International Journal of Pharmacy and Biological Sciences-IJPBS™ (2019) 9 (1): 283-288
Online ISSN: 2230-7605, Print ISSN: 2321-3272
Research Article | Biological Sciences | Open Access | MCI Approved
UGC Approved Journal

Receiver Operating Characteristic (ROC) Curves to Identify Anthropometric Indices to Predict Nutritional Status of the Hill Korwa Children of Sarguja District, Chhattisgarh

Irshad Khan[1] and J.K. Nayak[2]

[1]Guest Lecturer, Department of Anthropology, Rajeev Gandhi Government P.G. Collage, Ambikapur, Chhattisgarh, India.

[2]Assistant Professor & HOD, Department of Anthropology, Central University of Orissa, Koraput, Odisha, India.

Received: 8 Oct 2018/ Accepted: 6 Nov 2018/ Published online: 01Jan 2019
Corresponding Author Email: khanirshad0790@gmail.com

Abstract

The magnitude of the problem of malnutrition among children under five years of age is high throughout in India. The objectives of this study are to explore the levels and trends in malnutrition of Hill Korwa children aged 0-5 years and reveal their overall nutritional status using a comparison between Receiver Operating Characteristic (ROC) curves. The cross-sectional study was conducted during Dec-2015 to 16. The present study is based on anthropometric data from 1021 (595 boys and 426 girls) children between age of 0 to 5 years, from three blocks named Lundra, Batauli, and Sitapur in Sarguja district, Chhattisgarh. Purposive sampling was done for the selection of research participants. Schedules were also been prepared for collecting the data from the research participants, which contains basic information like age, sex etc. of the children for qualitative data in-depth interviews and observation were carried out in the field. Different indexes were applied for assessing nutritional status was determined based on Weight/Height^2 and Waterlow (Height-for-age & Weight-for-height) and Dughdale, Ponderal, Rao, Kanawati and Head circumference and Chest circumference Classifications. Prevalence of malnutrition can be well defined by the ROC curves. Among these different indexes it can be seen that the highest sensitivity is shown by the Waterlow classification while for the specificity Dughdale classification shows the highest percentage. For the present nutritional study on Hill Korwa children from 0 to 5 years, Dughdale index is better related to the other indices. From the ROC curves it has been found that Dughdale index covered maximum area (0.860) under ROC curve. As a result Dughdale index can be considered as a better index to assess the nutritional status of the Hill Korwa children in the present study. Children are facing Protein-Energy malnutrition are 56.6% of the total

population. In conclusion, special focus is needed for the nutritional improvement of children under the age of five living in the study area to prevent preventable morbidities and to achieve optimum development.

Keywords
Hill Korwas Children, Nutritional Status, Anthropometric Indices, Receiver Operating Characteristics.

*****

INTRODUCTION:

Malnutrition is a nutritional disorder or condition resulting from faulty or inadequate nutrition. It results from an imbalance between the body's needs and the intake of nutrients, which can lead to syndromes of deficiency or obesity. Malnutrition in early childhood has serious, long-term consequences because it impedes motor, sensory, cognitive, social and emotional development (Krishnan, 2004). Child nutrition status is an important measure of poverty in a population; and poverty, malnutrition and disease are interlinked with each other. Malnutrition in children is the consequence of a range of factors, which are often related to poor food quality, insufficient food intake, and severe and repeated infectious diseases or frequently it involves some combination of the three (De Onis *et al.,* 1993). These conditions, in turn, are closely linked to the overall standard of living and whether a population can meet its basic needs, such as access to food, housing and health care (WHO, 1997). Therefore, child nutritional status assessment not only serves as a means for evaluating the health condition and survival of children but also provides an indirect measurement of the quality of life of that population.

According to WHO (1997), malnutrition is synonymous with Protein-Energy-Malnutrition (PEM), signifying an imbalance between the supply of protein and energy and the body's demand for them and to ensure optimal growth and function. This imbalance of protein and energy intake leads to malnutrition in the form of stunting, wasting and underweight. In practice, stunting is defined as a height-for-age measurement of below minus two standard deviation of the median National Centre for Health Statistics (NCHS) reference values, and is generally considered a marker of chronic malnutrition (Mitra et *al.,* 2001). By contrast, acute malnutrition, termed as wasting is defined by a weight-for-height indicator. In addition, a composite form of malnutrition, known as underweight or under-nutrition is defined with a weight-for-age indicator. Each kind of malnutrition can be classified as Severe and Moderate levels according to the cut-off points. However, as different forms of malnutrition have different causes and consequences and require substantially different causes and appropriate nomenclature to differentiate them is needed (Collins *et al.,* 2006).

According to the most recent estimates, child under nutrition contributes to more than one third of child deaths. Undernourished children who survive may enter the vicious cycle of recurring illness and faltering growth, with irreversible damage to their growth, cognitive development, school performance, and future productivity as adults (UNICEF, 2015).

Malnutrition remains a widespread problem in developing countries, in particular among the poorest and most vulnerable segments of the population. Malnutrition is typically caused by the combination of inadequate food intake and infection which impairs the body's ability to absorb or assimilate food. It is an important cause of low birth weight, brain damage and other birth defects, and contributes to the developmental (physical and cognitive) retardation, increased risk of infection and death, and other problems in infants and children (Krishnan, 2004).

One approach of studying nutrition is to assess the nutritional status on the basis of anthropometric indicators. Three different indices were used to calculate the nutritional status for the children i.e., height-for-age, weight-for-height, and weight-for-age. The height-for-age index examines the linear growth retardation and is used as an indicator of chronic under nutrition. The weight-for height index compares body mass to body length. This index reflects acute under nutrition. Weight-for-age is a composite measure of both chronic and acute under nutrition. Malnourished children on the weight-for-age index are referred to as 'underweight' on the height-for-age index as 'stunted' and on the weight-for-height index as 'wasted'. The measurements on these three indices were compared with the international reference population as recommended by WHO (WHO, 1995). From an anthropometric perspective, a nutritional status can be seen as the output of a health production function, where nutrient intake is one

input, but where other individual, household, and community variables also feature.

Anthropometric indicators are both useful at an individual and at population level. At an individual level, anthropometric indicators can be used to assess the compromised health or nutritional well being. This information is quite valuable for screening children for interventions and for assessing the response to interventions. At the population level, anthropometry can be used to assess the nutrition status within a country, region, community, or socioeconomic group, and to study both the determinants and consequences of malnutrition. This form of monitoring is valuable both for the design and targeting of health and nutrition interventions.

OBJECTIVES OF THE STUDY:

The main objectives of the study are

- To explore the levels and trends in malnutrition of Hill Korwa children aged 0-5 years
- To reveal their overall nutritional status using a comparison through Receiver Operating Characteristic (ROC) curves.

MATERIALS AND METHODS:

Area and People:

Hill Korwa, a sub group of Korwa tribe was identified as a particular vulnerable tribal group (PVTGs) during the fifth five year plan (Ota, *et al.,* 2015). The history of this tribe reveals that they had moved westward into the Khudia Jamindari (Present Sanna and Bagicha revenue circles) of Jashpur district from Chhotanagpur region. They are distributed in the Sarguja, Jashpur, Balraampur, Shankargarh and Korba district and their total population is 34,122 (Tribal Research Training Institute, Raipur, Chhattisgarh, 2006). According to anthropological description of family, they belong to Austro-Asiatic family (Shrivashtav, 2007). Generally most of the Hill Korwas have a nuclear family. Hill Korwa is divided into five different totemistic endogamous clan, viz; *Hansadwar*, *Samar*, *Edigwar*, *Ginnur* & *Renla* (Shirvastav, 2009). The present study is conducted among the purposive randomly selected Hill Korwa tribe of Sarguja district of Chhattisgarh.

The present study carried out mainly in three blocks namely Lundra, Batauli and Sitapur of Sarguja district of Chhattisgarh. In this study, 16 gram panchayat comprising 26 villages were covered where Hill Korwas are predominately residing.

Sampling:

A cross sectional survey was conducted in Dec. 2015-2016 on Hill Korwa tribe. A total of 1021 (595 boys and 426 girls) children (0 -5 Years) of three blocks of Sarguja district of Chhattisgarh were included in this study. Purposive sampling was done for the selection of research participants. Those who were not willing to participate in the study were excluded. Apart from the above said sample the Anganwadi Centre, Primary Schools and Primary Health Care Centres were also been taken for the study purpose. Length/ Height and weight were measured by using the standard measuring boards and manual weighing machine. Mid upper arm circumference (MUAC) was measured using a non stretchable tape. Head circumference and chest circumference was measured using a measuring tape.

Data Collection:

During the time of collecting the information, basic general discussions with the locals were also been considered for collecting the general information of the people and area. Schedules were prepared for collecting the data from the research participants, which contains basic information like age, sex etc. of the child for qualitative data; in-depth interviews and observation also carried out in the field.

ROC curves were constructed to identify the global accuracy (area under the curves) of anthropometric indices to predicting nutritional status. Areas under the receiver operating characteristic (ROC) curves were calculated and ROC curves were plotted graph, respectively, to detect global accuracy and to identify nutritional cut-offs corresponding to the intersection of sensitivity and specificity curves. The areas under the curves were compared according to Water low (Height-For-Age) The areas under the curves were compared according to Water low Height-For-Age (HFA), HFA= Actual Height / Standard Height (WHO, 2004) X 100, Weight-For-Height (WFH), Dughdale HFA= Actual Height / Standard Height (WHO, 2004) X 100, Dughdale (Weight in kg/Height in cm $^{1.6}$), Ponderal (Weight/Height^3), Rao (Weight/Height^2), Kanawati (MUAC/ Head Circumference in cm ratio), Head circumference/Chest circumference, using chi-square statistics. Those areas were estimated by points and 95% confidence intervals (95% CI).

Statistical Analysis:

The statistical analysis of the entire data was carried out by using IBM SPSS version 23. SPSS was used to run regression analysis, and to calculated and compare the areas under the ROC curves. Non-parametrical graph ROC curves were built for Hill Korwa children in accordance to their weight, height, MUAC, Head and Chest circumference in order to determine the nutritional cut-offs (d_0) & predicting malnutrition which corresponded to the intersection between sensitivity and specificity curves (0_0). 0_0 values correspond to the mean between sensitivity (Se) and specificity (Sp) value: $0_0 =$ (Se + Sp)/2. Values

for d0 values for d0 were estimated by point and 95% CI.

ANALYSIS AND RESULTS:

Table-1: Different indices for assessing nutritional status of children (0-5 years) of Hill Korwa

Anthropometric Indices	*Malnutrition*		*Normal*	
	N=1021			
	No.	%	N	%
Waterlow (HFA)	533	52.2%	488	47.8%
Waterlow (WFH)	460	45.1%	561	54.9%
Dughdale Index	578	56.6%	443	43.4%
Ponderal Index	581	56.9%	440	43.1%
Rao Index	669	65.5%	352	34.5%
Kanawati Index	666	65.2%	355	34.8%
Head circumference/Chest circumference Index	952	93.2%	69	6.8%

Table -1 show that different indices for assessing nutritional status of Hill Korwa children of 0 to 5 years age groups. Here different anthropometric measurements were calculated from the different anthropometric indices were obtained. In this table-1 Water low (HFA) indices indicate that 52.2% children were suffering from malnutrition, whereas 47.8% were normal. Waterlow (WFH) indices show that 45.1% Hill Korwa children were malnourished and 54.9% were normal. Ponderal index shows that 56.9% were suffering from malnutrition problem, 43.1% were normal. Rao index indicates that 65.5% were suffering from malnutrition and 34.5% shows normal condition. Kanawati index shows that 65.2% were malnourished and 34.8% were normal. Head circumference /Chest circumference index shows that 93.2% were malnourished and only 6.8% were normal. Dughdale Index shows that 56.6% Hill-Korwa children were malnourished and 43.4% were normal.

Table-2: Comparative account of different indexes for assessing nutritional status of children (0-5 years) of Hill Korwa

Indices	Sensitivity (%)	Specificity (%)	Positive Predictive Value	Negative Predictive Value	chi square	p-value
Waterlow (HFA)	72.42	75.20	76.13	71.40	231.1	0.000
Waterlow (WFH)	88.48	82.17	80.28	89.69	504.7	0.000
Dughdale	81.49	91.87	92.90	79.18	539.9	0.000
Ponderal	61.96	66.59	71.01	57.00	81.7	0.000
Rao	69.36	87.78	91.52	60.12	301.2	0.000
Kanawati	65.77	80.56	86.39	55.64	198.8	0.000
Head circumference/Chest circumference	48.00	27.54	90.14	3.70	15.4	0.000

In this table 2, different indexes for the measurement of nutritional status has been shown and compared with respect to sensitivity, specificity, positive predictive value, negative predictive value, chi square and p value. Among these different indexes it can be seen that the highest sensitivity is shown by the Waterlow classification while for the specificity Dughdale classification shows the highest percentage. For the positive and negative predictive value index classifications the highest percentage has been shown by the Dughdale classification and Waterlow index classification respectively. The highest chi square value is also shown by the Dughdale index. From this table, it can be understood that for the present

nutritional study on Hill Korwa children from 0 to 5 years Dughdale index is better related to the other indices.

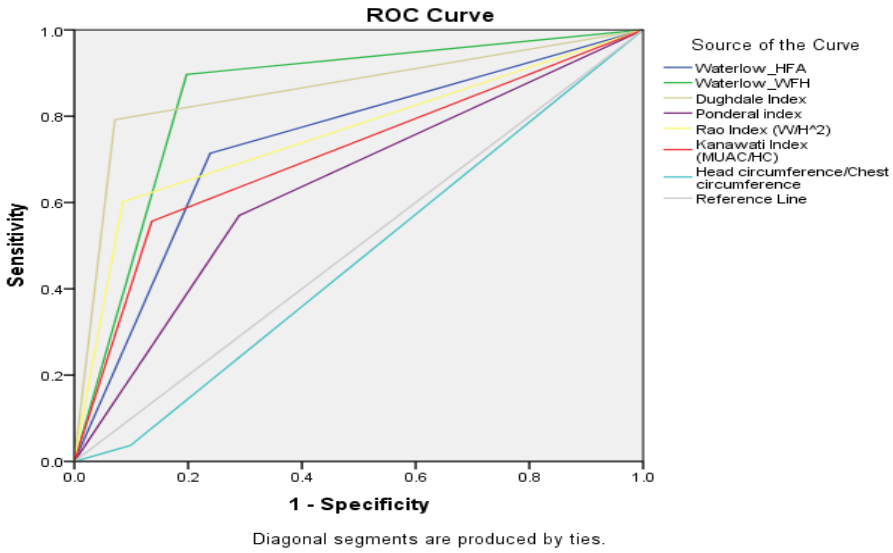

Figure-1: ROC Curve for different anthropometric indices for assessing nutritional status of children (0-5 years) of Hill Korwa

In the figure 1 different anthropometric indices has been compared with the Indian Academy of Paediatrics index which is been referred as a standard for nutritional assessment of the population in Indian subcontinent. There are seven different indexes which are been compared, in ordered to see the best index that can fit the present study of Hill Korwa population. For better comparison of these indexes various measurement of nutritional status such as sensitivity, specificity, positive value, and negative value are compared and plotted for the ROC curve chart. From the present ROC curves in the above chart it has found that Dughdale index covered the maximum area under ROC curve. For this reason Dughdale index can be considered as a better index to assess the nutritional status of the children of Hill Korwa in present study.

Table- 3: Comparative account of area under ROC curve for different indexes for assessing nutritional status of children (0-5 years) of Hill Korwa

Area Under the Curve					
Test Result Variable(s)	Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
Waterlow_HFA	.738	.016	.000	.707	.769
Waterlow_WFH	.850	.013	.000	.824	.875
Dughdale Index	.860	.013	.000	.836	.885
Ponderal index	.640	.017	.000	.606	.674
Rao Index (W/H^2)	.758	.015	.000	.728	.788
Kanawati Index (MUAC/HC)	.710	.016	.000	.678	.742
Head circumference/Chest circumference	.469	.018	.088	.434	.505

Comparison among the different indices regarding the nutritional assessment has been shown in the table-3 under ROC curve with the help of Area, standard error, asymptotic significance, Asymptotic 95% confidence

Interval. In this comparison, it can be seen that overall Dughdale Index has the highest area covered, while both the Dughdale index and Waterlow Index shows the lowest standard error of 0.013 in calculations. So from this it can be said that Dughdale index is better index for the analysis of the nutritional status of the Hill Korwa children of present study.

CONCLUSION:

The level of child malnutrition remains unacceptable throughout the world, with 90 per cent of the developing world's chronically malnourished (stunted) children living in Asia and Africa (UNICEF). Detrimental and often undetected until severe, malnutrition undermines the survival, growth and development of children, and diminishes the strength and capacity of nations. As a result, vital opportunities to save millions of lives are being lost, and many more millions of children are not growing and developing to their full potential. This study provides a window to peek inside the lives of Hill Korwa tribe & access the nutritional status of the Hill Korwa children. Among these different indexes it can be seen that the highest sensitivity is shown by the Waterlow classification while for the specificity Dughdale classification shows the highest percentage. For the present nutritional study on Hill Korwa children from 0 to 5 years is considered. Dughdale index is better related to the other indices. From the present ROC curves in the above chart it has found that Dughdale index covered maximum area (0.860) under ROC curve. This index can be considered as a better index to assess the nutritional status of the Hill Korwa children in present study. Children are facing Protein-Energy malnutrition are 56.6% of the total population.

Nutrition is a core pillar of human development and concrete, large-scale programming not only can reduce the burden of malnutrition and deprivation in countries but also can advance the progress of nations. Special focus is needed for nutritional improvement of less than five years living in this study areas to prevent preventable morbidities and to achieve optimum development.

REFERENCES:

Chakma T, Meshram PK, Rao PV, Singh SB, & Kavishwar A. Nutritional Status of Baiga- A Primitive Tribe of Madhya Pradesh. *Tribal Health Bulletin,* Regional Medical Research Centre for Tribals (ICMR), Jabalpur. 2009.

Collins, S., Dent, N., Binns, P., Bahwere, P., Sadler, K. & A. Hallam. Management of Severe Acute Malnutrition in Children, *Lancet*. 2006; 368(9551): 1992-2000.

DeOnis, M., Monteiro, C., Akre J. & G. Clugston. The Worldwide Magnitude of Protein-Energy Malnutrition: An Overview from the WHO Global Database on Child Growth, *Bulletin of the World Health Organization*. 1993; 71(6): 703-712.

Krishnan L. Nutritional Status of Children in Tribal Communities of Wayanad, Dissertation, Achutha Menon Centre for Health Science Studies, Sree Chitra Tirunal *Institute for Medical Sciences and Technology,* Thiruvananthapuram, Kerala, India. 2004.

Mitra, Satindra N., Al-Sabir, A., Saha, T. & Kumar,S.. Bangladesh Demographic and Health Survey 1999-2000, Dhaka: NIPORT and Mitra & Associates. 2001.

Moraes, S.A., Fritas, I.C.M., Mondini, L. & Rosas, J.B. Receiver Operating Characteristic (ROC) curves to identify birth weight cutoffs to predict overweight in Mexican School Children. Journal De Pediatria. 2009; 85 (1): 42-47.

Nayak JK & Singh P. Fundamental of Research Methodology: Problems and Prospects, SSDN Publishers & Distributor, New Delhi. 2015.

Ota AB & Mohanty SC. *Particularly Vulnerable Tribal Groups of Orissa: Anthropology of Health and Medicine.* SCSTRTI, Odisha. 2015; Vol.III, pp. 8-10.

Rahman, A. & Biswas, S.C. Nutritional status of Under-5 Children in Bangladesh, *South Asian Journal of Population and Health.* 2009: 2(1); 1-11.

Shirvastav M. Chhattisgarh ke Pahadi Korwa Janjaati ki Samajik Aarthik Dasha. Chhattisgarh Hindi Granth Akadmik, Raipur. 2009.

Srivastava VK. The Pahari Korwas: Socio Economic condition and their Development, Sonali Publications, New Delhi. 2007.

Tribal Research Training Institute. *Vikas Yojna,* Chhattisgarh Government, Raipur. 2006.

UNICEF India. The children: Nutrition Available from http://unicef.in/Story/1124/Nutrition. Accessed on 12 September 2015.

Waterlow, John C., Buzina, R., Keller, W., Lane, Michael J., Nichaman, Milton Z. & James M. Tanner. "The Presentation and Use of Height and Weight data for Comparing the Nutritional Status of Groups of Children under the Age of 10 Years",

Bulletin of the World Health Organization. 1977; 55(4): 489-98.

WHO. Physical Status: The Use and Interpretation of Anthropometry, Report of a WHO Expert Committee, Technical report series. 1955; 854: 1-452.

WHO. WHO Global Database on Child Growth and Malnutrition, Geneva: World Health Organization. 1997.