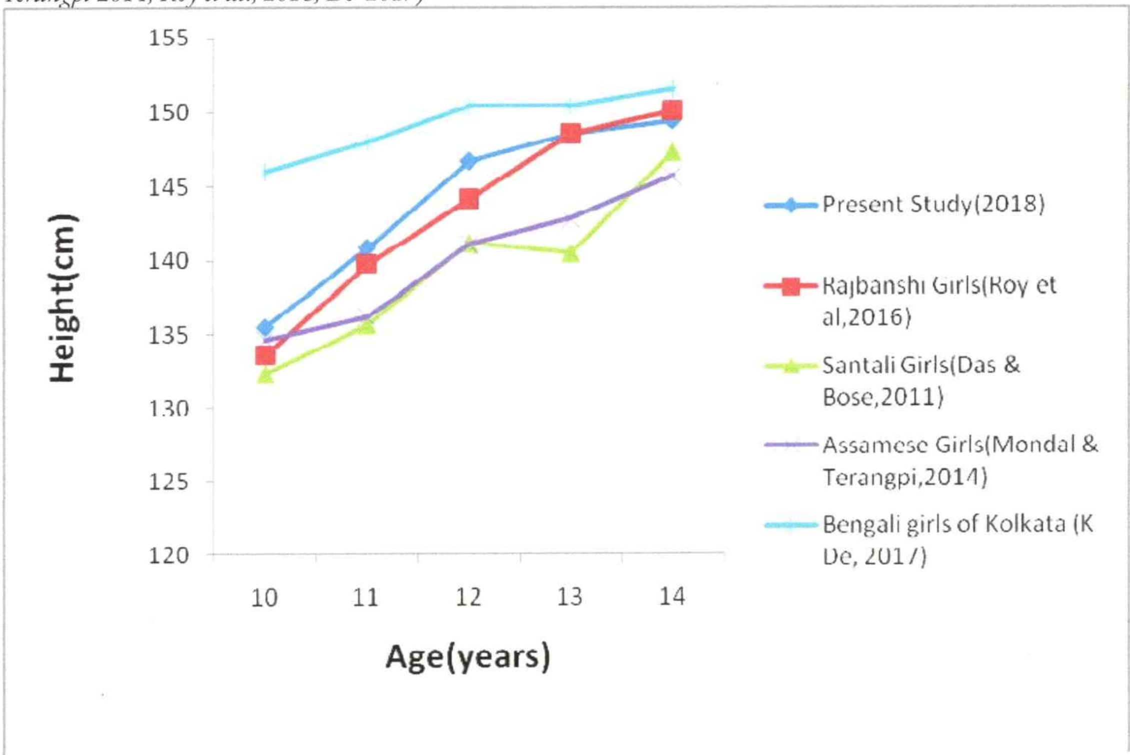


Figure 4: Age-specific comparison of mean weight of the girls with other Indian studies (Das and Bose 2011;Mondal and Terangpi 2014; Roy et al., 2016; De, 2017)

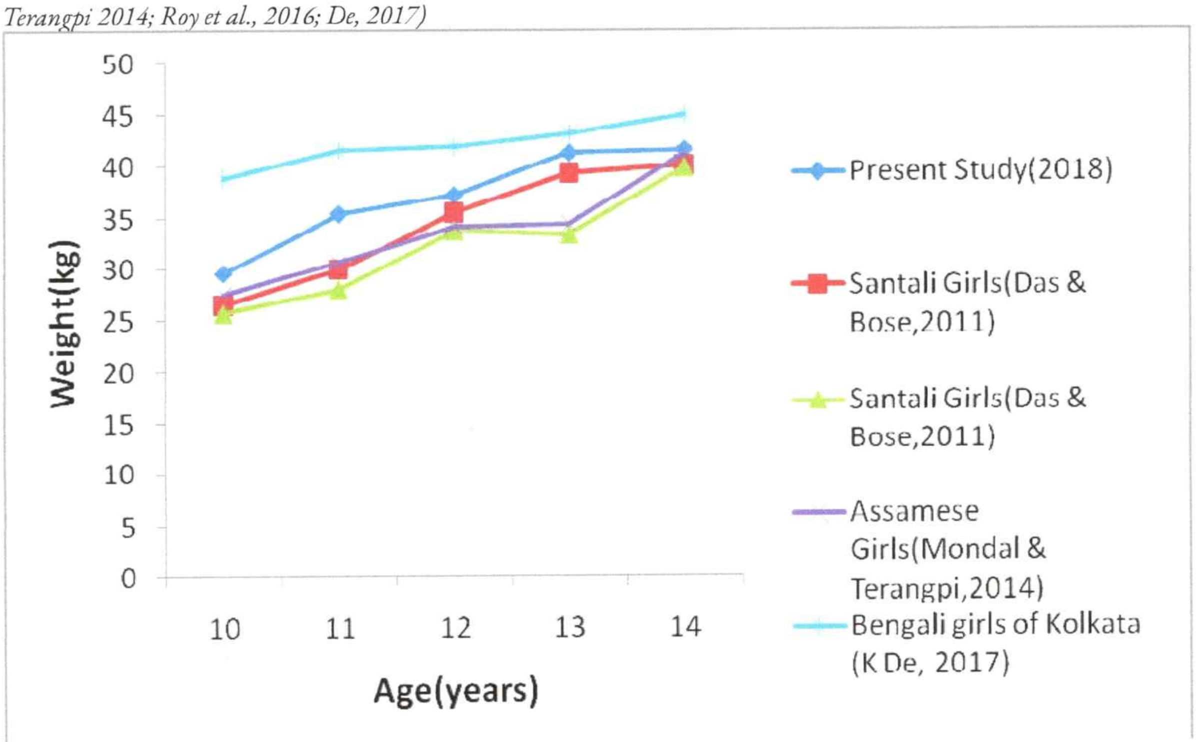
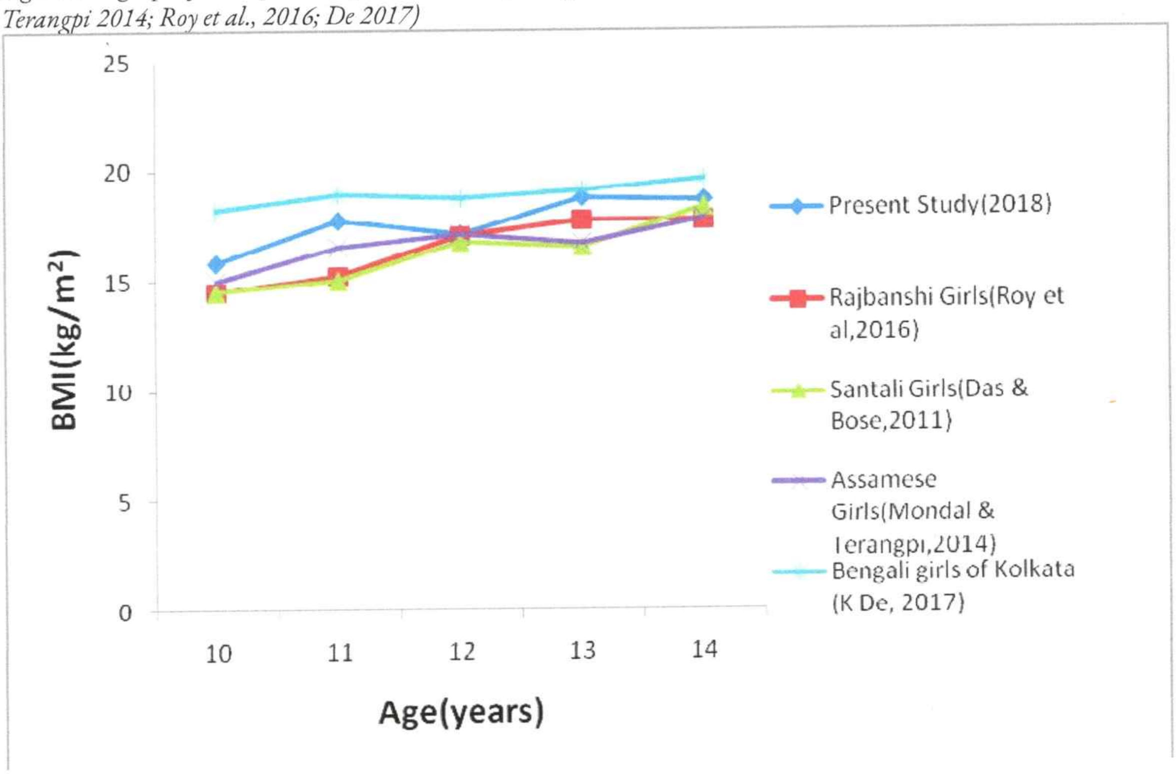


Figure 5: Age-specific comparison of mean BMI of the girls with other Indian studies ((Das and Bose 2011;Mondal and Terangpi 2014; Roy et al., 2016; De 2017)



North Bengal Anthropologist (2016) Vol. 4: 214-221
annualy

National Centre for Health Statistics (NCHS) Reference

[1]Isita Sinha

Abstract: Growth is a kind of velocity and measures the rate of change of size over a certain period of time. Growth measurements are taken at regular intervals over a specified period of time. Growth assessment is basically a kind of comparison with a reference normally called a "***growth reference***". Without such a reference, growth assessment becomes arbitrary. Until the late 1970s, a number of growth charts were utilized to assess child growth. In the year 1977, the National Centre for Health Statistics (NCHS) published a new set of growth charts for children aged <18 years based on data from the Fels Longitudinal Growth Study and nationally representative surveys. The NCHS later became a part of the Centre for disease control (CDC) in the year 1987. The NCHS growth charts consists of 14 sex specific growth charts and used different indicators like weight-for-age, weight- for- length, length-for-age, head circumference for age stature-for-age and weight-for-stature. These curves represent attained size, and do not describe rates of growth as might be represented in incremental or longitudinal growth charts. It utilizes per centile rankings to describe the relative size of a given child. The main advantage of NCHS reference is that the data was based on current and high quality growth data as well as on the most recent advances in data processing and analysis.

Key words: Growth, growth reference, nutrition, height, weight, malnutrition.

Introduction

The National Centre for Health Statistics (NCHS) is the United States (U.S) nation's principle health statistics agency, providing data to identify and address health issues. Since the 1970s the World Health Organization (WHO) has published several versions of growth references, recommended for international use to help assess children growth and nutritional status. Growth references are one of the commonly used tools for assessing the well being of groups of children and an individual's progress in reaching a range of health and other markers of social equity. Thus far, there are three widely known and used versions: the 1978 WHO/NCHS Growth References (for children up to age ten), the WHO Growth References (for children and adolescents up to age nineteen), and the 2006 WHO Growth Standards (for preschool children, under 6 years of age). In the year 1971, the American Academy of Paediatrics, the Maternal and Child Health Program of the Bureau of Community Health Services and the U.S. Public Health Services recommended new growth charts based on data from the NCHS Health Examination Surveys. This led to the development of the NCHS Growth Charts. The NCHS Growth Charts were released in the year 1977 and were recommended for the clinical assessment of infants and children (Owen, 1973). These NCHS Growth Charts included anthropometric measurements such as weight-for height, weight-for-age, height-for-age, and head circumference-for-age. The NCHS reference is cur-

[1] Research scholar, Department of Anthropology, University of North Bengal, Email: seriousisita@gmail.com

North Bengal Anthropologist
annually
Vol. 5: ·67-72 . 2017

Hair and nicotine exposure

Isita Sinha

Research Scholar, Department of Anthropology
North Bengal University.

Abstract: Exposure to environmental tobacco smoke (ETS) and second hand smoke (SHS) is a major public health problem throughout the world. Assessment of prevalence of tobacco use and of SHS exposure is needed to estimate smoking-attributable disease burden and to identifying its sources are fundamental steps needed to reduce exposure and to target prevention strategies throughout the world. ETS exposure is assessed by diverse methods, including questionnaires, air nicotine monitoring, and biomonitoring of nicotine or cotinine in biofluids as serum, urine or saliva. The most commonly used biomarker for ETS exposure are nicotine. During the past decade, hair nicotine concentration has increasingly been used as an alternative biomarker, because hair samples are easier to collect and less expensive to store and transport the biological fluids. Hair nicotine concentrations have been assessed using various chromatographic techniques, including high-performance liquid chromatography (HPLC) with an ultraviolet detector, an electrochemical detector, and mass spectrometry (MS, MS/MS) and gas chromatography (GC) with a nitrogen–phosphorus detector or mass spectrometry. Moreover, hair nicotine, advantageously, characterizes tobacco exposure over a longer time period than blood or urine cotinine, with each cm length of hair representing approximately one month of exposure. In addition, hair nicotine has shown better ability to discriminate exposure status when compared with urinary cotinine. However, studies comparing concentrations of hair nicotine with other biomarkers to distinguish active smokers from nonsmokers among different population are still limited.

Key words: Environment, biofluids, nicotine, cotinine, biomarker, hair

Introduction

Exposure to environmental tobacco smoke (ETS) and secondhand smoke (SHS) is a worldwide public health problem (Warren et al., 2006, Wipfli et al., 2008). In the presence of smokers, nonsmokers inhale secondhand smoke (SHS), the combination of side-stream

Human Biology Review(ISSN 22774424) 6(4) 2017
Original scientific paper (Sinha and Sen pp. 387-402)
Revised and Accepted on October 17, 2017

Factors affecting menopause among Rajbanshi women of North Bengal

I. Sinha[1] and J. Sen[2]

Citation: Sinha I and Sen J. 2017. Factors affecting menopause among Rajbanshi women of North Bengal. Human Biology Review, 6 (4), 387-402.

[1]Isita Sinha RGNF Research Scholar, Department of Anthropology, University of North Bengal, P.O. :NBU, Rajarammohanpur, District: Darjeeling, West Bengal, India. Email: seriousishita@gmail.com

[2]Jaydip Sen Department of Anthropology, University of North Bengal, P.O. :NBU, Rajarammohanpur, District: Darjeeling, West Bengal, India

Corresponding author: Professor Jaydip Sen, Department of Anthropology, University of North Bengal, P.O.: NBU, Rajarammohanpur, District: Darjeeling, West Bengal, India. Email: jaydipsen@rediffmail.com

ABSTRACT

Aims**: The present study aims to evaluate effects of different socio-economic, socio-demographic and lifestyle factors on natural age at menopause among Rajbanshi women of North Bengal.* ***Methods: *The study participants consisted of 510 Rajbanshi women aged between 45 years to 55 years who had experienced natural menopause. All the women were residents of Darjeeling district of West Bengal. The socio-economic, socio-demographic and lifestyle variables were recorded using a structured schedule. The data were statistically analysed using SPSS (version 17.0). The statistical tests included binary logistic regression and stepwise regression.* ***Results:*** *The mean age at natural menopause was 48.57 years (s.d.: 2.07; range: 44 years - 54 years). The binary logistic regression analysis showed that most of the factors except educational status (p>0.05) were significantly associated with natural menopause (p<0.05, p<0.01). The stepwise regression analysis showed that natural menopause was independently correlated with marital status, parity, last pregnancy and duration of breast feeding (p<0.01).* ***Conclusion:*** *Marital status, parity, age at last pregnancy and duration of breast feeding appear to have highly significant effects on natural age at menopause.*

Key words: *Menopause, Rajbanshi, marital status, occupation, health, parity.*

Age and Sex Variations in Anthropometric Characteristics and Body Composition of Adults Belonging to the Rajbanshi Population of Darjeeling District, West Bengal

ISITA SINHA†, ARKO PAL‡ & JAYDIP SEN*

Department of Anthropology, University of North Bengal, Raja Rammohunpur 734013, District Darjeeling, West Bengal
E-mail: jaydipsen@rediffmail.com

KEYWORDS: Anthropometry. Body composition. Body fat. Bioelectrical Impedence Analysis (BIA). Rajbanshi. Darjeeling district. West Bengal.

ABSTRACT: The present cross-sectional study was undertaken to assess the age and sex variations in anthropometric and body composition characteristics of adult Rajbanshi individuals of North Bengal. The study has been carried out among 350 adult individuals belonging to the Rajbanshi individuals in the age-group of 19-49 years and residing in the district of Darjeeling, West Bengal, India. Height and weight were recorded using standard techniques. Body subcutaneous fat, whole body skeletal fat, body fat, BMI and visceral fat level were recorded using an Omron body fat analyser. The statistical tests (ANOVA, Pearson correlation) were done using SPSS (version 17.00). The results showed that most of anthropometric variables were highly significantly correlated with each other ($p<0.05$). Age and skeletal muscle of whole body was negatively significantly ($r=-0.203$, $p<0.01$), ($r=-0.447$, $p<0.01$) correlated with height respectively. On the other hand, it was positively significantly correlated higher with subcutaneous whole body ($r=0.237$, $p<0.01$), body fat ($r=0.345$, $p<0.01$) and visceral fat ($r=0.239$, $p<0.01$). Height and weight were significantly ($p<0.05$) correlated with all other variables except BMI. All anthropometric and body composition variables (height, weight, whole body subcutaneous fat, whole body skeletal fat, body fat, BMI and visceral fat) were correlated with each other and showed a significant sex heterogeneity between these variables.

INTRODUCTION

Assessment of body composition is an important study of nutritional status, various disease processes and in examinations of risk profiles. It has been well established that the use of anthropometry is an efficient indicator of nutritional and health status of adults. General population data on body composition provide important references for interpreting results from such studies. Major changes in the body mass components and body dimensions are described to provide an enhanced awareness of the utility and increased needs for body composition information in applied and research settings. Age related changes also include changes in body composition. A decrease in fat-free mass (FFM) and an increase in body fat mass (BFM) are both considered hallmarks of human aging and can be used to assess functional status, disability and mortality. Among women, age-related changes in body composition have been observed particularly after menopause. FFM usually increases as humans

† Rajiv Gandhi National Fellow

‡ Ex-student, M.Sc.

* Professor, corresponding author

Anthropol. Anz. 75/3 (2018), 251–262
J. Biol. Clin. Anthropol.
Published online 11 June 2018, published in print August 2018

Article

Effects of socio-economic, demographic and lifestyle variables on overweight and obesity among rural Rajbanshi post-menopausal women of India

Isita Sinha[1], Nitish Mondal[2], and Jaydip Sen[3]

[1] RGNF Research Scholar, Department of Anthropology, University of North Bengal, West Bengal, India
[2] Assistant Professor, Department of Anthropology, Assam University (Diphu Campus), Karbi Anglong, Assam, India
[3] Professor, Department of Anthropology, University of North Bengal, West Bengal, India
Corresponding author: jaydipsen@rediffmail.com

With 1 figure and 3 tables

Abstract: Overweight and obesity are one of the most neglected public health problems in both developed and developing countries. Prevalence of overweight and obesity among post-menopausal women are increasing at a rapid pace. The present study aims to assess effects of socio-economic, demographic and lifestyle variables on prevalence of overweight and obesity among post-menopausal rural women belonging to an ethnic population of eastern India. This study has been carried out among 510 Rajbanshi women aged between 45–56 years and residing in the district of Darjeeling, West Bengal. Height and weight along with a number of socio-economic, demographic and lifestyle variables were recorded and body mass index (BMI = weight/height kg/m^2) was calculated. The WHO (2000) cut-offs were utilized to assess prevalence of overweight (BMI ≥ 23.00–24.99 kg/m^2) and obesity (BMI ≥ 25.00 kg/m^2). The statistical tests (ANOVA, chi-square and binary logistic regression) were done using SPSS (version 17.0).The prevalence of overweight and obesity were observed to be high among those aged 45–50 years (30.63%, 4.26%) and 50–56 years (32.36%; 18.91%). The binary logistic regression analysis indicated that age, marital status, parity, age at menarche, occupational status, age at first pregnancy, monthly income, education, use of oral contraceptives and tobacco use had significant effects on overweight and obesity ($p < 0.05$). Age, parity, education, use of oral contraceptives, age at menarche, tobacco use, occupation, monthly income, age at first and last pregnancy were observed to have greater influence on prevalence of overweight and obesity. Overweight and obesity associated with post-menopausal women require increased attention and a multidisciplinary approach for better health conditions among such women.

Keywords: overweight; obesity; BMI; menopause; Rajbanshi; anthropometry

Abbreviations used: BLR: Binary logistic regression; BMI: Body mass index; CI: Confidence interval; TEM: Technical error of measurement; WHO: World Health Organization

Introduction

Overweight and obesity are considered to be major public health challenges in the world. During the last few decades, obesity has been increasing at an alarming rate in both the developed and developing countries (Popkin 2001a; Popkin 2001b; York et al. 2004; WHO 2008; Seidell & Halberstadt 2015; Nakamura et al. 2018). A recent World Health Organization report (WHO 2016) estimates that in the global context, prevalence of obesity has been more than doubled. More than 1.9 billion adults aged ≥ 18 years were overweight and 600 million were obese. But recent acceleration in population obesity in low- and middle-income countries that are now increasingly being observed have been less recognized. Recent research studies have reported a steady increase in prevalence of overweight-obesity among Indian populations (Das & Bose 2006; Subramanian & Smith 2006; Subramanian et al. 2007; Wang et al. 2009; Masoodi et al. 2010; Sen et al. 2013; Rengma et al. 2015; Mondal et al. 2017; Tigga et al. 2018). Several researchers have also reported that the developing countries have shown significant increase in the burden of overweight-obesity prevalence in addition to burden of preventable non-communicable diseases affecting both children and adults (Stein et al. 2005; Monteiro et al. 2007).

Prevalence of obesity among individuals vary greatly within and between countries and women, in particular,

DOI: 10.1127/anthranz/2018/0863

www.schweizerbart.de
0003-5548/2018/0863 $ 3.00

Journal of Biosocial Science (2020), page 1 of 17
doi:10.1017/S002193202000019X

CAMBRIDGE
UNIVERSITY PRESS

RESEARCH ARTICLE

Association between age at menarche and age at menopause among women of an indigenous population of North Bengal, India

Isita Sinha[1], Pushpalata Tigga[2], Nitish Mondal[3] and Jaydip Sen[1*]

[1]Department of Anthropology, University of North Bengal, Darjeeling, West Bengal, India, [2]Department of Anthropology, Mrinalini Datta Mahavidyapith, Birati, Kolkata, West Bengal, India and [3]Department of Anthropology, Assam University, Diphu Campus, Karbi Anglong, Assam, India
*Corresponding author: Email: jaydipsen@rediffmail.com

(Received 03 March 2018; revised 21 September 2019; accepted 25 September 2019)

Abstract

Menarche and menopause are two major components of a woman's reproductive life. Ages at menarche and menopause vary widely between and within populations and are influenced by various factors, both genetic and environmental. The present community-based cross-sectional investigation aimed to assess the association between ages at menarche and natural menopause among women belonging to the indigenous Rajbanshi population of North Bengal, India. The investigation was carried out from January 2015 to May 2015 among 510 Rajbanshi women aged between 45 and 55 years residing in the district of Darjeeling, West Bengal, India. A structured schedule was used to collect data on ages at menarche and natural menopause, marital status, parity, education, age of first and last pregnancies, duration of breastfeeding, nature of occupation, health status, smoking and monthly family income. Anthropometric measurements of height and weight were recorded and Body Mass Index (BMI) calculated. The statistical analyses, which included descriptive statistics and binary logistic regression (BLR), were done using SPSS. The women's mean age of menarche and median age of natural menopause were 12.52 years and 50 years, respectively. The BLR analysis indicated that education, age at first pregnancy had significant effects on the age at natural menopause among women who experienced menarche at <12 years of age ($p<0.05$). In the case of women who attained menarche at ≥ 12 years of age, marital status, age at last pregnancy, parity, education, duration of breastfeeding, smoking, occupation, monthly income and BMI had a greater influence on age at natural menopause. There appears to be an indirect association between age at menarche and age at natural menopause, along with different predictor variables, among the Rajbanshi women.

Keywords: Menarche; Menopause; India

Introduction

Menarche and menopause are two major components of the reproductive life of women. The interval between these two events determines the natural reproductive period during which women can procreate. Mounting evidence indicates that early or late occurrences of these events are linked to heightened risks of chronic diseases such as endometriosis, metabolic disorders and breast cancer. Menarche, the first menstrual bleeding, is a sentinel marker for onset of the reproductive lifecycle of a woman and is preceded by a complex cascade of hormonal changes that culminates in reproductive capabilities and results in a complex series of physiological and molecular events, patterns of physical growth and body composition (DiVall & Radovick, 2008; Boynton-Jarrett *et al.*, 2013; Yermachenko & Dvornyk, 2014). Menopause refers to the permanent

Antrocom Online Journal of Anthropology vol. 16. n. 2 (2020) 141-152 – ISSN 1973 – 2880

Antrocom Journal of Anthropology

journal homepage: http://www.antrocom.net

Socio-economic and Demographic Determinants of Double Burden of Malnutrition among Rajbanshi School-going Children aged 9-14 Years from North Bengal, India

Antara Bose[1], Isita Sinha[1], Pushpa LataTigga[2], Nitish Mondal[3] and Jaydip Sen[1]

[1]Department of Anthropology, University of North Bengal, P.O. NBU, Raja Rammohunpur, District: Darjeeling, West Bengal, India; [2]Department of Anthropology, Mrinalini Datta Mahavidyaputh, Birati, Kolkata - 700 051, West Bengal, India; [3]Department of Anthropology, Sikkim University, Gangtok - 737102, Sikkim,, India; corresponding author's e-mail: <jaydipsen@rediffmail.com>

KEYWORDS

Anthropology, BMI, Overweight, Public Health, Thinness

ABSTRACT

The Double Burden of Malnutrition (DBM) is a recent phenomenon in the nutritional situation among populations belonging to the low-middle-income countries. Socio-economic, demographic factors with adoption of western lifestyle, unhealthy diets and physical inactivities are the main cause of DBM. The study aims to evaluate the socio-economic and demographic determinants among school-going children belonging to the Rajbanshi population of North Bengal, India. Prevalence of dual burden of undernutrition and overweight were among tha Rajbanshi adolescents children 9-14 years. The DBM has associations with sex/gender, age, birth order and house type. Higher associations were seen among higher age groups and those living in pakka houses.

Introduction

The "Double Burden of Malnutrition" (DBM) refers to the prevalence of both under- and overnutrition within an individual or household or population (Doak *et al.* 2005; Keino *et al.* 2014; Tzioumis and Adair 2014; Wong *et al.* 2015; Gubert *et al.* 2017; Yang *et al.* 2019). The DMB is an important health issue in many of the developing countries such as India. With rapid socio-economic, demographic and nutritional transitions, these countries are portrating an increases in incidence of overweight-obesity with relative risks of associated non-communicable diseases within the population. The DBM co-exists with an increasing incidence in a number of non-communicable diseases in many of these countries (Kavle *et al.* 2016; Nethan *et al.* 2017; Ayogu *et al.* 2018; Modjadj and Madiba 2019) including India (Khor 2008; Mondal *et al.* 2015; Kulkarni *et al.* 2017; Bharali *et al.* 2017; Tigga *et al.* 2018; Debnath *et al.* 2019). Studies have observed that such prevalence were usually confined to the urban socio-economic groups, the principal reasons being adoption of western lifestyles and physical inactivities (Subramanian *et al.* 2007; Tzioumis and Adair 2014; Ranjani *et al.* 2016; Jaiswal *et al.* 2017; Mondal *et al.* 2017; Yang *et al.* 2019). Studies have also reported certain socio-economic and demographic variables that are associated with an increase in DBM among Indian populations (Subramanian *et al.* 2007; Regma *et al.* 2015; Mondal *et al.* 2017; Bharali and Mondal 2019; Dev *et al.* 2020; Bose and Sen 2020). Several researchers have reported a high prevalence of thinness or stunting along with overweight within the same population/household (Popkin *et al.*

Please cite this article as: Bose A., Sinha I., LataTigga P., Mondal N., and Sen J., Socio-economic and Demographic Determinants of Double Burden of Malnutrition among Rajbanshi School-going Children aged 9-14 Years from North Bengal, India *Antrocom J. of Anthropology 16-2 (2020) pp. 141-152.*

Antrocom Online Journal of Anthropology vol. 17. n. 1 (2021) 155-167– ISSN 1973 – 2880

Antrocom Journal of Anthropology

journal homepage: http://www.antrocom.net

Anthropometric characteristics of rural Bengali adolescent girls from North Bengal, India

Isita Sinha[1], Neha Rani Pal[1], Nitish Mondal, [2]Jaydip Sen[1]

[1]Department of Anthropology, University of North Bengal, Raja Rammohanpur, P.O.:NBU Campus, District: Darjeeling, 734013, West Bengal, India; [2]Associate Professor, Department of Anthropology, Sikkim University, Gangtok-737102, Sikkim, India; corresponding author Dr. Jaydip Sen <jaydipsen@rediffmail.com>

KEYWORDS

Adolescence; Anthropometry; Physical growth; Bengali; India

ABSTRACT

Adolescence is the developmental period through which children grow into adults. Adolescents are the future generations of any country and their physical growth and nutritional needs are important for overall development of a society. The present cross-sectional investigation was undertaken to determine anthropometric characteristics of rural Bengali adolescent girls residing in North Bengal, India. The present investigation has observed that the adolescent girls exhibited low rates of physical growth when compared with the standard growth reference population but higher than those reported for other rural adolescent girls from India.

Introduction

Adolescence is the transitional phase between childhood and adulthood, and characterized by high growth acceleration, which is closely linked with nutritional status, and both are influenced by the process of sexual maturation. Nutrition plays a vital role during adolescence period because inadequate nutrition leads to malnutrition, growth retardation, reduced physical capacity, and poor mental and social development (Awasthi *et al.*, 2000; Chhatwal *et al.*, 2004; Sharma *et al.*, 2007; Mondal *et al.*, 2017; O' Brien *et al.*, 2018). In South-east Asia a large number of children and adolescents suffer from chronic undernutrition, which adversely effects their health and development (Venkaiah *et al.*, 2002; Olivieri *et al.*, 2008; Patanwar and Sharma 2013; Konwar *et al.*, 2019). The growth and nutritional status of adolescent girls, who are the future mothers bears special importance as they contribute to the overall nutritional status and health of the total population (Venkaiah *et al.*, 2002; Deshmukh *et al.*, 2006; Medhi *et al.*, 2007; Mondal and Sen, 2010; Roy *et al.*, 2016; Debnath *et al.*, 2017; Pal and Bose, 2017; Nandi *et al.*, 2018; O'Brien *et al.*, 2018). Currently, it is estimated that there are about 69.7 million adolescents' girls constituting about 7% of the total population in India. The adolescents are potentially and nutritionally vulnerable in view of their rapid physical growth and maturation (Das and Bose 2011; Khatun et al., 2016; Debnath et al., 2019). Inadequate diet and unfavorable environmental, socio-economic conditions and demographic variables can adversely affect the physical growth and nutritional status. Better nutritional environment of adolescents in the higher socio-economic groups accelerates, while poor socio-economic status retards the physical growth pattern (Bose and Mukhopadhyay, 2004; Bose *et al.*, 2005; Banik *et al.*, 2007; Rengma *et al.*, 2016; Joshi *et al.*, 2019; Vaishnaw *et al.*, 2020). Malnutrition is also one of the principal causes of premature mortality and morbidity among children and adolescents in India. World Health Organization (WHO) the ultimate

Please cite this article as: Isita Sinha, Neha Rani Pal, Nitish Mondal, Jaydip Sen. Anthropometric characteristics of rural Bengali adolescent girls from North Bengal, India. *Antrocom J. of Anthropology 17-1 (2021) pp. 155-167.*

ENLIGHTENMENT TO PERFECTION"

UGC-SPONSORED NATIONAL SEMINAR ON

"ETHNIC GROUPS OF INDIA: PROBLEMS AND PERSPECTIVES"

6TH - MARCH 2020

Organized by

DEPARTMENT OF ANTHROPOLOGY
UNIVERSITY OF NORTH BENGAL
(ACCREDITED BY NAAC WITH GRADE A)

CERTIFICATE

This is to certify that Dr./Ms./Mr **Isita Sinha** of **Department of Anthropology, University of North Bengal** *has participated and presented a paper entitled* **"Age at menarche and age at menopause among women of Rajbanshi population of North Bengal, India"** *in the UGC–Sponsored National Seminar organized by Department of Anthropology, University of North Bengal.*

Professor Jaydip Sen
Seminar Coordinator

Certificate of Participation

Certificate No.: Ant/21/78 *Issue Date: 07/01/2021*

This is to certify that ***Ms. Isita Sinha*** *of* ***North Bengal University*** *has participated in the* ***International Webinar on Contextual Relevance of Global Anthropological Issues*** *organized by Department of Anthropology, Gauhati University under UGC-SAP-DRS-I in collaboration with UGC-HRDC, Gauhati University during January 5-7, 2021.*

(Prof. Dwipen Bezbaruah)
Head & Coordinator, UGC-SAP-DRS-I
Deptt. of Anthropology, Gauhati University

(Dr. Shyamanta Chakaraborty)
Director (i/c)
UGC-HRDC, Gauhati University