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A Study on the Intake and Expenditure of Calories among the Manufacturing Workers

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Abstract:

Nutrition and adequate diet plays an important role in the efficiency and welfare of the workers and non workers and in manufacturing work, the nutrient demand and energy expenditure are little high as compare to Non workers. Therefore, adequate nutrient and energy intake of manufacturing workers is of paramount importance. The interrelationship of physical activity, food intake and extremes of environmental temperature are important considerations influencing nutritional intake and physical performance in various activities of workers. Here, an attempt has been made to assess the Intake and Expenditure of Calories among the Manufacturing Worker of Uttar Pradesh.

The present study assessed the nutritional status of 152 workers working in different working level under Varanasi district. The dietary status was determined by the food and nutrient intake using diet history and the energy expenditure was computed by a factorial method using activity level and time records of 7 days. Another object was to develop survey methods for assessing the proportions of the calorie intake spent by industrial workers on various activities. The opportunity was taken during the survey of collecting certain Anthropological, medical and physiological data for industrial workers. The energy expenditure during work was estimated from the energy costs of individual tasks and the time spent in those tasks. The objects of the study, which was a new development in the survey field, were in general successfully achieved. The study showed that the necessary information could be collected by survey methods, but that there are difficulties in interpretation and that, in particular, further study of job assessment and more data on standards of calorie expenditure for various activities are required.

Key words: *Nutrition, Food Consumption, Calorie Intake, Medical Examination, Job Assessment.*

INTRODUCTION

Due to Globalization phenomenal industrial progress is going on among the developing countries, including India. Several of these industries have large-scale employment potential. Industrial workers constitute a vital segment in view of their significant contribution to the national income (WHO 1978). Increasing of number of person in employment, their working efficiency and output are very much dependant on the health and physical fitness of the individual. Recent Globalization and industrialization changing the occupational morbidity drastically consequences of this nutritional deficiencies are raised in workers.

Nutrition and adequate diet plays an important role in the efficiency and welfare of the workers and essential for optimum output. Nutritional status refers to the health of an individual as it is affected by the intake and utilization of nutrients. Nutritional health can be described at several levels. Normal nutrition implies a sufficiency of nutrients and energy intake, neither deficiency nor excess, that affords the highest level of well-being. The relationship between biological and cultural factors is well exhibited by nutritional aspects under the rubric of different ecosystems. The nutritional aspect mainly covers foods, nutrients and related other substances there in their action, interaction and balance in relationship to health and diseases. Nutrition is concerned to a certain extent with social, economic, cultural and physiological implications of food and dietary habits. A number of studies have been made on dietary aspects and assessment of nutritional status of different populations by different authors, viz Dandekar and Patwardhan, 1971; Gopalan et.al, 1974,1984; Sukhatme, 1977; Choudhry and Visweswara, 1983; Rao, 1995; Hiwarkar et.al, 1998; Barker et.al, 2006; Tungdim and Kapoor, 2008 and many others.

In manufacturing work, the nutrient demand and energy expenditure in workers are little high as compare to Non workers. Workers need nutritious foods to remain healthy and productive. We understand about nutritional deficiencies, many diseases associated with nutrition, such as cancer and anaemia, asthma etc., the need for proper nourishment is all the more pressing to ensure a healthy workers. Proper nutrition leads to gains in productivity and worker morale, prevention of accidents and premature deaths, and reductions in health-care costs. Therefore the components of workers diet must be chosen judiciously to provide all the nutrients needed in adequate amounts and in proper proportion. If daily energy expenditure is higher than the energy intake, subsequently the energy balance becomes negative. Few quantitative studies, which are summarized in an International Labor Office publication in 1989 (Apud et al 1989), have assessed the daily energy intake of workers in different countries. According to the previously mentioned International Labor Office publication, in Finland (1960), an average daily energy intake of 4763 kcal per 24 hours was reported; in Canada (1973), daily meals provided 5500 kcal; and in the Netherlands (1972), a daily energy intake of 4260 kcal was calculated. In a study on German workers (Wirths 1972), it was reported that daily meals provided 4530 kcal on average. In Chile, during a case study of 57 forestry workers, a mean daily energy intake of 3519 kcal and an energy expenditure of 3541 kcal were recorded (Apud 1983).

Energy is the capacity to do work. In biologic systems it is usually measured in kilocalories (kcal) or kilojoules (kJ). One kilocalorie (equivalent to 4.184 kJ) is the amount of heat required to raise the temperature of 1 kg of water 1°C (e.g., from 15 to 16°C) at standard atmospheric pressure (760 mm Hg). Energy balance refers to the relationship of energy intake to energy expenditure and energy storage. Less energy expenditure than energy intake results in a positive energy balance and storage of energy primarily as body fat. Prolonged insufficient energy intake results in malnutrition, which is observed in many developing countries. In most cases, insufficient food intake results from a lack of economic ability to obtain food, from an illness, or from physical or mental disorders that prevent sufficient ingestion or utilization of food to meet energy expenditure, or in some cases from voluntary restriction of food intake and dieting.

Dietary survey carried out by the Ministry of Health and the Medical Research Council on men working in factories associated with the Slough Industrial Health Service. The total calorie intake per man was estimated from measurements of the food consumed, and, using energy expenditure rates for ordinary routine daily activities published by other workers, the average calorie expenditure per minute in excess of basal requirements was calculated for light to heavy work grades (Bransby 1954). Extensive dietary surveys have been carried out by Widdowson, Edholm, and McCance (1954) on military cadets and coupled with energy expenditure measurements by Edholm, Fletcher, Widdowson, and McCance (1955) on similar groups, and by Garry, Passmore, Warnock and Durnin (1955) on miners and clerks in the East Fife coalfield.

There have been several country-wide Diet and Nutrition Surveys in India. But few of these pertain to industrial workers and cover such aspects as common nutritional disorders and dietary intake (De Mello et al. 1950; Banerjee et al. 1959; Ramanamurthy and Dakshayani 1962;

Swaminathan 1967; Sharan and Puttaraj 2003) and work output (Satyanarayana et al. 1972, 1977, 1979). Here, an attempt has been made to assess the Intake and Expenditure of Calories among the Manufacturing Worker of Uttar Pradesh.

METHODS

Sample and information collected

The men included in the survey worked in twenty-one industries at Varanasi, Uttar Pradesh. Researcher, approached the managements of a number of factories of Varanasi, and explained the nature of the survey to them. A selection was made of jobs thought suitable for study and some of the men working on these jobs were invited to co-operate. No attempt was made to obtain a random sample of men engaged on particular jobs or in particular factories.

Medical examination

Each subject was given an anthropo-medical examination and assessment was made of his state of health and nutrition. Height, weight, blood pressure and skinfold measurement were taken. Samples of blood were drawn for estimating haemoglobin and pseudo- cholinesterase (Berry, Cowin & Davies, 1954). The medical examinations were made by staff of the Sir Sunderlal hospital, BHU, Varanasi, Uttar Pradesh.

Job assessment

An ordinary industrial classification in terms of heaviness was made of each job. The classification was empirical but in general was related to the physical energy expended during the shift. In making the assessments, account was taken of the following factors:

1. Individual and total weights lifted and handled, and the heights to which they were raised.
2. The method of lifting, that is, whether or not mechanical aids were used.
3. The speed and periodicity of the work and rest pauses.
4. The length of the working shift and whether or not overtime was worked.
5. Whether or not there were complaints of fatigue at the end of the day’s work.

Research also categorize the worker according their grading of job i.e light, light to medium, medium, medium to heavy and heavy.

Record of out-of-factory activities

The subjects were asked to provide for one week a record of their out-of-factory activities. Each man was given a sheet on which were listed certain key points of the day, such as time of getting up, of breakfast, of leaving for work, and of arrival at work, and so on. There was space to record also information on the method of travelling, for example, whether the subject walked or went by bus or train and, if so, whether he stood or sat. At the week-end the researcher also visited in their homes to check the information recorded.

Record of food consumption (Food Intake)

A record was obtained of the food eaten inside and outside the home and the amount of water drunk by each subject for one week. Each subject, together with the person in the household who usually prepared the meals, was instructed in the method of recording the food intake. The wife or mother made the measurements and kept the records. Most individuals interviewed lived away from their families, had a very uniform diet, additional checks could be obtained by questions on the amounts of food bought daily and weekly and on the amount of money spent on edibles (lists and prices of foods locally purchasable in one bazaar and in the village were obtained and checked). In each factory where there was a canteen, samples of the food served during the period were weighed on each day that the survey was being made in that factory. The men on being interviewed about their out-of-factory activities were asked to say also what tea or coffee they had drunk. The record of the home diet was collected by the weighing method of Widdowson (1936), McCance and Widdowson (1946) and of Beltram and Bransby (1950), but measuring glasses were provided for measuring liquids.

The limitation of the study is that, the loss through damage and wastage was not taken into consideration in the calculation and it was assumed that all category of employees consumed approximately equal amounts of food.

The field work of the survey took place during the latter part of January and during February and March 2011. We tried to take 174 sample but out of 174 subjects 22 subjects withdrawn the survey due to some personal reason i.e. illness, parent illness etc.

Intake of calories and nutrients (Method of calculation)

The nutrient content of each food item was estimated following Gopalan et al. (1991). The average quantity of consumption of each of these major food groups and nutrient groups for a worker for a day was estimated and compared with the quantity of Recommended Dietary Allowance for the Indians by ICMR (1984). The dietary and nutrient intake is expressed as percentages of the excess/ deficit of the Recommended Dietary Allowances for Indians (ICMR 1984). The limitation of the study is that, the loss through damage and wastage was not taken into consideration in the calculation and it was assumed that all category of employees consumed approximately equal amounts of food.

The calorie intake was recorded to be higher in all the three categories of employees i.e., light, light to medium, medium to medium heavy, and heavy. An allowance of 1.1 Cal./min was made for basal metabolism, with a deduction of 10 percent for the time spent asleep (based on Robertson & Reid, 1952) British Medical Association (1990). The allowance for specific dynamic action was 6 percent of that for basal metabolism.

To estimate the energy spent on out-of-factory activities, the activities were grouped as shown in Table 2, and the mean time spent during the survey week on each of them was calculated from the total time spent on them by all the individual men in each group.

Estimated rates of energy expenditure for the activities listed in Table 2 were provided by Dr R. Passmore and are based on results of indirect calorimetry with the respirometer, from a laboratory study (Passmore, Thomson & Warnock, 1952)) and from a field study in a manufactory industry in Uttar Pradesh.

RESULTS

Clinical Findings

There was no clinical evidence of deficiency disease, the nutritional condition of the men being assessed clinically as good. The haemoglobin and pseudo-cholinesterase values, and the blood pressures, heights and weights were all in the range accepted as normal **(Table 2).** There are insufficient other data available for assessment of the skinfold measurements.

Table 1. Classification of activities and average number of calories expended on them by the 152 men (Basal metabolism is included, the allowance for it being 1.1Cal./min)

S. No.	Activity	Average amount of energy expended * (Cal./min)
1	Dressing, including washing and shaving	3.6
2	Sitting, including time spent at meals	1.6
3	Standing, including waiting	1.9
4	Walking, including shopping and pushing pram	4.5
5	Cycling	7
6	Domestic work, light household and mechanical repairs, motor driving	3.5
7	Gardening	5
8	Light games, such as darts and billiards	2.5
9	Athletic games and dancing	5
10	Lying down, including reading in bed	1.1
11	Fetching and carrying, e.g. loading lorry, shifting crates, stacking chairs	5
12	Sleeping	1
	* Based on rates of energy expenditure provided by Dr Passmore et al.(1952)	

Table 2. Average clinical, anthropometric and biochemical values for the men medically examined, analysed according to age and heaviness of work.

Attribute measured	Whole group			Average values subdivided according to grade of work				Average values subdivided according to age in years			
	No	Average value	SD	Light	Light to medium	Medium to medium heavy	Heavy	Under 20	20-29	30-39	40 and over
Height (cm.)	151	170.2	7.6	170.2	167.6	170.2	172.7	172.7	170.2	172.7	170.2
Weight (kg.)	151	66.7	9.9	64.9	66.7	68.1	66.7	63.6	65.4	69.5	65.8
Skinfold (mm.)*	151	48	20	49	49	49	42	39	43	51	50
Systolic pressure (mm. Hg)	147	130	12	127	128	133	129	121	129	131	130
Diastohc pressure (mm. Hg)	142	81	9	79	81	82	81	77	79	82	82
Pseudo- cholinesterase+	130	106	24	104	107	103	111	117	104	107	105
Haemoglobin (% Ha1dane)#	149	104	7	104	105	104	101	104	105	105	102

SD=Standard Deviation

* *Sum of the five measurements: front of arm midway between head of humerus and antecubital fossa with fore-arm slightly flexed and supinated; a corresponding point on back of arm; just below angle of scapula with arms held to side of body; just below costal margin in mid clavicular line; 1 in. to right and below umbilicus. Caliper contact plates measured 1.4sq .cm each; opening tension was 170 g rising to 360 g at 1cm.*

+ *Measurements of pseudo-cholinesterase in plasma were made by the staff of the Sir Sunderlal hospital, BHU, Varanasi, Uttar Pradesh. The technique used was one described by Ainsworth, Davies & Rutland (Berry et al. 1954). The unit of activity of pseudo-cholinesterase was expressed as the volume of CO2 in µl. produced in 0.5 h from the blood in two 0.5 inch. disks of no. 31 Whatman filter-paper, using 0.03 M-butyrylcholine substrate.*

Haemoglobin levels, taken from capillary blood with the subject prone for 2-3 min, oxyhaemoglobin being tested in a grey-wedge photometer.

Food consumption and intake of calories and nutrients

For the 152 men surveyed, **Table 3** shows the average weekly consumption of various foods, and **Table 4** the average daily intake of calories and nutrients. The dietary patterns differed somewhat at different ages and with the heaviness of the work done, the principal variations being: with increasing heaviness of work a rise in meat and fish consumption and a fall in fruit consumption, and with increasing age a rise in fish consumption and a fall in that of breakfast cereals, fruit, preserves, sweets, soups and pickles.

Table 3. Average weekly consumption of various foods eaten by the men.

S.No.	Food item	Average amount eaten per week (Oz)	Average amount eaten per week (gms)
1	Bread	77	2182.9
2	Breakfast cereals	7	198.4
3	Cake and biscuits	20	566.9
4	Cheese	5	141.7
5	Cheese dishes	0.6	17
6	Eggs	4	113.4
7	Fats	12	340.2
8	Fish	8	226.7
9	Fruit and nuts	16	453.5
10	Meat	31	878.8
11	Milk and cream	76	2154.5
12	Potatoes and chips	62	1757.6
13	Preserves	3	85
14	Soup and gravy	11	311.8
15	Meat stew, puddings and pies	10	283.4
16	Sugar	16	453.5
17	Fruit puddings, pies and milk sauces	35	992.2
18	Confectionery	4	113.4
19	Vegetables, greens	12	340.1
20	Peas, beet and other vegetables	19	538.6
21	Pickles and sauces	0.7	19.8

Table 4. Average daily intake of calories and nutrients for the whole group of 152 men

	Calories (Ca1.)	Vegetable Protein (g)	Animal Protein (g)	Fat (g)	Carbo-hydrate (g)	Calcium (g)	Iron (mg)	Vitamin A (i.u.)	Thiamine (mg)	Nicotinic acid (mg)	Ribo-flavin (mg)	Vitamin C (mg)
Average intake	3549*	54	55	138	435	1.3	21	4171	1.7	14	1.8	42
Standard deviation	620	11	16	28	80	0.3	4	2253	0.3	3	0.4	18

* Including 130 Cal. obtained from drink.
Nutrient Requirements & Recommended Dietary Allowances for Indians (1990, Reprinted 2004)

Table 5 shows the number of calories per Oz of food eaten by men of different ages and doing work of different degrees of heaviness; it increased with both increasing age and heaviness of work. Correlation coefficients between the haemoglobin values and the dietary intakes of iron and animal protein were calculated; they were 0.096 and 0.103, respectively, and were not significant at the 5 percent level.

Table 5. Average number of calories per oz. food eaten by 146 men* according to age and heaviness of work.

No. of men and calorie value per Oz food eaten by men aged in years							
Grade of work	20-29		30-39		40 and over		All Ages No. of Men
	No.	Cal./Oz.	No.	Cal./Oz.	No.	Cal./Oz.	
Light	6	73	12	81	12	85	30
Light to medium	16	82	10	80	12	81	38
Medium to medium heavy	12	77	22	81	14	79	48
Heavy	10	81	6	85	14	91	30
All grades	44	-	50	-	52	-	146

*The data for five men under 20 and one man where work was not graded are not included; **1 oz.= 28.35 g**

Calorie intakes for different kinds of work and calorie expenditures for various activities

The average daily calorie intake of men doing light work was 3269 Cal., light to medium 3446, medium to medium heavy 3476, and heavy 3903. For men aged 20-29,the average daily intake was 3593 Cal., for those aged 30-39 3510 and for those aged 40 or more 3432. For the whole group, basal metabolism and specific dynamic action accounted for 46 % of the calorie intake, out-of-factory activities for 22 percent and work for 32 percent. The proportions differed from group to group; thus men doing light work spent 26 percent of their energy intake at work and those doing heavy work 41 percent **(Table 6**).

Table 6. Distribution of the average total daily calorie intake of the 137 men, whose calorie expenditure was studied, between the calories required for specific dynamic action, basal metabolism, out-of-factory activities and work.

Grade of work	No. of men	Average intake (Cal.)*	Average amount of energy and percentage of whole expended on							
			Specific dynamic Action		Basal metabolism		Out-of-factory activities		Work	
			(Cal.)	%	(Cal.)	%	(Cal.)	%	(Cal.)	%
Light	28	3269	93	3	1550	47	788	24	838	26
Light to medium	39	3446	92	3	1532	44	759	22	1063	31
Medium to medium heavy	42	3476	92	3	1533	44	838	24	1013	29
Heavy	28	3903	92	2	1534	39	692	18	1585	41

** The average daily calorie intake of all 137 men included in this part of the study was 3512 Cal. compared with 3549 for all 152men included in the food survey.*

Table 7 shows the calorie expenditure per minute on work, over and above that required for basal metabolism, for the different grades of work. For men of all ages, the calorie expenditure was 2.2 Cal./min for light work, 2.7 for light to medium, 2.6 for medium to medium heavy, and 3.8 for heavy, the calorie expenditure per minute for heavy work being thus nearly twice that for light work.

Table 7. Average calorie expenditure per minute by the 137 men on work, exclusive of basal metabolism, according to heaviness of work.

Grade of work	No. of men	Energy spent on work (Cal./min)
Light	28	2.2
Light to medium	39	2.7
Medium to medium heavy	42	2.6
Heavy	28	3.8

Table 8 shows the time spent by men doing different grades of work on the activities listed in **Table 5.** The bottom line but one of the figures in **Table 8** shows for the group as a whole the percentage of the total time spent on each activity. Working and sleeping accounted for 63.3 percent of the total time and sitting for a further 21.6 percent. Dressing and doing domestic work and light household and mechanical repairs each accounted for 3.8 percent of the time and walking for 2.1 percent. Each of the other activities accounted for less than 2 percent. Of the total energy spent on out-of-factory activities shown in the last line of **Table 8**,

dressing, sitting, walking, cycling and domestic work accounted for 88 percent. The importance of such activities becomes apparent from studies of this kind.

Table 8. Average number of hours per week spent on different activities by the 137 men of all ages, analysed according to heaviness of work, (B) average percentage of the total time spent by all the men on the various activities, and (C) average percentage of the calories spent outside the factory devoted to each of the various activities.

Grade of work **A**	No. of men	Dres sing	Sitt ing	Stan ding	Walki ng	Cycl ing	Domestic work	Garden ing	Light games	Athletic games	Lying down	Fetching and carrying	Slee ping	work
Light	28	6.8	36.3	1.9	3.6	3.6	6.6	1.4	0.7	0.4	0.6	0.1	59.9	46.5
Light to medium	39	6.3	36.0	2.6	3.6	3.6	5.2	1.1	1.9	1.0	0.5	-	60.9	46.0
Medium to medium heavy	42	6.5	34.4	2.1	3.6	3.6	9.0	0.9	1.0	0.4	0.5	0.4	59.0	46.6
Heavy	28	6.0	39.2	3.2	3.5	2.6	4.2	1.1	0.9	0.2	0.2	-	58.1	48.8
B		3.8	21.6	1.4	2.1	1.9	3.8	0.7	0.7	0.3	0.3	0.1	35.4	27.9
C		17.4	19.8	2.1	13.1	20.6	16.7	5.0	1.8	2.2	0.6	0.7		

DISCUSSION

The medical examinations showed that the nutritional state of the men included in the study was good and that there were no signs of specific deficiency. The fifteen men excluded from the study of calorie intake and expenditure were not omitted because of any ascertained nutritional deficiency, but because it was thought better not to include in such a study anyone with an impairment that might possibly affect his metabolism.

The differences in calorie intake due to differences in age and in heaviness of work necessarily led to differences in the kinds and amounts of food eaten. The extra calories required by heavy workers came principally from bread and cakes, cheese, fish and potatoes and for some men from eggs and milk. There was no greater consumption of meat by the heavy than by the light workers, although the intake of animal protein was greater. The fact that heavy workers ate more of certain foods or had a higher intake of certain nutrients than other workers does not mean that they had a special physiological need for such foods and nutrients.

It has generally been accepted that persons with high calorie requirements take the more concentrated foods, so as to avoid a too bulky diet, and the present study confirmed this, the tendency being the same for the older and for the younger men. The weight of food eaten was greater for the younger than for the older men, but more calories per Oz. food were obtained by the older than by the younger, possibly because with advancing age the stomach cannot cope with so large a volume. Some of the foods for which consumption fell with increasing age were bulky, such as potatoes, soups and gravy, milk and fruit, but for some other bulky foods, among them stews (A stew is a combination of solid food ingredients that have been cooked in liquid and served in the resultant gravy) and vegetables, consumption did not fall with age. Heavy workers tended to have a low consumption of stews, fruit and other vegetables, although young heavy workers took relatively large quantities of milk. A noticeable feature was the relatively high consumption by younger men of confectionery, pickles and sauces.

The intakes of all nutrients were as high as those recommended by the Indian Council of Medical Research, I.C.M.R, New Delhi and National Institute of Nutrition, Hyderabad. The calorie intakes can broadly be compared with the standards of calorie intake recommended by Indian Council of Medical Research, New Delhi (1985). Exact comparison is not possible because the two methods of calculating calorie values are not the same.

The National Institute of Nutrition (N.I.N) suggests that calorie requirements should be reduced by 7.5 percent of the requirement at the age of 25 for every 10 years beyond that age; thus, persons aged 45 are considered to require about 15 percent less calories than those aged 25. The present results show a decreasing intake with age, but not to the extent suggested by N.I.N, Hyderabad. According to the method of calculation recommended by I.C.M.R. and N.I.N., the average calorie requirements of adult men in the India are 3200 Cal. at 20-29years, 2960 Cal. at 30-39 years and 2720 Cal. at 40-49 years. The intakes of 3593, 3510 and 3432 found in the present survey for those three age groups exceed these I.C.M.R. standard values. Moreover, whereas no sedentary workers were included in the present study, the average intake of 3269 Cal. by men doing light work exceeded the I.C.M.R. standard. The implication is, therefore, that the standards proposed by I.C.M.R. are too low, and still more so when account is taken of the difference in the method of calculating calorie values mentioned above.

The survey showed that, for the groups examined, heavy workers took some 600 Cal. a day more than light workers. Light workers spent 2.3 Cal./min at their work compared with 4.9 for heavy workers; of the total daily calorie intake, light workers spent 26% on work and heavy workers 41 % (Table 7).

The present findings do not confirm those from a survey in different industries of Uttar Pradesh reported by Officer of the Ministry of Health (Ministry of Health, 1990), in which no difference in calorie intake was found between men doing work of different grades of heaviness. The average daily intake of 3549 Cal. for all the men working in the different sector of manufactory industry of Varanasi, Uttar Pradesh, who were the subject of this study agreed well with that of 3406 for the men in Bhadohi, Uttar Pradesh. The Bhadohi survey was a preliminary study, and no figures provided by it would permit of analysis similar to that for the Varanasi, results. The classification of the work into grades of heaviness was made by using the standard of I.C.M.R. to show differences of calorie intake for different kinds of work in the manufactory industry.

The method used in the present study for allocating energy expenditure to different activities is applicable to average values for groups of men but not for individual men. Thus, the man with the lowest intake, 1918Cal./day, was a heavy labourer aged 58 of slight physique. His out-of-factory activities were normal. Because of his low body- weight his energy expenditure on out-of-factory activities would, by the use of average values, probably have been overestimated. The food record suggests that he was not eating normally during the survey week.

It is important also that groups whose calorie intake and expenditure are to be compared must be broadly similar in height and weight and should be similar in those respects also to groups from which the standards of energy expenditure are derived.

The importance of ensuring this is demonstrated by comparing the figures for the six men with the lowest calorie intakes and the six with the highest. The six men with the low calorie intakes had much the same kind of out-of-factory activities as those with the high calorie intakes. For the men with the low calorie intakes, the energy estimated to be spent at work was about 0.1Cal./min; the corresponding figure for the men with the high calorie intake was 6.8. The former value is obviously too low, and the latter would seem too high. Further examination of the figures showed that the average weight of the six men with the low calorie intakes was 58 kg and that of the six with the high calorie intakes 72kg. If, as is likely, the energy expenditure on different activities varies with the body-weight of the subject, then the energy available for work would be underestimated for the men with low calorie intakes and over- estimated for those with high calorie intakes, Fortunately the heights and weights of the various groups examined in the present study were for all practical purposes the same.

The estimate of the calories spent on work was obtained indirectly, as the difference between the total energy intake and the estimated amount spent on basal metabolism, specific dynamic action and out-of-factory activities. Any error in any of these estimates thus directly affected the estimate of the calories spent on work. The values used for basal metabolism, specific dynamic action and out-of-factory activities should be fairly reliable, since they are based on many direct determinations of energy expenditure.

The estimates of the average calorie intakes of the groups, as calculated from food tables, are likely to be reasonably reliable also, but there may well be substantial weekly variations in intake. The effect of a wrong estimate of the calorie intake can be shown by supposing that the estimated value was 10% above the true value-say, 320 Cal./ day for men doing light work and 390 for those doing heavy work. The excess would be credited to the energy spent at work and would amount to about 0.8 and 1.0Cal./min, respectively. There is, however, no reason to suppose that such possible errors would fall more heavily on any one group than on any other; in consequence, differences between groups are not likely to be much affected.

The figures in Table 9, which show the average number of hours per week spent on the various activities, suggest that the men had a fairly uniform pattern of behaviour. The hours per week spent by the individuals in all groups on dressing range from 6.0 to 6.8, on sitting from 34.4 to 39.2 and on sleeping from 58.1 to 60.9. Similar observations on more groups in different parts of the country could help to establish these patterns more firmly. The distribution of the calories spent on out-of-factory activities shows the importance of such activities as sitting and walking and the relative unimportance of such more active occupations as dancing and gardening.

CONCLUSION

Because of the dearth of research on the food and nutrition intake and nutritional status of the industrial workers, comparison of the present observation with other similar findings was not possible. However in view of the above results and discussion some recommendations are suggested which may be used as the tips for improving the quality of food supplied by the canteen. Worker should add fresh fruits, fibrous vegetables, and some raw vegetables in the diet, especially in the form of salads to provide bulk and to reduce the caloric content of the diet .The amount of fresh curd should be increased in the diet of vegetarians. Vegetables rich in Beta-carotene like carrot, papaya, different green leaves (leaves of radish, carrot, onions etc.) should be included in the diet. It is very much essential to follow the method of cooking in which the use of oil is less, i.e. boiling, steaming, stewing, sauteing, braising, roasting, grilling and as well as pressure cooking. The common practice of deep fat frying of most of the food items should be avoided.

To enhance the qualities of the diet, it is essential to include different types of cereals like rice, wheat, jowar, bajra, ragi etc in the menu. Similarly different types of dals (legumes) also should be included in the menu.

Diet counselling should be imparted individually to the workers with the help of visual aids like charts, pamphlets and diet sheets on consequences of over-eating, danger of obesity, principles and methods of weight control, importance of dietary modification with special reference to energy balance, quantity and quality of fats to be used and inclusion of liberal amount of fibrous foods should be stressed. Approaches for improvement of health and nutritional status, food and nutrition knowledge of the workers are also recommended. Efforts should be taken to educate the workers on fundamentals of nutrition emphasizing role of good nutrition in improving work capacity. Mass education efforts to encourage choice of low cost nutritious foods, better health care education and discourage use of alcohol are also suggested.

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