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An Ergonomic Study on Posture-Related Discomfort Among Preadolescent Agricultural Workers of West Bengal, India

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In India, particularly in West Bengal, preadolescents are primarily associated with agricultural work in rural areas. Owing to poor socio-economic conditions, they are compelled to carry out a considerable number of manual, rigorous tasks in agricultural fields. The main aim of this study was to investigate postures adopted by preadolescent agricultural workers during individual agricultural activities and to analyze the causes of discomfort related to those postures. Fifty male and 50 female preadolescent agricultural workers were randomly selected and a detailed posture analysis was performed with the Ovako Working Posture Analysis System (OWAS). It was observed that those workers worked continuously in awkward postures during certain agricultural activities. Consequently they suffered from discomfort in different parts of their body. Even though they were very young, they were likely to suffer from serious musculoskeletal disorders in the future.

preadolescence agricultural worker posture discomfort

1. INTRODUCTION

Preadolescent agricultural workers are mainly involved in different agricultural activities related to potato cultivation. Most of those workers come from poor socio-economic conditions. They are compelled to perform agricultural activities along with other family members so that they can earn money to help their family. Some of them work on their own land to increase the productivity and to maintain the economic balance of their family.

Preadolescent workers mainly perform the following activities: (a) weeding, (b) ridging, (c) carrying seeds, (d) planting seeds, (e) spading, (f) sprinkling water, (g) picking crops, and (h) carrying crops. To carry out such activities, workers most

often have to adopt awkward postures that result in discomfort (pain) affecting different body parts.

Prior to potato cultivation, weeding is done to remove unwanted weeds. Spading is done on the same day, or sometimes the next day after weeding, to make the edge of the cultivation land clear and prominent. Ridging land is the last step of land preparation before seeds are planted.

In the next step of cultivation, a potato is cut into small pieces (mainly known as seeds), which is another activity mainly done by adults. These seeds are carried on the same day by preadolescent agricultural workers from the cutting zone to the plantation area of the agricultural field.

The next step is planting seeds, which is done on the same day. For this activity, preadolescent

agricultural workers adopt a very awkward posture for a prolonged time. On the same day the seeds are covered (planted into a deep or groove region of the field) with soil with the help of a spade. Spading is another very strenuous activity whereby the workers have to work in a constantly bent posture.

After a few months during the last phase of cultivation, there are two activities done by preadolescents: picking crops from the field with a constantly bent posture followed by carrying them to a zone where other agricultural workers also accumulate their crops (potato).

In this study an attempt was made to correlate workers' discomfort with their postures during different strenuous potato cultivation activities.

2. METHODS

2.1. Selection of Subjects

For this study 50 male and 50 female preadolescent agricultural workers were randomly selected from the villages of Chowtara, Gopinagar, Banna and Ichhapur near Tarakeswar in West Bengal, India.

The average age of the male preadolescent agricultural workers was 11 years ($SD \pm 1.15$; range: 10–13) and that of the female 12 years ($SD \pm 1.24$; range: 10–13).

A study based on a modified Nordic Musculoskeletal Disorder Questionnaire [1] was performed. The questionnaire consisted of a series of objective questions with multiple-choice responses. To investigate discomfort, it included detailed questions on work-related pain. The participants were interviewed about any kind of discomfort affecting different body parts during every activity associated with potato cultivation.

2.2. Analysis of Working Posture

The analysis of different working postures of the preadolescent agricultural workers with the Ovako Working Posture Analysis System (OWAS) [2] was carried out with the aid of digital photography (Sony Handycam 360X, Japan). Later on stick diagrams were drawn from freezed frame video records and eventually subjected to analysis. The most frequent postures adopted by the workers were taken into consideration.

2.3. Assessment of Physiological Parameters

The subjects' heart rate both before each individual agricultural activity and just after completion of that activity was measured [3].

The total time taken and the total distance traversed by the subjects during each agricultural activity were measured to ascertain the level of stress that was generated at work.

2.4. Statistical Analysis

A two-tailed chi square test of independence was applied to determine whether or not a test item had any significant association with the response (discomfort or no discomfort). The computed chi square (χ^2) was next compared with critical chi square (χ^2) values for the chosen level of significance ($p < .05$) [4].

3. RESULT AND DISCUSSION

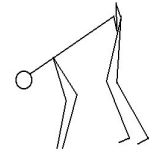
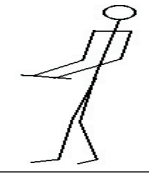
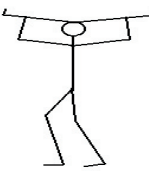
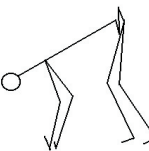
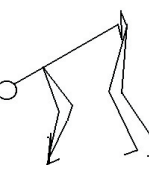
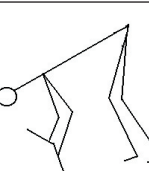
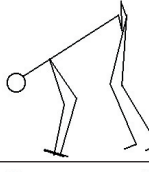
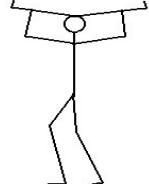
The results revealed that preadolescent agricultural workers were compelled to traverse long distances during different agricultural activities and the time consumed during each individual activity varied greatly from one activity to another (Table 1).

TABLE 1. Distance Covered and Net Time Taken Per Day for Each Agricultural Activity

Activity	Average Distance Covered/Day (cm)		Net* Average Time Taken/Day (s)	
	Male	Female	Male	Female
Weeding	1548.4	1825.8	3480	4089
Ridging	3091.7	3860.8	3168	3723
Carrying seeds	911.9	1046.5	525	560
Planting seeds	2786.9	3055.7	4740	4953
Spading	2533.1	2996.7	2778	2953
Sprinkling water	5225.8	5935.5	3488	3686
Picking crops	2534.9	2565.4	7389	7446
Carrying crops	914.4	1066.8	602	696

Notes. *—net average time is the total time spent on a particular agricultural activity excluding resting time.

TABLE 2. Analysis of Working Posture

Activity	Figure	Posture	Code	Action Category	Remarks
Weeding		Back bent forward and twisted, both arms below shoulder level, both knees bent, weight 10 kg or less.	4141	4	Corrective measures immediately
Ridging		Back bent forward/backward, both arms below shoulder level, walking or moving, weight/force needed over 10 kg but less than 20 kg.	2172	3	Corrective measures as soon as possible
Carrying seeds		Back straight, both arms at or above shoulder level, walking or moving, weight or force needed over 10 kg but less than 20 kg.	1372	1	No corrective measures
Planting seeds		Back bent and twisted or back bent forward and sideways, both arms below shoulder level, both knees bent, weight/force needed 10 kg or less.	4141	4	Corrective measures immediately
Spading		Back bent and twisted or bent forward and sideways, both arms below shoulder level, both knees bent, weight/force needed over 10 kg but less than 20 kg.	4142	4	Corrective measures immediately
Sprinkling water		Back bent forward/backward, both arms below shoulder level, both knees bent, weight/ force needed 10 kg or less.	2141	3	Corrective measures as soon as possible
Picking crops		Back bent forward and twisted, both arms below shoulder level, both knees bent, weight 10 kg or less.	4141	4	Corrective measures immediately
Carrying crops		Back straight, both arms below shoulder level, walking or moving, weight or force needed over 20 kg.	1373	2	Corrective measures in the near future

The maximum distance covered was 5225.8 cm (males) and 5935.5 cm (females) when sprinkling water with the time required 3488 s for males and 3686 s for females. This was followed by ridging, where the distance covered was 3091.7 cm (males) and 3860.8 cm (females) with the time

spent by males 3168 s and females 3723 s. It was also evident from the analysis of posture (Table 2) that the postures adopted during those activities needed corrective measures as soon as possible. Thus it was clear that by remaining in awkward postures for prolonged time during those activities,

preadolescent workers suffered from discomfort affecting different body parts.

It was further observed (Table 1) that the longest time was spent on picking crops (7389 s for males and 7446 s for females), with the distance covered 2534.9 cm (males) and 2565.4 cm (females). This was followed by planting seeds, where the time spent was 4740 s (males) and 4953 s (females) and the distance traversed was 2786.9 cm (males) and 3055.7 cm (females). It was also found from posture analysis that those two activities involved postures that required immediate correction. Although the distance covered during weeding was comparatively shorter, the time spent was quite long, indicating that the activity was extremely strenuous and involved constant bending. Posture analysis indicated that immediate corrective measures were required. Spading was also a highly rigorous process involving repetitive motions of different body segments. So the posture adopted during spading required immediate corrective measures too.

It was observed that both male and female preadolescent workers' heart rate (Table 3) rose to more than 100 beats/min in almost all the activities (excepting carrying seeds). It was also observed that heart rate was highest during spading (170.4 beats/min for males and 175.3 beats/min for females). This result clearly reveals that spading is the most strenuous process among agricultural activities. An analysis of the questionnaire in which all the workers reported discomfort (Table 4) during spading corroborates this result. They mostly felt pain in the low back region.

Planting seeds was the second most strenuous activity (Table 4). Ninety-two percent of males and 90% of females felt discomfort when planting seeds. Spading, plantation with traditional hoes, weeding and ridging were activities during which the workers most often were required to bend double for many hours a day. This may lead to musculoskeletal disorder among preadolescent agricultural workers. This fact was also established by Nwuba and Kaul [5], who examined the

TABLE 3. Heart Rate (beats/min) of Male and Female Agricultural Workers

Gender		Heart Rate Before Work		Heart Rate Just After Work			
		Weeding	Ridging	Carrying Seeds	Planting Seeds		
Male (n = 50)	M	86.0	111.3	102.9	94.9	134.2	
	SD	6.28	5.49	5.71	6.46	9.04	
Female (n = 50)	M	87.7	113.8	104.8	95.8	143.24	
	SD	7.61	8.36	7.93	6.69	9.36	

Gender		Heart Rate Just After Work			
		Spading	Sprinkling Water	Picking Crops	Carrying Crops
Male (n = 50)	M	170.4	118.5	110.0	116.6
	SD	7.32	7.04	4.42	6.63
Female (n = 50)	M	175.3	121.0	113.1	120.4
	SD	7.71	8.07	8.09	8.96

TABLE 4. Discomfort (Pain) During Different Activities

Activity	Discomfort			
	Male (n = 50)		Female (n = 50)	
	Number	%	Number	%
Weeding	42	84	44	88
Ridging	37	74	41	82
Carrying seeds	4	8	3	6
Planting seeds	46	92	45	90
Spading	50	100	50	100
Sprinkling water	30	60	36	72
Picking crops	35	70	38	76
Carrying crops	23	46	18	36

TABLE 5. Gender Effect on Workers' Subjective Assessment of Discomfort During Different Activities

Activity	Gender	No Discomfort	Discomfort	χ^2	$p < .05$
Weeding	Male	8	42	0.08	ns
	Female	6	44		
Ridging	Male	13	37	0.52	ns
	Female	9	41		
Planting seeds	Male	4	46	2.34	ns
	Female	0	50		
Sprinkling water	Male	20	30	1.11	ns
	Female	14	36		
Picking crops	Male	15	35	0.20	ns
	Female	12	38		
Carrying crops	Male	27	23	0.56	ns
	Female	32	18		

working posture of the Nigerian hoe farmer. They reported that workers developed strain in the low back and that this was harmful to their health.

A chi square test was used to establish whether there was any gender effect in the responses, i.e., discomfort or no discomfort during each individual agricultural activity (Table 5). It was found that there was none; preadolescent agricultural

workers, irrespective of whether male or female, suffered from discomfort in almost all agricultural activities. A chi square test was also used to find out whether there was any association between activity and response in the case of male as well as female subjects (Tables 6 and 7). In most cases a significant association was found.

TABLE 6. Effect of Different Kinds of Activities on Workers' Subjective Assessment of Discomfort in Men

Activity	No Discomfort	Discomfort	χ^2	$p < .05$
Weeding	8	42	1.50	ns
Ridging	13	37		
Weeding	8	42	58.13	significant
Carrying seeds	46	4		
Weeding	8	42	1.51	ns
Planting seeds	4	46		
Weeding	8	42	8.69	significant
Spading	0	50		
Weeding	8	42	7.14	significant
Sprinkling water	20	30		
Weeding	8	42	2.76	ns
Picking crops	15	35		
Weeding	8	42	15.86	significant
Carrying crops	27	23		
Ridging	13	37	45.01	significant
Carrying seeds	46	4		
Ridging	13	37	5.74	significant
Planting seeds	4	46		
Ridging	13	37	14.94	significant
Spading	0	50		
Ridging	13	37	0.45	ns
Sprinkling water	20	30		
Ridging	13	37	0.19	ns
Picking crops	15	35		
Ridging	13	37	8.16	significant
Carrying crops	27	23		

TABLE 6. (continued)

Activity	No Discomfort	Discomfort	χ^2	$p < .05$
Carrying seeds	46	4	70.56	significant
Planting seeds	4	46		
Carrying seeds	46	4	85.18	significant
Spading	0	50		
Carrying seeds	46	4	30.12	significant
Sprinkling water	20	30		
Carrying seeds	46	4	22.37	significant
Carrying crops	27	23		
Planting seeds	4	46	4.16	significant
Spading	0	50		
Planting seeds	4	46	14.03	significant
Sprinkling water	20	30		
Planting seeds	4	46	7.86	significant
Picking crops	15	35		
Planting seeds	4	46	24.73	significant
Carrying crops	27	23		
Spading	0	50	0.25	<i>ns</i>
Sprinkling water	20	30		
Spading	0	50	17.64	significant
Picking crops	15	35		
Spading	0	50	36.98	significant
Carrying crops	27	23		
Sprinkling water	20	30	0.70	<i>ns</i>
Picking crops	15	35		
Sprinkling water	20	30	1.96	<i>ns</i>
Carrying crops	27	23		
Picking crops	15	35	5.91	significant
Carrying crops	27	23		

TABLE 7. Effect of Different Kinds of Activities on Workers' Subjective Assessment of Discomfort in Women

Activity	No Discomfort	Discomfort	χ^2	$p < .05$
Weeding	6	44	0.70	<i>ns</i>
Ridging	9	41		
Weeding	6	44	67.48	significant
Carrying seeds	47	3		
Weeding	6	44	0.10	<i>ns</i>
Planting seeds	5	45		
Weeding	6	44	6.38	significant
Spading	0	50		
Weeding	6	44	4.00	significant
Sprinkling water	14	36		
Weeding	6	44	2.43	<i>ns</i>
Picking crops	12	38		
Weeding	6	44	28.69	significant
Carrying crops	32	18		
Ridging	9	41	58.60	significant
Carrying seeds	47	3		
Ridging	9	41	1.32	<i>ns</i>
Planting seeds	5	45		

TABLE 7. (continued)

Activity	No Discomfort	Discomfort	χ^2	$p < .05$
Ridging	9	41	9.89	significant
Spading	0	50		
Ridging	9	41	1.41	ns
Sprinkling water	14	36		
Ridging	9	41	0.54	ns
Picking crops	12	38		
Ridging	9	41	21.86	significant
Carrying crops	32	18		
Carrying seeds	47	3	70.67	significant
Planting seeds	5	45		
Carrying seeds	47	3	88.67	significant
Spading	0	50		
Carrying seeds	47	3	45.77	significant
Sprinkling water	14	36		
Carrying seeds	47	3	50.64	significant
Picking crops	12	38		
Carrying seeds	47	3	13.56	significant
Carrying crops	32	18		
Planting seeds	5	45	5.26	significant
Spading	0	50		
Planting seeds	5	45	5.26	significant
Sprinkling water	14	36		
Planting seeds	5	45	3.47	ns
Picking crops	12	38		
Planting seeds	5	45	31.27	significant
Carrying crops	32	18		
Spading	0	50	16.27	significant
Sprinkling water	14	36		
Spading	0	50	13.63	significant
Picking crops	12	38		
Spading	0	50	47.05	significant
Carrying crops	32	18		
Sprinkling water	14	36	0.20	ns
Picking crops	12	38		
Sprinkling water	14	36	13.04	significant
Carrying crops	32	18		
Picking crops	12	38	16.23	significant
Carrying crops	32	18		

4. CONCLUSION

From this study it can be concluded that preadolescent agricultural workers work continuously in a bent posture and by remaining in an awkward or stressful posture during a particular agricultural activity, they suffer from discomfort or pain in different parts of their body,

specifically the lower back, neck and knee regions. The feeling is aggravated if that strenuous posture is maintained for a prolonged time. Consequently they are fatigued after such arduous tasks. This not only hampers their education and normal physical activity but it may also result in the development of a serious musculoskeletal disorder in the near future.

REFERENCE

1. Dickinson CE, Campion K, Foster AF, Newman SJ, Thomas PG. Questionnaire development: an examination of the Nordic Musculoskeletal Questionnaire. *Appl Ergon* 1992;23(3):197–201.
2. Wilson JR, Corlett EN. Evaluation of human work; a practical ergonomics methodology. 2nd ed. London, UK: Taylor & Francis; 1995.
3. Astrand P, Rodahl K. Textbook of work physiology. 3rd ed. New York, NY, USA: McGraw-Hill; 1986.
4. Das D, Das A. Statistics in biology and psychology. Calcutta, India: Academic; 1993.
5. Nwuba EIU, Kaul RN. The effect of working posture on the Nigerian hoe farmer. *Journal of Agriculture Engineering Research* 1986;33:179–85.