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Dietary Requirement of Mountaineers for Expeditions in High Altitude

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ABSTRACT
Mountaineering, like all other endurance sports, require proper nutrition with some caveats that it isendowedwithvarious life-threateningcomplications. Ourstudy,a retrospective cross-sectional study, has been undertaken to assess the nutritional requirement among adult mountaineers withexperiences of climbing more than 6000 meterspeaks and residing in and around Kolkata. Data wascollected from 50 mountaineers (male & female both, n=50) through standard detailed questionnaireregarding diet, general health conditions and complications during expeditions at high altitude. Westudiedindetaildifferentcomponentsoffoodsconsumedbymountaineersandstatisticallyevaluated pros and cons of each component. Aim of this study is to statistically finding out optimum nutritional requirements to avoid complications in high altitude low temperature situations involved in mountaineering.

KEYWORDS*Diet,Mountaineer,HighAltitude,Nutrition,Calorie*

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I. INTRODUCTION

For ages, high terrestrial altitude and mountains have attracted mankind. Millions of people go tohigh altitude mountain for recreation and adventure sports. Theoretically, high altitude begins at2400metre height from sea level.[1]But high altitude essentially means an extreme environment withlowtemperature,less oxygen,high solar radiation where basic needs like acquisition of food, shelter and protection require extraordinary efforts and these ultimately result in loss of significantamountofbodymass,fatmassaswellasfat-freemass[2].

High altitude also leads to hypoxia due to low oxygen pressure in air. Complications related to high-altitude hypoxia include Acute Mountain Sickness (AMS), hypophagia, hypodipsia. Symptoms ofAMS include headache, anorexia, nausea, vomiting, malaise etc[2]. Life threatening conditions likeHAPE (High Altitude Pulmonary Edema)orHACE (High Altitude Cerebral Edema) may also arise[2].

In defense to changes in temperature related to high altitude, several physiological changes likeshivering and vasoconstriction occurs to maintain homoeothermic failing which frostbite, chilblains,and hypothermiamightoccurwithgraveconsequences.

Hypoxia plays an important role in metabolic adaptability and thus nutritional requirements changeaccordingly. In many circumstances, food and nutritional values are given less of importance. But itis observed that mountaineers who are unaware about nutrition, face much more complications. Thisstudyaimstoevaluatetheenergyrequirementsofmountaineersandalsothebeneficialordetrimentaleffectsofdifferentnutrientspresentinfood.

II. LITERATUREREVIEW

As the altitude increases, decrease in barometric pressure results in full of partial pressure ofoxygenresultinginrapidbloodflowandthussubsequentinappropriateoxyhaemoglobindissociation.

The main limiting factor of human performance in hypoxia is attributed to a decrease in VO_{2max}i.e.decrease in maximal O_2 uptake. Diminished VO_{2max} is associated with a lowered O_2 partial pressureinarterialblood(PaO_2),whichreducesO_2deliverytotissuesandnegativelyaffectsmusclemetabolismand contractionleadingto peripheralfatigue.Altitude relatedchronicexposure tohypoxiaimprovesO_2transportcapacitybyenhancingerythropoietinsecretion.Thisresultsinconsequential increase in total haemoglobin (Hb) mass leading to improvement of VO_{2max} and thusphysicalperformance.

With increasing altitude, PaO_2 falls causing a decrease in O_2 saturation of Hb in arterial blood(SaO_2). It results in decreased O_2 pressure gradient, especially in capillaries where PO_2 gradientmay be close to zero. With

lowering of PO_2 the blood flow is so rapid that inappropriate gaseousexchangeoccursresultingunfavorableoxyhaemoglobindissociation.Hypoxiainduceshyperventilation which is critical to improve blood oxygenation, particularly alveolar PO_2 and byincreasingpH(duetotoCO_2washout),shiftstheoxyhaemoglobindissociationcurvetoleft.[8]

Respiratory quotient (RQ) is important determinant of physical performance as partial pressure ofalveolaroxygen(P_{AO2})is directlyproportionatetoRQ,indicatedby theformula[3]

$P_{AO2}=P_{IO2}- P_{ACO2}/RQ$which canbesimplifiedas$P_{AO2}=F_{iO2}(P_{ATM}–P_{H2O})-P_{ACO2}/RQ$

As we can see from the equation, P_{AO2} increases when the value of RQ increases. Now RQ isprimarily dependentonthe macro-nutrients.If metabolismconsists solely oflipids, the RQ isapproximately0.7,for proteinsitisapproximately0.8,andfor carbohydratesitis1.0.

Negative nitrogen balance is reported athigh altitude and this is mainly due to decreased foodintake resulting energy deficiency[2]. A high protein diet does not stop or attenuate fat-free mass lossif energy intake is deficient. Biochemical and physiological abnormalities noted also mimic energydeficiency status. But after long term acclimatization, there seems to be no abnormalities in themetabolicprocess.

Althoughthereisnochangeinfatdigestibilityataltitude<4500m,therearestudiesthatfatabsorption getsimpairedin≥5000maltitude[4].Anorexiaalsoplaysarole.

OBJECTIVEOFSTUDY

To find out optimum nutritional requirements for mountaineers involved in mountaineering in highaltitudes.

III. METHODOLOGY

StudyType: Retrospectivecrosssectionalstudy.
Studypopulation: MountaineersresidinginandaroundKolkata
Samplesize:50
Study tools & method: A standard detailed questionnaire regarding diet, general health conditions(before and during high altitude expeditions) has been formulated. Detailed responses against thispre-formulated questionnaire have been methodically collected fromveteran mountaineers fromtheir previous experiences in high altitude expeditions. Dietary preferences as well as conveniencefactors have also been taken into consideration. Average daily calorie intake during preparatoryphase and proportions of carbohydrate, protein, fat and other nutrients have also been calculatedusing foodcompositiontable assuggestedbyNIN,ICMR.[6]

On the basis of these data obtained, total energy requirement of an individual based on body weightand height as well as detailed menu plan have been formulated. Adequacy of diet plan in relation tomeeting the requirements of mountaineers has also been assessed thoroughly.Mean, median,quartiles have been calculated from all collected data using relevant statistical formulas. Chi squaretest,Fisher'sExacttest,Oddratioetc. hasalsobeen used wherever needed.
Inclusion criteria: Adult (>18 years) climbers/mountaineers with experience of climbing >6000m.Peaks
Exclusion criteria: Any climbers/mountaineers having diabetes or hypertension or any liver or kidneydisease,anyonerequiringspecialkind ofdietduetometabolicdisorder.
Durationofstudy: April2019toDecember2021

IV. RESULTS NDDISCUSSION

We have a study population of fifty (n=50) among which males are 38 and females are 12. The totalcalorie intake along with proportions of different nutrients has been calculated. Total calorie intakevaried widely among individuals and also among different sexes. The lowest calorie intake was2072.16 Kcal and highest was 3550.97 Kcal. The difference between highest and lowest values(Range,instatisticalterms)washopping1478.81Kcal.

On closer inspection of values of calorie intake, it is seen that there is considerable differencebetween male and female mountaineers. So we analyzed all data of males and females separately.Although the recommended dietary allowances for male and female athletes are almost similar,[7] in such cases our study comprising Indian males and females show, there is trend of taking 10% to20%lesscalorieintakeamong femalesovermales.

In case of males, the lowest calorie intake was 2194.97 Kcal and highest was 3550.97 Kcal. Meanvalue of calorie intake was 2724.53 Kcal (Range 1356 Kcal). We divided the values of calorie intakeinto quartiles (Q1, Q2, Q3) using statistical formula. In our study, Q1 represents the quartile ofpopulation with least calorie intake and Q3 represents the quartile of population with highest calorieintake.Q2 representsthe quartile ofpopulationbetweenQ1andQ3 andalso representsthemedian value.Calculated valuesare—Q1=2351.16,Q2 =2693.90(median),Q3=3042.81.

In case of females, lowest calorie intake was 2072.16 Kcal and highest was 2878.43 Kcal. Meanvalue

of calorie intake was 2381.38 Kcal (Range 806.27 Kcal). Calculated values of quartiles are — Q1=2086.89,Q2=2291.82(median),Q3=2720.66.

Exercise intensity and durationare the main factors that influence energy expenditure [5]. In ourstudy,lower incidence of complications was found with persons takingcalorie ranging between3042 Kcal (Q3) to 3550 Kcal (Maximum), i.e. around 50-60 Kcal/kg body weight/Day. In our study,lower quartiles (less than median) represent46% of total study populationthat is 23. Total7persons had complications among which 6 persons are among low calorie intake group (less thanQ2). The statistical probability between lower calorie intake and occurrence of complications can bemeasured bytheOddsRatio.

Table 1: Incidence of complications among different calorie taking group.

Calorie intake	Complication present	Nocomplication
Lowcalorieintake	6	17
Adequatecalorieintake	1	26

From the above chart, Odds Ratio would be = (6x26)/(1x17) = 9.18 (P=0.0486) and calculatedRelative Risk is 7.04. Thus, from above calculations, it can be easily postulated that lower calorieintakecarriesmuchhigher risk(morethan7 times)ofcomplicationsinmountaineers.

Due to variability of calorie intake in different individuals, energy input from Carbohydrates, Proteinsand Fats have been calculated in absolute terms and then we measured in percentage with relationtopreferabletotalcalorieintake.

Formales,Carbohydratesconsumptionvariedfrom749.72to2236.64Kcal.Median(Q2)ofcarbohydrate consumption is 1523.7 Kcal. It is seen statistically from the data that all those who hadcomplications,have lower overall carbohydrate consumption(lessthanmedian).Forfemales,Carbohydrate consumption greater than median (1237.1 Kcal) is associated with better overallperformance.AsCarbohydratehasaRQof1,itistheprimaryfuelinhigheraltitudes.Corroborating with this fact, our study shows that higher carbohydrate intake (≥ median), rangingfrom62.83%to69.37%,isassociated withmuchlowerincidenceofcomplications.

Protein consumption in male varied from 313.56 to 745.4 Kcal. Data shows that two-third of allpersons faced complications, had higherproteins in their diet (more than median 424.04 Kcal).While adequate protein is necessary to protect muscle mass and its recovery, higher protein shouldnot be taken at the expense of carbohydrate in high altitudes. In case of females, median of proteinconsumption is 387 Kcal. According to our study, favorable outcomes are seen when total calorieintake from protein ranges between 372.44 to 424.04 Kcal which amounts to 15-16% of total calorieintake.Hence1.75gm/Kgbodyweightofproteinwillmeettheproteinrequirementofmountaineers.

Fatconsumptioninmalerangesfrom478.8to1193.49Kcal;median(Q2)being584.01Kcalwhereas, in females, median value of fat consumption is 649.98Kcal. While fat consumption asenergy-dense food is important but it should not be taken at expense of carbohydrate. Favorableoutcomes are seen when fat consumption is less than 584 Kcal (Median). When calculated inpercentage,itrangesfrom20.36to 24.89.

Vitaminsandminerals performthe sameessentialfunctionformountaineers.Anti-oxidants arerequired for activities with high energy requirements due to production of free radicals. Consumptionof adequate amount of iron is essential for optimum aerobic strenuous activities. Calcium intakeshouldalsomatchrecommendeddailyallowance.

Adequate waterintake is requiredfora mountaineerto maintainthe fluidbalance inextremeenvironment.

V. CONCLUSION:

Our study is focused on factors that decrease complications among mountaineers in high altitudelow temperature situations.Along with other factors like acclimatization, weather,comorbidities,foodalsoplaysimportantrolekeeping complicationsatbay.

Minimum energy requirement for mountaineers at high altitude low temperature situations rangefrom50 to 60 Kcal/kg body weight/day.Carbohydrates must comprise 63-69% of totalcalorieintake. While prevention of muscle mass loss and subcutaneous fat loss is important, daily proteinand fat intake should not replace minimum required carbohydrates. From our study, it has beenconcluded that total protein intake should be 15-16% of total calorie which amounts to 1.75gm/kgbody weight. Fat content should be 20-25% of total calorie. Vitamins and minerals present in foodsusually suffice their daily requirement as there is no evidence that taking more vitamins will improvetheperformance [5].

Table 2: Asamplemenuplanisgiven herewith.

Meal	Preparation/Menu
Earlymorning:	Teawithmilk&sugar
Breakfast:	Bread+Butter/Jam Boiled Egg / Chenna Banana
MidMorning:	Sprouts+Dryfruits
Lunch:	Rice+Chapatis Dal Vegetablecurry Fishcurry/Paneerpreparation Curd
Postlunch:	Fruitjuice
Evening:	Tea with milk & sugar Biscuits
Lateevening:	Salad+Cheese
Dinner:	Rice Dal Vegetablecurry Meat Preparation (Chicken / Mutton-Bone less) / Soya bean curry Dessert
BedTime:	WarmMilkwithSugar

Note: Customized diet chart should be according to height, weight, physical and metabolic conditionofthemountaineer.

REFERENCES:

[1]. M.B. Anusha, Naveen ShivannaAndK.R. Anilakumar. Nutritional Requirement AtHigh-AltitudewithSpecial Emphasis To BehaviourOf Gastro-Intestinal Tract And Hormonal Changes. DefenceLifesciencejournal,Vol.2,No.2,April2017,Pp.120-127,DOI:10.14429/Dlsj.2.11371.

[2]. Dr. S. N. Singh. Unit 18 Nutritional Requirements For Special Conditions. In: Dr. S. Seshadri,Editor,Advancenutritionmfn-004.Newdelhi:IGNOU,February2008(Reprint).P.546-551.

[3]. J. PR Brown, M. PW Grocott, Humans At Altitude: Physiology And Pathophysiology. Continuingeducation In Anaesthesia Critical Care &Pain, Volume 13, Issue 1, February 2013, Pages 17–22,Doi.Org/10.1093/Bjaceaccp/Mks047.

[4]. A.M.W.J.Schols, K.R. Westerterp, Hypoxia, Nitrogen Balance And Body Weight. EuropeanRespiratoryJournal2002 20:252-253;Doi:10.1183/09031936.02.00403702.

[5]. Dr. D. Kapur, Dr. M. Wasuja. Practical 6 Sports Nutrition. In Dr. D. Kapur, Editor, Advancenutritionpracticalmanualmfnl-004..Newdelhi:IGNOU,March2008(Reprint).P.101-106.

[6]. C. Gopalan, B.V. Rama SastriAndS.C. Balasubramanian. Nutritive Value OfIndian Foods.Revised Edition1989,Hyderabad,NIN,ICMR,2007.

[7]. Mr. D. H. Pai Panandiker, Dr. K. Satyanarayana, Dr. Y. Venkata Ramana, R. Sinha, Dr. Ann C.Grandjean, Dr. S. Harris, R. Sharma. Nutrition And Hydration Guidelines ForExcellence In Sportsperformance.ILSI-INDIA,NIN,SAI.March2007.P.20.

[8]. Calbet, Jose, and Carsten Lundy. High Alt. Med. & Biol. 10. 123-134, 2009. Doi: http//doi.org/10.1089/ham.2008.1099.