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Research Paper :

Physiological workload of fetching water

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ABSTRACT

Fetching of water is one of the common household activities of Assam. An attempt was made to assess the physical characteristic, physiological workload and physiological cost of fetching water on the basis of heart rate and energy expenditure of the respondents. Thirty respondents were selected in the age group of 21 - 30 years and 31 - 40 years having normal body temperature, blood pressure and heart rate. There was no difference between the age groups in terms of BMI. On the basis of average and peak heart rate (beats/min) and energy expenditure (kJ/min^{-1}), the physiological workload of fetching water was categorized as 'light' to 'very heavy' activity. Average rating perceived exertion (RPE) ranged from 2.2 to 3.2 in 5 point scale. Angle of deviations was found to be more in younger age group than older age group while drawing water. Incidence of pain was more in low back region of the respondents.

Key words : Drudgery prone, Ergometer, Postural analysis, Physiological workload, Perceived exertion.

Rural women are responsible for multiple labour intensive and time consuming chores, both inside and outside their households. They perform the activities such as fetching water, cooking, washing vessels, washing clothes, sweeping, mopping, bringing firewood, childcare activities, weaving etc. The long hours of works, much effort and labour spent in repetitive home operations results in fatigue and drudgery. A physically fit person with normal physical characteristics influence the person's capacity to do the work and may experience less drudgery for the same amount of work than physically unfit persons. Knowledge of physiological workload of various household operations as they are traditionally performed in the rural homes is of great practical values in order to provide comfort and consequently to promote health and well beings of the home makers. A good working posture reduces the physiological cost of work and fatigue to a minimum, where in static muscular efforts and incorrect postures for long period during households operations can lead to musculoskeletal problems. Knowledge of physical cost of work in terms of heart rate and energy expenditure of rural women will be of great use in providing necessary changes required in the work environment, work place and methods of performing the task.

Fetching of water is one of the common household activities performed by rural women in Assam. The extent of drudgery involved in the activity was determined through assessment of physical fitness, physiological workload and musculoskeletal problems of rural women.

METHODOLOGY

A sample of 30 rural women having normal pressure and temperature in the age group of 21-40 years was selected from Jorhat district of upper Brahmaputra Valley Zone of Assam.

Body composition :

Estimation of Lean Body Mass (LBM) was determined from skin fold thickness at four sites ie. biceps, triceps, subscapular and superilliac with the help of skinfold calipers by using the methods proposed by Durmin and Rahman (1967). BMI for Quetlet's Index Weight (kg) / Height (m^2) was used to classify the body types as Ectomorph(<20), Mesomorph(20-25) and Endomorph (>25).

Determination of physical fitness :

Step-test method was used for determining physical fitness of the respondents. The test was administered according to designed protocol, resting, working and recovery heart rate were monitored continuously by using Heart Rate Monitor (Polar Sports Tester- PE 4000) during all the three phases. The stepping exercise (30 steps/min) was continued for a period of five minutes. The recovery pulse rate was recorded while the subjects were sittings completely on a chairs. PFI was measured with the score obtained from stepping exercise and was interpreted using the physical fitness index.

Poor physical fitness (up to 80), low average (81-100), high average (101-115), good (116-135), very good

(136-150), excellent (beyond 150).

Evaluation of physiological workload :

The physiological workload of the subjects was determined by recording the heart rate at rest for five minutes before starting the fetching of water, working heart rate at one minute interval till the activity was completed and the recovery heart rate responses using the following formula by Varghese *et al*. (1989):

Energy expenditure ($kJ.min^{-1}$) =0.159x HR ($b.min^{-1}$) -8.72

The workload was categorized as per the workload classification developed by Varghesae *et al* on the basis of heart rate and energy expenditure. The total cardiac cost of work (TCCW) is the sum of cardiac cost of recovery (CCR) and cardiac cost of work (CCW).

Rating of perceived exertion:

A modified rating scale of perceived exertion (RPE), developed by Varghese *et al*. (1994), based on Borg's 10 points scale(Brog, 1982) was adopted to measure the perceived exertion in terms of Very light(1), light(2), moderately heavy(3), heavy (4), Very heavy(5).

Musculo-skeletal problems:

To ascertain musculo-skeletal problems in terms of severity of pain in different body parts among respondents, a 5-point scale ranging from 'very severe' to 'very mild' was used.

FINDINGS AND DISCUSSION

The findings obtained from the present investigation are presented below :

Physical characteristics:

The mean age of the respondents of the younger age group was 25.1 years and older age group was 37.1 years as revealed from Table 1. The mean height and weight were 151.12cm and 150.29cm and 44.70 kg and 44.70 kg, respectively for both the age groups. The Lean Body Mass was found to be 30.5kg for younger age group and 29.18 kg older age group. There was no difference between the age groups in terms of BMI. Majority of the respondents belonged to the 'Ectomorph' group (63%) followed by 'Mesomorph' (20%) and 'Endomorph' (17%) (Table 2).These findings shows that majority of the respondents had slender type of body.

Table 1 : Physical characteristics of selected respondents involved in fetching water N=30

Physical characteristics	Age	
	21-30 years Mean +SD	31-40 years Mean+ SD
Age (years)	25.1+1.70	37.1+2.16
Heights (cm)	151.12+4.82	150.29+3
Weights (kg)	44.70+4.65	44.70
LBM (kg)	30.55+3.31	29.18
BMI (kg/m^2)	19.65+1.96	19.57

Table 2 : Distribution of the respondents according to body type N=30

Body type	21-30 years		31-40 years		Total	
	N	%	N	%	N	%
Ectomorph	9	60	10	67	19	63
Mesomorph	4	27	2	13	6	20
Endomorph	2	13	3	20	5	17

Physical fitness of the respondents:

Physical Fitness Index (PFI) of the respondents assessed by using wooden stool ergometer revealed that 50% were in 'high average' followed by 33% 'below average' and 17% were in 'good' physical fitness category (Table 3). According to VO_2 max the maximum respondents had high average physical fitness *i.e.* 50% and 40% in both the age groups followed by low average. Only 15%was categorized having 'good' physical fitness.

Table 3 : Physical fitness Index of the selected respondents N=30

Physical fitness index	21-30 years		31-40years		Total	
	No.	%	No.	%	No.	%
Poor (up to 80)	-	-	-	-	-	-
Below average (81-120)	5	33	5	33	10	33
High average (101-115)	7	47	8	54	15	50
Good (116-135)	3	20	2	13	-	-
Very good (136-150)	-	-	-	-	-	-
Excellent >150	-	-	-	-	-	-

Details of the activity:

Fetching water is a home activity exclusively performed by rural women in Assam. The activity of fetching water comprises of three sub-activities *i.e.* onward journey to the source, drawing water and carrying filled water bucket to storage place. The source of water is a pond which is usually located in their own boundary or in some public places. All the respondents of both the age groups were found to use bucket for carrying water.

Average weight of the empty vessels was 1.38 kg for both the age group where the average weight of the filled vessels was 10.60 kg. Mode of carrying of both the age group was solely by hand. The total distance traveled by younger age group was more than the older age groups *i.e.* 4.7 km and 4.1 km, respectively. The total time spent by the older age group was found to be slightly more than the younger age group.

Classification of physiological workload:

The heart rates and energy expenditures of the rural women were measured in three phases for assessing physiological workloads of the respondents. The phases were as follows:

– Splitting up the activity in terms of –onward journey to sources, drawing water from the sources and backward journey with filled vessels.

– By completing the fetching water in one cycle.

The physiological workload of fetching water was assessed on the basis of heart rates (beats/min) and energy expenditures (kJ/min) values as classified by Varghese *et.al* (1994). Average and peak heart rate and energy expenditure values were assessed for sub activities and complete cycle. The backward journey with filled vessels had maximum heart rate and energy expenditure for younger age group (115 b.min^{-1} and 9.56 kJ/min) and older age group (113 b.min^{-1}and 9.24 kJ/min). The overall analysis of heart rate with age of the subjects shows that working heart rates decreased as the age of the subjects increased. Table 4 shows that onward journey for older age group was found to be 'light' while rest of the sub activity including complete cycle of fetching water was 'moderately heavy' for both the age groups on the basis of average heart rate and energy expenditure. Drawing of water and backward journey were 'Moderately heavy' for both younger and older age groups based on average heart rates and energy expenditures in contrary to the findings of *AICRP-FRM of Andhra Pradesh*, in which fetching of water was a 'very heavy' activity. This was due to the fact that the farm women had to travel a long distance to fetch water from the source whereas the Assamese women used to fetch water from the pond dug in their home compounds.

Data on TCCW revealed that average TCCW was highest in complete cycle in younger age group (284.15(beats) as compared to older age group. Physiological cost of work (PCW) assessed from TCCW was highest in backward journey for older age group (30.15b.min^{-1}) than complete cycle also.

Rating of perceived exertion (RPE) indicates highest value for both the age groups in backward journey while carrying water. Further, it was observed from the Table 5 that heart rate values of the respondents were highly co-related with perceived exertion for all the sub-activities (r value=0.84 to 0.92) and complete cycle (r value=0.85) in both the age groups which indicated that higher the heart rate higher was the respondents experience of exertion. It was observed that heart rate and energy expenditure is highly co-related with perceived exertion of the respondents for all the split up activities and

Table 4: Average and peak heart rate, energy expenditure and physiological workload in fetching water

Activity	Working HR(b.min^{-1})				Energy expenditure(kJ/min)				Classification of workload			
	Average		Peak		Average		Peak		Average		Peak	
	21-30 years	31-40 years	21-30 years	31-40 years	21-30 years	31-40 years	21-30 years	31-40 years	21-30 years	30-41 years	21-30 years	31-40 years
Onward Journey	105.35	98.92	123.5	112.50	7.95	7.0	10.92	9.32	MH	Light	H	MH
Drawing water	111.00	109.25	136	126.00	8.92	8.64	12.9	11.31	MH	MH	VH	H
Backward journey	115.00	113.00	141	129.00	9.56	9.24	13.70	11.79	MH	MH	VH	H
Complete cycle	107.40	106.00	126.5	129.5	8.35	8.09	11.39	11.87	MH	MH	H	H

Table 5 : Average of total cardiac cost of work (TCCW), physiological cost of work(PCW) and rating of perceived exertion for fetching water

Activity	TCCW (beats)		Physiological cost of work (b.min^{-1})		RPE		'r' value between heart rate and EE with RPE			
							HR and RPE		EE and RPE	
	21-30 years	31-40 years	21-30 years	31-40 years	21-30 years	31-40 years	21-30 years	31-40 years	21-30 years	31-40 years
Onward journey	176.65	158.65	18.3	15.30	2.60	2.20	0.88	0.84	0.84	0.82
Drawing water	168.65	218.85	22.2	27.05	3.20	2.90	0.85	0.90	0.66	0.90
Backward journey	219.40	273.40	23.75	30.15	3.10	3.20	0.92	0.88	0.88	0.86
Complete cycle	284.15	255.75	22.00	21.30	3.10	2.70	0.85	0.85	0.84	0.72

complete cycle for both younger and older age groups.

Postural analysis of fetching of water :

Analysis of posture showed that majority of rural women used 'standing' and 'bending' postures. It was observed from the Table 6, that the angle of normal curve was 188.7^0 for younger age group (21-30 years) and 186.6^0 for older age group (31-40 years). Angle of bend (AOB) was measured for both drawing water and backward journey with filled water bucket. Angle of bend was little less in older age group than younger age group for both drawing and backward journey. Angle of deviation was found to be more in younger age group (4.1^0) than older age group (3.8^0) while drawing water but it was reverse in case of backward journey.

Table 6 : Postural analysis of the activity – fetching of water N=30

Postural analysis (Angle of bend)	Onward journey		Drawing water		Backward journey		Complete cycle	
Years	21-30 years	31-40 years	21-30 years	31-40 years	21-30 years	31-40 years	21-30 years	31-40 years
Angle of normal curve	188.7^0	186.6^0	-	-	-	-	188.7^0	186.6^0
Angle of bending	-	-	192.8^0	190.6^0	190.8^0	189.2^0	192.8^0	190.6^0
Angle of deviation	-	-	4.1^0	3.8^0	2.1^0	2.6^0	4.1^0	3.8^0

Musculo-skeletal problems in fetching water:

Identification of musculo-skeletal problems of the subjects was identified by using the Body Map indicating different parts of the body: Upper extremities-eye, neck, shoulder joint, upper arm, wrist, cervical, upper lumber, lower extremities: lower lumber, buttocks, thigh muscles, knee joint, calf muscles and ankle. Analysis of musculo-skeletal problems of fetching water on sub-activity as well as complete cycle revealed that, incidences were comparatively more in case of older age group. Incidence of pain was considerably more in low back region. It was also found that pain in shoulder joints in both the age groups while drawing water and in backward journey. A very meagre percentage of respondents reported to have pain in upper arm, elbows, wrist, calf muscles and ankles. No strain was felt by respondents on their certain body parts eg eye, buttocks, upper leg/thigh, knees, ankle/feet. No incidence of pain was reported in onward journey by the respondents

Conclusion:

From the foregoing discussion it can be concluded that except the onward journey, rest of the sub activities of fetching water including complete cycle was moderately heavy for both the age groups on the basis of average Heart Rate and Energy Expenditures. Where as drawing of water and backward journey was found to be 'very heavy' for younger age group and 'heavy' for older age group on the basis of peak Heart Rate and Energy Expenditure. Analysis of musculoskeletal problems shows that the older age group had higher incidence of musculoskeletal problems than younger age group. Therefore, there is a need to design women friendly technologies or tools to reduce physical stress and to improve health status of rural women.

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