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Nutritional status of Four Distinct Particularly Vulnerable Tribal Groups Adult Females of Chhattisgarh, India using Mid-Upper Arm Circumference

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ABSTRACT

Introduction. Malnourishment plays a substantial role in the world's mortality rates, especially among old and children. Even though malnutrition mortality among adult women dropped greatly between 1990 and 2021, maternal health is still a matter of concern. The purpose of this study is to evaluate the nutritional status among adults belonging to four Particularly Vulnerable Tribal Groups (PVTGs) of Chhattisgarh, India, through Mid-Upper Arm Circumference (MUAC) as a major indicator.

Materials and Methods. The cross-sectional survey was carried out from 2020 to 2024 in 272 adult women belonging to the Abujhmadia, Baiga, Birhor, and Hill Korwa tribes. Prior to data collection, participant consent was received with the measurement of Mid-Upper Arm Circumference at the middle of the upper arm. Descriptive statistics and ANOVA tests were used for data analysis in comparing the mean Mid-Upper Arm Circumference in different age groups.

Results. The results indicated that the Abujhmadia cluster had the greatest prevalence of undernutrition at 82.7%, followed by Hill Korwa (77.3%), Baiga (75.5%), and Birhor (60%). Important age-specific patterns in the prevalence of undernutrition were observed, especially within the 18-27 age groups.

Discussion. Mid-upper arm circumference is a valid and affordable tool for determining nutritional status in low-resource environments. It brings to light the nutritional plight of Particularly Vulnerable Tribal Groups (PVTGs), necessitating the implementation of specific public health interventions to tackle these problems.

Conclusion. The findings of the study highlight the need for immediate nutritional intervention programs for PVTGs in Chhattisgarh. Identification of their special nutritional needs can considerably enhance health outcomes and mitigate malnutrition in these vulnerable groups.

Keywords: nutritional status; malnutrition; Abujhmadia, Baiga, Birhor, Hill Korwa; Mid-Upper Arm Circumference

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Оценка нутритивного статуса взрослых женщин четырех особо уязвимых племенных групп из Чхаттисгарха, Индия, по измерениям окружности плеча

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РЕЗЮМЕ

Введение. Недостаточное питание существенно влияет на уровень смертности в мире, особенно среди пожилых людей и детей. Несмотря на то, что смертность от недоедания среди взрослых женщин значительно снизилась в период с 1990 по 2021 год, материнское здоровье по-прежнему вызывает озабоченность. Цель этого исследования – оценить нутритивный статус взрослых, принадлежащих к четырем особо уязвимым племенным группам в Чхаттисгархе, Индия, с помощью измерения окружности плеча в средней трети в качестве основного показателя.

Материалы и методы. В 2020 по 2024 годах проведено поперечное обследование 272 взрослых женщин, принадлежащих к племенам абуджмадия, байга, бирхор и пахари Корва. Перед сбором данных было получено согласие участников на измерение окружности плеча в средней трети. Для анализа данных при сравнении окружности плеча в разных возрастных группах использовались описательная статистика и ANOVA-тесты.

Результаты. Показано, что наибольшая распространенность недоедания наблюдается у обследованных женщин в племени абуджмадия (82,7%), за которым следуют пахари Корва (77,3%), байга (75,5%) и бирхор (60%). Были отмечены важные возрастные закономерности в распространенности недоедания, особенно в возрастных группах от 18 до 27 лет.

Обсуждение. Измерение окружности плеча в средней трети является эффективным и доступным инструментом для определения статуса питания в условиях нехватки ресурсов. Это позволяет выявить тяжелое положение с питанием в особо уязвимых племенных группах, требующих принятия конкретных мер в области общественного здравоохранения для решения этих проблем.

Заключение. Результаты исследования подчеркивают необходимость немедленного проведения программ по улучшению питания особо уязвимых племенных групп в Чхаттисгархе. Выявление их особых потребностей в питании может значительно улучшить состояние здоровья и смягчить последствия недоедания в этих уязвимых группах.

Ключевые слова: оценка питания; недоедание; абуджмадия; байга; бирхор; пахари Корва, окружность средней трети плеча

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Introduction

Malnutrition plays a key role in increasing mortality, especially among the elderly and child mortality globally, including in India. More than 30 million individuals lose their lives every year to hunger. In 2022, about 390 million adults were classified as underweight, whereas 2.5 billion were overweight and 890 million were obese, based on the World Health Organization (WHO, 2024). Even though there has been a significant reduction in malnutrition-related death rates among adult women worldwide and in India between 1990 and 2019/2021, it is still a priority health issue, particularly maternal health. Malnutrition has the potential to lead to complications and risk of death during pregnancy and delivery. In India, malnutrition-related deaths decreased by 80%, from 2.4 million in 1990 to 0.5 million in 2021. Also, maternal deaths globally due to malnutrition declined by 42.35% between the same years, from 73,460 to 42,350 (Global Nutrition Report, 2022). Proper nutrition from an equilibrated diet is important for meeting the body's demands and maintaining basic physiological processes. Inadequate nutrition may contribute to over-nutrition in the form of too many calories or under-nutrition due to a deficiency in necessary nutrients (de Onis et al., 1993). Nutrition has a strong impact on the quality of life in children and adults (Kennedy, 2006). It is crucial for the population growth in general (Zala, 2018) and is also very important in life expectancy and successful aging (Kennedy, 2006). The World Bank has noted a worldwide shift in nutrition that has brought about rapid changes in food systems, ecosystems, and standards of living (Dutta et al., 2019). The coexistence of undernutrition with overweight and obesity is an overwhelming challenge for low- and middle-income countries (LMICs) (Dutta et al., 2019). While adults tend to be regarded as the economic support of society, their nutritional issues tend to be overlooked (Ghosh & Bharati, 2006). Worldwide, there are 390 million underweight and 2.5 billion overweight adults, including 890 million who are obese (NFHS-4, 2017). This condition has increased, with the rates of prevalence being 22.9% for men and 24% for women in NFHS-5 (IIPS, 2021). India is ranked 111th among 125 nations by the Global Hunger Index, which points towards a very serious issue with hunger and undernourishment (von Grebmer et al., 2023). Even though malnutrition is a serious but frequently neglected development prob-

lem in India, there have only been a few studies that have measured the nutritional status of adults, mostly children aged less than five (Bhan et al., 2016). Body Mass Index (BMI) is a widely applied measure of nutritional status in anthropology (WHO, 1995). BMI is determined by dividing the person's weight in kilograms by his/her height in meters squared (kg/m^2). While health professionals with training will have no problem taking height and weight, it can be extremely difficult within the community setting. Specialized equipment used in such measurements is costly, and it takes frequent training and standardization to obtain correct results (Himes, 2009). In addition, moving the equipment over challenging terrain poses serious logistical challenges, rendering it impossible to utilize BMI in identifying overweight and obese subjects in large-scale surveys (Himes, 2009). Other methods of body measurement, such as taking circumferences of the neck, waist, and limbs with a basic measuring tape, may be more convenient for low-resource environments (Saka et al., 2014; Casadei & Kiej, 2025). The body circumference measurements are also simple, easy to administer, and inexpensive, qualities well-suited to low-resource settings. They also do not involve intricate calculations and are simple to use in the field. Therefore, employing circumferences of the body will be more efficient for large population-based research and programs (Sultana et al., 2015; Das et al., 2020). Mid-upper arm circumference (MUAC) is a well-established measure that can be used as an alternative to Body Mass Index (BMI) in adults. It is simple to use, easy to understand, low-cost, and transportable, and therefore does not require trained health workers to administer it (Sultana et al., 2015; Van Tonder et al., 2019; Tang et al., 2020; Philpott et al., 2021). Current guidelines suggest applying MUAC for rapid screening of adults for undernutrition, which helps in deciding whether admission to feeding programs is needed (James et al., 1994; Collins, 1996; Ferro-Luzzi & James, 1996; Collins et al., 2000). Anthropometric measurements are well-established markers of nutritional and health status in children and adults (WHO, 1995). Mid-Upper Arm Circumference (MUAC) is a useful measure for the assessment of the nutritional status of adults and is particularly advocated for the diagnosis of malnutrition in developing nations (James et al., 1994). The fact that MUAC is simple and requires minimal equipment makes it a good indicator of morbidity and mortality,

as accurate as weight deficits (Briend et al., 1989). Also, arm circumference can be substituted for Body Mass Index (BMI) measurements or used to complement them as a more discriminating marker of peripheral muscle and subcutaneous fat depletion (James et al., 1994). Significantly, the novelty of the MUAC study lies in the fact that there are no data on the prevalence of undernutrition, as indicated by MUAC, in India (Das & Bose, 2012). This research endeavors to assess the nutritional status of adult females based on MUAC among four Particularly Vulnerable Tribal Groups (PVTGs) of Chhattisgarh, India: Abujhmadia, Baiga, Birhor, and Pahadi Hill Korwas.

Materials and Methods

The current cross-sectional study explored the nutritional status according to Mid-Upper Arm Circumference (MUAC) in adults from four Particularly Vulnerable Tribal Groups (PVTGs) communities, namely the Abujhmadia tribe of Narayanpur district, the Birhor and Baiga tribes of Bilaspur district, and the Pahadi Hill Korwa tribe of Jashpur district of Chhattisgarh, India. These districts were chosen because of the prevalence of their respective PVTGs. The research was carried out between 2020 and 2024, and participants gave written consent before it was undertaken. Data was collected among the Abujhmadia adults in the Orcha block of Narayanpur district. Data on the Birhor and Baiga tribes was collected in the Umariya Dadar gram panchayat of Bilaspur district, and data on the Pahadi Hill Korwa tribe was collected in the Bagicha block of Jashpur district, Chhattisgarh. The communities were selected as no earlier anthropometric surveys based on MUAC were found targeting the PVTG adult women in these regions. The age of participants was taken from birth certificates or Aadhar cards and cross-checked with family members. For tabulation and analysis purposes, age was divided into five categories, ranging from 10-year intervals. Altogether 272 adult PVTG women aged 18 years and above were taken in the study, which included 52 Abujhmadia, 53 Baiga, 70 Birhor, and 97 Hill Korwa, taking stratified random sampling. Because of their forest-dwelling and nomadic nature, it was difficult to collect a greater sample. The Mid-Upper Arm Circumference (MUAC) of the participants was measured by (P.S., A.T., & S.D.) with a non-stretch measuring tape. The measurement was done around the left arm at the midpoint

between the elbow and the shoulder (between the olecranon and acromion), in such a way that the skin was not compressed. MUAC was measured to the nearest 0.1 cm (Lohman et al., 1988). The nutritional status was measured based on the cut-offs provided for adults: Undernourished: ≤ 24 cm and Normal: > 24 cm (Maalouf-Manasseh et al., 2020). Ethical clearance was sought from the departmental ethics committee, and the present study abided by the ethical standards given in the Declaration of Helsinki (Touitou et al., 2004). Informed consent was obtained from each consenting participant prior to the interview and measurements, following an explanation of the specifics of the study in a language that the participant would be able to comprehend.

Abujhmadia: The Abujhmadia tribe uses the Abujhmadia Gondi language. The population of the Abujhmadia, as per the 2011 Census, is 22,000 (Census of India, 2011a).

Baiga: The Baiga tribe uses Baigani and Chhattisgarhi languages of Hindi, and Baigani is a dialect of Chhattisgarhi. Baiga population in Chhattisgarh is 89,744 (Census of India, 2011a).

Birhor: The Birhor people use the Mundari language, which falls under the Austro-Asiatic family and is also known locally as Birhori, Parchi, or Parsi. There is a total of 1,744 Birhor in Chhattisgarh (Census of India, 2011a; Tripathi, 2017).

Hill Korwa: Hill Korwa is a tribe that belongs to the Austro-Asiatic sub-family of the Austric family. The mother language, or "Korwai," is spoken only by the Hill Korwa people. Hill Korwas in Chhattisgarh numbered 37,195 as of the 2011 Census (Census of India, 2011a).

Statistical Analysis Overview

Descriptive statistics were applied to obtain the mean and SD for different ethnic and age groups. A one-way ANOVA test was performed to assess differences in mean MUAC between the PVTGs. One-way ANOVA tests were also used to compare variations in mean MUAC among different age groups. In order to evaluate the importance of differences between groups in the prevalence of undernutrition, a Chi-square/Fisher's Exact (χ^2) test was conducted to see the relationship between nutritional status with PVTGs and community community-specific relationship of age-groups with nutritional status. IBM's Statistical Package for Social Sciences (SPSS 16.0) was utilized to analyse the data

Table 1. Age-group-wise distribution of studied female PVTG Abujhmadia, Baiga, Birhor and Hill Korwa) participants (N= 272)

Таблица 1. Распределение по возрастным группам обследованных женщин, принадлежащих к племенам абуджмадия, байга, бирхор и пахари Корва (N= 272)

Age Group (Years) Возрастные группы (лет)	Tribal Groups/Племенные группы				Age Group Wise Total (Years) Объединенная Группа (лет)
	Abujhmadia Абуджмадия (N)	Baiga Байга (N)	Birhor Бирхор (N)	Hill Korwa Пахари Корва (N)	
18-27	19	9	31	40	99
28-37	13	10	13	20	56
38-47	12	10	15	13	50
48-57	5	10	7	10	32
58-67	3	14	4	14	35
Total/Всего	52	53	70	97	272

with statistical significance at $p < .05$. Graphical illustrations were produced with Microsoft Office Excel.

Results

The age-group-wise distribution of the studied PVTGs presented in table 1. This cross-sectional study examines 272 PVTG females aged 18-67 years. The breakdown includes 52 Abujhmadia females, 53 Baiga females, 70 Birhor females, and 97 Hill Korwas. In the Abujhmadia community, the 18-27 age group has the highest population, totaling 19 individuals. Among the Baiga community, the 58-67 age group is more populous than the younger age groups. For the Birhor community, the 18-27 age group also has the highest number, with 31 individuals. Similarly, in the Hill Korwa community, the 18-27 age group represents the largest population of 40 females. As shown in the table, the Baiga community has the highest number of older individuals, while the other three communities predominantly consist of younger individuals. Data for each community was collected from specific villages in each district of Chhattisgarh state.

The age-specific trends in the mean and standard deviations of Mid-Upper Arm Circumference (MUAC) for females aged 18-67 across four distinct ethnic groups: Abujhmadia, Baiga, Birhor, and Hill Korwa 2 shows in table 2. The highest mean MUAC is found in the Abujhmadia group,

measuring 23.6 cm for the 38-47 age range, while the lowest mean is 21.8 cm in the 18-27 age group. For the Baiga group, the highest mean is 23.8 cm in the 28-37 age range and the lowest is 22.1 cm in the 18-27 age group. In the Birhor group, the highest mean MUAC is 25.1 cm for those aged 48-57, with a lowest mean of 23.1 cm in the 18-27 age group. The Hill Korwa group shows a highest mean of 25.2 cm in the 38-47 age range and a lowest mean of 22.6 cm in both the 18-27 and 48-57 age groups. When comparing the mean MUAC across the four Programs for Vulnerable Tribal Groups (PVTGs), there were no significant differences in mean MUAC by age group overall. However, significant age group differences were identified among Abujhmadia females ($F = 3.844$; $p < 0.01$) and Hill Korwa females ($F = 7.230$; $p < 0.000$).

The combined mean Mid-Upper Arm Circumference (MUAC) for female groups from four Particularly Vulnerable Tribal Groups (PVTGs) in Chhattisgarh: Abujhmadia, Baiga, Birhor, and Hill Korwa illustrated in table 3. The Birhor females exhibit the highest mean MUAC at 23.7 cm, followed by Hill Korwa females at 23.3 cm, Baiga females at 23.2 cm, and Abujhmadia females with the lowest mean of 22.7 cm. There is no significant ethnic difference in mean MUAC among the four PVTGs studied.

The age-specific prevalence (%) of undernutrition among Abujhmadia, Baiga, Hill Korwa, and Birhor PVTG females in Chhattisgarh using MUAC

Table 2. Age-group specific trend in mean MUAC among PVTG (Abujhmadia, Baiga, Birhor and Hill Korwa) (18-67 years) females of Chhattisgarh

Таблица 2. Средние значения обхвата предплечья в возрастных группах (18-67 лет) обследованных женщин из особо уязвимых племенных групп (абуджмадия, байга, бирхор и пахари Корва) из Чхаттисгарха

Age Group (Years) Возрастные группы (лет)	Tribal Groups/Племенные группы								F	(Sig.)
	Abujhmadia Абуджмадия (N)		Baiga Байга (N)		Birhor Бирхор (N)		Hill Korwa Пахари Корва (N)			
	M	SD	M	SD	M	SD	M	SD		
18-27	21.8	1.4	22.1	2.6	23.1	3.3	22.6	1.3	1.585	0.198
28-37	23.4	1.3	23.8	1.5	23.4	1.6	23.6	1.6	0.170	0.916
38-47	23.6	1.7	22.9	1.4	24.3	4.2	25.2	2.7	1.414	0.251
48-57	22.2	1.9	23.7	2.9	25.1	3.0	22.6	1.5	1.998	0.137
58-67	23.3	1.5	23.4	1.3	23.8	3.4	23.8	1.4	0.151	0.928
Total/Всего	22.7	1.7	23.2	2.0	23.7	3.2	23.3	1.9		
F	3.844		1.167		0.705		7.230			
(Sig.)	0.009		0.337		0.591		0.000			

Notes. M= Mean; sd= Standard Deviation; F= ANOVA; Sig= Significance level.

Примечания. M= Средняя арифметическая; sd= Стандартное отклонение; F= ANOVA; Sig= уровень значимости.

Table 3. Age combined comparative mean MUAC among four PVTG (Abujhmadia, Baiga, Birhor, and Hill Korwa) Female Groups of Chhattisgarh

Таблица 3. Средние значения обхвата предплечья в возрастных группах (18-67 лет) в объединенной группе обследованных женщин из особо уязвимых племенных групп (абуджмадия, байга, бирхор и пахари Корва) из Чхаттисгарха

Tribal Groups Племенные группы	N	M	SD	Lower Bound Нижняя граница	Upper Bound Верхняя граница	F	(Sig.)
Abujhmadia Абуджмадия	52	22.7	1.7	22.3	23.2	1.775	0.152
Baiga Байга	53	23.2	2.0	22.7	23.8		
Birhor Бирхор	97	23.3	1.9	22.9	23.7		
Hill Korwa Пахари Корва	70	23.7	3.2	22.9	24.5		

Notes. M= Mean; sd= Standard Deviation; F= ANOVA; Sig= Significance level.

Примечания. M= Средняя арифметическая; sd= Стандартное отклонение; F= ANOVA; Sig= уровень значимости.

presented in table 4. In the Abujhmadia community, 34.6% of females aged 18-27 years were classified as undernourished. Similarly, in the Baiga community, 20.8% of females aged 58-67 years fall into the undernourished category. Among the Hill Korwa community, 38.1% of females aged 18-27 years

were undernourished, while in the Birhor community, 27.1% of females in the same age group were undernourished. The data also indicate that only the Hill Korwa community exhibits a highly significant mean difference in undernutrition prevalence. In contrast, the other three communities

Table 4. Age-specific Prevalence (%) of Undernutrition among Abujhmadia, Baiga, Hill Korwa, and Birhor PVTG Females of Chhattisgarh (Based on MUAC)

Таблица 4. Распространенность недостаточного питания (%) в возрастных группах обследованных женщин из особо уязвимых племенных групп (абуджмадия, байга, бирхор и пахари Корва) из Чхаттисгарха (по данным измерения обхвата предплечья)

Age Group (Years) Возрастные группы (лет)	Tribal Groups/Племенные группы								x ²	df	(Sig.)
	Abujhmadia Абуджмадия		Baiga Байга		Birhor Бирхор		Hill Korwa Пахари Корва				
	UN	N	UN	N	UN	N	UN	N			
18-27	34.6	1.9	13.2	3.8	38.1	3.1	27.1	17.1	14.080 ^a	3	0.003
28-37	21.2	3.8	13.2	5.7	15.5	5.2	14.3	4.3	0.741 ^a	3	0.863
38-47	15.4	7.7	15.1	3.8	6.2	7.2	12.9	8.6	2.897 ^a	3	0.408
48-57	7.7	1.9	13.2	5.7	8.2	2.1	2.9	7.1	5.719 ^a	3	0.126
58-67	3.8	1.9	20.8	5.7	9.3	5.2	2.9	2.9	1.414 ^a	3	0.702
x ²	4.676 ^a		0.533 ^a		13.915 ^a		4.620 ^a				
df	4		4		4		4				
(Sig.)	0.322		0.97		0.008		0.329				

(Abujhmadia, Baiga, and Birhor) do not show significant mean differences. The significant age-specific relationship in undernutrition prevalence, as measured by MUAC, has been observed for the age group 18-27 years ($X^2=14.080$; $df=3$; $Sig.=0.003$) and significant relationship of age-group and nutritional status has also been observed among Birhor females ($X^2=13.915$; $df=4$; $Sig=0.01$).

The overall prevalence of undernutrition among Abujhmadia, Baiga, Hill Korwa, and Birhor PVTG females in Chhattisgarh, combining all age groups presented in figure 1. The Abujhmadia group exhibited the highest prevalence at 82.7%, followed by Hill Korwa at 77.3%, Baiga at 75.5%, and Birhor at 60%. This data clearly indicates that all four studied PVTGs in Chhattisgarh are facing a critical situation regarding their nutritional status.

Discussion

Nutritional assessment is a critical component of public health, particularly among vulnerable populations such as the Particularly Vulnerable Tribal Groups (PVTGs) in India. Among various methods of nutritional assessment, the Mid-Upper Arm Circumference (MUAC) has gained prominence due to its simplicity, cost-effectiveness, and reliability (Van Tonder et al., 2019; Pradhan et al., 2020). This method is especially relevant for assessing nutritional status in adult females within

these tribal groups, who often face unique nutritional challenges (Das et al., 2020). Numerous studies have utilized Mid-Upper Arm Circumference (MUAC) as a nutritional assessment tool across various population groups, including inpatients, the elderly, schoolchildren, pregnant and lactating women, as well as adolescent and adult females (Kok et al., 2004; Bose & Das, 2010; Sánchez-García et al., 2007; Rothman, 2008; Casadei & Kiel, 2020; Luma et al., 2017).

A few reports on nutritional status based on MUAC of females of different groups in Chhattisgarh, India and in some other states of India are presented in figure 2. Very High (Critical) rates of undernutrition are observed in all of the PVTGs of Chhattisgarh India like Abujhmadia (77.3%), Baiga (75.5%), Birhors (60%), and Hill Korwa (77.3%). Nutritional status of some studies in India (Banik, 2008; Bisai & Bose, 2009; Chakrabarty et al., 2009; UNICEF, 2016 (Unpublished); UNICEF, 2016 (Unpublished); SMART survey, 2017; Sethi et al., 2017; UNICEF, 2017 (Unpublished)) shows high prevalence of undernutrition among studied females using MUAC. Thus, the regular assessments can help identify trends within these populations, informing policy decisions and resource allocation. The data collected can also contribute to broader studies on health disparities faced by PVTGs, thereby enhancing understanding and action toward improving their nutritional status (Kumar & Singh, 2021).

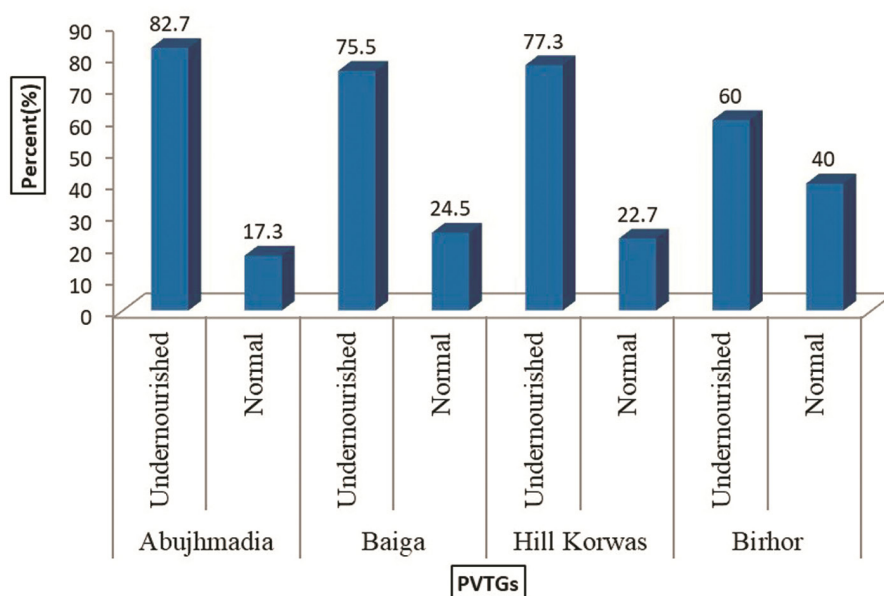


Figure 1. Overall (Age Combined) Prevalence (%) of Undernutrition among Abujhmadia, Baiga, Hill Korwa, and Birhor PVTG Females of Chhattisgarh

Рисунок 1. Распространенность недоедания (в %) в группах обследованных женщин из особо уязвимых племенных групп (абуджмадия, байга, бирхор и пахари Корва) из Чхаттисгарха без учета возраста

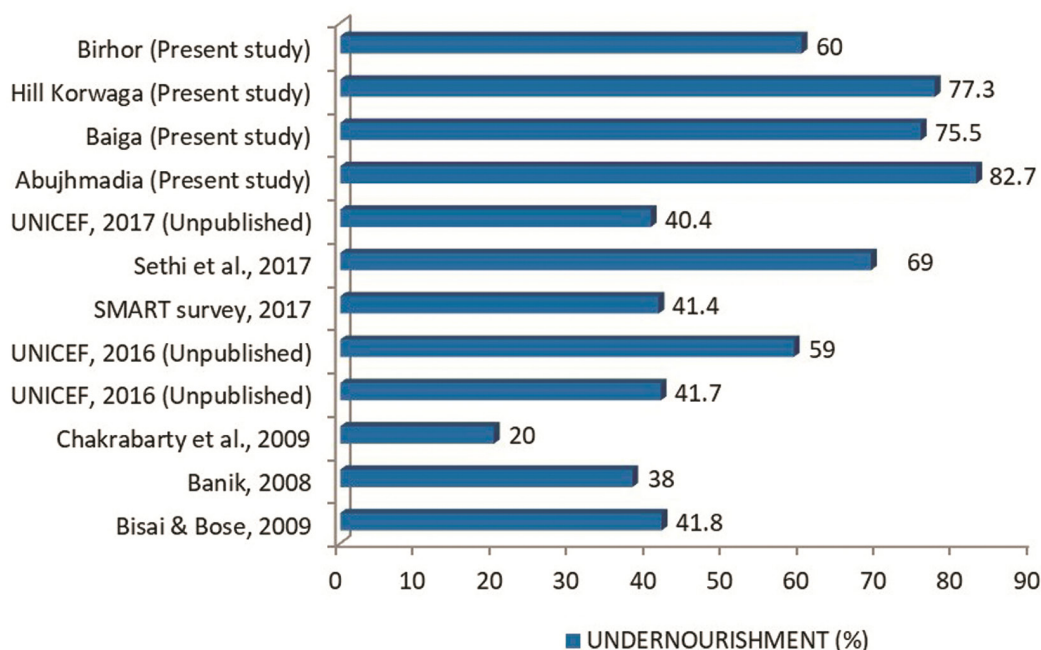


Figure 2. Comparative prevalence (%) of Undernutrition among present studies (Abujhmadia, Baiga, Hill Korwa, and Birhor) PVTG Females of Chhattisgarh with other studies.

Рисунок 2. Сравнительная оценка распространенности недоедания (в %) в обследованных группах женщин из особо уязвимых племен (абуджмадия, байга, бирхор и пахари Корва) из Чхаттисгарха с данными из других исследований

Conclusion

The overall rate of undernutrition across the four PVTGs studied together illustrates a situation of extreme nutritional status with the highest rate of 82.7% in the Abujhmadia community, followed by Hill Korwa at 77.3%, Baiga at 75.5%, and Birhor at 60%. This figure indicates an imperative nutritional crisis situation facing all researched PVTGs of Chhattisgarh. Finally, a systematic evaluation of nutrition status by MUAC in adult Indian women of PVTGs is an essential practice that responds to the specific challenges confronting these communities. Through its use, public health workers will be able to better comprehend and address the nutritional requirements of these high-risk groups to enhance health outcomes. Prompt nutritional intervention programs are required to counter the extremely critical situation of PVTGs, and this can be one of the prime causes of the dwindling demographic profile of PVTGs in Chhattisgarh, Bharat.

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