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ORIGINAL ARTICLE

# Temporal trends in overweight and obesity among Nicobarese adults in Nicobar Islands, India, 1960s–1999

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## KEYWORDS

Overweight;  
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## Summary

**Objective:** The aim of the present study is to assess the change in the prevalence of overweight and obesity among Nicobarese adults from 1960s to 1999 using WHO recommendations for the classification of overweight and obesity.

**Methods:** The sample includes 774 individuals (424 men and 350 women) during 1960s and 484 individuals (259 men and 225 women) during 1999, aged 20–64 years from Nicobar Islands, India. Height (cm), weight (kg) and sitting height (cm) were measured and BMI ( $\text{kg}/\text{m}^2$ ) was calculated. Overweight and obesity were defined as  $\text{BMI} \geq 25 \text{ kg}/\text{m}^2$  and  $\text{BMI} \geq 30 \text{ kg}/\text{m}^2$ , respectively.

**Results:** There was significant increase of height, weight and BMI among both the men and women of 20–39, and 40 and above years age groups. However, the higher magnitude of increment was observed in 20–39 years. The prevalence of overweight increased from 5.42% to 22.01% among men and from 4% to 21.78% among women, while obese individual was absent during 1960s and the prevalence of obesity increased to 2.70% in men and 8.89% in women. The magnitude of increment was higher among women compared to men.

**Conclusion:** The results indicate remarkable increase in the prevalence of both overweight and obesity among Nicobarese adult in Nicobar Islands.

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## Introduction

The increasing trend of overweight and obesity has reached epidemic proportions not only in developed countries but also under-developed and developing

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countries in the Asia-Pacific region [1]. It is estimated that about one fifth of the world population is overweight and about 300 million people are obese [1,2]. Increased mortality among the overweight and obese is evident for several life threatening diseases including type-2 diabetes mellitus [3], cardiovascular disease (CVD), gall bladder disease, and hormonal sensitive and gastrointestinal cancers. Risks are also higher for some non-fatal conditions such as back pain, arthritis, infertility and poor psychosocial function [1,4–9].

Trends over time can be seen in almost every countries in the world (1), for example, in Samoa (1978–1991) [10] and Mauritius (1987–1992) [11] as well as Canada (1981–1996) [12], where marked increases in the prevalence of obesity have occurred, especially in rural Samoa. The cumulative incidence of overweight or obesity in men ranged from 10.8% in Chinese to 18.2% in Creoles, and in women from 16.1% to 27.5% in Chinese and Creoles, respectively. In Japan, although the little increase of obesity over time has been observed but there has been a 2–4 times increase in overweight men. The increasing trends have also been observed in China [13], Malay and also Indian women [14]. Therefore, there are regional, ethnic and cultural variations in the temporal trends for obesity and overweight [1]. The obese have an elevated risk from all cause mortality with elevated risk of 1.9 being reported among both men and women who were more than 40% of the average weight in a large scale prospective study of 750,000 individuals [15].

In India, the prevalence of overweight and obesity is found to be lower than the Asian countries mentioned above. The WHO Global database on body mass index concluded in 1998 that showed the prevalence of overweight and obesity in young adults were 4.3% and 0.3% in case of men and 4.5% and 0.5% in case of women, respectively. However, regional studies are shown higher prevalence of overweight and obesity among different ethnic group compared to national level studies, mostly living in urban area and has impaired energy intake and expenditure level. Overweight and obesity are not only constricted among non-tribal group but also among tribal group, who are practicing modern and changing life-style pattern. Sarkar found that the overweight and obesity prevalence are higher among Bhutia tribal community of Sikkim Himalaya [16]. Sahani reported similar picture among Nicobarese tribal group in Indian Island [17].

In order to understand increased level of vulnerability of population over time, the present study aims to understand the temporal change of overweight and obesity among Nicobarese adult, a tribal group in Nicobar Island, India.

## Materials and methods

### Study area and sample

The Nicobar Islands are located about 1200 km away from the east coast of Indian mainland and situated in the southernmost portion of the Bay of Bengal of the Indian Ocean. Its location ranges from 6° and 10°N latitude and the meridians of 89° to 94°E longitude. The archipelago consists of 319 Islands and 22 come under the Nicobar group of whom only 12 were inhabited. The northernmost island of the Nicobar group of Island is Car Nicobar which is 75 miles South of Little Andaman Islands.

The study was conducted during 1960s among the Nicobarese tribal population at Nicobar Islands and also in the year 1999 among the similar group of population from same regions. The present study was based on cross-sectional samples of Nicobarese adults. The sample includes 774 individuals (424 men and 350 women) during 1960s and 484 individuals (259 men and 225 women) during 1999, aged 20–64 years.

The anthropometric measurements such as height (cm), sitting height (cm), and weight (kg) were measured according to the standard techniques suggested by Martin and Saller for both the time periods to keep the uniformity [18].

In the present study, body mass index (BMI) (weight/height<sup>2</sup>) has been calculated. The subjects were classified on the basis of BMI gradation [19,1].

The mean and standard deviation of anthropometric variables including height, weight, sitting height and BMI were carried out according to age group and sex. *t*-Test was used to understand mean difference of anthropometric traits between 1960s and 1999 data. Odd ratio has been calculated using logistic regression in understanding degree of getting overweight between two time periods. All data were analyzed using SPSS software, version 11.0; significance level is set at 5%.

## Results

Table 1 shows the temporal difference of mean anthropometric characteristics among men and women. There was significant increase of mean height, weight and body mass index (BMI) in both men and women between 1960s and in the year 1999 except sitting height. The increase of height was higher among men (2.5 cm) than women (1.0 cm). In contrast, increase of weight and BMI was higher among women (6.2 kg weight; 2.5 kg/m<sup>2</sup>

**Table 1** Characteristics of the subjects.

Variables	Men		Women		Total	
	1960s (n=424) mean ± SD	1999 (n=259) mean ± SD	1960s (n=350) mean ± SD	1999 (n=225) mean ± SD	1960s (n=774) mean ± SD	1999 (n=484) mean ± SD
Age (years)	32.0 ± 9.8	37.9 ± 12.5	32.7 ± 10.0	36.3 ± 10.8	32.3 ± 9.9	37.2 ± 11.8
Height (cm)	158.7 ± 5.0	161.2 ± 6.1	149.2 ± 4.5	150.2 ± 5.8	154.4 ± 6.7	156.1 ± 8.1
Weight (kg)	55.5 ± 5.0	60.7 ± 8.9	46.9 ± 5.8	53.1 ± 1.4	51.6 ± 6.9	57.2 ± 10.4
Sitting height (cm)	84.2 ± 2.7	84.1 ± 3.8	79.3 ± 2.7	78.8 ± 3.8	82.0 ± 3.7	81.7 ± 4.6
BMI (kg/m <sup>2</sup> )	22.1 ± 1.8	23.3 ± 2.9	21.0 ± 2.2	23.5 ± 4.1	21.6 ± 2.0	23.4 ± 3.5
		t-Test		t-Test		t-Test
		6.8**		4.2**		7.9**
		5.9**		2.2*		3.9**
		9.7**		9.3**		11.5**
		0.3 <sup>ns</sup>		1.5 <sup>ns</sup>		1.3 <sup>ns</sup>
		7.1**		9.5**		11.7**

<sup>ns</sup> not significant.  
\* p < 0.05 significance level.  
\*\* p < 0.01 significance level.



**Figure 1** Temporal prevalence of overweight and obesity among Nicobarese adult.

BMI) compared to men (5.2 kg weight; 1.2 kg/m<sup>2</sup> BMI). Irrespective of sex, increase of weight and BMI was comparatively higher than height.

Table 2 represents increased of mean BMI on the basis of age group between 1960s and the year 1999. It was noted that both men and women in the age group of 20–39 years were shown higher increase of mean BMI compared to 40 and above years age groups. However, the differences of both age groups were statistically significant.

Fig. 1 and Table 3 demonstrate the percentage difference of BMI gradation in two time periods on the basis of sex and age groups. The prevalence of overweight increased from 5.42% to 22.01% among men and from 4% to 21.78% among women, while obese individual was absent during 1960s and the prevalence of obesity increased to 2.70% in men and 8.89% in women. The prevalence of overweight men in 1960s was only 3.51% compared to 23.81% in 1999 in the age group of 20–39 years and 1.36% was in obese (BMI ≥ 30.0 kg/m<sup>2</sup>). The prevalence of obese individuals was higher in 40–64 years age group compared to 20–39 years age group in both the sexes. Over all, the increment of the prevalence of overweight and obesity was higher in both the sexes rather than increment in the prevalence of undernutrition among Nicobarese adult.

Table 4 shows odd ratio values and 95% confidence interval of overweight and obese combined group between two time periods. The entire odd ratio values showed that both men and women of 1999 were significantly more likely to be getting overweight and obese compared to 1960s counterparts. In case of men, the vulnerability of suffering overweight was more likely to be higher in the age group of 20–39 years age group during 1999 (Odd ratio 9.23, p < 0.01) compared to 40 and above years age group (Odd ratio 2.62, p < 0.05). However, women were shown that equal chance of suffering overweight (p < 0.01) in both age groups during 1999.

**Table 2** Distribution of mean BMI by sex and age group.

Sex and age group (years)	n		Mean BMI		t-Test
	1960s	1999	1960s	1999	
<b>Men</b>					
20–39	313	147	22.0 ± 1.7	23.0 ± 2.5	6.5**
40 and above	111	112	22.2 ± 2.0	23.3 ± 3.3	3.1*
<b>Women</b>					
20–39	254	143	21.1 ± 2.1	23.4 ± 4.0	7.5**
40 and above	96	82	20.8 ± 2.4	23.7 ± 4.3	5.7**
<b>Total</b>					
20–39	567	290	21.6 ± 1.9	23.3 ± 3.3	9.7**
40 and above	207	194	21.5 ± 2.3	23.5 ± 3.7	6.4**

\*  $p < 0.05$  significance level.\*\*  $p < 0.01$  significance level.**Table 3** Distribution of BMI gradation by sex and age group.

Sex and age group (years)	Year of study	BMI (kg/m <sup>2</sup> )							
		Undernutrition (<18.50)		Normal (18.50–24.99)		Overweight (25.00–29.99)		Obese (≥30.0)	
		n	%	n	%	n	%	n	%
<b>Men</b>									
20–39	1960s	6	1.92	296	94.57	11	3.51	0	0.00
	1999	4	2.72	106	72.11	35	23.81	2	1.36
40 and above	1960s	2	1.80	97	87.39	12	10.81	0	0.00
	1999	4	3.57	81	72.32	22	19.64	5	4.46
<b>Women</b>									
20–39	1960s	24	9.45	219	86.22	11	4.33	0	0.00
	1999	9	6.29	91	63.64	31	21.68	12	8.39
40 and above	1960s	15	15.63	78	81.25	3	3.13	0	0.00
	1999	10	12.20	46	56.10	18	21.95	8	9.76
<b>Total</b>									
20–39	1960s	30	5.29	515	90.83	22	3.88	0	0.00
	1999	13	4.48	197	67.93	66	22.76	14	4.83
40 and above	1960s	17	8.21	175	84.54	15	7.25	0	0.00
	1999	14	7.22	127	65.46	40	20.62	13	6.70

## Discussion

The purpose of this paper was to assess changes in the prevalence of overweight and obesity of Nicobarese adults from 1960s to 1999. The results provide compelling evidence that there has been a progressive increase in the prevalence of overweight and obesity among Nicobarese. This is one of the new emerging issues in Indian population even in Indian tribal population. Similar findings have been reported for the Asian and Pacific Islander population living in Rhode Island (overweight 33.4% and obese 4.8%). Obesity prevalence rates of between 60% and 80% can be found among men and women in some islands including Samoa

and Nauru. In Tonga, 60% of the adult population was suffered by obesity and recently 12% of men and nearly 18% of women were identified with type 2 diabetes mellitus, a doubling of the rate over 25 years. A further 20% were found to be at risk due to elevated blood sugar levels [20]. It may be due to sustained economic growth and increasing political stability in many countries at Asian region, thereby bringing about rapid advances in socio-economic status for more than three decades [21]. The situations have been reflected in the form of nutrition transition [22], where high fat diets have a greater risk for obesity than high sugar and low fat diets [23]. However, traditionally diets of the Island populations have been very low in fat, and

**Table 4** Odd ratio (95% confidence interval) by sex and age group.

Sex	Age group (years)	Year of study	Overweight and obese (BMI $\geq 25$ kg/m <sup>2</sup> ) (Odd ratio)	95% confidence interval (lower–upper)
Men	20–39	1999	9.23**	4.55–18.74
		1960s	1.00	
	40 and above	1999	2.62*	1.25–5.49
		1960s	1.00	
Women	20–39	1999	9.49**	4.71–19.17
		1960s	1.00	
	40 and above	1999	14.39**	4.16–49.74
		1960s	1.00	
Total	20–39	1999	9.44**	5.74–15.53
		1960s	1.00	
	40 and above	1999	4.82**	2.61–8.88
		1960s	1.00	

\*  $p < 0.05$  significance level.\*\*  $p < 0.01$  significance level.

high in complex carbohydrates, dietary fibre, and foods of plant origin as shown among the Pacific Islands and Melanesia [24]. But dietary change may have played a major contributing factor showing a higher contribution of fat and protein to total energy intake as observed among urban communities of Pacific Islands than among those practicing traditional subsistence [25,26]. Most importantly, dietary change and changes in patterns of physical activity may be associated with levels of education, occupational status, and rural residence have been invoked as being central to the emergence of obesity in this Island region as suggested by many researchers [27–29]. The Federated States of Micronesia (FSM) has received considerable attention for their alarming rates of overweight and obesity. On Kosrae, one of the four districts in the FSM, 88% of adults aged 20 or older are overweight (BMI > 25), 59% are obese (BMI > 30), and 24% are extremely obese (BMI > 35). This may be because of the long history of foreign rules and social change over the last 100 years, and suggests that a combination of dietary change influenced by foreigners, dependence on foreign aid, and the ease of global food trade contributed to poor diet and increased rates of obesity in Micronesia, where foreign dependence and global food trade exacerbates their obesity epidemic [30]. Fatness and obesity became an important public health problem among Pacific Island populations during the second part of the twentieth century, along-side great increases in population size in many of the Pacific Island nations, and migration from the Pacific Islands to urban centers, especially in the United States, France, New Zealand, and Australia. Best documented is the rise of obesity and fatness among adults in West-

ern Samoa [31,28] the Cook Islands [32,27], the Tokelau Islands [33], Tuvalu [34], the Marquesas Islands [35], and American Samoa [28]. There are indications that people are becoming overweight and obese earlier in life; girls and young women in particular tend to gain weight during adolescence and pregnancy. The overall adult obesity rate (BMI > 30) was 60% in the 2004 survey in Tonga [36]. The increase in mean body mass index observed in Pacific Islanders in the second half of the twentieth century can in general be attributed to dietary change associated with greater food and energy intake, associated with increased consumption of fatty foods and meat, most of which are imports [37]. However, nation base data in India, the prevalence of overweight and obesity is found to be lower than the Asian countries. The WHO Global database on body mass index showed that in 1998 the prevalence of overweight and obesity in young adults were 4.3% and 0.3% in case of men and 4.5% and 0.5% in case of women, respectively [38]. But in India, Bharati et al. 2007 showed that more than 31% of women are malnourished and the percentage of overweight and obese women in urban area is about four times higher than that of rural areas. Reddy et al. suggested that in India, urban–rural difference in overweight and obesity would be due to the difference in life-style factors including physical activity and nutrition by residence [39]. Urban area of living plays a significant role in deciding the obesity status of the population, which is a threat to India in the context where urban population is increasing dramatically [40].

The present study also revealed that the magnitude of increment of obesity (not overweight) is higher among women compared to men. However,

the association of obesity with gender is complex and dynamic in nature [41]. Overall, the results indicate similar picture as remarkable increases in the prevalence of both overweight and obesity among Nicobarese adult in Nicobar Islands from 1960s to 1999 and proportion of change can be reflected through odd ratio values, specifically found among men with overweight and obese were more likely to be higher in 20–39 years age group during 1999 (Odd ratio 9.23) compared to 40 and above years age group (Odd ratio 2.62). This may be due to change in their life-style pattern, particularly in 20–39 years men than their 40 and above counterparts. Traditionally, Nicobarese consumed low carbohydrate content diet from a starchy pulp from the *Pandanus leram* and also from coconut, banana, yam, taro as well as other tubers. The sources of animal protein were fish (mostly marine), pork, fowl, wild birds, crab, turtle, and octopus. Coconut milk and *toddy* (traditional alcoholic drink) was the usual beverage [42,43]. Their diet was very rich in protein and fat. They got 34% calories from the fat and above 10% from the coconut *toddy* [42]. Now a day, they are consuming modern exotic foods like rice, wheat flour, pulses, biscuits, sugar, powder milk, oil. Rice is now staple food replacing the *Pandanus leram*. Distilled liquor is in frequent use [44–46]. On the other hand, the primary subsistence activities were horticulture, fishing and rearing of pigs and fowls. They engaged themselves in making baskets, mats, wooden iron spears and repairing canoes [43]. At present, a sizeable number of Nicobarese adults are in white-collar jobs, besides some have opened petty shops [44]. Comparison of activities performed by the Nicobarese and life-style based on earlier works and the present field observation clearly showed decreasing physical activity level and change in life-style. There is also drastic change in food habits and dietary intakes. The replacement of staple in the form of cereals enhanced carbohydrate intake, with slight decrease of protein [45]. Therefore, the changing life-style, which reduces physical activity level along with dietary changes, especially decrease of protein and increase of carbohydrate, may be the causal factor of high obesity. However, further study is necessary to understand the specific underlying causes behind this adverse situation among this Island population.

## References

- [1] World Health Organization (WHO). Obesity: preventing and managing the global epidemic technical report series no. 894. Geneva: WHO; 2000.

- [2] World Health Organization (WHO). Reducing risk. Promoting healthy life. World health report. Geneva: WHO; 2002.
- [3] de Courten M, Zimmet P, Hodge A, Collins V, Nicolson M, Staten M, et al. Hyperleptinaemia: the missing link in the, metabolic syndrome? *Diabet Med* 1997;14:200–8.
- [4] Pi-Sunyer FX. Medical hazards of obesity. *Ann Intern Med* 1993;119:655–60.
- [5] Must A, Jacques PF, Dallal GE, Bajema CJ, Dietz WH. Long-term morbidity and mortality of overweight adolescents: a follow-up of the Harvard growth study of 1922 to 1935. *N Engl J Med* 1992;327:1350–5.
- [6] Hunter T. The prognosis of early rheumatoid arthritis: how early is early? *J Rheumatol* 1993;20:1999–2000.
- [7] Fontaine P. Gestational diabetes. *Rev Prat* 2003;53:1894–9.
- [8] Adams J. Trends in physical activity and inactivity amongst US 14–18 year olds by gender, school grade and race, 1993–2003: evidence from the youth risk behavior survey. *BMC Public Health* 2006;7:57.
- [9] Jee SH, Sull JW, Park J, Lee SY, Ohrr H, Guallar E, et al. Body-mass index and mortality in Korean men and women. *N Engl J Med* 2006;355:779–87.
- [10] Hodge AM, Dowse GK, Toelupe P, Collins VR, Imo T, Zimmet PZ. Dramatic increase in the prevalence of obesity in western Samoa over the 13 year period 1978–1991. *Int J Obes Relat Metab Disord* 1994;18:419–28.
- [11] Hodge AM, Dowse GK, Gareeboo H, Tuomilehto J, Alberti KG, Zimmet PZ. Incidence, increasing prevalence, and predictors of change in obesity and fat distribution over 5 years in the rapidly developing population of Mauritius. *Int J Obes Relat Metab Disord* 1996;20:137–46.
- [12] Tremblay MS, Katzmarzyk PT, Willms JD. Temporal trends in overweight and obesity in Canada, 1981–1996. *Int J Obes Relat Metab Disord* 2002;26:538–43.
- [13] Ge L. Body mass index in young Chinese adults. *Asia Pac J Clin Nutr* 1997;6:175–9.
- [14] Bharati S, Pal M, Bhattacharya BN, Bharati P. Prevalence and causes of chronic energy deficiency and obesity in women in India. *Hum Biol* 2007;79:396–412.
- [15] Lew EA, Garfinkel L. Variations in mortality by weight among 750,000 men and women. *J Chronic Dis* 1979;32:563–76.
- [16] Sarkar S. Risk of cardiovascular disease in relation to contrasting life styles among the Bhutias of Sikkim. Thesis submitted at University of Calcutta; unpublished.
- [17] Sahani R. Life style changes and emerging obesity in Nicobar Islands. In: A paper presented in the Islands of the WORLD VIII International Conference “Changing Islands—Changing Worlds”. 2004.
- [18] Martin E, Saller K. *Lehrbuch der anthropologie*, vol. 3. Stuttgart, Germany: Fisher; 1956.
- [19] World Health Organization (WHO). Physical status. The use and interpretation of anthropometry. WHO technical report no. 854. Geneva: WHO; 1995.
- [20] Colagiuri S, Colagiuri R, Na’ati S, Muimuiheata S, Hussain Z, Palu T. The prevalence of diabetes in the kingdom of Tonga. *Diabetes Care* 2002;25:1378–83.
- [21] E-Siong T. Obesity in Asia: prevalence and issues in assessment methodologies. *Asia Pac J Clin Nutr* 2002;11:S694–701.
- [22] Popkin BM. Nutrition in transition: the changing global nutrition challenge. *Asia Pac J Clin Nutr* 2001;10:S13–8.
- [23] Bolton-Smith C, Woodward M. Dietary composition and fat to sugar ratios in relation to obesity. *Int J Obes Relat Metab Disord* 1994;18:820–8.
- [24] Shintani TT, Hughes CK. Traditional diets of the Pacific and coronary heart disease. *J Cardiovasc Risk* 1994;1:16–20.
- [25] Hanna JM, Pelletier DL, Brown VJ. The diet and nutrition of contemporary Samoans. In: Baker PT, Hanna JM, Baker

- TS, editors. The changing samoans: behavior and health in transition. New York: Oxford University Press; 1986. p. 275–96.
- [26] Hezel FXSJ. Expensive taste for modernity: Caroline and Marshall Islands. In: Robillard AB, editor. Social change in the Pacific islands. London: Kegan Paul International; 1992. p. 203–19.
- [27] Evans JG, Prior IAM. Indices of obesity derived from height and weight in two Polynesian populations. *Br J Prev Soc Med* 1969;23:56–9.
- [28] Bindon JR, Baker PT. Modernization, migration and obesity among Samoan adults. *Ann Hum Biol* 1985;12:67–76.
- [29] McGarvey ST. Obesity in Samoans and a perspective on its etiology in Polynesians. *Am J Clin Nutr* 1991;53:1586S–94S.
- [30] Cassels S. Overweight in the Pacific: links between foreign dependence, global food trade, and obesity in the Federated States of Micronesia. *Global Health* 2006;11:10.
- [31] Jackson LR, Taylor S, Faaiuso S, Ainuu SP, Whitehouse S, Zimmet P. Hyperuricaemia and gout in Western Samoans. *J Chronic Dis* 1981;34:65–75.
- [32] Hunter JD. Diet, body build, blood pressure and serum cholesterol levels in coconut eating Polynesians. *Fed Proc* 1962;21:36–43.
- [33] Prior IA, Stanhope JM, Evans JG, Salmond CE. The Tokelau Island migrant study. *Int J Epidemiol* 1974;3:225–32.
- [34] Zimmet P, Taft P, Guinea A, Guthrie W, Thoma K. The high prevalence of diabetes mellitus on a Central Pacific Island. *Diabetologia* 1977;13:111–5.
- [35] Darlu P, Couilliot MG, Drupt F. Ecological and cultural differences in the relationships between diet, obesity and serum lipid concentrations in a Polynesian population. *Ecol Food Nutr* 1984;14:169–83.
- [36] Sara FLK, Cockbain AJ, Beazley J. Obesity in Tonga: a cross-sectional comparative study of perceptions of body size and beliefs about obesity in lay people and nurses. *Obes Res Clin Pract* 2008;2:35–41.
- [37] Ulijaszek S. Modernisation, migration and nutritional health of Pacific Island populations. *Environ Sci* 2005;12:167–76.
- [38] Nishida C, Mucavele P. Monitoring the rapid emerging public health problem of overweight and obesity: the WHO Global database on body mass index. *SCN News* 2005;29:5–12.
- [39] Reddy KS, Prabhakaran D, Shah P, Shah B. Differences in body mass index and waist: hip ratios in North Indian rural and urban populations. *Obes Rev* 2002;3:197–202.
- [40] Diwakar A, Qureshi MH. Demographic processes of urbanisation in Delhi. *Popul Geogr* 1992;14:27–36.
- [41] Wang Y, Beydoun MA. The obesity epidemic in the United States—gender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta-regression analysis. *Epidemiol Rev* 2007;29:6–28.
- [42] Roy JK, Roy BC. Food sources, dietary habits, and nutrient intake of the Nicobarese of Great Nicobar. *Indian J Med Res* 1969;57:958–64.
- [43] Shyam Chaudhuri NK. The social structure of Car Nicobar Islanders. Calcutta: Anthropological Survey of India; 1977.
- [44] Justin A. The Nicobarese. Calcutta: Seagull Books; 1990.
- [45] Chattopadhyay M, Ravi Prasad BV. The nutritional status of the Nicobarese of Great Nicobar Island. In: Tyagi D, Bhattacharya KK, editors. Nutritional status of Indian population: Andaman and Nicobar Island. Kolkata: Anthropological Survey of India; 2002.
- [46] Sahani R, Dinda A. Growth and development of Nicobarese children: a bio-cultural studies. In: Sharma MB, editor. Growth and development of children. A bio-cultural perspectives. Kolkata: Anthropological Survey of India; 2009. p. 226–57.

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