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Effect of Body Posture on Stress Experienced by Worker

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ABSTRACT The paper intends to study the effect of standing and sitting workplace in context with wash area in the household. The main objectives of the study were to design a wash area ergonomically and then test the efficacy .The sample for the study consisted of 30 performers selected on the basis of vision acuity and general well being. The ergonomic design of the wash area was based on functionality, floor size and placement of work centers, ventilation, storage, safety and others. The findings of the study reveal that the energy consumption was lesser in the performance of the work in standing position than in sitting in context with the job of washing clothes. Also perceived exertion and spine angle deviation was considerably low when the performers accomplished the job in standing as compared to sitting position.

1. INTRODUCTION

Work-related factors that present the greatest risk for MSIs involve fixed and constrained postures that are frequently awkward, uncomfortable and maintained for too long a time, repetitive and forceful hand movements and a high pace of work. Such movements strain and gradually cause "wear and tear" on the muscles and tendons in the forearms, wrists and affect the back and neck. People who do repetitive work with their bodies in fixed and static positions are even more susceptible to getting work related health problems. Such problems continue to be one of the leading causes of preventable injuries in the workplace.

The task of washing linen in the households is inevitable and strenuous, so it was chosen for the present study. The task is characterized by bent static posture for long periods of time and a considerable amount of effort on the part of the worker. The task is known to be heavy and imposes great amount of stress on the worker's body.

Washing linen is a tiring task that takes up to 10-15% of the total working time in the household. The substantial part of washing is carried out manually. As suggested by Grandjean (1973), trouble free washing within the home requires well-designed and well-equipped places. The human body possesses lot of adaptability and flexibility and thus the effect of bad working conditions may not be apparent immediately but ultimately they would affect the efficiency badly. Unorganized and ill planned work areas are stress areas. The individuals who use well-designed areas react with increased satisfaction and pleasure.

The most ignored part of the wash areas is the workplace. The heights of the workplace are inadequate, hence cause problem in lifting, and the elbow and arm are in strained position or the person may adjust his whole body downward resulting in poor posture. Bad working conditions have adverse influence on worker's productivity and so have the bad workplace layout. Introduction of ergonomics to the design of the wash areas for linen can be of great benefit to the physical well being of the work. Ergonomics aims to ensure that human needs for safe and efficient working are met in the design of the work systems. The goal of ergonomics is to optimize the interaction between the human body and its physical surround (Bridger 1995).

Recognizing poorly designed work and workplace environments is important for assessment of conditions leading to musculoskeletal disorders. The study aimed at designing an ergonomically sound workplace for washing linen and testing the efficacy so that the stress on the part of the worker can be minimized.

2. LITERATURE REVIEWED

The amount of fatigue experienced depends largely on the posture of the performer. According to Bellis (2007), the goal of ergonomics in the workplace is to prevent injuries and illnesses (work-related musculoskeletal disorders or WMDs) by reducing or eliminating worker exposure to occupational hazards. These hazards include awkward postures, repetition, force, mechanical compression, duration, vibration, and temperature extremes (http://inventors.about.com).

The human body was designed to move and it cannot tolerate immobility for long. Holding the upper body still in an upright position requires a lot of muscular effort and contributes to what is called a static load. That is the invisible but constant battle against gravity and fatigue, and injury is the price (http://www.ccohs.ca). Dempsey (1998) concluded that if the strain imposed on musculoskeletal and cardio vascular systems exceeded the capacity of the system, the potential results included discomfort, fatigue or injury. Pascal (2003) reported that static posture increases the risk of work-related MSDs; varied posture and rest periods may lower risk. Karasek et al. (1987) reprted that positive associations with upper extremity disorders have also been found in studies using measures of perceived work- pressure and workload (www.cdc.gov).

3. MATERIALS AND METHODS

To accomplish the objectives of the study, three phases were adopted

Phase I consisted of the designing the wash area based on the specifications regarding the room orientation, floor size, ceiling height/type, location, sink dimensions, counter dimensions, storage, number and sizes of doors and windows, flooring material, plumbing arrangements, lighting and equipment in the wash area. Regarding these specifications, the literature available was considered which comprised standards given by Neufert (1991) and Chaira et al. (1995). The standards given by both were considered and implemented in the architecture of the wash area.

Phase II was related to standardization of the wash area, which was done on the basis of physiological workload, perceived exertion and postural analysis with 9 subjects. The standardization was done with 9 subjects 3 each in height ranges 150-155cm, 155-160cm and 160-165cm.

Phase III comprised testing of the efficacy of the self designed wash area with 30 subjects on the basis of physiological workload, perceived exertion and postural analysis. During standardization, the work area was found to be the best fit for the height range of 155-160cm. Thus 30 subjects under the mentioned height range were taken for the experiments.

4. RESULTS AND DISCUSSION

The self-designed wash area had the specifications given in Table 1. The wash area was developed after a panel of 5 experts judged the area in terms of functionality and convenience of the worker. The observations were made on the basis of physiological workload, perceived exertion and postural analysis. Pulse monitor was used to obtain the pulse rate of the subjects while resting, working and just after work. Energy expenditure was calculated as

Energy Expenditure (KJ/ min.) = 0.159 x Average pulse rate – 8.72(beats/min.)

RPE (Ratings of Perceived Exertion) scale given by Varghese et.al. (1994) was used to assess qualitative workload given in Table 2

Flexi curve was used to record the movement of the spine. The cervical (C1-C8) and upper lum-

Table 1: Details of the wash area

Aspect	*Reason for selection*
Floor size (2.10m x 3.30m)	The space was supposed to be sufficient for both hand and machine washing
Ceiling Height (2.75m)	To maintain optimum temperature in the wash area.
Location (nearest to the drying yard)	To minimize the strain of lifting and carrying
Sink (60 cm x40 cm)	Size most widely used
Washing counter (150cm x 60cm x 90cm)	Height seemed adequate in relation to elbow height as suggested by Bridger (1995) Green marble was used as it does not hold water
Storage (30cm x 47.5 cm x 110cm)	Appropriate size for all the supplies needed in the wash area
Windows (nearly 10% of the floor area)	Suitable for Indian climate
Flooring material (Terrazzo)	Moisture proof and non skid
Walls (white in color)	White has highest reflection (89%) of light
Lighting fixtures (fluorescent source)	Most soothing to eyes
Washing machine (3’2" clearance)	Space enough for free movement of the body of the worker

Table 2: 5-point scale for workload

Physiological workload	*Energy expenditure (KJ/ min.)*	*Heart rate (beats/ min.)*
Very light	Up to 5	90
Light	5.1-7.5	91-105
Moderately heavy	7.6-10.0	106-120
Heavy	10.1-12.5	121-135
Very heavy	12.6-15.0	136-150

bar L1 and lower lumbar L5 were marked. The workers reported perceived exertion after the work.

4.1. Standardization of the Wash Area

The wash area was standardized with a sample of 9 subjects. The subjects were selected on the basis of normal BP, pulse rate and vision acuity. The following results were obtained

4.1.1 Physiological Workload: It was calculated with the help of pulse rate with the help of which energy expenditure was measured. The workload was analyzed on RPE (Ratings of Perceived Exertion) scale given by Varghese (see Table 3).

Thus, the area was best fit for the workers with the height range of 155-160 cm.

4.1.2 Postural Analysis: The spinal curvature was measured with flexi curve. The observations to calculate the angle of deviation are given in Table 4.

The working postures of the workers in the height range 155-160 cm deviated the least i.e. 0.4º to 1º at cervical and 1º to 2.4º at lumbar region.

4.1.3 Perceived Exertion: It was analyzed on the basis of subjective feeling towards work (see Table 5). The indoor climate conditions were analyzed on the criteria given in Table 6.

Table 5: Perceived exertion during work (n=9)

Feeling toward work	*N*	*%*
Comfortable	9	100
Uncomfortable	Nil	0

Table 6: Aspects of Indoor Climate (n=9)

Aspect considered	*Yes*		*No*	
	N	*%*	*N*	*%*
Sufficient light	9	100	Nil	Nil
Comfortable temp.	9	100	Nil	Nil
Physically comfortable humidity	9	100	Nil	Nil

Table 3: Perceived physiological workload (n=9)

Height range (cm.)	*Soaking*		*Washing*		*Rinsing*	
	Energy exp (KJ/min)	*Workload*	*Energy exp (KJ/min.)*	*Workload*	*Energy exp (KJ/min.)*	*Workload*
	3.4	v. Light	5.04	Light	5.2	Light
150 to 155	3.57	v. Light	4.6	v. Light	6.2	Light
	4.2	v. Light	6.4	Light	9.0	M. Heavy
	3.2	v. Light	4.0	v. Light	6.6	Light
155 to160	3.5	v. Light	3.7	v. Light	5.1	Light
	3.6	v. Light	4.0	v. Light	6.1	Light
	3.2	v. Light	4.09	v. Light	5.6	Light
160 to 165	4.3	v. Light	5.6	Light	8.2	M. Heavy
	5.2	Light	6.3	Light	8.2	M. Heavy

Table 4: Angle of deviations in different postures (n=9)

Height range (cm.)	*Angle of normal curve A°*		*Angle while working Bº*		*Angle of deviation Cº*	
	Cervical	*Lumbar*	*Cervical*	*Lumbar*	*Cervical*	*Lumbar*
	102.3	85.3	106	83.0	3.7	2.3
150 to 155	101.6	94.3	108	93.6	6.4	0.7
	101.6	77.6	94.6	80.0	7.0	2.4
	100.3	102.0	101.6	100.3	1.3	1.7
155 to160	101.6	10.6	102.3	98.6	0.7	2.0
	101.6	101	102.0	98.6	0.4	2.4
	110.3	91.3	113.3	98.6	3.0	7.3
160 to 165	104.6	110.3	114.0	98.6	9.4	11.7
	111.3	100.3	105.0	96.0	6.3	4.3

4.2 Testing the Efficacy of Self Designed Wash Area

30 subjects in the best fit height standardized for the wash area i.e. 155-160 cm were selected on the basis of normal BP, vision acuity and average static and dynamic anthropometry. The efficacy was tested based on comparison between self-designed and traditional wash area. The traditional wash area is any place where washing activity is carried out. Generally it is a bathroom where the activity is performed in a sitting posture with no adequate storage and without any regard to posture acquired while working.

4.3 Comparison of Self Designed Wash Area with Traditional Wash Area

The subjects were made to work on the standardized wash area and traditional wash area.

Table 7: Comparison between Energy expenditure while working on traditional and self-designed work area (n=30)

Wash area	*Energy exp at rest (KJ/min.)*	*Energy exp at work (KJ/min.)*	*Energy exp after work (KJ/min.)*
Self designed wash area	2.73	212.8	4.9
Traditional wash area	2.75	390.78	11.1

4.3.1 Physiological Workload: The mean scores of energy expenditure in washing activity in self designed (X) and the traditional (Y) wash area is given in Table 7. The t values show that there was no significant difference in energy expenditure at rest in two wash areas. But t values while working and just after work indicate that the workers consumed significantly lower energies in self designed wash area. As the effort in balancing a posture decreases the consumption of energy is also decreased. Also, a stable and comfortable posture is necessary to support neutral positions and to prevent injury exposures created by awkward postures. As reported by Hedge. (1999) there is a statistically significant correlation between the musculoskeletal symptoms and postural discomfort.

4.3.2 Postural Analysis: Mean scores of angle of deviation while working on self-designed and traditional wash area are given in Table 8. The t values show that there was highly significant difference between the angles of deviation when washing was done in the self-designed and traditional wash area. The lesser the angle of deviation while performing work, lesser is the strain imposed on the worker's body. It can further be elaborated by the fact that neutral posture helps to preserve the normal arc of the cervical spine. Such an attitude of the body is found to be comfortable to the workers. As it is evident from the studies that with poor posture, muscles are less efficient, and they are working at a biomechanical disadvantage, so they have to work harder all the time and a stress is felt on the neck, shoulders and back. It is necessary that workers are able to acquire their normal upper body muscle flexibilities and strength balances, so that muscles can work effectively.

Table 8: Comparison of angles of deviation while working on traditional and self-designed work area (n=30)

Wash area	*Angle of deviation in cervical region*	*Angle of deviation in lumbar region*
Self designed wash area	1.3°	1.6°
Traditional wash area	1.6°	4.63°

Table 9: Comparison of perceived exertion while working on traditional and self-designed work area (n=30)

Feeling towards work	*Self designed wash area*		*Traditional wash area*	
	N	*%*	*N*	*%*
Uncomfortable	0	Nil	24	80
Comfortable	30	100	6	20

4.3.3 Perceived Exertion: Subjective feelings towards the work were observed while working on the self-designed and traditional wash area as given in Table 9. All the workers found it comfortable to wash clothes in standing position on the ergonomically designed wash area. There is always a reduction in strain experienced by workers when a normal or a close to normal attitude of the body is maintained. As mentioned in www.medicalnewstoday.com (2005), pain is related to reductions in nearly every aspect of productivity measured-the more severe the pain, the greater is the effect on productivity. Pain's impact on health and productivity is particularly extensive for workers with musculoskeletal disorders.

5. CONCLUSION

Thus it can be extrapolated that the self-designed standing wash area imposed less strain on the body of the worker as compared to that by the traditional wash area. The impact of posture on the efficiency of the worker could be seen. It is beneficial for the workers if work is performed in an attitude where the spine remains the closest to its normal attitude. CTDs are caused by poorly designed workplace environments, and often lead to decrease in productivity, quality and efficiency in workplaces. Grozdanovic (2002) suggested that it is possible to identify broad principles to design to reduce exposure to CTD risk factors that are applicable to all tasks. Also, these principles can be used in the design of work or modifying existing operations, and in the design of new equipment and processes.

Ergonomics can help design workplaces and hence help to reduce stress on the part of the worker. The design of any work area should include the anthropometric features related to posture while work as well as other environmental factors like illumination, humidity, and noise.

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