

Nutritional Status, Lipid Profile, Oxidative Stress and Antioxidant Status in Tribal Population of Zawar Mines (Rajasthan)

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Abstract-

Rajasthan has about 12% tribal population spread over Aravali hills, forests and plains. Majority of them live in Aravali hills with bare means of subsistence. In recent decades some tribals have descended in plains owing to economic compulsions. Zawar is a tribal township with over 60% tribal population. It consists of highly undulating ridges, hills with zinc mines. Area for agriculture is very small. The present study was aimed to assess nutrient status. Concomitantly, lipid profile, oxidant and antioxidant status were also examined.

Key Word: Tribals, Nutrition, Lipid-profile, Oxidative Stress, Antioxidants.

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I. Introduction

An appropriate diet, having adequate amounts of carbohydrate, protein, fat, minerals and vitamins, is essential to growth, sustaining physiological functions, metabolic activities and vigor. Corrective nutrition is, indeed, an ever evolving science. In developing and deprived economies, poor nutrition is a major concern which leads to under-nutrition, infections and chronic diseases²⁻⁵. Furthermore, under-nutrition adversely affects mental and physical growth. Developing countries like India are in phase of transition and suffer from many disadvantages and drawbacks. Among them nutrition is one of the most challenging problems where it has to feed 1.32 billion population^{2,3,6,7}. Undoubtedly India is on the fast track of social and economic progress, it is the third largest economy of the world, its GDP grew 6.2% between 1980-2010 compared to global rate of 3.3% and recent economic reforms focused on development include better nutrition, health facilities and health care³. These have resulted in vast improvements yet India represents a visible paradox. On one hand is visible affluence bewitched with optimism, increasing literacy, improving socio-economic status, better health care and nutrition and standard of living; on the other hand there is bewailing poverty and wretched with food scarcity, poor hygiene, unclean water and bare means of survival in harsh and horrid environment. More than one third of world's undernourished children live in India. The 2017 Global Hunger Index (GHI) report ranked India 97th out of 118 countries with serious hunger situation in general.² Those who are poor are also at greater risk of under nutrition and have no chance of developing full potential. Grafted upon it, they exhibit greatly reduced resistance to disease & resulting in increasing incidence of infection and chronic diseases^{1,3}. Among all the sectors and societies of India 'Tribals' are most marginalized, underdeveloped and undernourished and most of them live in highly inimical environment⁸⁻¹⁰.

Zawar is a tribal area with about 60% tribal population. It is situated at the base of Aravali hills, where a large number of tribals still reside with meager resources. Tribals in Zawar town have taken up agriculture or labour or jobs as labourer etc. in Zawar mines which is one of the richest Zinc mine in India. Geographically, Zawar consists of undulating hillocks and ridges with a very small plain area for agriculture. Basically it can be called as foot-hill zone of Aravali hills. The tribal population largely consists of Bheels and Bheel-Meenas. Some reports have shown pathetic state of under nutrition in tribals in Rajasthan⁹⁻¹³.

In the present study we have examined the nutritional status by dietary recall method in tribals residing in Zawar. Simultaneously we have also examined serum lipid profile and oxidative stress (OS) and antioxidants. Lipid profile is a very good marker of cardiovascular status¹⁴. Presently oxidant antioxidant balance is considered as an excellent marker of Redox¹⁵. Altered 'Redox' can initiate or abet chronic diseases. Free radical generation (OS is marker) is considerably influenced by nutrition and environment¹⁶.

II. Materials and Methods

Location:- Zawar is a growing township with one of the richest Zinc mines in India. It is about 44 km by road from Udaipur City (Southern Rajasthan). Zawar is a highly hilly region and is situated at the foothills of Aravali hills. Area for cultivation is very small; mostly covered by forests, which are now gradually getting eroded. Irrigation facilities are meager. It is a tribal area with about 60% tribal population.

Selection of the subjects:- In total 1286 male persons were included in this study (1203 tribals and 83 non-tribals). All the tribals belong to Bheel or Bheel-Meena community. 1019 tribals were surveyed for nutrient intake, 83 for lipid profile and 101 for OS and antioxidant levels in blood. 83 non-tribal healthy subjects were also assessed for OS and antioxidant levels in blood.

Tribals inhabited either in Zawar proper or in adjoining Aravali hills. They were unable to tell exact date of birth as they did not keep any count of calendar. They just explained the precise season etc. We tried to make it as precise as possible by oral questioner. None of the children included in this study were breast fed.

Dietary survey :- Dietary survey was conducted door to door by dietary method for three consecutive days and average was taken. They were shown calibrated cups and spoons for measuring food intake. It was recorded on a structured performa. Nutrient intake was calculated from ICMR booklets^{17,18}.

Collection of blood samples for lipid profile and TBARS and antioxidants :

Blood samples were collected after overnight fasting between 8am to 9am. Total cholesterol and HDL-cholesterol were determined in serum by enzyme kits method. Friedwald formula was used for calculation of LDL-cholesterol and VLDL-cholesterol. NCEP ATP III criteria were used for interpreting the lipid profile (Table-2).

Table -2
Serum Lipid Profile (mg/dl)
National Cholesterol Education Program (NCEP) ATP III

LDL cholesterol	<100	Optimum
	100-129	Near or above optimum
	130-159	Borderline high
	160-189	High
	≥190	Very high
Total cholesterol	<200	Desirable
	200-239	Borderline high
	≥240	High
HDL cholesterol	<40	Low
	≥60	High

For determination of Thiobarbituric Acid Reactive Substances (TBARS, as marker of OS)¹⁹, super-oxide-dismutase (SOD)²⁰, catalase (Cat)²¹, glutathione per-oxidase (GD_x)²², and reduced glutathione (GSH)²³ hemolysate was used. For this purpose blood was collected in EDTA vials. It was centrifuged at 2500 rpm. for 15 minutes. RBC button was removed and washed with normal saline three times and then lysed in distilled in ratio of 1 (RBC) : 3 (distilled water). Nutrient and antioxidants vitamin A, C, beta carotene²⁴ and E²⁵ were measured in serum (blood collected in plain vials) Standard methods were used for the determination all parameters.

For statistical analysis, unpaired student was used as and when considered necessary <0.05 was taken as significant.

III. Results

The present study examines the intake of calories, protein, fats, ascorbic acid and beta-carotene in tribals belonging to different age and socio-economic groups in Zawar (Rajasthan) (Tables-3-7). In each table nutrient intake is given. In the adjacent column is given the percent intake of ICMR recommendation. In the last column ICMR recommendations are given.

Table-1
Tribal population: age and socio-economic distribution

Age (Yrs.)	Lower Soc. Eco.	Lower-Middle Soc. Eco.	Middle Soc. Eco.
	GP	GP	GP
1-3	49	12	11
4-6	48	22	32
7-9	63	16	79
10-12	19	22	37
13-15	29	28	58

16-18	27	19	43
19-50	261	149	195

Table-3
Intake of Calorie/day in tribal males

Age (yrs)	Lower		Lower-Middle		Middle		ICMR Recommendation
	Cal Consumed	% of ICMR recommendation	Cal Consumed	% of ICMR recommendation	Cal Consumed	% of ICMR recommendation	
1-3	531* ±106	50.1	610* ±158	57.5	688* ±135	64.9	1060
4-6	687* ±143	50.9	753* ±178	57.8	784* ±163	58.1	1350
7-9	938* ±192	55.5	952* ±203	56.3	1101* ±206	65.1	1690
10-12	1153* ±158	52.7	1234* ±301	56.3	1382* ±298	63.1	2190
13-15	1279* ±140	46.5	1255* ±311	45.6	1444* ±251	52.5	2750
16-18	1344* ±165	44.6	1357* ±344	44.2	1536* ±256	58.9	3010
19-50	1300* ±163	48.1	1319* ±330	47.6	1483* ±293	53.5	2770

Actual calorie consumed vs. ICMR recommendation

*p <0.05 taken as significant

In the lower socio-economic group caloric intake was 531 ± 106 C/d in 1-3 year age group, it progressively increased to 1344 ± 155 C/d in the age group of 16-18 yrs and then decreased slightly (1300±163 C/d ; **Table-4**).

Table-4
Intake of proteins/day in tribal males

Age (yrs)	Lower Soc. Eco. GP		Lower-Middle Soc. Eco. GP		Middle Soc. Eco. GP		ICMR Recommendation
	gm/day	% of ICMR recommendation	gm/day	% of ICMR recommendation	gm/day	% of ICMR recommendation	
1-3	9.8* ±2.2	58.7	14.2* ±5.3	85.0	13.8* ±4.8	82.6	16.7
4-6	14.6* ±2.6	72.6	16.0* ±5.1	79.6	15.7* ±4.0	68.1	20.1
7-9	20.4* ±4.9	69.1	24.0* ±6.4	81.3	23.3* ±6.8	78.9	29.5
10-12	20.3* ±3.4	50.8	23.5* ±5.9	58.8	25.8* 6.7	64.6	39.9
13-15	31.4* ±7.6	57.8	36.8* ±7.6	66.2	35.2* ±4.3	64.8	54.3
16-18	32.5* ±6.5	52.8	34.8* ±7.4	56.5	40.6* ±5.7	66.0	61.5
19-50	36.8* ±7.2	61.3	40.0* ±8.1	66.6	45.8* ±8.1	76.3	60.0

Actual protein consumed vs. ICMR recommendation

*p <0.05 taken as significant

The caloric intake slightly improved with socio-economic status but never attained ICMR recommended level. Proteins are main body building material and also form numerous other vital molecules. It too was never adequate (**Table-5**).

Table-5
Intake of fat/day in tribal males

Age (yrs)	Lower Soc. Eco. GP		Lower-Middle Soc. Eco. GP		Middle Soc. Eco. GP		ICMR Recommendation
	gm/day	% of ICMR recommendation	gm/day	% of ICMR recommendation	gm/day	% of ICMR recommendation	
1-3	4.2* ±2.5	15.5	11.8* ±3.0	43.7	10.5* ±2.1	38.8	27
4-6	6.8* ±2.5	27.2	11.5* ±3.0	46.0	15.4* ±2.1	61.6	25

	±2.6		±3.1		±3.6		
7-9	8.6* ±3.5	28.6	14.5* ±3.9	48.3	15.0* ±3.0	50.0	30
10-12	8.0* ±2.7	22.8	20.2* ±4.5	57.7	25.8* ±6.1	73.7	35
13-15	10.2* ±3.0	22.6	24.5* ±3.9	54.4	24.5* ±5.2	54.4	45
16-18	10.7* ±4.2	21.4	29.8* ±5.5	58.0	25.7* ±4.8	51.4	50
19-50	11.5* ±4.5	34.8	17.8* ±6.3	53.9	21.4* ±3.7	64.8	33

Actual fat consumed vs. ICMR recommendation

*p <0.05 taken as significant

Indeed, it could be one of the important risk factors for lower anthropometric measurements in various tribal populations. Interestingly protein intake considerably improved in lower-middle and middle socio-economic group as compared to lower socio-economic group. Fat is a dense source of energy and provides more than double to that of proteins and carbohydrates (9C/gm). Its intake was distressingly low in lower socio-economic group and just ranged between 26.0% to 43% of ICMR recommendations. Its picture did not substantially differ in lower-middle socio-economic group but improved in middle socio-economic group.

The importance of ascorbic acid can never be underscored. Its intake was critically low in lower and lower middle socio-economic groups (Table-6).

Table-6
Intake of ascorbic acid/day in tribal males

Age (yrs)	Lower Soc. Eco. GP		Lower-Middle Soc. Eco. GP		Middle Soc. Eco. GP		ICMR Recommendation
	mg/day	% of ICMR recommendation	mg/day	% of ICMR recommendation	mg/day	% of ICMR recommendation	
1-3	10.5* ±3.2	26.2	10.6* ±2.5	26.5	12.4* ±2.3	31.0	40 mg/day
4-6	6.8* ±2.6	27.2	11.5* ±3.1	35.2	20.6* ±6.1	51.5	in
7-9	13.6* ±4.6	34.0	15.2* ±3.8	38.0	24.2* ±3.6	60.5	all
10-12	17.4* ±4.2	43.5	16.0* ±3.8	40.0	21.5* ±4.8	53.7	age
13-15	16.3* ±5.0	40.7	15.2* ±3.1	38.0	22.1* ±5.6	55.2	groups
16-18	15.6* ±4.3	39.0	17.2* ±3.0	43.0	23.1* ±3.5	57.7	
19-50	16.2* ±3.2	40.5	16.8* ±3.7	42.0	19.5* ±4.8	48.7	

Actual ascorbic acid consumed vs. ICMR recommendation

*p <0.05 taken as significant

The ICMR recommended intake is 40 mg/day across all age groups. As against it, the intake ranged between 26.2% to 43.5% in low socio-economic group, 26.5% to 43.0% in lower middle socio-economic group, and 31.0% to 60.5% in middle socio-economics group. Beta-carotene partly provide vitamin A requirement after cleaving. It also serves as an antioxidant. Its intake was also low.

Table-7
Intake of beta-carotene/day in tribal males

Age (yrs)	Lower Soc. Eco. GP		Lower-Middle Soc. Eco. GP		Middle Soc. Eco. GP		ICMR Recommendation
	mg/day	% of ICMR recommendation	mg/day	% of ICMR recommendation	mg/day	% of ICMR recommendation	
1-3	1256* ±116	39.2	1357* ±142	42.4	1461* ±200	45.6	3200
4-6	1382* ±195	43.1	1482* ±170	46.3	1569* ±227	49.0	
7-9	1517* ±266	31.6	1616* ±244	33.6	2858* ±341	59.5	4800
10-12	1502* ±208	31.2	1828* ±350	38.0	2110* ±316	43.9	
13-15	1650* ±238	34.3	1960* ±295	40.8	2116* ±452	44.0	
16-18	1694* ±328	35.2	1948* ±316	40.5	4910* ±452	39.7	

	±203		298		±317	
19-50	1582* ±246	32.9	1975* ±216	41.1	2220* ±342	46.2

Actual beta-carotene consumed vs. ICMR recommendation

*p <0.05 taken as significant

Lipid profile is a good test in the investigative protocol of cardio-vascular diseases. The ICMR recommended levels of cholesterol and triglycerides are given in table-2 and results of the investigations on tribals are given in **Table 8**.

Table-8
Lipid profile of tribal males

Age (yrs)	1-12 (n=14)	13-18 (n=13)	19-60 (n=44)	>60 (n=12)
Total Cholesterol (mg/dl)	145.1 ±13.6	155.6 ±15.1	177.4 ±26.5	1809 ±24.1
HDL-Cholesterol (mg/dl)	38.4 ±4.0	36.9 ±3.2	44.3 ±19.5	48.2 ±20.6
LDL-Cholesterol (mg/dl)	88.2 ±5.4	101.3 ±8.2	99.3 ±37.0	129.3 ±20.2
VLDL-Cholesterol (mg/dl)	18.4 ±3.0	17.4 ±2.9	31.9 ±14.8	26.3 ±12.4
Triglyceride (mg/dl)	92.3 ±12.8	87.1 ±14.5	159.7 ±74.1	131.1 ±61.6

The levels were normal in all the subjects in age group 1-12 yrs and 13 to 18 years. In age group 19 to 60 years only two subjects had cholesterol in borderline high zone and none in high risk zone. In age group 60 years one had borderline high cholesterol and one had high risk level. Interestingly triglyceride level was normal in all the age group of subjects despite the fact that all the subjects above 18 years were smoking and drinking alcohol. The most striking feature is low HDL-cholesterol in all the age groups. (**Table-8**).

The results of OS (TBARS) level and antioxidants SOD, GPx, Cat, reduced GSH, retinol, alpha-tocopherol, ascorbic acid and beta-carotene are given in table-9 for tribals and non-tribals.

The TBARS levels in all the age group tended to be higher in tribals. Notably, GSH levels were lower in tribals as compared to non tribals. Similarly the level of three nutrient oxidants (retinol, alpha-tocopherol and ascorbic acid) and beta-carotene were also lower than non-tribals.

Table-9
Oxidative stress (TBARS) and antioxidant levels in blood of tribal and non-tribal males

Age (yrs)	Tribals				Non-Tribals			
	1-9 (n=21)	10-18 (n=12)	19-50 (n=53)	>50 (n=15)	1-9 (n=14)	10-18 (n=13)	19-50 (n=44)	>50 (n=12)
SOD (per ml RBC)	6.50 ±1.42	6.90 ±2.39	6.93 ±2.19	5.85 ±1.21	7.53 ±1.60	7.28 ±2.17	8.65 ±2.93	6.57 ±2.69
SOD (per ml Plasma)	3.22 ±1.28	2.91 ±1.37	3.59 ±3.59	2.08 ±0.97	2.74 ±0.84	3.23 ±0.76	3.41 ±0.88	4.57 ±1.34
GPx (Unit/mg Hb)	2.10 ±0.22	2.28 ±0.41	2.66 ±0.38	2.59 ±0.30	2.48 ±0.22	2.68 ±0.37	2.56 ±0.33	2.60 ±0.27
Catalase (µ mol H ₂ O ₂ consumed/mts/mg/protein)	144 ±31	147 ±51	168 ±31	158 ±28	154 ±56	174 ±31	170 ±40	153 ±40
Reduced Glutathione mg/dl	30.6* ±4.2	35.3* ±6.2	34.5* ±6.4	35.6* ±5.4	35.6 ±4.8	40.3 ±5.9	48.5 ±6.0	47.2 ±4.3
TBARS (n mol/ml RBC)	3.42 ±0.86	3.65 ±0.66	3.72 ±0.58	3.82 ±0.76	2.99 ±1.05	3.32 ±0.67	3.30 ±1.20	3.22 ±0.43
TBARS (n mol/mg/creatinine)	8.57 ±1.74	8.68 ±1.46	10.86 ±2.79	11.62 ±2.67	8.40 ±1.68	12.69 ±5.85	9.55 ±3.35	14.01 ±3.28
Retinol (µ gm/dl)	16.6* ±3.6	18.6* ±6.1	18.8* ±5.9	19.8* ±6.0	20.1 ±4.33	22.75 ±6.19	25.37 ±6.42	26.03 ±4.69
Beta-Carotene (µ gm/dl)	74 ±14	100 ±13	110 ±30	107 ±25	79 ±14	106 ±17	117 ±21	107 ±15
Alpha tocopherol (mg/dl)	0.48* ±0.16	0.55* ±0.20	0.75* ±0.20	0.52* ±0.18	0.69 ±0.23	0.67 ±0.20	0.85 ±0.23	0.82 ±0.20
Ascorbic acid mg/dl	0.46* ±0.20	0.51* ±0.26	0.53* ±0.24	0.43* ±0.10	0.62 ±0.17	0.70 ±0.37	0.88 ±0.29	0.91 ±0.21

Tribal vs Non tribal

*p< 0.05 taken as significant

IV. Discussion

Global researches on health and nutrition unequivocally recognize the crucial role of nutrition in growth, maintenance and tissue repair in human health, and that under-nutrition leads to a) under-weight, b) stunting c) wasting d) recurrent infection and illness e) anemia f) weak immune system and g) increased mortality.^{2-5,26-28} Plenty of reports incriminating these problems in tribals from different parts of India are reported and that major cause in these is under-nutrition.⁶⁻⁸ The observations in this series also support them and highlight the poor state of under-nutrition among Bheel and Bheel-Meena tribals in Zawar area of Rajasthan.

The caloric intake was poor in all the tribals belonging to lower, lower middle and middle socio-economic groups. In an earlier study we observed low caloric intake in tribals living in Udaipur city or adjacent area while studying urolithiasis³². In present series, the caloric intake was $\leq 50\%$ to that recommended by ICMR (table 3); it slightly improved with better socio-economic status but never attained the ICMR recommendations. Proteins are main structural material. Further, enzymes and many hormones are proteins. More over several amino acids and peptides independently supervise important functions. The deficiency of proteins is primarily responsible for many pathological conditions stated above. In the present series protein intake varied from low to very low. Obviously this low intake is a strong risk factor in Zawar tribals (table-4). Indeed, excess of fat is harmful as it leads to obesity²⁹ but a standard amount is necessary in diet to maintain adipose tissues and fatty acids. In this series fat intake was critically low in low-socio-economic group. It slightly improved but still seriously low in lower-middle and middle socio-economic tribals (table-5). Ascorbic acid and pre-vitamin beta-carotene were also measured. Intake of both was quite low in all the groups (table-6 and 7). Importance of ascorbic acid in human health is enormous. It participates in numerous metabolic activities. By virtue of being water soluble antioxidant, it also participates in maintenance of cellular redox homeostasis. Beta-carotene partly provides vitamin A and also acts as an antioxidant.^{1,15,16} Thus these data, taken collectively, suggest serious under-nutrition among Bheel and Bheel-Meena tribals in Zawar. These observations are thus in agreement with others that under-nutrition is highly prevalent among tribals in Rajasthan. For example, Mandot et al¹³ from their anthropometric study on school going children from Garaua tribe reported high prevalence of stunting and wasting due to severe under nutrition. Singh et.al¹¹ examined four clusters of population in rural area of Rajasthan and reported that 85% tribal children suffered from under nutrition. Rao et al³⁰ reported stunting in 40-60% of Saha primitive tribe. Mitra et. al³¹, on the basis of dietary assessment in tribes of Chhattisgarh, reported that protein energy malnutrition was widely prevalent, and that 80% children in age group 4-6 yrs suffered from stunting, wasting and underweight. Raj Kiran et. al³² reported low caloris intake in tribals in Udaipur and adjacent villages, while studying urolithiasis.

Das and Bose^{8,10} in their excellent and comprehensive reviews reported the state of serious under-nutrition, using body mass index as criterion, in tribals from different parts of India. Thus in summary tribals in Zawar and other parts of India are reeling under the pressure of nutritional stress and require still more focused attention of official and social agencies.

There is an increasing consciousness about the quality and quantity of fat in the diet as it powerfully influences the lipid status (cholesterol and triglycerides) in blood and tissues; and that there is a dynamic equilibrium between blood and tissues. Disturbance in this equilibrium leads to many diseases especially cardiovascular diseases (CVD).³³ Cholesterol fractions are major participants and to some extent triglycerides. HDL-cholesterol is a protective factor and LDL-cholesterol is belligerent risk factor. It is for this reason ICMR has prescribed the limits of total cholesterol, LDL-cholesterol, HDL-cholesterol and triglycerides in the blood (table-2). Dyslipidemia of any origin is harmful,³³⁻³⁶ that it has been noticed even in normal population;³⁷ and that it differs from population to population predicting the possibility of the disease. In tribals of Zawar, three important features were visible : first low HDL-cholesterol, second LDL-cholesterol was not an aggressive risk factor and third triglyceride levels were within normal limits despite the fact that all adults were consuming alcohol.

Oxidants (ROS and RNS) and antioxidants are integral part of aerobic cells and are major players in maintaining "Cellular Redox"^{38,40}. Innately oxidants are slightly in excess. This is designated as OS Redox flexes (very mild fluctuations in OS) supervise energy driven reactions. Hence raised OS disturbs 'Redox' Balance thereby disturbing physiology. Antioxidants rein OS within physiological limits³⁸. Recent resurging researches solidly point out two things: first Redox supervises many signaling processes^{15,37} and second chronic raised OS causes chronic diseases like cardiovascular diseases, diabetes mellitus, neurological and cancer.^{15,38-41} Genetically profile, nutrition and environment are important determinants of OS. Antioxidants rein OS within normal limits. Naturally lower level of antioxidants tends to raise OS. This underlines need to examine OS and antioxidants in a given population. In the present series we have examined both tribals and non-tribals. Two points require mention, first the level of GSH was significant low in tribals and second the levels of vitamin A,

C and E were significantly lower. Glutathione is an endogenously synthesized versatile molecule⁴². It is readily inter-convertible into oxidized and reduced state. Hence strong, active and effective antioxidant and plays quantitatively important role in Redox maintenance. It has many other important physiological functions as well.

In short, the tribal community in general including Zawar is marginalized and economically and socially deprived. Supplementing their food basket is not final solution. They require a blended approach of empathy, economic upliftment and education. The tribals in Zawar suffer from nutritional stress, low HDL-cholesterol levels and deficiency of several antioxidants. Even mildly raised OS is a reckoning risk factor in this population.

V. Conclusion

In conclusion, the tribals living in Arawali hills in Zawar or precinct are extremely poor, and live in poverty stress and undesirable conditions. Those who have migrated to Zawar town are only marginally better with very slightly better nutrition, but still very short of nutritional requirements. Poverty, under-nutrition and unhygienic environment are integrally related and interwoven with poor health problems. Adding to these miseries is their pristine social structure; archaic habits, incarcerated living style and closed circuit out-dated and out-molded traditions and culture. They have intractable attachment to their centuries old customs. Studies on them often provide clues on human development on evolutionary scale because they are supposed to be in close proximity to the nascent civilization as compared to modern one. The tribals who have migrated to Zawar and have taken up employment as laborer in zinc mines are economically better yet are negligent about their nutrition as observed by us in this study. Social and educational intervention are as much necessary as medical intervention.

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