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Assessment of Nutritional Status through Body Mass Index among Adult Males of 7 Tribal Populations of Maharashtra, India

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ABSTRACT

This paper deals with the assessment of nutritional status through body mass index (BMI) in adult males of 7 tribal populations of the Maharashtra state of India. Anthropometric data collected by the Anthropological Survey of India on 600 adult males aged 18-60 years were used in this analysis. Majority of them were thin and lean with medium to short stature. The mean BMI was found to be highest among the Gond (18.33 kg/m^2) followed by Korku (18.30 kg/m^2) and Mahadeokoli (18.17 kg/m^2). There were significant variations in the mean BMI among the tribal populations, ranging between 16.82 kg/m^2 and 18.33 kg/m^2. The prevalence of Chronic Energy Deficiency (CED) was highest among the Warli, among whom 30.0% were found to be suffering from severe CED, 32.0% moderate CED and 26.0% mild CED. A greater prevalence (36.0%) of normal status of nutrition was found among the Korku. The linear regression coefficient (b ± standard error) of BMI on Cormic Index or CI (SH/H) for these tribal groups was 13.68 ± 3.3 (t=4.14, $p < 0.000$), and the correlation coefficient (r ± standard error) was 0.16 ± 0.02. The differences in BMI across the tribes were significant even after allowing for the Cormic Index. It can be said that the majority of the tribal populations of Maharashtra were lean. The high proportion of individuals with CED corroborates their low social and economic status.

INTRODUCTION

There are many measures to assess the nutritional status of a population. Body mass index (BMI) is one of them. Anthropometry is considered to be an important tool for assessing nutritional status of individuals or of the community. Hence, measurements like stature, sitting height, weight and indices based on these measurements developed by different scholars have been extensively used to define the extent of malnutrition. Body mass index (BMI) expressed as ratio of weight to height squared can be a good parameter to grade chronic energy deficiency (CED) in adults (Naidu *et al.*, 1991). There are many studies based on this aspect (for example Ferro-Luzzi *et al.*, 1991; Khongsdier, 2001). Inadequacies in nutritional intake or under-nutrition can be considered as a major source of many adverse effects on the growth and health of individuals (Gordon *et al.*, 1968). Knowledge of the nutritional status of a community is necessary to have a comprehensive idea about its development process, as under-nutrition is one of the

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major health problems in developing countries. It is reported that the basic causes of under-nutrition and infections in developing countries are poverty, poor hygienic conditions and little access to preventive health care (Mitra, 1985; WHO, 1990). Hence, assessment of the nutritional status of a population has attracted the attention of not only the nutritionists and other biological scientists, but also economists and other social scientists with a view to understanding the health and socio-economic status of the population (Osmani, 1992). Literature on BMI of adult Indians is limited to certain geographical areas or populations. Noteworthy among them are the study of BMI among the North-East Indian (Khongsdier, 2001) and South Indian populations (Ferro-Luzzi *et al.*, 1991). However, little is known about the BMI of tribal populations. The present study is an attempt to assess the nutritional status through body mass index among adult males of seven tribal populations in the state of Maharashtra, located in the North-Western part of India.

Approximately 10% of the population of Maharashtra (about 85 million) belongs to tribal population groups. These groups remain isolated, living in forests and hilly areas. Majority of them have poor health status (Kate, 2000).

MATERIALS AND METHODS

The study sample is based on basic anthropometric data collected on adult males aged 18-60 years by the Anthropological Survey of India (Basu *et al.*, 1994). In the present study, data were collected on 600 individuals from 7 tribal groups to assess their nutritional status. These tribal groups are: 1. Andh, 2. Bhil, 3. Gond, 4. Kathodi, 5. Korku, 6. MahadeoKoli and 7. Warli. Anthropometric data were collected by trained physical anthropologists of the Anthropological Survey of India, following standard techniques (Martin and Saller, 1956). Therefore, it can be well assumed that the accuracy of the data is properly taken care of. Subjects were not chosen on the basis of bodily structure and proportion. Efforts were also made to exclude closely related individuals like brothers, fathers, sons and those with any kind of physical deformities. Therefore, the samples were free from any selection bias. For convenience only, adult males who looked apparently active and healthy (not suffering from any apparently visible infection or disorder) were considered in the sample. In this study, body weight (W), height (H) and sitting height (SH) were taken to calculate cormic index (SH/H) and BMI (W/H^2). Both MS-EXCEL and SPSS software were used to analyse the data. Cormic index and body mass index were calculated for each individual followed by calculation of central tendency viz. mean and deviation of each measurement among each tribe. Further ANOVA-Test or one-way analysis of variance was performed. For screening of the CED groups, the value of 18.5 was taken as a cut-off point following James *et al.* (1988), Ferro-Luzzi *et al.* (1991), and Khongsdier (2001). Regression analysis was done to find the correlation between BMI and CI.

RESULTS

Mean and SD values for age, height, sitting height, weight, cormic index and body mass index for each tribal group are shown in Table 1. Average age of sample population varies between 31.52 years among Bhil and 37.53 years among Korku, while it is 33.04 years for total population. In stature, Bhil are the tallest with 164.41 cm average height. Their sitting height was also found to be greater (83.79 cm). Side by side, sitting height and weight was also higher among them than other tribal groups. However, Warli are shorter in stature as well as in sitting height as

Table 1. Mean and standard deviations of age, anthropometric measurements and indices

Tribal Groups	*N*	*Age*	*Height (cm)*	*Sitting height (cm)*	*Weight (kg)*	*Cormic Index*	*BMI* 1
1 Andh	50	34.30±10.83	161.36±4.78	80.45±2.79	45.49±4.08	0.499±0.014	17.13±2.81 2
2 Bhil	200	31.52±11.01	164.41±5.58	83.79±2.75	48.74±5.81	0.509±0.011	18.02±1.83 3
3 Gond	100	30.23±11.45	162.00±5.11	81.57±7.04	48.17±5.92	0.503±0.043	18.33±1.91 4
4 Kathodi	50	30.88±08.52	161.54±5.05	80.30±2.36	44.40±3.31	0.497±0.010	17.03±1.29 5
5 Korku	50	37.53±11.75	162.06±5.61	80.89±3.14	48.08±4.68	0.500±0.014	18.30±1.47 6
6 Mahadeokoli	100	37.35±10.33	163.07±6.00	82.11±3.19	48.37±5.74	0.504±0.014	18.17±1.72 7
7 Warli	50	32.50±10.38	160.45±5.58	80.20±3.27	43.32±4.41	0.499±0.016	16.82±1.39
Total	600	33.04±11.07	162.76±5.60	82.03±4.13	47.45±5.60	0.503±0.021	17.86±1.89

compared to the other 6 tribal groups. Average weight of Warli was also found to be comparatively lower. The variation in mean BMI between populations was highly significant, ranging between 16.82 among Warli and 18.33 among Gond. Mean value of BMI was highest among Gond followed by Korku, Mahadeokoli and so on, as evident from bar diagram (Figure 1). The mean BMI for the total sample is 17.86±1.89, which is slightly greater than the estimation of Ferro-Luzzi *et al.* (1991) for Indian males (17.7±2.1). The mean cormic index (CI) or proportion of sitting height to stature was found to vary between 0.499±0.014 among Andh and 0.499±0.016 among Warli to 0.509±0.011 among Bhil.

It is apparent from Table 2 that the prevalence of Chronic Energy Deficiency (CED) is highest in the Warli, among whom 30.0 percent of the population falls under the severe grade of CED, 32.0 percent under the moderate grade of CED and 26.0 percent under the mild grade of CED. A greater percentage of individuals with normal status of nutrition was observed among Korku (36.0 percent). All

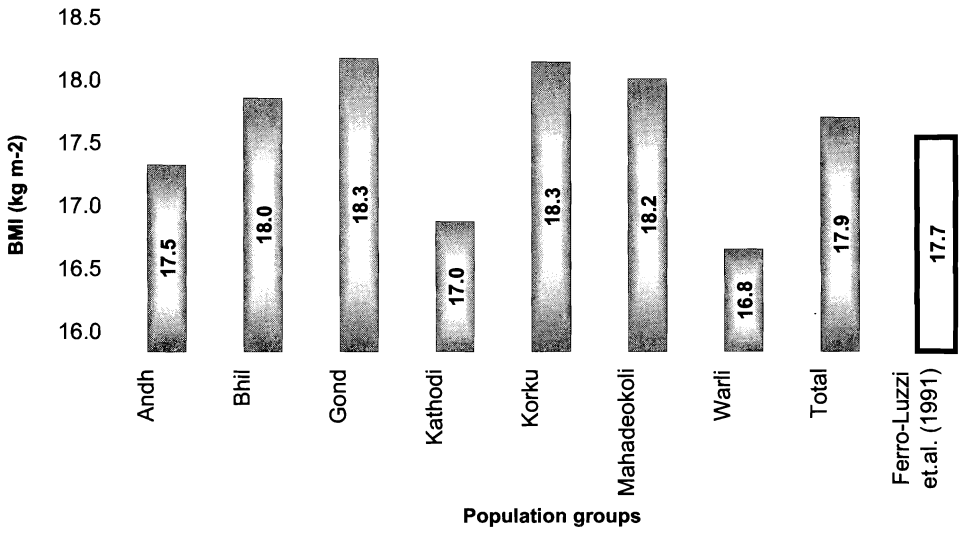

Figure 1. Mean BMI among different tribal groups of Maharashtra, India

Table 2. Percentage distribution of population as per chronic energy deficiency level

Tribal Groups	*Percentage distribution of population as per chronic energy deficiency level*						
	CED Grade III (Severe) < 16.0	*CED Grade II (Moderate) (16.0-16.99)*	*CED Grade I (Mild) (17.0-18.49)*	*Low Weight Normal (18.5-19.99)*	*Normal (20.0-24.9)*	*Obese Grade I (25.0-29.99)*	*Total*
1 Andh	12.0	26.0	44.0	16.0	2.0	0.0	100.0
2 Bhil	13.0	10.0	43.5	21.5	11.5	0.5	100.0
3 Gond	13.0	9.0	40.0	16.0	22.0	0.0	100.0
4 Kathodi	12.0	34.0	44.0	10.0	0.0	0.0	100.0
5 Korku	8.0	16.0	30.0	36.0	10.0	0.0	100.0
6 Mahadeokoli	11.0	15.0	35.0	24.0	15.0	0.0	100.0
7 Warli	30.0	32.0	26.0	8.0	4.0	0.0	100.0
Total	13.5	16.3	39.0	19.7	11.3	0.2	100.0

seven tribes along with their proportionate distribution in different grades of CED are shown in the 100% bar diagram in Figure 2. Cumulative distribution of adult BMI among different tribal groups is shown in Figure 3. It reveals that 54 to 90 per cent of the respondents were chronic energy deficient with BMI value below 18.5. The differences between the proportions of subjects with a low BMI were also striking.

To find out the difference in mean BMI between pairs of studied tribal groups, the ANOVA test was applied, results of which are furnished in Table 3. It appears that in most of the cases, there exists no significant difference, excepting the pairs Andh and Gond, Andh and Korku and Mahadeokoli and Warli. In the same way when the same test was applied to find the difference of mean CI between the groups, all the results of the test showed insignificant difference.

The regression coefficient of BMI on CI was calculated and the results are furnished in Table 4, and in bivariate scattered plot diagram (Figure 4). The regression coefficient was found to be significant ($p>0.05$) among Bhil, Kathodi and Mahadeokoli. It is apparent from the bivariate plot diagram (Figure 4) that there is a positive correlation between BMI and CI. Side by side, BMI is dependent on CI and increases with rise in CI. On the basis of bivariate scattered plot diagram the studied tribal groups can be categorised into two different groups. Andh, Kathodi and Warli form the first group, characterised by low mean BMI and CI, while the second group is formed by Korku, Gond, Mahadeokoli and Warli with considerably higher values of mean BMI and CI.

Bivariate correlation values among three anthropometric measurements and two indices are furnished in Table 5. There is significant correlation (at the 0.01 level) between stature and sitting height, and stature and weight; whereas an inverse correlation was observed between stature and cormic index, and stature and BMI among studied groups. Significant correlation was also found between BMI and sitting height, BMI and weight, and BMI and CI.

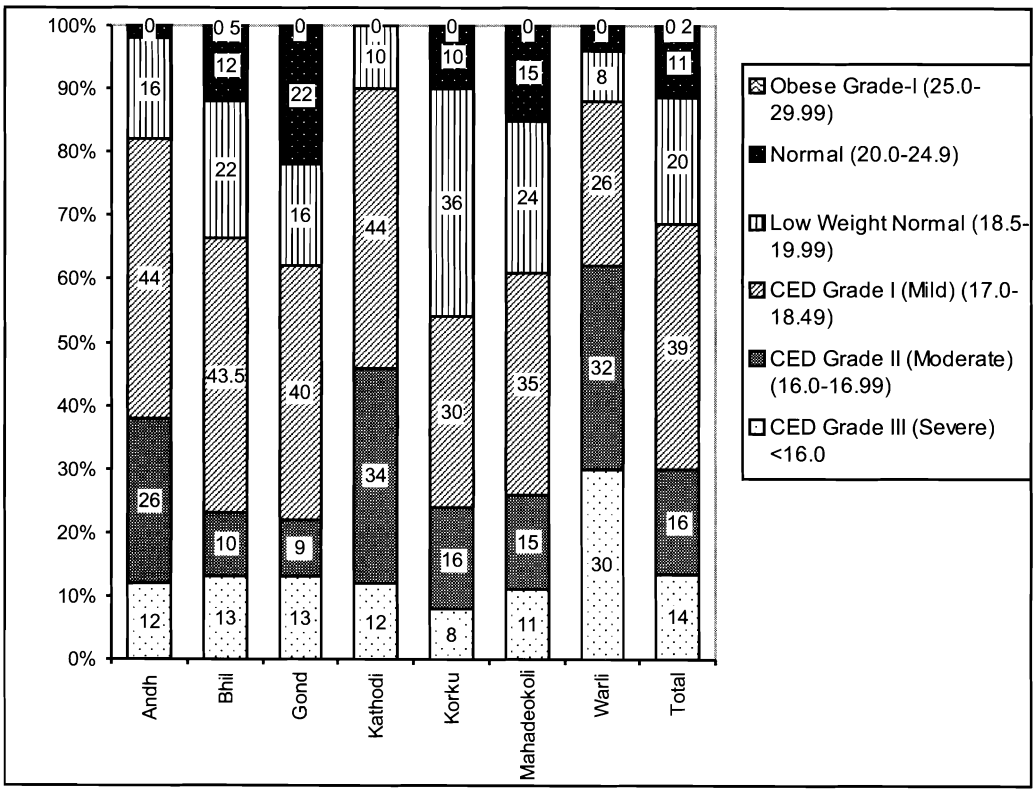

Figure 2. 100% Bar-diagram showing proportional distribution of each tribal population in different grades of chronic energy deficiency.

Table 3. One way analysis of variance test for BMI

Tribal Groups	Andh	Bhil	Gond	Kathodi	Korku	Mahadeokoli	Warli
Andh		-	+	-	+	-	-
Bhil			-	-	-	-	-
Gond				-	-	-	-
Kathodi					-	-	-
Korku						-	-
Mahadeokoli							+
Warli							

+ $p<0.05$, - $p>0.05$

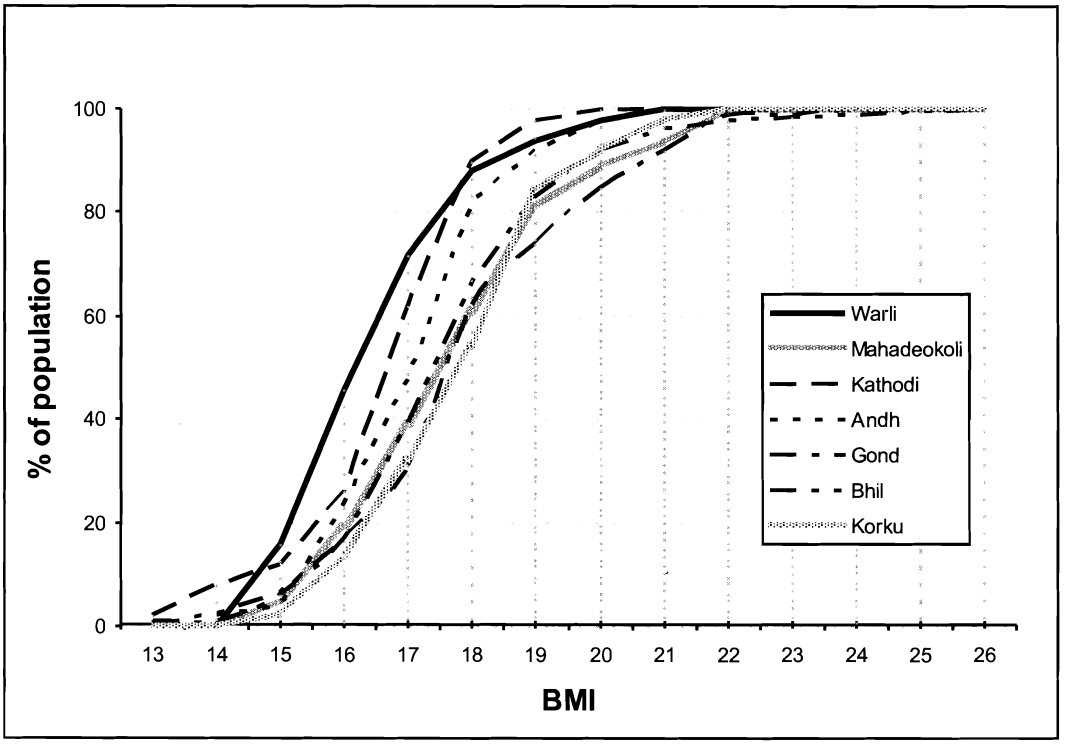

Figure 3. Cumulative frequency distribution of adult BMI among 7 tribal populations of Maharashtra India

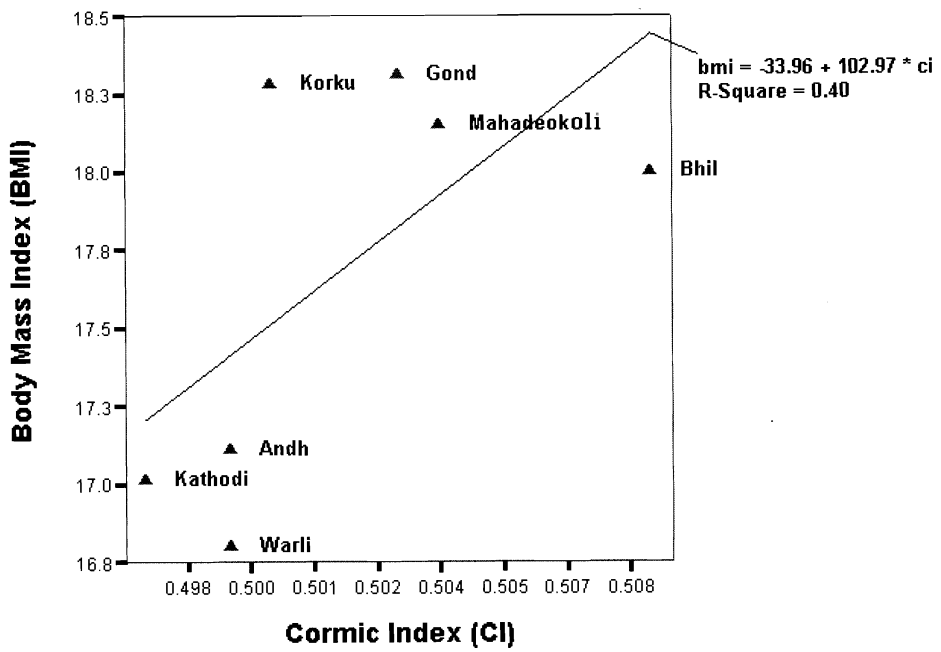

Figure 4. Bivariate Scattered diagram of the populations with Cormic Index and Body Mass Index values

Table 4. Regression coefficient and F statistics of BMI on CI

Tribal Groups	*Coefficients of Regression*					*F Statistics*	
	R	r^2	β	*SE*	*t- value*	*F Change*	*p-value*
Andh	0.176	0.031	16.793	13.545	1.240	1.53	0.221
Bhil	0.138	0.019	22.594	11.550	1.956	3.82	0.052
Gond	0.103	0.011	4.613	4.504	1.024	1.04	0.308
Kathodi	0.289	0.084	38.199	18.241	2.094	4.38	0.042
Korku	0.176	0.031	17.762	14.379	1.235	1.52	0.223
Mahadeokoli	0.370	0.137	43.802	11.123	3.938	15.50	0.000
Warli	0.230	0.053	20.258	12.392	1.635	2.67	0.109
Total	0.167	0.028	13.680	3.300	4.141	17.14	0.000

Table 5. Bivariate correlations between stature, sitting height, weight, cormic index and body mass index

	Stature (cm)	*Sitting Height (cm)*	*Weight (kg)*	*Cormic Index*	*BMI*
Stature (cm)	1.000	0.569**	0.558**	-0.134**	-0.033
Sitting Height (cm)		1.000	0.428**	0.731**	0.116**
Weight (kg)			1.000	0.059	0.809**
Cormic Index				1.000	0.167**
BMI					1.000

**Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

It is clear from the above findings that the tribes of Maharashtra state of India are thin and lean with medium to short stature. Majority of them fall into the category of chronic energy deficient grades, using the BMI value 18.5 as the cut-off point. Altogether 69 percent of the respondents fall below the level of 18.5. In this context, it can be said that the tribes of Maharashtra have had poor subsistence of livelihood. A large proportion of their foodstuffs are coarse grains, and forest produces like roots, shoots, leaves, berries, seeds, tender bamboo sticks, mushrooms, flowers, fruits, nuts etc., which lack essential nutrients. Availability of these foodstuffs is also affected by seasonal variability, rainfall, monsoon and other environmental ups and downs. In such an adverse condition, tribes are used to facing starvation or partial starvation. For generations, they have been surviving in such conditions and may adapt to survive with deficiency of essential energy required for normal activity by a normal person. Besides poor subsistence of livelihood, alcoholism is also common among tribals, which may be one of the causes associated with low BMI. Ferro-Luzzi *et al.* (1991) proposed that BMI alone is sufficient to define CED in adults, irrespective of energy turnover as they suggested earlier (James *et al.*, 1988). Furthermore, their findings on the distribution of BMI accord-

ing to various grades of CED in a south Indian population seem to be corroborated by the present result, i.e. a large proportion of individuals with CED belong to grade I CED. They have suggested that the majority of the rural populations in India are likely to be undernourished if grade I CED is associated with increased risk of morbidity and mortality.

Quetlet's Index, or BMI, is widely used as a measure of fatness, or the nutritional status of populations in both developed and developing countries (Khongsdier, 2001). Recent studies have, however, questioned the validity of BMI as an indicator of fatness (Frankenfield *et al.*, 2001; Kyle *et al.*, 2003) because it lacks specificity in terms of the variation in body composition, and the confounding effects of various factors such as age, sex, body shape and ethnicity (Norgan, 1994; Gurrici *et al.*, 1998; Wagner and Heyward, 2000; Prentice and Jebb, 2001). It has also been suggested that body fat composition varies considerably between ethnic groups (Norgan, 1994; Gallagher *et al.*, 2000).

Norgan (1994) was of the opinion that BMI is correlated with sitting height, or BMI is lower in those populations with higher sitting height. It indicates that there exists an inverse relationship between BMI and CI, but in the present study it was found that none of the 7 tribes had this inverse relationship. Further, the differences in means of CI between studied tribal groups were insignificant. The present findings thus do not support the view of Norgan (1994). According to Khongsdier (2001) BMI is largely independent of ethnic or genetic variation; its correlation with CI may have certain implications as the latter may be subject to both genetic and environmental influences. So the differences in means of BMI between ethnic groups in the present study (Table 3) may not only be due to nutrition, but also due to the low degree impact of other environmental and genetic factors, as BMI is determined by both genetic as well as environmental factors, whereas CI is determined more by genetics and less by environment. The regression analysis (Table 4) also supports that BMI is less dependent on CI as r-value varies from 0.103 to 0.370. However, it can be surmised that improvement in the socio-economic conditions of these tribes may lead to an increase in their BMI. The present study also indicates a need for effective implementation of nutrition programmes among the studied populations. Other information like dietary intake, morbidity and health studies should also be collected from such tribal groups.

Note: This is a revised version of the paper presented in the National Seminar on "Tribal Health in India: Perspectives and Challenges", organised by the Department of Anthropology, Pondicherry University, Pondicherry, India, 14 - 15 March, 2005.

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