ICASTOR Journal of Engineering
Vol. 5, No. 2 (2012) 103 – 110

DISCOMFORT LEVELS IN FOUR WORKING POSTURES IN USE DURING *GARI* FRYING

T. M. Samuel

Dept. of Agricultural Engineering
Olabisi Onabanjo University
Ogun State, Nigeria

J. C. Igbeka

Dept. of Agricultural and Environmental Engineering
University of Ibadan
Ibadan, Nigeria

O. P. Kolawole

International Institute for Tropical Agriculture (IITA)
Ibadan, Nigeria

ABSTRACT

Working postures adopted at work depend on the discomfort experienced as workers tend to opt for the most comfortable posture to them depending on the work at hand. The same is true for *gari* fryers. Four common working postures of *gari*-frying workers in Southwestern Nigeria are sitting beside (SB), sitting in front (SF), alternating sitting and standing (ASS) and standing (S). Discomfort levels in the identified postures were measured in 120 workers using Cornell Musculoskeletal Discomfort Questionnaire. Results of analyses indicated higher work-related musculoskeletal disorders (WMSDs) in the low back and upper back, placing musculoskeletal discomfort in the trunk. Specifically, WMSDs occurred in the hip-buttock, knee and neck for SB, hip-buttock for SF, low leg and shoulder for S and right forearm for ASS. This implies that ASS had the least discomfort among other postures analyzed. Therefore, ASS is recommended with seat modification to incorporate short backrest for reducing spinal loading.

KEYWORDS: Back, Discomfort, G*ari* frying, Posture, Work-related musculoskeletal disorders.

STATEMENT OF RELEVANCE

The four common postures adopted in the *gari*-frying task investigated gave varying levels of discomforts in body parts. These were evaluated using Cornell Musculoskeletal Discomfort Questionnaire, placing highest risk in the trunk. Thus, sit-stand posture was recommended as best for this task among others, having the least discomfort for the worker.

INTRODUCTION

Gari frying (*garification*) is about the last operation in *gari* production and, to a large extent, the determinant of the final product. This involves simultaneous cooking and dehydration, that is, heat treatment of dewatered cassava mash, which has been pulverized into grains, to produce gelatinized and dried grains known as *gari*.

Correspondence: Dr. T. M. Samuel, Dept. of Agricultural Engineering, Olabisi Onabanjo University, Ogun State, Nigeria. E-mail: Samuel_taiwo1966@yahoo.com

Traditionally, *gari* is fried by women in cast-iron pans over fire from wood. The women sit sideways by the fireplace and continuously turn the mash in the pan with a small paddle until the batch is ready. This operation is quite tedious and uncomfortable, especially the discomfort of the operator, the heat, the sitting posture required and smoke disturbance. In the improved traditional method the workplace and utensils used are redesigned to ease operation (Igbeka, 1995)

Unfortunately, there has been limited application of research related to ergonomics and musculoskeletal disorders, although farmers frequently report musculoskeletal signs and symptoms (Meyers et al., 1995). More production agriculture workers suffer musculoskeletal disorders than any other type of injury or illness. Musculoskeletal disorders can also disable individuals at rates near or above those of traumatic injury, respiratory injury, pesticide intoxication, dermatological injury or other types of injuries and illnesses (Mazza, 1997).

Discomfort is difficult to define because it has both objective and subjective elements. Discomfort results in as "urge to move" caused by a number of physical and physiological factors. Pressure on soft tissues can cause ISCHEMIA (depletion of the local blood supply to the tissues), resulting in a shortage of oxygen and a buildup of carbon dioxide and waste products such as lactic acid. This condition is known to lead to pain and discomfort. Discomfort is a subjective experience, which can result from a combination of physiological and psychological processes, including muscle fatigue.

The objective of this study is to measure discomfort level score (DLS) and analyze the individual items to determine where there might be a postural problem for them through using Cornell Musculoskeletal Discomfort Questionnaire (CMDQ).

1. MATERIALS AND METHODS

Agricultural processing is necessary when farm produce is not for immediate consumption, to enhance longer shelf life or add value to the product, thus reducing post-harvest losses.

Improved Traditional *Garification* Methods are improvements over the traditional manual methods where the workplace, tools and methods are redesigned for ease of operation and health of workers. Samuel (2008, 2010) had identified eight types with four working postures common to them as follows:

ITGWP I – sitting beside (SB): A seated fryer – beside the fireplace, and adopting conventional sitting posture (Figure 1).

ITGWP II – sitting in front (SIF): A seated fryer – directly facing the fireplace, with either or both legs fully stretched out (Figure 2).

ITGWP III– stand (S): A standing fryer– beside the fireplace, with some movement around the Workpiece (Figure 3).

ITGWP IV – alternating sitting and standing (ASS): A sit-stand fryer – beside the fireplace and alternating between sitting and standing postures, with some movements round the workpiece. (Figure 4).

Figure 1. ITGWP I – Sitting Beside (SB)

Figure 2. ITGWP II – Sitting-in-front (SIF)

Figure 3. ITGWP III – Standing (S)

Figure 4. ITGWP IV – Alternating between sitting and standing (ASS)

Methods for measuring postures have been categorized into three, namely, self-reports from workers on workplace exposure to both physical and psychosocial factors, observational methods and direct methods. One of such self-reporting methods is being used in this paper. In this method, individual workers assess themselves on the discomfort experienced at work with the aid of structured questionnaire. Two common ones are Standard Nordic Questionnaire and Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). CMDQ (Hedge et *al*., 1999) is similar to Nordic Musculoskeletal Questionnaire.

CMDQ is a chart comprising a body map with annotated essential body parts required for work depending on posture. It is a self-reporting method of assessing discomfort in the body. The validated questionnaire was circulated to the subjects who were guided to fill in the required information. These questionnaires were replicated three times over six months and the average scores computed for each ITGWP.

Purposive sampling was used to select 120 subjects, 30 for each ITGWP. The average age and working experience of workers involved were 34.6 (±3.0) and 7.3 (±2.4) years respectively. All the workers were female. The age range picked represents a median value because the age ranges widely between 16 and 67 years. The subjects were screened such that only physically fit were used for the experiment: BMI of the subjects were between 18.4 and 24.9 for normal weight individual and this was calculated following standard method (Heyward, 2002). The workers worked for eight hours a day on the average. They were screened before the commencement of the research to ensure they were medically fit and had no musculoskeletal disorder prior to the experiment.

The survey covered all important segments of the body which is associated with the workload on the processors. This included neck, shoulder, upper back, upper arm, forearm and wrist in the upper extremity; low back, hip/buttock, thigh, knee, low leg and foot in the lower extremity. The scoring guideline (available in *http://ergo.human.cornell.edu/ahmsquest.html* or Cornell University Ergonomic web) were used to compute results which gave what is referred to as 'Discomfort Level Score' (DLS) for all body regions specified in the body map for which the respondents had earlier completed the questionnaire. The final score in this study is referred to as discomfort level score (DLS).

2. RESULTS AND DISCUSSIONS

Table 1 shows the result of the discomfort level examined in the CMDQ which indicates the intensity of discomforts in increasing order of ASS, SIF, SB and S. On the average, it was noted that the postures S and SB have high discomfort level score (DLS) that was more than twice what obtained in ASS and SIF postures. Generally, in the resulting analysis, low back and upper back had the highest risk of musculoskeletal disorder in relation to other body regions: as much as 3 times that of the neck; 4 times right/5 times left shoulder, 4 times right/6 times left upper arm, 2 times right/8 times left forearm, 9 times right/21 times left wrist, 3 times hip-buttock, 2 times right/3 times left thigh, 3 times right/4 times left knee, 3 times right and left legs, 17 times right/21 times left foot.

CMDQ gave a wide disparity between the ITGWPs. This implies that versions of the adopted ITGM and the corresponding ITGWPs stressed different parts of the body more differently. This clearly shows that the risk of musculoskeletal disorder in the *gari*-frying task is in the back, specifically in the spine. This was highest in the S posture, followed by SB, SIF and ASS in that order. This confirms the theoretical basis that both spine and the pelvis are loaded in postures that involve sitting and/or standing, and that almost all the movements of the torso and head involve the spine and pelvis in varying degrees. Hence, the submission that the posture of the trunk may be analyzed in terms of the average orientation and alignment of the spinal segments and pelvis (Adams and Hutton, 1980), apart from the highest musculoskeletal risk recorded in the trunk, specific body parts relative to the ITGWP.

PARAMETER	NECK	SHOULDER		UP BACK	UP ARM		L0 BACK	FOREARM		WRIST		HIP/ BUTTOCK	THIGH		KNEE		LO LEG		FOOT		TOTAL	AVG
		R	L		R	L		R	L	R	L		R	L	R	L	R	L	R	L		
SB	234.5	49	39	480	46	36	552	205	58.5	42	15	300	199	178	288	209	46	50	18	13	3058	152.90
SIF	131	42	25	217	45	29	280.5	109	33.5	36	18	225	66	140	48	77	24	22	19	14	1600	80.00
S	28	254	199	344.5	235	150	430	160	69	50	21	10	261	234	130	106	333	280	30	21	3345	167.30
ASS	135	67	39	100	43	34	185.5	177	30	39	14	40	75	60	39	22	106	88	16	12	1322	66.08
TOTAL	528.5	411	302	1141.5	369	249	1448	651	191	167	68	575	601	612	505	414	509	440	83	60	9324	
AVG	132.1	103	75.5	285.375	92	62	362	163	47.8	42	17	143.75	150	153	126	104	127	110	21	15		

N.B. *SB implies sitting beside* *SIF implies sitting in front* *S implies standing*
ASS implies alternating between sitting and standing *AVG implies average*
R implies Right *L implies Left*

Table 1.

The Neck

In the neck, SB recorded the highest DLS of 235, followed by ASS, SIF and S, respectively. The DLS for SB is almost twice that of SIF and ASS and more than eight times that of S, which is the lowest. This implies that bending of the neck during *garification* work was highest in SB and lowest in S (Table 1). However, since the SB posture was the closest to the traditional method of *garification*, recording the highest there could only mean that this posture had to be changed in order to improve the work system. The drastically low DLS for S recorded implies the posture is the most suitable position among others for observation of the workpiece during work (Table 1).

The Shoulders and Upper Arms

In the case of the right and left shoulders, S had the highest DLS, while SIF the lowest. The DLS in S was about eight times higher than in others. This implies that those of standing posture are exerting more pressure on the shoulder than their counterparts adopting sitting posture. This situation was even more pronounced as reflected in the recorded investigation recorded in the upper arm where S had the highest DLS and the others had lower or approximately the same DLS. It is also pertinent to note high DLS values of the right part in all cases because all the respondents were right-handed, hence that is the part of the body that was more utilized than the left. The high recorded DLS in S was due to the raised shoulder which implies that the level of the work surface was not appropriate.

The Back

In the upper back, S had the highest DLS, followed by SB, while ASS had the lowest. A glance at the results of the low back also revealed a similar trend, though at a higher level. This may not be surprising because the S posture tends to exert a large pressure on the spine more than sitting posture. The high DLS in the low back, (also recorded in the case of SB) may not be unconnected with the static work inherent in that posture compared to others. In all probability, this study discourages S and SB postures, and prefers ASS posture, to reduce the risk of musculoskeletal disorders (Table 1).

The Forearms and Wrist

The forearm and the wrist are the parts of the body that witnessed highest frequency of use in stirring the *gari* mash placed under fire. SB had the highest DLS among other postures while DLS was higher in the right arm than the left one and the. Wrist SIF had the lowest, followed by ASS. This implies that either SIF or ASS is preferred to S and SB postures as far as discomfort in the arms is concerned (Table 1).

The Hip-buttock

At the lower extremity, SB had the highest DLS in the hip/buttock, followed by SIF. This is expected since the subject in this sitting posture engaged more in static work by sitting in the same place for very long periods. However, S posture had the lowest in this ranking since the musculoskeletal loads was borne, not only by the hip-buttock and low back as in the sitting position, but also by the legs (Table 1). Hence lower DLS in the standing postures.

The Thigh

For the thigh, it was observed that both right and left thigh recorded close DLS, except in SIF posture where the left thigh recorded more than twice the stress recorded in the right part. This was so because the weight of the body is almost distributed almost equally on the thighs as well as on the knees, low leg and perhaps feet in SB, S and ASS postures where the legs are directly touching the supporting surface. However, in the case of SIF the right leg is always well stretched even when movement is impermissible This implies that sitting postures are prone to discomfort in the thigh more than standing postures and should be avoided. Hence ASS is preferred as regards discomfort in this body region (Table 1).

The Knees

Discomfort in the knees (both left and right) in SB was more than twice that of S, three times that of SIF and more than six times that of ASS. This may be explained by the fact that there was serious restriction of the knees in SB which constituted high degree of static work, since the processors using this posture do complained of regular pains in the knees to corroborate these findings. The DLS of S was high because the knee is the link or joint for the legs which carries the weight of the body. In the ASS, however, the subjects had flexibility of relieving the legs of this load as processors rested intermittently during work whereas the SIF subjects had less of this problem as their weight is only carried by the hip/buttock. So ASS is the preferred posture for the reduction of discomfort in the knees (Table 1).

The Low Legs

Discomfort in the low leg is fairly close in both right and left legs and feet and is highest in S posture followed afar by ASS. While S had more than double DLS recorded in ASS, it was more than ten times in others. Expectedly, since the legs bear the whole weight of the body while standing and only intermittently do so in ASS but rarely in the sitting postures. So, this reflects the situation of disorder in this region of the body. On the other hand, the foot had borne the load in a fairly uniformly distributed manner regardless of the posture, except in S where DLS was high, but less than double for other postures. Sitting postures, therefore, is preferred to standing once there is need to reduce discomfort in the low legs and feet. Hence SIF is most preferred in this regard.

CONCLUSIONS

From the foregoing, the highest risk of musculoskeletal discomfort disorder occurred in the trunk in all the ITGWPs. ASS has the overall least DLS in all the body regions among the ITGWPs investigated. The highest occurred in S posture, followed by SB posture. Similar trend could also be observed in most of the other body regions. Other risks of musculoskeletal disorder occurred in different parts of body region subjected to high stress depending on the postures in this investigation as follows:

SB: hip-buttock, knees and neck,

SIF: hip-buttock, with very high

S: low leg and shoulder

ASS: right forearm (yet the lowest in the four ITGWPs)

On the whole, the analysis rated ASS as having the lowest risk of musculoskeletal disorder among the investigated ITGWPs, and, therefore, it is the preferred posture.

REFERENCES

1. Adams, M. A., Hutton, W.C. The Effect of Posture on the Role of the Apophyseal Joints in Resisting Intervertebral Compressive Forces; Journal of Bones and Joint Surgery; 2B, 1980, pp. 358-362.
2. Bridger, R. S. Introduction to Ergonomics, International Edition; .McGraw-Hill Inc. N. Y., 1995.
3. Hedge, A., Morimoto, S., McCrobie, D. Effects of keyboard tray geometry on upper body posture and comfort; Ergonomics; 42 (10), 1999, pp. 1333-1349.
4. *http://ergo.human.cornell.edu/ahmsquest.html*
5. Kuorinka, I., Jonsson, B., Kilbon, A. Standardized Nordic Questionnaires for the analysis of musculoskeletal symptoms; Applied Ergonomics; 18 (3), 1987, pp. 233-237.
6. Mazza, J. J., Lee, B. C., Gunderson, P.D., Stueland, D. T. Rural health care providers' educational needs related to agricultural exposures; Journal of Agricultural Health and Safety; 3(4), 1997, pp. 207-215.
7. Meyers, J., Bloomberg, L., Faucett, J., Janowitz, I., Miles, J. A. Using ergonomics in the prevention of musculoskeletal cumulative trauma injuries in agriculture: learning from the mistakes of others; Journal of Agromedicine; 2(3), 1995, pp. 11-24.
8. Samuel, T. M. Effects of Working Postures on Musculoskeletal disorders among Gari Frying Workers in Southwestern Nigeria; Unpublished PhD Thesis, Department of Agricultural and Environmental Engineering, University of Ibadan, Ibadan. Nigeria; 2008.
9. Samuel, T. M., Igbeka, J. C, Kolawole, O. P. A Survey of Improved Gari frying Methods; International Journal of Food Engineering; Vol. 6, Issue 2, Article 15; Berkeley Electronic Press, 2010.
10. Sauter, S. L, Schaefer, L. M, Knutson, S. J. Work posture, workstation design, and musculoskeletal discomfort in a VDT data entry task; Hum. Factors; 33(2), 1991, pp. 151-167.