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Body Weight and Skinfold Thickness in Antarctica

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Abstract

Body weight and skinfold thickness at eleven different sites of 18 men of the IX Indian Scientific Expedition to the Antarctica were measured during the entire period of journey and stay of 14 months (December'89 to January'91) at Maitri (70°45'S, 11°44'E). Group mean body weight and mean skinfold thickness increased at all the sites significantly almost throughout the stay. Maximum increase of mean body weight was 6.14 kg in November'90. Increase of skinfold thickness was maximum at abdomen (17.0 mm), mid - axilla (15.0 mm), juxtanipple (10.1mm), suprailliac (9.7mm) and subscapular (9.3mm) points. Mean increase of body weight showed positive correlation with the various skinfold thickness in each month. However, body weight was significantly correlated to the forearm, abdomen, juxtanipple, suprailiac and mid-axillary skinfold thickness only, except the forearm limb sites, that had very little significant correlation with body weight. It was concluded that much of the fat deposition took place around the abdomen, chest and back of the Indian wintering members. The data could be used for the designing of exercise schedule to keep the members fit and productive during long term stay in Antarctica.

Introduction

Most of the reported observations on the changes of body composition on long term stay in Antarctica considered mainly skinfold changes in relation to body weight variations. These observations were mostly contradictory.

Lugg (1965) and Acheson (1980) found a negligible change in the body weight and skinfold thickness (SFT) throughout the year. Easty (1967) showed that body weight and SFT at four sites (subscapular, lateral arm, abdomen and chest) increased from February to September and then declined slightly. However, Massey (1956), Lewis *et al.,* (1960) and Wilson (1960) observed a seasonal change in body weight and SFT i.e. an increase in winter and a fall in the summer. In contrast to the above, Orr (1965) found no or little change in body weight but a distinct decrease in SFT during the first 2 or 3 months of residence in Antarctica.

All these studies were carried out on the white population drawn mainly from the temperate zones of the world (Gunderson, 1974).

The wintering members of the IX Indian Scientific Expedition to Antarctica were examined during their prolonged stay of 13 months at the Indian permanent base, Maitri, in East Antarctica. The study evaluated the response of body weight and SFT of tropical Indian subjects during their stay in the extreme environment with altered life style in Antarctica.

Method

The observations were made on board ship, on the way to Antarctica and at Maitri (70°45'S, 11°44'E) during 1989-91.

Subjects : Eighteen out of the 21 wintering members served as subjects. They were aged between 25 and 51 yrs (mean 37.5 ± 1.48 yrs), with their initial body weight ranging between 50.56 and 78.21 kgs (mean 65.38+1.49 kg) and their heights between 1.65 and 1.80 m (mean 1.70+1.17 m). There were 4 scientists, 13 technicians and one cook. All the technicians and the cook were drawn from Indian Army and Navy.

Body Weight: All the volunteers at base were weighed at approximately monthly intervals preferably at the beginning of every month. The men were weighed wearing underwear in the early morning hours immediately after getting up from an overnight sleep and after emptying the bladder. A human electronic platform scale (capacity 100 kg ± 20 gm) was used to measure the body weight.

Skinfold Thickness (SFT) : SFT was measured with a Lange skinfold caliper using the techniques described by Weiner and Lourie (1969) at eleven different sites namely, biceps, triceps, subscapular, mid-axillary, juxtanipple, abdomen, suprailiac,forearm, anterior thigh, calf (medial) and calf (lateral) on the right side of the body. SFT was measured simultaneously with the body weight. Each measurement was made three times and the mean of all the measurements was taken as the SFT of that site. SFT was recorded to the nearest 0.1 mm.

Statistical Analysis : Statistical analysis of the data was performed by the methods of the two way analysis of variance using Newman-Keul's multiple range test for comparing the means of each month with the initial. The product moment correlations between body weight and different SFT were calculated using the standard statistical formula. The significance of the correlations were evaluated using t-test.

Results

The physical characteristics of the 18 subjects and their maximum weight gain have been presented in Table 1. The subject's weight gain ranged from 0.61 kg to 16.5 kg, during their entire stay.

The mean (SEM) increase of body weight in each month compared to their initial value in December'89 has been shown in Fig.l. The mean weight for the whole group had increased to 6.14 kg by November'90. The group mean value of body weight in this month was 71.52 kg. The increase of body weight in different months was highly significant ($p<0.01$) compared to the initial value.

Fig.2 reveals the pattern of change of group mean (SEM) SFT with level of significance, at 11 different sites for 14 months. Most of the SFT showed a steady increase till the end of their stay, except at the triceps and forearm. Skinfold at these points increased till September-October'90 and then either declined slowly as in the case of triceps or remained steady as in the case of forearm. The initial maximum and minimum mean SFT values were at the subscapula (17.83+1.37 mm) and at the biceps (4.78±0.40 mm) which increased to a maximum of 27.08+1.51 mm in January'91 and 7.89±0.57 mm in November'90, respectively.

Table 1: Physical Characteristics of Individual Subjects

Subject	Initial Age (Yrs)	Height (m)	Initial Weight (Kg)	Maximum Weight (Kg)
1	32	1.77	71.0	77.10
2	46	1.65	65.12	71.72
3	39	1.65	57.95	65.72
4	51	1.67	65.00	68.72
5	41	1.72	69.00	75.02
6	34	1.76	69.20	77.42
7	37	1.67	66.71	67.32
8	38	1.68	63.84	66.72
9	36	1.68	62.58	72.18
10	44	1.76	66.22	78.84
11	36	1.76	69.62	71.72
12	45	1.76	70.88	75.40
13	35	1.65	50.56	60.72
14	31	1.68	66.82	83.32
15	35	1.80	78.21	86.84
16	40	1.68	68.12	70.66
17	31	1.67	58.66	64.08
18	25	1.66	57.42	72.14
Mean	31.56	1.70	65.38	72.54
SEM	1.4847	1.1684	1.4884	1.574
Range	(25-51)	(1.65-1.80)	(50.56-78.21)	(60.72-86.84)

Fig.3 shows the mean increase in the absolute values of various SFT with respect to their initial values for the total period of stay. Maximum increase of mean SFT is represented below in a descending order, abdomen (17.0 mm), midaxilla (15.0 mm), juxtanipple (10.1 mm), suprailiac (9.7 mm), subscapula (9.3 mm), calf (medial) (7.5 mm), triceps (6.6 mm), ant-thigh (6.3 mm), calf (lateral) (5.5 mm), biceps (3.1 mm) and forearm (3.1 mm).

The intercorrelations between body weight and various SFT for 14 months with level of significance are shown in Table 2.

Discussion

All the studies to date showing a positive change of body weight, during prolonged stay in Antarctica, revealed a maximum mean increase of 5 kg body weight of the five scientific

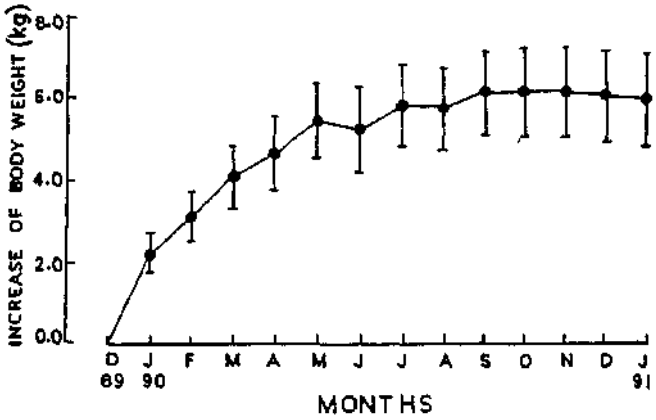

Fig. 1. Changes in mean (± SEM) body weight in every month as compared to the initial (December 89) value.

workers at South Pole during one year of stay (Millan *et al.,* 1961). The group mean increase of 6.14 kg body weight found in the present study was greater than that in any reported observation. The mean body weight of Indian polar community showed a remarkable, steady and significant ($p<0.01$) increase till November'90 and remained steady afterwards (Fig.l). This observation differed from that of Mclean (1919), Easty (1967) and Parker (1985), where subjects gained body weight till winter only.

It appeared from this study, that most prominent increase of mean SFT, took place in the abdomen, chest and at the back- reflecting a substantial deposition of subcutaneous fat at these points (Wilson, 1960; Lewis *et al.,* 1960). The increase of limb skinfolds were comparatively less, the upper limbs being the least.

The parallel increase of body weight and SFT observed in the present study almost throughout the period of stay was unique and has not been reported by any earlier study conducted so far in Antarctica. The increase of body weight and SFT, especially during winter was explained by Lewis *et al.,* (1960), Wilson (1960) and Easty (1967) as lack of activity, confinement and overeating. However, our subjects were not confined to the main station even in winter. Except the cook, all of them were active in construction and various logistic activities required for running a polar base throughout the year. The level of physical activity during both the summers were obviously much more than in the winter and involved heavy manual material handling operations. The fall of triceps skinfold and no further increase of forearm and biceps skinfold in second summer could not be explained due to seasonal change in energy expenditure (Wilson, 1960). There was no decrease of these and lower limb skinfolds during first summer when the level of physical activity was significantly more than in any season of the year. Hicks (1966) measured the left triceps skinfold on 23 men for one year of stay in Antarctica. He found an initial increase in the first four months but during the following three months it returned to the initial value and remained steady. The cause was not explained.

Interestingly, a positive correlation was observed between the mean increase of body weight in each month and mean SFT of our subjects. However, the body weight was

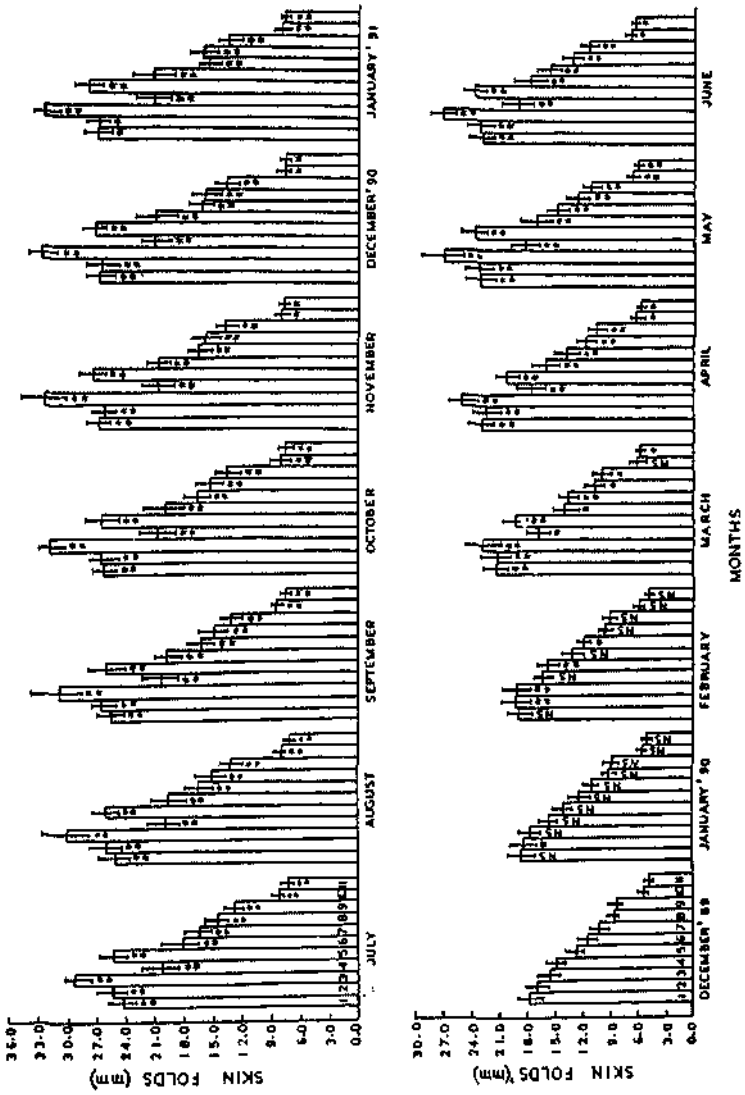

*Fig. 2. Variations of mean (±SEM) skinfold thickness at 11 different sites for 14 months [1- Sub - scapula, 2 - Juxtanipple, 3 - Abdomen, 4 - Anterior thigh, 5 - Mid-axilla, 6 - Suprailiac, 7 - Triceps, 8 - Calf (medial), 9 - Calf (lateral), 10 - Forearm, 11 - Biceps) NS - Not significant, "p <0.05, ** p < 0.01.*

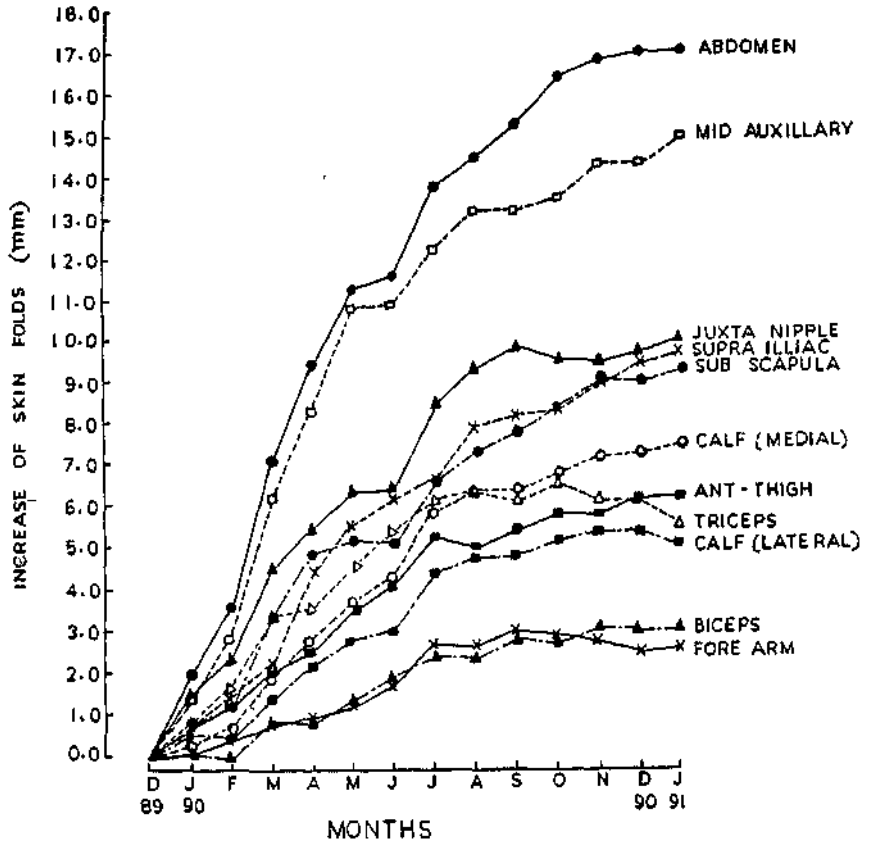

Fig. 3. Mean increase of various skinfold thickness as compared to their initial (December'89) value.

significantly correlated to the forearm, abdomen, juxtanipple, suprailiac and mid-axillary skinfolds only. The above observation was different from Massey (1956) who found no correlation between body weight and SFT at 12 sites, while Lewis *et al,* (1958) reported a positive correlation between body weight and SFT. But, majority (Palmai, 1962b; Orr, 1965; Hicks, 1966; Budd, 1974; Parker, 1985) found no correlation between body weight and SFT.

Though the subscapular and calf (medial) skinfolds, increased markedly throughout the year, they showed significant correlation with the body weight in few months only. Except the forearm, the limb sites had very little significant correlation with the body weight (Lewis *et al.,* 1960). The reasons behind the observed insignificant correlation between the body weight and other SFT of our subjects remained obscure.

Table 2: Intercorrelations with Level of Significance between Body Weight and Skinfold Thickness in Different Months

Months	B.W. vs Bicep	B.W. vs Tricep	B.W. vs Sub scapula	B.W. vs Juxta nipple	B.W. vs Mid auxiliary	B.W. vs Abdomen	B.W. vs Supra illiac	B.W. vs Forearm	B.W. vs Ant thigh	B.W. vs Calf(med)	B.Wvs Calf(lat)
	ns	ns	*	ns	*	ns	ns	ns	ns	ns	ns
DEC'89	0.2245	0.3738	0.4763	0.4477	0.5655	0.4392	0.4223	0.3632	0.1889	0.2618	0.2031
	ns	ns	*	*	*	*	*	**	ns	ns	ns
JAN'90	0.4373	0.4023	0.4904	0.5580	0.5025	0.5008	0.5116	0.5925	0.1669	0.4083	0.2828
	ns	ns	*	*	ns	ns	*	**	ns	ns	ns
FEB'90	0.1977	0.4027	0.5194	0.5193	0.4104	0.3961	0.5141	0.6059	0.2055	0.3600	0.2148
	ns	ns	ns	*	ns	*	*	**	ns	ns	ns
MAR'90	0.3220	0.3992	0.3320	0.5704	0.3390	0.5677	0.5312	0.6085	0.1484	0.2938	0.1875
	ns	ns	*	*	*	*	*	*	ns	ns	ns
APR'90	0.3716	0.3907	0.4812	0.5457	0.4907	0.4926	0.4882	0.5165	0.2352	0.2208	0.1064
	ns	ns	ns	*	ns	*	*	ns	ns	ns	ns
MAY'90	0.2930	0.3686	0.3428	0.5516	0.4530	0.5512	0.4833	0.4261	0.2662	0.2657	0.1080
	ns	*	ns	*	*	*	*	*	ns	ns	ns
JUN'90	0.2602	0.4869	0.3616	0.5648	0.4711	0.5429	0.5065	0.5538	0.2375	0.3378	0.1409
	ns	ns	*	*	*	**	ns	*	ns	ns	ns
JUL'90	0.4574	0.4351	0.5733	0.5734	0.5556	0.6053	0.4578	0.5455	0.2383	0.4262'	0:2257
	ns	*	ns	*	**	**	*	*#	ns	*	ns

Contd...

Table 2: *Contd.*

AUG" 90	0.3976 *	0.5239 ns	0.4091 *	0.5708 *	0.6019 **	06714 **	0.4908 **	0.6527 **	0.3192 ns	0.5031 ns	0.2952 ns
SEP'90	0.5022 *	0.3936 ns	0.5798 ns	0.5287 *	0.6649 *	0.6649 **	0.6854 *	0.6854 ***	0.2520 ns	0.3772 *	0.1521 ns
OCT'90	0.5029 *	0.4390 *	0.4455 ns	0.5742 **	0.5417 *	0.6432 **	0.5165 *	0.7093 **	0.2680 ns	0.4730 *	0.2838 ns
NOV 90	0.5007 *	0.4789 *	0.4485 ns	0.6148 **	0.4880 *	0.6856 **	0.5256 *	0.6690 **	0.2628 ns	0.4782 *	0.3705 ns
DEC'90	0.4907 ns	0.4972 ns	0.4391 *	0.6124 **	0.4757 *	0.6781 **	0.5088 *	0.6274 **	0.2746 ns	0.5149 *	0.3374 ns
JAN'91	0.3733	0.4513	0.4889	0.6023	0.5444	0.6805	0.5496	0.6719	0.3092	0.4752	0.2670

ns, - not significant; *, - $p<0.05$; **, - $p<0.01$;' $p<0.001$

Conclusion

The level of correlation between body weight and various SFT strongly indicated that much of the fat deposition of our subjects took place around the abdomen, chest and the back. This regional variation in the increase of SFT and subcutaneous fat deposition over long term stay in seclusion in Antarctica is of great significance in designing of the type and duration of physical exercise required to keep the expedition members fit and productive. The results can be used further in designing of the polar clothing for Indian wintering personnel.

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