Anthrop. Anz. **Jg. 63** 4 449–460 Stuttgart, Dezember 2005

Effect of skill on work productivity and physical body dimensions of the Oraon tea garden labourers of the Jalpaiguri district, West Bengal, India

Subrata K. Roy, Arupendra Mozumdar and Sujata Kar

Biological Anthropology Unit, Indian Statistical Insitute, Calcutta, India

With 1 figure and 5 tables

Summary: Skill is one of the factors influencing labour productivity of manual labour. The present study aims to find out the possible relationship between skill and productivity and between skill and physical body dimension among the tea garden labourers of Northern West Bengal, India. Skill was measured by indigenously devised test protocols developed only for this purpose. Productivity or labour output was measured in terms of amount of tea leaves (in weight) plucked in a day by an individual. Physical body dimension was recorded in terms of a list of anthropometric traits. The results show an inconsistent relationship between skill and productive output and a non-significant relationship between skill and physical body dimensions. However, there are some trends that skill is high in younger individuals and low skill in females is associated with relatively high fat accumulation in the body.

Key words: Oraon labourers, Skill, Tea leaf plucking, Anthropometry.

Zusammenfassung: Die Geschicklichkeit ist eine der Fähigkeiten, welche die Arbeitsproduktivität von Handarbeitern beeinflusst. Die vorliegende Untersuchung hat das Ziel, an Teeplantagenarbeitern aus Nordwest-Bengalen (Indien) einen möglichen Zusammenhang zwischen Geschicklichkeit und Produktivität auf der einen Seite und Geschicklichkeit und körperlichen Charakteristika auf der anderen Seite zu erfassen. Dabei wurde die Geschicklichkeit an Hand von Testprotokollen bestimmt, die eigens für diesen Zweck entwickelt worden sind. Die Produktivität der körperlichen Leistung wurde an Hand des Gewichts der Teeblätter bestimmt, die von den einzelnen Arbeitern an einem Tag gepflückt wurden. Die körperlichen Charakteristika wurden an Hand einer Reihe von anthropometrischen Merkmalen erfasst. Die Ergebnisse zeigen eine inkonsistente Beziehung zwischen Geschicklichkeit und produktivem Ergebnis sowie eine nichtsignifikante Beziehung zwischen Geschicklichkeit und körperlichen Charakteristika. Allerdings ergaben sich einige Trends insofern, als bei jüngeren Individuen die Geschicklichkeit beträchtlich ist, gering dagegen bei Frauen mit relativ hohem Körperfettanteil.

Schlüsselwörter: Oraon-Arbeiter, Geschicklichkeit, Pflücken von Teeblättern, Anthropometrie.

Introduction

It is generally known that the tea industry holds a considerable potential for the economic development, as it earns substantial foreign exchange and provides em-

ployment to a large number of people in India. The production of tea mainly depends on human labourers, who pluck green tea leaves in the tea gardens. In India, tea plucking is done manually; both male and female labourers participate in the job of tea leaf plucking. The more the green leaves plucked by the individual, the more the production of tea.

It is often understood and evidences have shown that physical work performance or capacity for work is influenced by many factors, for instance, biological (e.g. age, sex, body dimensions, etc.), psychic (attitude, motivation, etc.), environmental (altitude, air pressure, heat, cold, etc.), nature of work (intensity, duration, technique, etc.), and training and adaptation (Åstrand & Rodahl 1977). Many studies conducted in different countries have suggested that adult body dimensions, e.g. height, weight, etc. have positive relationships with work capacity or productivity (Harrison et al. 1977). Wyndham et al. (1963) used the criteria of body weight as a rapid method of screening Bantu mining recruits. Basta et al. (1973) found no relationship of weight and height with work capacity among Indonesian road construction workers. Spurr et al. (1977) observed a significant negative correlation between percent body fat and productivity among Columbian sugarcane workers. A positive relationship of height with productivity was reported from Guatemala (Immink 1978). In India, a positive relationship between work output (in terms of number of fuses produced per day) and body size has been recorded among industrial workers engaged in the preparation of safety fuse wires for detonation (Satyanarayana et al. 1977). On the other hand, Sukhatme (1982), studying the work output of women (in terms of the number of "chapatis", a type of hand made bread, produced per hour) and their energy intake and body weight, failed to find any relationship. However, the most extensive use of somatotyping has been used in evaluating the relationship between physique and physical performance of the athletes (Carter 1970, de Garay et al. 1974). Unfortunately, there is no literature on the relationship of actual work productivity and somatotyping. Skill is the acquired fitness (resulting out of training and adaptation) or intelligence or any natural endowment, which helps individuals to do a job more efficiently than other individuals. In any work situations, where manual labour is necessary, skill is one of the inevitable components for the better performance. Although it is intuitively understandable that skill may contribute substantially to the productivity, to our knowledge there is no published literature to establish this relationship.

It is worthwhile to clarify the term 'work performance', which is often used somewhat loosely in various senses, such as physiological working capacity measured by oxygen consumption or by actual productive output or productivity, measured in terms of the amount of work done. In the present study the term 'productivity' has been consistently used to mean the productive output of an individual in tea leaf plucking in a day. It should be noted that individual tea leaf plucking is measured in quantitative terms (weighing of green leaves plucked by the individual) in most of the tea gardens of India. Green tea leaves are weighed 4 times a day and extra remuneration is paid for the extra plucking (this could obviously control the motivational factor in plucking) and 22 kg plucking per day is considered as the statutory task of the individual.

Following from this, the consideration of the present article is to find out a relationship with skill and other variables (productivity, physical body dimensions,

etc.). In view of these, the present study was undertaken among the Oraon labourers of two tea gardens in the Duars area under the Birpara police station, Jalpaiguri District, West Bengal, to look into the following:

1. Is there any relationship between skill and productive output/productivity?
2. Is there any relationship between skill and physical body dimensions?

Material and method

A total number of 182 individuals (93 males and 89 females) were selected for the present study. The subjects were tea leaf pluckers, selected from the tea gardens of Birpara and Dalgaon tea-estates of the Alipurduar sub-division of the Jalpaiguri District. The present study is based on the partial data collected in connection with a bigger research project conducted in the area.

The Oraons are numerically dominant in the Jalpaiguri District and they are predominantly a larger group in most of the tea gardens in the district as well. Oraons are well known for their efficiency as tea garden labourers, because tea garden authorities used to prefer Oraons than the locals, as local people used to suffer from malaria very frequently, which hampers the work of the tea gardens. Oraons are supposed to be the inhabitants of Chotanagpur and Santal Parganas of Bihar (presently Jharakhand State). They were brought into this area by the labour contractors as labourers in different industrial sectors (especially in the tea gardens) at the end of the 19th century (Choudhuri 1978). Linguistically the Oraons belong to the Kurukh or Dravidian speaking group (Dalton 1872). The study was restricted to an endogamous and single ethnic group – the Oraon, in order to eliminate possible ethnic (genetic) variation in physical traits.

Data set

Anthropometric measurements were taken by a single investigator (SKR) using a single set of standardized instruments following standard techniques (Weiner & Lourie 1981). A calculation of technical errors of measurements was not determined and therefore is likely to have bias in the observation.

Anthropometric somatotype scoring has been done following Carter & Heath's multiple regression equation (Carter & Heath 1990). Endomorphy was determined by using the following formula: $-0.7182 + 0.1451(X) - 0.00068(X^2) + 0.0000014(X^3)$, where X is the sum of the triceps, subscapular and suprailiac skinfold thickness, adjusted for stature [i.e., X = sum of skinfold thickness × (170.18 cm/stature)]. Mesomorphy was determined using the following formula: [(0.858 × bi-epicondylar diameter of femur) + (0.601 × bi-condylar diameter of humerus) + {0.188 × (upper arm circumference – triceps skinfold)} + {0.161 × (calf circumference – calf skinfold)}] – (stature × 0.131) + 4.50. Ectomorphy was obtained by using the reciprocals of the Ponderal Index, and the formula is HWR (Height-Weight Ratio) × 0.732 – 25.58, where HWR = stature/weight$^{0.333}$. If HWR is less than 40.75 but greater than 38.25, ectomorphy is determined by using HWR = 0.643 – 17.63. If HWR is less than 38.25, a rating of 0.1 is assigned to the ectomorphic rating (Carter & Heath 1990).

Skinfold measurements were taken at four sites such as triceps, subscapular, suprailiac and calf. Body density was calculated following Durnin & Womersley (1974). Following equations were used for calculating body density: in males [1.1704 – 0.0731 × Σ SKT*] and in females [1.1327 – 0.0643 × Σ SKT*]. Then body fat percentage was calculated following the formula of Siri (1956): (4.95/body density – 4.5). The total body fat was estimated by the prediction equation: fat % × weight/100. *Σ SKT = sum of triceps, subscapular and suprailiac skinfold thickness.

Tea leaf plucking and skill test

The present skill test method was developed and devised for the pluckers (those who pluck green leaves from the bushes) only. Before describing the method of the skill test, it would be worth to illustrate briefly the actual tea plucking method, which is usually followed in most of the tea gardens in the area. This will help to understand the skill test more clearly. Generally, tea leaf plucking is done manually by human labourers. The tea plants are maintained as dwarf bushes, which are 3–4 feet high. Tea plants are transplanted maintaining uniform rows and columns, at maturation each tea bush produces the flushes (young leaves) in every seven or eight days during the hot and wet months. The pluckers pluck the flushes having two leaves and a bud during their eight hours duty schedules. The pluckers nip off a single flush between their fingers until their palms are full and throw them into the bag hanging at their back (Fig. 1, left). Both hands move simultaneously over each bush with a great speed. The output of plukking is measured in terms of the weight of the green tea leaves plucked out of an eight hours duty schedule.

The review of literature shows the lack of a standardized and conventional method of skill test for tea leaf pluckers. Therefore, the present skill test was specially designed for the present purpose by the Patiala University and the Netaji Subhash Institute of Sports, Patiala, Punjab. Because of the non-universality of the present skill test method, it would be necessary to describe the method in detail.

The test was performed by placing two wooden trays on a table (Fig. 1, right) at the height of 3–3.5 feet (considering the height of a tea bush) with 100 marbles in each tray. Each tray consists of 100 holes for the accommodation of marbles, which were placed in the holes of the trays (seems to represent flushes). The subjects were asked to tie the bag (as used in the tea gardens during plucking for collecting tea leaves) on their back and were asked to pick up the marbles from the trays as quick as possible. The subjects were strictly instructed not to pick up more than one marble at a time and to use both hands simultaneously. The time taken by each

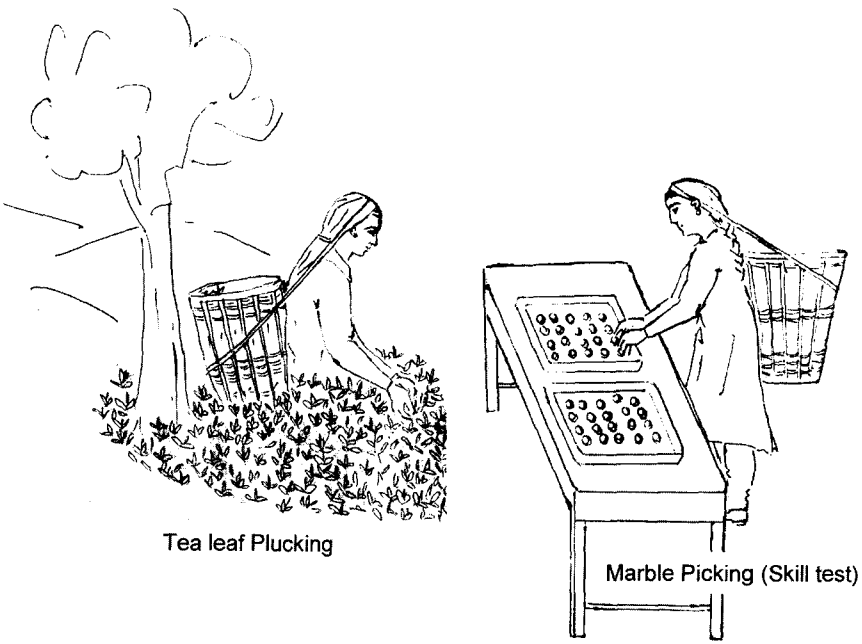

Fig. 1. Tea leaf plucking in the field (left side); skill test (right side).

individual to pick up 200 marbles from the trays was recorded with the help of a stopwatch. In the present study the skill is measured in terms of the time taken by each individual in picking up 200 marbles. The more the time needed for picking up marbles seemed to be poor skilled and the less the time needed are skillful. Therefore, in the data the time is more for low skill labourers and average time is less for high skill labourers.

No statistical sampling of the individuals has been done because of the obvious difficulties in the field, e.g. suspicion against selection of individuals. But the subjects were chosen without any conscious bias, actually the subjects who could be persuaded to participate in the study and volunteer themselves to participate in the study were taken for measurement. However, in selecting the subject, at least 5 years plucking experience was considered, because according to the tea garden authorities each plucker requires at least 4 years of training to reach the optimal skill in plucking. Therefore, the data collection was limited to the adults only, who had at least 5 years of experience in plucking. Age estimation was certainly a great problem in the field, where written records were not available in most of the cases, especially in this community. But age was corrected in all possible ways such as reference with the important local events of recent history and of course cross checking from the elderly individuals of the community.

Analysis

As has been mentioned earlier that the presently used skill test method is not a standard anthropological test, therefore, there is no age or sex-wise standard time-score for the test. In view of this, the subjects were classified into two groups, on the basis of the median values of time-score in the skill test for either sex separately. Therefore, there are two groups in each sex, which have been designated as low skill group (skill test scores for males are => 144.0 seconds and for females are => 146.0 seconds) and high skill group (skill test scores for males are < 144.0 seconds and for females are < 146.0 seconds). The classification has been done for the comparison of the data between the groups.

The SPSS (Release 7.5.1) package was used to carry out statistical analyses. The t-test values were compared within each sex, to access the significance of difference between the low and high skill groups for all the traits under study. Since the high skill groups in both sexes seem to be younger compared to the low skill groups. Therefore, a regression analysis was done to eliminate the possible effect of age on the traits, which show a significant correlation with age. Then t-values were again calculated on the residuals of those traits.

To identify, which of the variables (i.e., anthropometric measurements and indices) are significantly related to skill test scores and were useful for predicting it, we carried out a stepwise regression analysis. Firstly, we build up a multiple regression model to predict skill test scores in a stepwise manner by entering and/or removing one variable at a time from a list of potential predictors. The aim was to select a good set of predictor variables under study, i.e., to separate the more important variables from those that are less necessary. In this analysis, the variables were included in a stepwise manner by entering the variable of addition which would maximize R^2 most at each step. Secondly, since most of the variables, including skill, were strongly dependent on age, we first regressed out the linear effect of age from all variables, including BMI [although it is well documented that BMI is less influenced by age (Shetty & James 1994), but in the present study BMI seemed to be affected by age in the case of females]. The age-corrected values of the variables were then used to identify significant predictors of the skill test. The default tolerance level was 0.0001 at each step.

Somatotype data were analyzed with MANOVA, considering all three somatotype components as a matrix. MANOVA was originally developed by Wilks in 1932 and was used in the analysis of somatotype data by Cressie et al. (1986). MANOVA results are expressed as the value of Wilks' Λ (lambda), a standard statistic (together with its p-values). Then MANOVA was performed to find out the existence of differences between components of the two groups.

Table 1. Descriptive statistics of different variables in both sexes.

	Male					Female				
	High skilled N = 47		Low skilled N = 46		t df = 91	High skilled N = 45		Low skilled N = 44		t df = 87
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Age (years)	27.39	5.45	33.34	10.3	3.47*	32.07	8.59	36.57	11.68	2.07*
Stature (cm)	161.6	5.58	159.62	6.65	–1.55	150.01	4.62	149.43	5.11	0.55
Weight (kg)	48.61	4.18	48.31	6.77	–0.25	40.14	4.37	39.95	4.5	0.20
Body Mass Index	18.6	1.18	18.89	1.68	0.93	17.82	1.59	17.88	1.75	0.17
Upper arm circumference (cm)	23.58	1.36	23.26	1.56	–1.08	20.65	1.54	20.95	1.68	0.87
Calf circumference (cm)	29.45	1.71	29.27	1.99	–0.47	27.46	2.07	27.47	1.99	0.01
Triceps Skinfold (mm)	4.59	0.98	5.08	1.43	1.92	6.96	2.31	8.27	3.53	2.07*
Sub-scapular Skinfold (mm)	8.57	1.46	8.88	2.74	0.66	9.07	2.39	10.65	4.23	2.18*
Supra-iliac Skinfold (mm)	4.48	0.77	4.86	1.38	1.62	5.14	2.04	4.92	2.31	0.48
Calf Skinfold (mm)	5.06	1.47	5.15	2.09	0.25	6.69	1.72	7.17	2.99	0.94
Total Body Fat (kg)	4.14	1.13	4.53	1.89	1.20	8.98	2.16	9.39	2.62	0.80
Bi-condylar diameter of Humerus (cm)	5.92	0.56	6.03	0.46	1.04	5.2	0.38	5.34	0.28	1.96
Bi-epicondylar diameter of Femur (cm)	8.7	0.51	8.76	0.39	0.61	7.91	0.37	8.01	0.35	1.39
Output (kg)	36.98	14.67	33.44	12.27	1.26	33.75	14.54	32.00	10.44	0.65

* Significant at 5% level.

Table 2. Descriptive statistics of residual values (eliminating the effect of age) in both sexes.

	Male					Female				
	High skilled N = 47		Low skilled N = 46		t df = 91	High skilled N = 45		Low skilled N = 44		t df = 87
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Stature (cm)	0.33	5.67	–0.34	6.22	0.54	–0.04	4.35	0.04	4.90	–0.09
Weight (kg)	–0.26	4.25	0.27	6.52	–0.47	–0.40	3.70	0.41	3.79	–1.03
Body Mass Index	–0.15	1.18	0.16	1.69	–1.03	–0.17	1.45	0.18	1.58	–1.10
Upper arm circumference (cm)	0.00	1.47	0.00	1.43	–0.01	–0.25	1.44	0.25	1.60	–1.56
Calf circumference (cm)	–0.16	1.88	0.16	1.71	–0.87	–0.16	1.95	0.16	1.83	–0.78
Triceps Skinfold (mm)	–0.10	0.98	0.10	1.40	–0.77	–0.72	2.25	0.74	3.50	–2.35*
Sub-scapular Skinfold (mm)	0.15	1.74	–0.15	2.49	0.68	–0.91	2.24	0.93	4.18	–2.60*
Supra-iliac Skinfold (mm)	–0.10	0.94	0.10	1.30	–0.87	–0.04	1.85	0.04	2.26	–0.18
Total Body Fat (kg)	0.09	1.24	–0.10	1.80	0.59	–0.21	2.16	0.22	2.62	–0.84

* Significant at 5% level.

Table 3. Descriptive statistics of Skill (time in seconds) in different age groups in both sexes.

	Male			Female		
Age Groups	N	Mean	SD	N	Mean	SD
< 25 years	26	140.8	19.7	18	143.6	23.0
25 – 34 years	48	141.9	22.0	35	145.8	19.6
35 – 45 years	9	157.8	20.8	20	145.9	23.4
> 45 years	10	183.2	37.9	16	165.3	31.3

Table 4. MANOVA of somatotypic components in both sexes.

	Wilks' Lambda	F	df	Sig.
Males	0.939	1.939	3, 89	0.129
Females	0.948	1.550	3, 85	0.208

Results

Table 1 shows the descriptive statistics of anthropometric traits and age of the low and high skilled labourers for both sexes. The comparison between the groups reveals a significant difference in mean age in both sexes, and high skilled labourers are generally from a lower age group. Most of the anthropometric traits do not show any significant difference between groups in either sex, except the significant difference in the case of triceps and subscapular skinfold among the female groups only. Other anthropometric traits do not show any significant differences.

Table 2 shows the descriptive statistics of residual values of anthropometric traits between the low and high skilled labourers in both sexes after removing the effect of age. The anthropometric traits used here show a significant correlation with age. However, female groups show significant differences in triceps and subscapular skinfolds only and none of the traits among male groups seems to be significant.

In the present data, stepwise regression analysis was done to find out the best subset variables for suitable prediction of the skill performance. The table of analysis has not been presented, but the regression equation has been presented, which is valid for Oraon tea garden labourers, age ranges between 20 to 62 years.

The regression equation of skill taking all physical traits including age as independent variable is: Skill = 19.40628 + 1.607945 (age) + 13.25958 (bi-condylar diameter of humerus) in males and Skill = 121.0697 + 0.589012 (age) + 3.621561 (triceps skinfolds) – 3.9593 (suprailiac skinfold) in females.

Further, regression analysis was performed to see the changes in the prediction equation, if any, after removing the age. The following equations were computed: Skill = 147.571 + 22.29335 (residuals of suprailiac skinfold) – 62.4121 (residuals of total body fat) + 24.4041 (residuals of triceps skinfold) + 20.19653 (residuals of subscapular skinfold) + 5.5 (residuals of weight) in males and Skill = 148.8865 + 6.156849 (residuals of triceps skinfold) – 6.40189 (residuals of total body fat) in females.

Table 3 reveals the descriptive statistics of time scores of the different age groups in both sexes. The table shows that the time score (skill) is more with the increment

Table 5. ANOVA of somatotypic components in both sexes.

	Male						Female					
	High skilled N = 47		Low skilled N = 46		df (1,91)		High skilled N = 45		Low skilled N = 44		df (1,87)	
	Mean	SD	Mean	SD	F	Sig.	Mean	SD	Mean	SD	F	Sig.
Ectomorphy	3.862	0.806	3.533	0.933	3.318	0.072	3.547	1.021	3.536	1.033	0.002	0.962
Mesomorphy	2.709	0.826	3.054	0.685	4.818	0.031	2.244	0.809	2.466	0.845	1.595	0.210
Endomorphy	1.489	0.423	1.598	0.564	1.103	0.296	1.733	0.728	1.943	1.013	1.264	0.264

of age and the trend is similar in both sexes. Since all the age groups do not have a sufficient number of samples after classification, it was therefore not possible to see the age changes in skill (time score). But apparently the males show less skill at the 35–44 years age group and females at the 45+ years age group.

Multivariate analysis of variance (MANOVA) of somatotype components (ectomorphic, mesomorphic and endomorphic) was performed considering the somatotype components as a matrix between low and high skilled labourers for both sexes (Table 4). The analysis reveals that there is hardly any difference in somatotype components between the groups in either sex.

ANOVA has been done to see differences between groups in individual somatotype components. Table 5 represents the one way analysis of variance (ANOVA) of somatotype components (ectomorphic, mesomorphic and endomorphic components) among low and high skill labourers in both sexes. The analysis reveals a significant difference only in the case of mesomorphic components in males.

Discussion

The present study was undertaken to find out the relationship between skill and output (green tea leaf plucking performance) and between skill and few body dimensions of the Oraon tea leaf pluckers. The data have been collected from the Oraon individulas (both males and females) of the Birpara and Dalgaon tea estates of the Birpara area, Jalpaiguri District in Northern West Bengal. The data have been collected following standard protocols. Although the skill test was developed and devised for the present purpose, the method seems to have some limitations. It would have been better to fix up the time (as the time is fixed in the tea gardens for plucking) and to let the subject pick up the marbles from an unlimited number. But it seems difficult to count the number of marbles picked up by the subject within the particular time limit in the field situation. However, in the present study the method was slightly modified for the convenience of the study in the field. In actual working situations, plucking is done against some resistance of the tea bush; here the resistance is absent. Further, the pluckers usually pluck only the young flushes (two leaves and a bud) out of so many leaves and do not leave any young shoot unplucked. Therefore, there is a choice factor in actual plucking, which is absent in the skill test. Still the present skill test method was used for its operational simplicity.

The skill tests are generally used to know the level of ability of the individual in the sports activity. Therefore, skill tests often require the coordination of specific muscular activity, brain and eye. In view of this, the skill tests were performed and time scores were used to know the levels of ability of the individuals in the specific job (green tea leaf plucking in the present case). To our knowledge, there is no literature on the skill-productivity (work output in actual working situation) relationship, but it is intuitively understandable that skill may have some effect on the working performance of an individual in any specific job. The present analysis was based on the data collected on the pluckers, who have at least five years of plucking experience in order to minimize the training and adaptation effect. However, there were still great variations in plucking performance (output) within/between the subjects.

The results (Table 1) reveal that there is no significant difference between high and low skilled labourers in plucking output. But there is a trend, which may not be ignored. In both sexes, high skill labourers have a higher average plucking output than low skill labourers. Again the correlation coefficients computed between plucking output and skill in both sexes are not significant ($r = -0.15$ in males and $r = -0.009$ in females), but indicate the same trend as stated earlier. This result of negative correlation implies that those who are taking more time to pick marbles have less output in plucking and those who are taking less time have a high output.

The mean age of high skill labourers is significantly less compared to the low skill labourers in both sexes. The results indicate (Table 3) that the labourers have a tendency of scoring much time in skill with increasing age. This may be due to gradual deterioration of health and eye-hand coordination because of ageing.

Two male skill groups do not show any difference in anthropometric traits, however, among females, triceps and subscapapular skinfold thickness are significantly high in the case of low skilled groups (Table 1), even after removing the effect of age (Table 2). This indicates that low skilled females have more fat in the body than high skilled females. As it is generally known that accumulation of fat hampers physical fitness and flexibility, this may perhaps have affected skill of low skilled females.

Predicting skill from the variables under study reveals that age has certainly some effects on the skill in both the sexes. Beside age, male groups show biepicondylar diameter of humerus as the predictor variable and female groups show skinfold variables of two sites (triceps and suprailiac). After removing the effect of age, the predictor variables changed (suprailiac, triceps and subscapular skinfolds, total body fat and body weight in males and triceps and total body fat in females). Both males and females show some common traits that skill is highly dependent on the fat mass. Presently it is not possible to compare and contrast the present finding because of the lack of any published literature on this aspect.

Analysis of somatotype components does not show any significant difference altogether (Table 4). High skilled labourers show a consistent trend of high ectomorphic scores than low skilled labourers in both sexes, although not significant. Male low skilled labourers have significantly high mesomorphic scores than high skilled labourers, imply that the plucking work in the tea garden does not require any high muscular activity.

In sum, the results of the present study does not confirm either the existence of the relationship between skill and plucking output or the relationship between skill and the physical body dimensions. However, the present results show some trends, which cannot altogether be ignored in such small anthropological studies. Before conducting future studies, the skill test may be developed, keeping the limitation of the present test in mind and relatively large sample testing may give some confirmatory results.

Acknowledgements

The authors are indebted to the people of the study areas for their unhesitating help and cooperation. The sketches of tea leaf plucking and marble picking, which has kindly been drawn by Rabi R. Biswas, deserve sincere thanks. Financial and logistic support given to this work by the Indian Statistical Institute is acknowledged.

References

Åstrand, P.O. & Rodahl, K. (1977): Text Book of Work Physiology: Physiological Bases of Exercise. – McGraw Hill, New York.

Basta, S.S. & Karyadi, D. (1973): Nutrition and Health of Indonesian Construction Workers: Endurance and Anaemia. – World Bank Staff Working Paper No. 152.

Carter, J.E.L. (1970): The somatotype of athletes – a review. – Hum. Biol. **42**, 535–569.

Carter, J.E.L. & Heath, B.H. (1990): Somatotyping – Development and Applications. – Cambridge University Press, Cambridge.

Choudhuri, M.R. (1978): The Tea Industry in India. A Diagnostic Analysis of its Geoeconomic Studies. – Oxford Book and Stationary Company, Calcutta.

Cressie, N.A.C., Withers, R.T. & Craig, N.P. (1986): The statistical analysis of somatotype data. – Yearbook of Physical Anthropology **29**, 197–208.

Dalton, E.T. (1872): Descriptive Ethnology of Bengal. – Government of Bengal, Calcutta. Reprint 1960 by Indian Studies: Past and Present. – Firma K.L.M., Calcutta.

de Garay, A.L., Levine, L. & Carter, J.E.L. (1974): Genetic and Anthropological Studies of Olympic Athletes. – Academic Press, New York.

Durnin, J.V.G.A. & Womersly, J. (1974): Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. – Brit. J. Nutrition **32**, 77–97.

Harrison, G.A., Weiner, J.S., Tanner, J.M., Barnicot, N.A. & Reynolds, V. (1977): Human Biology. An Introduction to Human Evolution, Variation, Growth and Ecology. – Oxford University Press, London.

Immink, N. (1978): Human Energy Supplementation and Worker Productivity. A Case Study of Sugarcane Cutters in Guatemala. – Ph. D. Thesis, University of Hawaii, Honolulu (cited by Wolgemuth et al. 1982).

Satyanarayana, K.A., Nadamuni Naidu, A., Chatterjee, B. & Narsinga Rao, B.S. (1977): Body size and work output. – Amer. J. Clin. Nutrition **30**, 322–325.

Shetty, P.S. & James, W.P.T. (1994): Body Mass Index. A Measure of Chronic Energy Deficiency in Adults. – FAO, Rome.

Siri, W.E. (1956): University of California Radiation Laboratory. – Publishing No. 3349.

Spurr, G.B., Barac-Nieto, N. & Maksud, M.G. (1977): Productivity and maximal oxygen consumption of sugarcane cutters. – Amer. J. Clin. Nutrition **30**, 316–321.

Sukhatme, P.V. (1982): Poverty and malnutrition. – In: Sukhatme, P.V. (ed.): New Concepts in Nutrition and their Implications for Policy. – Maharashtra Association for the Cultivation of Science Research Institute, Pune.

Weiner, J.S. & Lourie, J.A. (1981): Practical Human Biology. – Academic Press, London.

Wolgemuth, J.C., Latham, M.C., Hall, A., Chesher, A. & Crompton, D.W.T. (1982): Worker productivity and the nutritional status of Kenyan road construction labourers. – Amer. J. Clin. Nutrition **36**, 68–78.

Wyndham, C.H., Strydom, N.B., Morrison, J.F., Peter, J., Williams, C.G., Bredell, G.A.G. & Joffe, A. (1963): Differences between ethnic groups in physical working capacity. – J. Appl. Physiol. **18**, 361–366.

Received October 9, 2002

Address for correspondence:
Dr. Subrata K. Roy, Biological Anthropology Unit, Indian Statistical Institute,
203, Barrackpore Trunk Road, Calcutta - 700 108, India.
E-Mail: rsubrata@isical.ac.in