

CALORIC COST OF THE DIFFERENT ACTIVITIES OF A GROUP OF SOLDIERS AT HIGH ALTITUDE AND AT DELHI

By

S. D. NISHITH, R. M. RAI, T. R. A. DAVIS, H. S. NAYAR,
K. C. SINHA, K. K. GUPTA AND N. D. P. KARANI

Office of Director General, Armed Forces Medical Services, Ministry of Defence, New Delhi.

The study of caloric cost of different activities was carried out by combined Indian and American Research Team in Ladakh at heights of about 13,000 ft. above sea level.

The work done at these heights is limited. Pugh et al. (1962) in one of their Mount Everest expeditions have worked the caloric cost of different activities at different heights, but the nature of their activities was different and also the training of these people was for a different kind of activity in comparison to our troops working at different heights in Ladakh.

Johnson and Kask (1947) have reported that cold increases the caloric requirement and when individuals were shifted from desert to arctic the caloric intake increased from 3100 K. cal. to 4000 K. cal. There was no change in height above sea level.

Masterton et al. (1957) have held cold and change in nature of activities from light to heavy as responsible for the increase in caloric intake.

METHODS

The studies were done on eight persons at 13,000 ft. above sea level. These persons were living on these heights and above for more than one year. They were brought down to Delhi for control studies. The control studies were done after about three weeks after their arrival at Delhi.

The criteria of selection of these persons were their average height, weight and normal health. The age varied from 18 to 25 years. The weight of these persons was recorded at high altitude and at Delhi before starting the experiments. No statistically significant change was obtained in weight.

The daily routine of high altitude activities as given by their O.C. was taken as the guide for different activities performed there. Similar activities were performed at Delhi in order to have a comparative study. The average time spent for each activity of the day was also calculated after finding out the time spent for each activity per day in a week.

The energy expenditure for each activity was found out by indirect calorimetry.

The expired air was collected in the Douglas bags during steady state of the activity. Time for collection, atmospheric pressure and respirometer temperature were recorded.

A sample of this air was analysed by Beckman Oxygen Analyser.

From these data volume of Oxygen used per minute at S.T.P.D. was calculated. Using the R.Q. of mixed diet the caloric value of Oxygen used per minute for that kind of activity was determined. Four to six experiments for each activity were carried out and average was calculated.

The energy cost for the total period of an activity was calculated and later on for all the activities of 24 hours.

The atmospheric temperature at high altitude varied from 2°C to 6°C, wind velocity 10 to 29 miles per hour and relative humidity from 10 to 20%.

At Delhi the atmospheric temperature varied from 29°C to 35°C during experimental hours. The wind velocity from 10-20 miles per hour and relative humidity from 15 to 30%.

RESULTS

Table I shows the caloric value of an activity/min. at high altitude and at Delhi.

It is seen that the caloric cost of each activity is increased at high altitude. This is more even during sleeping.

The increase is more marked for activities like 'sentry duty', 'arms cleaning' and 'walking around the tent' than for activities like P.T., playing volley-ball and digging and removing the soil.

Table II shows the caloric cost of whole work in twenty-four hours.

Graph I shows the time/24 hours spent for each activity while Graph II shows the difference in the caloric cost per minute at Delhi and at high altitude. The slope in the line joining H.A. and D. is the index of magnitude in difference.

DISCUSSION

The average daily energy cost for a high altitude acclimatised soldiers activities has been worked out at Delhi and at high altitude. The energy expenditure is less at Delhi than at high altitude.

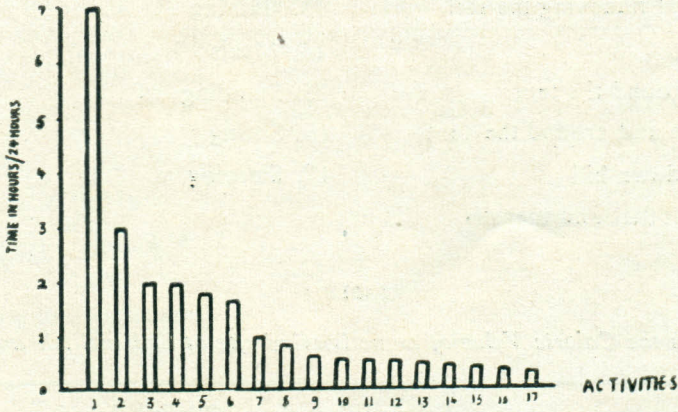
The caloric cost for twentyfour hours activities at high altitude was found to be 4286 K.Cal. while for Delhi it was 3254 K.Cal. There is more caloric expenditure per minute for each kind of activity at high altitude.

The possible reasons for this difference could be as follows :—

- (i) Change in temperature.
- (ii) Change in heights above sea level (Hypoxia & Terrain).
- (iii) The hampering effect of heavy clothes on performance of physical tasks.
- (iv) Increased respiratory and circulatory effort.

These factors could be acting on each other and could modify the effect of other on caloric cost of an activity.

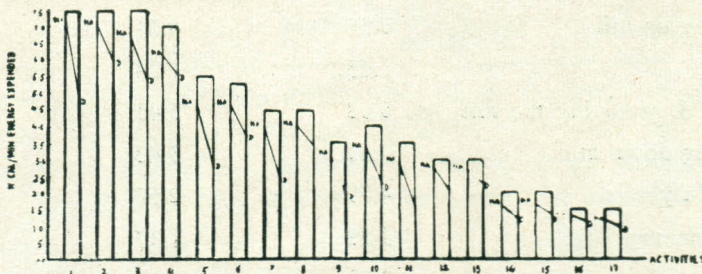
Cold as such has been shown to increase the caloric requirement. Malhotra et al. (1960) say that cold as such without a change in weight of clothing, does not increase the caloric cost. At high altitude it is not possible.



Graph No. 1. Different activities of a day.

List of activities indicated by numbers in graph No. 1 is given below :—

- | | |
|---------------------------------|------------------------------------|
| 1. Sleeping | 10. Working in and around the tent |
| 2. Sitting | 11. Bathing |
| 3. Marching up | 12. Walking around the tent |
| 4. Digging and removing soil | 13. P. T. |
| 5. Standing | 14. Cleaning of the Bukhari |
| 6. Meals | 15. Sentry duty |
| 7. Marching down | 16. Dressing up |
| 8. Washing clothes and utensils | 17. Playing volley-ball |
| 9. Arms cleaning | |



Graph No. 2. Increase in caloric cost per minute for different activities at high altitude in comparison to Delhi.

List of activities indicated by numbers in graph No. 2 is given below :—

- | | |
|-----------------------------------|-------------------------|
| 1. Marching up hill | 10. Cleaning of Bukhari |
| 2. P. T. | 11. Arms cleaning |
| 3. Playing volley-ball | 12. Dressing |
| 4. Digging and removing the soil | 13. Bathing |
| 5. Sentry duty | 14. Meals |
| 6. Walking around the tent | 15. Standing |
| 7. Working in and around the tent | 16. Sitting |
| 8. Marching down hill | 17. Sleeping |
| 9. Washing clothes and utensils | |

TABLE I

Difference in the Caloric Value of an activity/minute at high altitude and at Delhi.

S.No.	Activities	Caloric Values of work/min at High Altitude K. Cal.	Caloric Value of work/min at Delhi K. Cal.	Increase in caloric expenditure at High Altitude K. Cal.
1.	Sleeping	1.21	1.05	0.16
2.	Sitting	1.33	1.20	0.13
3.	Standing	1.51	1.25	0.26
4.	Cleaning of Bukhari	3.42	2.20	1.22
5.	Washing clothes and Utensils	3.51	2.24	1.27
6.	Working in and around the tent	4.14	2.40	1.74
7.	Bathing	2.63	2.23	0.40
8.	Dressing	2.82	2.01	0.81
9.	Walking around the tent	4.74	3.58	1.16
10.	Marching up hill	7.30	4.51	2.79
11.	Meals	1.63	1.24	0.39
12.	Digging & removing the soil	6.08	5.48	0.60
13.	Marching down hill	4.02	3.43	0.59
14.	Sentry duty	4.79	2.50	2.29
15.	Arms cleaning	2.89	1.37	1.25
16.	P.T.	7.01	5.91	1.10
17.	Playing volley-ball	6.88	5.22	1.66

TABLE II

Comparative table of the Caloric Value of different activities calculated for the same period of work at High Altitude and at Delhi.

S.No.	Activities	Time/24 hours Hrs : Min	Caloric value of activity at High Altitude	Caloric value of same activity at Delhi	Difference
1.	Sleeping	7-00	508.2	441.00	67.20
2.	Sitting	3-00	239.4	216.00	23.40
3.	Standing	1-50	166.1	137.50	28.60
4.	Cleaning of Bukhari	0-30	102.6	66.00	36.60
5.	Washing of clothes & Utencils	0-52	182.52	116.48	66.04
6.	Working in and around the tent	0-35	144.9	84.00	60.90
7.	Bathing	0-34	89.42	75.82	13.60
8.	Dressing	0-25	70.50	50.25	20.25
9.	Walking around the tent	0-32	151.68	114.56	37.12
10.	Marching up hill	2-00	876.00	541.20	334.80
11.	Meals	1-40	163.00	124.00	39.00
12.	Digging and removing the soil	2-00	729.60	657.60	72.00
13.	Marching down hill	1-00	241.20	205.80	35.40
14.	Sentry Duty	0-30	143.7	75.00	68.00
15.	Arms cleaning	0-40	115.60	54.80	60.80
16.	P. T.	0-32	224.3	189.12	35.18
17.	Playing Volley-ball	0-20	137.6	104.40	33.20
	Total	24-00	4286.32	3253.53	1032.79

Hypoxia of High altitude affects the various processes of the body. The cardiovascular and respiratory changes are there. There is increased respiratory and circulatory effort of the body to meet the demand. It has been shown that there are great circulatory and respiratory efforts for meeting the demand.

There is increase in caloric value even during sleeping. Along with hypoxia the other external conditions are not so comfortable as they could have been in the standard test for basal metabolic rate and probably the test subjects are not completely acclimatised to these conditions.

The more marked increase in caloric values at high altitude for sentry duty, and walking around the tent is probably due to climbing uphill included in these activities. Activities like P.T., playing volley-ball and digging and removing the soil have not so marked differences at high altitude probably because they include rest pause at both places and are not performed at very fast rate.

CONCLUSION AND SUMMARY

The caloric cost of 24 hours activities of a soldier at the height of 13,000 ft. has been worked out as 4,286 K. Cal. and at Delhi 3.254 K. Cal., by indirect calorimetry.

The caloric cost of each activity per minute has been found to be more at high altitude. This increase may be on account of more than one of the following reasons, which would modify the effect of each other as well.

1. Lower temperature.
2. High Altitude (Hypoxia & terrain).
3. Heavy clothes.
4. Heavy respiratory and circulatory effort.

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