Anthropometric and clinical nutrition status of workers in some Indian factories

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Anthropometric and clinical nutritional status of 195 male factory workers was assessed in Nainital, North India. Relationships between anthropometry and clinical scores and between nutritional status and either education or income were evaluated. Mean± standard deviation values were: height 161.3± 6.0 cm, weight 52.7± 7.6 kg, BMI 20.2 ± 2.4 and MUAC 24.0 ± 2.3 cm. For BMI, 57% of the subjects were below 20, a value below which FAO predicts that there will be increased risk of work performance. Values corresponding to chronic energy undernutrition (below 18.5 BMI) were found in about 20% of workers. Clinical signs of nutritional deficiencies were found to be 10.76% for vitamin B complex, 2.05% for ascorbic acid and 2.05% for iron. Clinical scores and anthropometric values were negatively correlated with each other, indicating that clinical signs of nutritional deficiencies increased with decreasing anthropometric values. Education and per capita income appeared to have a positive influence on nutritional status.

Introduction

Industrialization has been recognized as the main solution to the problem of unemployment in developing countries like India, in recent years. There has been a steady increase in the number of persons employed in various factories, over the past few years. The majority of these employees may be referred to as 'workers' or 'labourers'. The overall production of the factories (and thus the national income) depends to a great extent, on the work efficiency of the workers, which is closely related to their health and nutritional status[1,2]. Work efficiency may be predicted from body size and superficial appearance[3].

Although malnutrition has been known to be a major public health problem in developing countries, data on nutritional status of factory workers are lacking. Information gathering on all segments of population is essential for formulating programmes and policies aimed at improving nutrition. Therefore, a project was undertaken to study the nutritional status of factory workers. Food and nutrient intakes, anthropometry and clinical status are presented.

Limitations of the study

1 For practical reasons, the survey was conducted only during the working hours of the factories. Some factories were not willing to spare workers for survey during working hours as in their opinion, this would affect the factory's production adversely. Thus only four factories were surveyed.
2 It was not feasible for the investigators to survey the workers who were doing evening or night duties, thus only 'day shift' workers were chosen. The population sample surveyed was randomly selected by personnel management. Absenteeism was not a basis for non-inclusion.

Methods

The survey was conducted in the factories located in the 'Tarai region' of Nainital district, Uttar Pradesh (U.P.), North India. Nainital is about 300 km from Delhi and the survey site lies in the Himalayan area. Ethical norms for medical research, as described by Walton et al[4], were followed during the entire study. The study subjects were neither compelled to participate in the survey nor subjected to any kind of risk. Data collected are being utilized only for welfare of industrial workers.

After obtaining preliminary information about all the industries of the district, which were 49 in number, four accessible industries were selected for the survey. All available workers on 'day duty' were chosen. The sample size was 195 male adult workers randomly selected from the four factories. The sample details are shown in Table 1. The survey was conducted by trained personnel. Using an interview protocol, general information about the workers was collected,

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Table 1. Sample selection.

Factory no	Total number of workers	Number of shifts	Number of workers in day shift	Number randomly studied
1	3000	3	1000	60
2	100	2	50	50
3	125	2	65	51
4	106	1	106	34
Total	3331	–	1221	195

Table 2. Scores allotted to clinical signs of nutritional deficiencies.

Sign	Score
Bitot spot	1
Conjunctival xerosis	1
Corneal xerosis	1
Corneal vascularization	1
Night blindness	1
Angular stomatitis	1
Cheilosis	1
Red tongue	2
Magenta tongue	2
Atrophic papillae	1
Swollen gums	1
Bleeding gums	1
Pale nails	1
Flat nails	1
Spoon shaped nails	1
Nasolabeal seborrhoea	1
Dermatitis of extremities	1
Enlarged thyroid	1

including socio-economic status and dietary practices. Questions were also asked about the industrial food service, including menu items, number of meals purchased by the worker and if not purchased, the reasons for not purchasing. Anthropometric measurements including height, weight and mid upper arm circumference (MUAC) measurements were taken by standard procedure[3]. Body mass index (BMI) was computed and classified by the method suggested by Naidu et al[5]. A clinical survey was conducted by the method of Jelliffe[3] and scores for clinical signs of nutritional deficiencies were determined by the method of Swaminathan[6]. The scores allotted to clinical signs are shown in Table 2. Data were collected for both summer and winter and averages calculated. The data were subjected to statistical analysis. Means ± standard deviations (SD) were computed. For studying the relationships among different parameters, simple correlation studies were done and correlation coefficients ('r' values) were computed.

Results

Background information about factories

The factories were mainly manufacturing food products, paper, wood products, cotton and textiles, machinery parts, tools, electrical appliances, communication equipment and gas. The work was being done partially by machines and partially manually. Based on the classification of Satyanarayana[7] the work fell in the moderate category. The working period per day for a worker was 8 h and most of the industries had 2–3 shifts per day. Employees were generally male adults. Canteens were run by contractors who had low levels of formal education and who did not possess professional qualifications in foods and nutrition, and function mainly to serve tea and snacks. Meals were not commonly served.

General information about workers

The majority of workers came from different parts of Uttar Pradesh state and the remainder immigrated from other states of India. A small proportion (16%) lived in residential colonies provided by the factories; the others lived in their own houses at a distance of 5–16 km from the work place and came for duty on bicycles or buses. Besides the pay from the 8-h duty in the factories, generally the workers had no occupation or other sources of income. The mean age of workers was 27.7 ± 7.3 years. About 29% of them were illiterates, and of the remainder, the majority had less than 10 years of schooling. Mean family size was 5.8 ± 2.7 and in most cases the worker was the only wage-earning member of the family. Per capita income (PCI) per month was 342 ± 194 rupees. The frequency distribution of subjects based on income is shown in Table 3. A per capita income below which a diet providing at least 2100 kcal (per person per day) in the urban and 2400 kcal in the rural areas can not be purchased/consumed is considered as the poverty line. Based on the norms adopted in the seventh 5-year plan[8], Razdan[9] has indicated this amount to be 122 rupees per month in the urban areas (from where the present sample was drawn). About 6% of the subjects in the study fell below the poverty line.

Table 3. Income distribution of workers.

Per capita income (rupees per month)	Percentage of workers
Below 122	5.6
122–200	22.1
201–300	25.1
301–400	19.0
401–500	11.8
Above 500	16.4

Table 4. Mean± SD* of daily food and nutrient intake.

Foods	Mean intake ± SD* (g/day)	Nutrients	Mean intake ± SD* (per day)
Cereals	429 ± 117	Energy	2135 ± 583 kcal
Pulses	37 ± 29	Protein	62.3 ± 18.9 g
Green leafy vegetables	7 ± 18	Fat	28.1 ± 15.3 g
Other vegetables	103 ± 57	Calcium	456 ± 282 mg
Roots and tubers	102 ± 52	Iron	16.7 ± 5.1 mg
Milk and milk products	152 ± 198	β-carotene	976 ± 1197 μg
Sugar and jaggery	11 ± 10	Thiamin	1.8 ± 0.5 mg
Fats and oils	28 ± 15	Riboflavin	1.0 ± 0.4 mg
Meat/fish	16 ± 28	Nicotinic acid	17.8 ± 5.1 mg
Eggs	3 ± 10	Ascorbic acid	29.6 ± 18.5 mg
Fruits	9 ± 38		

Food pattern and nutrient intake
Table 4 shows the mean daily intake of food and nutrients of the workers. The day-to-day dietary pattern was similar during the survey period. Cereals (rice and wheat) predominated in the diets and were eaten with small quantities of pulses and non-leafy vegetables. Leafy vegetables were consumed occasionally in winter. Although the majority of the workers were non-vegetarians by food habit flesh foods were rarely consumed for economic reasons. Milk and fruits were also not consumed in sufficient quantities. When compared with the RDI (recommended dietary intakes)[10] it was found that majority of the subjects were not consuming the recommended quantities of most of the nutrients. The percentage of men receiving the recommended quantities were: energy 13, protein 51, fat 68, calcium 45, iron 3, β-carotene 14, thiamin 72, riboflavin 9, nicotinic acid 44 and ascorbic acid 26.

Table 5. Frequency distribution of workers based on anthropometric parameters.

Parameter	Class	Percentage of workers
Height (cm)	Below 150	1.0
	150–165	65.1
	165–180	33.9
Weight (kg)	Below 50	36.4
	50–60	48.2
	60–70	11.3
	Above 70	4.1
BMI (kg/m^2)	Below 16	1.0
	16.0–17.0	4.1
	17.0–18.5	14.9
	18.5–20.0	34.4
	20.0–25.0	41.0
	25.0–30.0	4.1
	Above 30	0.5
Mid upper arm circumference (cm)	17.6–20.5	3.6
	20.5–23.4	39.5
	23.4–26.3	40.5
	26.3–29.3	13.8
	Above 29.3	2.6

Anthropometry
Height of the workers ranged from 140 cm to 179 cm with a mean of 161.3 ± 6.0 cm. Weights fell between 36 and 85 kg (52.7 ± 7.6 kg), mid upper arm circumference (MUAC) 19.0 to 31.5 cm (24±2.3 cm) and body mass index 14.9 to 30.3 (20.2 ± 2.4). The frequency distribution based on anthropometry is presented in Table 5.

Clinical status
Table 6 provides prevalence figures of deficiency signs suggestive of deficiencies of vitamin B complex, vitamin C and iron. About 33% of the subjects also showed the dental symptoms 'mottling' or discolouration. This was studied due to its epidemiological relationship with dietary habits, although it is not strictly a deficiency sign.

Table 6. Percentage prevalence of nutritional deficiency signs in workers.

Clinical sign	% prevalence
Cheilosis	2.1
Magenta tongue	0.5
Red, raw tongue	3.6
Atrophic lingual papillae	2.1
Corneal vascularization	2.1
Swollen/Bleeding gums	2.1

Correlations
The correlations among different parameters under study are summarized in this section. As far as the anthropometric parameter 'height' is concerned only a small proportion of subjects had not reached adulthood. The age range was 15–54 years, two workers were 16 years old, 27 were of 17–20 years and the remaining 166 were 21 or more years old. Height of adults is a reflection of childhood nutritional status, rather than current nutrition[11].

Relationship between anthropometric status and clinical scores. The correlation coefficient values obtained for anthropometric parameters with clinical scores were: height –0.15, weight –0.34, body mass index –0.31 and mid upper arm circumference –0.36, and are statistically significant. The clinical signs of nutritional deficiency were more in number and the intensity was more in workers who had poorer anthropometric values, and height had the least relationship with clinical scores.

Table 7. Correlation coefficient values of anthropometric parameters and clinical scores with education and income.

Parameter	'r' values with Education	'r' values with Income (PCI)
Height	0.31**	0.13
Weight	0.39**	0.24**
BMI	0.27**	0.19**
MUAC	0.25**	0.22**
Clinical score	–0.29**	–0.16*

* Significant at 5% level.
** Significant at 1% level.

Effect of education on anthropometric and clinical status. Table 7 shows the correlation coefficient values obtained for the anthropometry and clinical scores with the education level of workers. Workers having higher education level had better anthropometric values and fewer number (less intense) of clinical signs of nutritional deficiencies.

Effect of income on anthropometric and clinical status. Table 7 also depicts the 'r' values of height, weight, body mass index, mid upper arm circumference measurements and clinical scores with the per capita income of workers. Height was the only parameter which did not show any significant correlation with per capita income and clinical signs. The other body measurements were significantly (positively) influ-

Table 8. Correlation coefficients of anthropometry with nutrient intake of workers.

Nutrient	'r' values with Height	Weight	BMI	MUAC
Energy	0.17	0.26	0.20	0.20
Protein	0.16	0.22	0.17	0.18
Fat	0.09*	0.25	0.25	0.21
Calcium	0.20	0.20	0.13*	0.18
Iron	0.15	0.18	0.12*	0.13*
β-carotene	0.22	0.24	0.17	0.20
Thiamin	0.19	0.21	0.13*	0.14
Riboflavin	0.27	0.30	0.20	0.25
Nicotinic acid	0.15	0.14	0.07*	0.08*
Ascorbic acid	0.15	0.27	0.23	0.24

Values with (*) only are not significant

enced by income. With increasing income, the number and intensity of nutritional deficiencies decreased.

Relationship of anthropometry with dietary intake. Weight, in general, was found to be more correlated with dietary intake of most of the nutrients, although height, body mass index and mid upper arm circumference also showed significant 'r' values with the intakes of several nutrients (Table 8).

Relationship of social status to dietary intake. Study of the relationship of education and per capita income (PCI) with dietary intake of various nutrients revealed that education exerted a significant (positive) influence on energy (r = 0.21), protein (r = 0.17), fat (r = 0.23), β-carotene (r = 0.14), riboflavin (r = 0.20) and ascorbic acid (r = 0.16) consumption. With the PCI also a positive trend was noticed, although the 'r' values were not statistically significant.

Discussion

Since work output is influenced by nutritional status, the nutritional status of workers is of concern. Underweight with body mass index less than 18 has been found to be associated with lower work output according to some Indian studies[1,2]. There are also studies from other countries in more recent years, suggesting that even marginal malnutrition among men may have deleterious effects on vital functions. In a meeting held under the auspices of the World Health Organization in 1987, the significance of mild-to-moderate malnutrition was highlighted, as summarized by Buzina et al[12]. Marginal malnutrition, including subclinical vitamin and mineral deficiencies can affect some vital functions such as physical work capacity (PWC), immunological competence, cognitive functions and behaviour. In malnourished Columbian men the loss of PWC was largely due to decreased muscle mass and, in a group of severely malnourished individuals PWC and other indices could be partially corrected by a supplement of good quality meat in controlled hospital environment. Of the micro-nutrients iron has been shown to have the clearest relationship with PWC and even mild deficiency is of significance. The B complex vitamins, particularly thiamin and riboflavin, and vitamin C showed a strong influence on PWC. When these intakes were 20% below the recommended dietary intakes, seven out of the eight studies in the United States of America (USA) showed a deleterious effect on PWC. Similar reports have been made by James et al[13], who have discussed the findings of several scientists in different countries. The report indicates close association of low body mass index with reductions in lean tissue, serum albumin levels and VO_2 max.

Poor body measurements and varying degrees of clinical nutritional deficiency signs among factory workers have been reported not only in India but also in other parts of the world. Among Pakistani workers, underweight and low subcutaneous fat deposits were common problems[14]. Vitamin A and riboflavin deficiencies and anaemia have been widespread among workers of Kenya[15]. Even in advanced countries like the USA, signs and symptoms of malnutrition due to deficiencies of vitamin A, riboflavin, and thiamin have been seen in workers[16]. Earlier studies in India have shown results similar to those obtained in the present study. Workers in Hyderabad had low anthropometric measurements[17]. The industrial labour surveyed by the National Nutrition Monitoring Bureau[18, 19] showed clinical signs of vitamin A deficiency in 2.6% and B complex deficiency in 2.7% of the subjects. In the year 1981 the survey of National Nutrition Monitoring Bureau[20] included the state of Uttar Pradesh (from where the present sample was drawn), Average daily consumption of energy, vitamin A and riboflavin were below the recommended dietary intakes. Clinical signs of B complex deficiency were noticed among 1.4% of the adult males. For the years later than 1981, the Bureau has not published any data on this subject with respect to the state of Uttar Pradesh. In the mid 1950s 8% of the workers surveyed in a Bombay factory were found to have angular stomatitis and 50% of the male workers were anaemic[6]. The same author[6] reported that among the 974 workers surveyed in Ahmedabad, the percentage prevalence of angular stomatitis was 1.4, glossitis 4.9, and in general, they were underweight.

The low body mass index of more than half of the subjects of the present study suggest that the workers were not meeting their energy requirements. According to the sub committee of International Dietary Energy Consultative Group (IDECG), body mass index values between 20 and 25 are normal and between 18.5 and 20.0 are 'low weight normal', whereas, values below 18.5 correspond to chronic energy deficiency and those above 25.0 correspond to obesity[5]. It has been proposed by several scientists[5, 13] that body mass index values below 18.5 may further be classified into three grades of chronic energy deficiency (CED), that is, 17–18.4 CED grade I, 16.0–17.0 CED grade II and below 16.0 CED grade III. A BMI of 17 or below is taken as too low and as constituting a substantial risk to health. Gibson[21] has suggested that values below 20 may be considered as underweight and may be associated with health problems for some individuals. The diet survey of subjects in the present study had revealed that, in general, the intake of cereals was lower than the recommended quantities[22]. The prevalence of energy deficiency as well as some of the other deficiency signs noticed clinically could have been lower if the cereal intakes had reached the recommended levels.

While reporting the clinical signs, the authors agree with other scientists[3, 21] that clinical measures are general and not necessarily specific to deficiencies of individuals nutrients. It is, however, agreed upon generally that in field studies it may not be feasible to confirm clinical signs with laboratory experiments. Thus nutritionists continue to hold the view that clinical signs may be used as indicators of nutritional deficiencies when studied along with anthropometry and dietary data. However, data on haemoglobin have been collected by the Indian Council of Medical Research[10] and iron deficiency anaemia has been reported to be common among Indian adult men also, although the prevalence is greater among women and children. In the present study, iron deficiency is most likely to be a contributing factor for the atrophic lingual papillae noticed in about 2% of the subjects. Other than this, some of the B complex deficiencies are likely to be responsible for the sign. For both iron and B complex vitamins, cereals are significant sources in Indian diets[10] and thus higher intake of this food item could have prevented the deficiency sign, to a great extent. However, poor consumption of milk was mainly responsible for the riboflavin deficiency. The vitamin C deficiency signs, swollen and/bleeding gums, is attributed to low intake of fruits and green leafy vegetables.

While on one hand it may be recommended to increase the intakes of low-cost foods like cereals, leafy vegetables and some of the fruits, an improvement in wages is recommended on the other. It is known that wages are low in case of Indian workers. The positive correlation of income with nutritional status strongly suggests that there is an urgent need to pay higher wages.

Providing subsidized meals at the work site has been recommended by some earlier scientists[14, 15, 23] as an effective measure to improve the nutritional status and work output. In the present investigation it was observed that, about 15% of the factories had canteens to serve meals to the workers on duty. The subsidy provided by them varied from 25 to 50% of the cost price. However, only a small proportion (15%) of workers utilized the canteen facility regularly (they had the option either to eat from canteen or from home). The reasons reported for such poor utilization were: (1) monotony of taste in food preparations and (2) eating from canteen would entail a reduction in the 'carry-home' salary – they felt that there would not be any difference in the family's expenditure whether one of the members ate one meal there or not. Although nutritionally the canteen and home meals generally differ (canteen giving higher values), the workers' main consideration was not of nutrition, but of expenditure. Thus while it is suggested that all industries should provide maximum subsidy on meals, it is also emphasized that conditions attracting all employees to eat from the canteen also need to be created. Deducting 'lunch money' from the salary of each staff may lead to a 100% attendance at canteen lunch, however if this has to be done the industrial management has to ensure that the meal meets not only nutritional requirements but other requirements such as palatability. Stewart and Wahlqvist[24] have reported that shift work may have some influence on canteen food purchase and food intake pattern of workers. Their Australian study showed that the frequency and energy density of foods purchased from canteen varied among day shift, afternoon shift and night shift workers. Although such effects are possible in the subjects of present study, no conclusions are drawn, as these have not been studied by us.

Nutritional education of the workers may be beneficial to encourage the workers to eat from the canteen. Nutritional education may also help in proper selection of food items. Stewart and Wahlqvist[24] found a significant change away from consumption of higher energy density food items towards the lower density category after a 1-year nutrition education programme among aluminium plant workers directed at weight control and hyperlipidaemia. The positive correlation of education with nutritional status suggests that measures need to be taken to improve the education levels of the workers. Other scientists[25, 26] have also reported that major differences in nutritional intake even among people earning the same amounts of money may be found due to different education levels. Other than formal education, health and nutrition education can form a component of intervention programmes.

While dietary intake, income and education have important roles in anthropometric and clinical nutritional status, other indirect factors such as unhygienic living and working conditions and poor medical facilities may also be contributory. These need to be studied in factory workers.

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一些印度工廠工人的生理測量和臨床營養狀況

摘要

作者在北印度 Nainital 地區測定了 195 位男工廠工人的生理測量和臨床營養狀況，他們評估了生理測量與臨床得分間的關係，同時評估了營養狀況和教育或收入之間的關係，結果發現平均值 ± 標準差值爲：身高 161.3 ± 6.0 厘米、體重 52.7 ± 7.6 公斤、體質指數（BMI）20.2 ± 2.4 和中上臂圍（MUAC）24.0 ± 2.3 厘米。體質指數低於 20 的對象有 57%，這個數值 FAO 預測會增加工作操作的危險。體質指數低於 18.5（相當於慢性能量營養不良）的對象約有 20%。營養缺乏症狀的對象有：複合維生素 B 缺乏 10.76%、維生素 C 缺乏 2.05% 和鐵缺乏 2.05%。臨床得分與生理測量值呈負相關，即營養缺乏症狀增加，生理測量值下降。教育程度和每人收入水平似對營養狀況有良好影響。