ASSESSMENT OF WATER CARRYING BAG FOR DRUDGERY REDUCTION

Original Research Article

ISSN : 2456-1045 (Online)
(ICV-HMS/Impact Value): 3.08
(GIF) Impact Factor: 2.174
Publishing Copyright @ International Journal Foundation
Journal Code: ARJMD/HMS/V-19.0/I-1/C-7/NOV-2017
Category : HOME SCIENCE
Volume : 19.0 / **Chapter**- VII / **Issue** -1 (NOVEMBER-2017)
Journal Website: www.journalresearchijf.com
Paper Received: 23.11.2017
Paper Accepted: 29.11.2017
Date of Publication: 07-12-2017
Page: 32-36

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Citation of the Article

Jukaria S & Singh S. (2017) *Assessment of Water Carrying Bag for Drudgery Reduction. ; Advance Research Journal of Multidisciplinary Discoveries.19.0,C-7 (2017):32-36; available at : http://www.journalresearchijf.com*

ABSTRACT

The farm women of hills spend most of their time in various house hold activities. Water carrying from distant places is a tedious job in northern hills of India. This may expose women to risk factors such as force, awkward postures, and repetitive motions that can lead to injuries, and wasted energy and time. To bring in better work effectiveness and reduced drudgery, an attempt was made to disseminate ergonomically designed water carrying bag in hill areas of Uttarakhand in India. Carrying water on waist was found beneficial as the mean score of drudgery experience matrix was found to be 11.52 compare to traditional method of water carrying i.e. 25.80.

Keywords :

Ergonomics,
water carrying bag,
drudgery experience matrix

I. INTRODUCTION

The farm women of hills spend most of their time in various house hold activities. Water carrying from distant places is a tedious job in northern hills of India. This may expose women to risk factors such as force, awkward postures, and repetitive motions that can lead to injuries, and wasted energy and time. Right from ancient time women of Indian society are fully occupied and overburdened with three fold responsibilities of farm, home and livestock management [1]. The water carrying activity from far off places is an integral part of numerous occupational, recreational and household tasks, thus they cause considerable physical and mental fatigue and other problems. Studies of various researchers witnessed the water carrying activity by the humans and its effect on the body [2-7].

Despite many technological advances, water carrying activity still remains an indispensable resource for many occupational tasks and several daily life activities. Ergonomics intervention has the potential to reduce the incidence of occupational hazards in developing countries [8-9]. A need was felt to assess and popularize ergonomically designed water carrying bag in hill areas of Uttarkhand in India. Therefore, to bring in better work effectiveness, an attempt was made to disseminate ergonomically designed water carrying bag in hill areas of Uttarakhand in India. The study has similar implications in other areas of northern hills of India.

II. MATERIALS AND METHODS

Sampling Method

Till the year 2010 there was negligible information available about the load carrying activities by the rural women, so a sampling frame based on available sources was developed. We were able to obtain census data from statistics department of the government in the area. Our sampling frame included the district Nainital. There were 120 women in this list. Of these, we randomly selected five villages, out of the randomly selected five villages, we randomly sampled them for survey, so that there would be independent samples of similar size for the period of the study. In 2010 onwards and till 2015, ten women representative each year of the sample were purposively selected for the assessment and intervention experiments based on their anthropometric data to minimize the human errors on the results of the study.

Instrument

A questionnaire based on standardized recommendations[1] was developed which, in total, required between 10 to 20 min to complete. Part – I of the questionnaire was comprised of personal information and demographic information. Part – II was about load carrying activities and body ailments, discomfort and perceived exertion while manually carrying the loads in day to day activities. The protocol was approved and pre tested by the Govind Bhallabh Pant University of Agriculture and Technology, India. The repercussions of carrying load were subjective based on the perceived feeling of discomfort.

Energy measurement

Drudgery matrix and perceived fatigue was recorded on the protocol developed[10-12]. The measurements were taken in the field conditions same as the load carrying work is performed by the women in daily activities.

Design of water carrying bag selected for the study

Two critical dimensions i.e. length (sitting shoulder height) and the width (shoulder breadth) of the backpack were used and the 90th percentile was used to determine the length and width of the backpack (55 x 39) cm. Weight of the external frame of water carrying bag was approximately 2.0 kg. The volume of the backpack was approximately 0.06 m3 without any load (Figure -1).

Figure-1: Ergonomically designed water carrying bag

III. STATISTICAL ANALYSIS and GRAPHICAL PRESENTATION

Reasonably complete questionnaires were coded and entered into a database. All of the questionnaires were manually checked to verify the accuracy of data entry. Data for the whole period of the study from 2010 to 2015 for descriptive analysis and also for experimental analysis is reported. Descriptive statistics (e.g. mean, standard deviation, and percent) were used to describe the sample.

IV. RESULTS AND DISCUSSION

Personal Profile of Participants

Table 1 shows that very small number of households (11.67%) among selected households were headed by the women generally due to either their widowhood or their husbands were out of home for service whereas most of the households (88.33%) were headed by the male members only. Among the selected respondents 63.33% of total women (120) fall under the age group of 26-35 years and comparatively less number of women fall under the age group of the 16-25 years (15.83%) and 36.45 years of age group (20.83%). It may be due to the reason that younger girls and old ladies are supposed to do the less loaded works. The mean age of the participants is 30.28 years and standard deviation from the mean age is found to be ± 6.006. Educational level of participants for data collection falls in between the illiteracy (15.83%) and

Intermediate (10.83%). None of them was graduate and not having any technical skills. About 24.17 percent of total women have passed primary school and 28.33% were having middle school education. Most of the women were having the farming (68.33%) as their occupation and only few were engaged in the some other business (31.67%) to earn their livelihood as subsidiary occupations such as knitting, shops, embroidery and stitching, milk delivery, selling vegetables etc. A very few women (4.17%) work as a pair worker for others but most of them were either unemployed (33.33%) or self employed (31.67%) as minor and small scale business or work as unpaid worker (30.83%) for their family. About more than half of the sample women were daughter-in-laws (61.67 %) who do the work of manual material handling and they are equally distributed among their families having ordinal position of eldest, middle and youngest.

TABLE 1. Personal Profile of participants

Sl. No.	Characteristics	Participants					
		Marginal & Small n = 38		Medium n= 82		Total (N = 120)	
		Frequency	%	Frequency	%	Frequency	%
1.	Women headed households						
	(a) Yes	9	7.5	5	4.17	14	11.67
	(b) No	29	24.167	77	64.17	106	88.3
2.	Age group (Yrs.)						
	(a) 16 - 25	5	4.17	14	11.67	19	15.83
	(b) 26 - 35	31	25.83	45	37.5	76	63.33
	(c) 36 - 45	2	1.67	23	19.17	25	20.83
	Mean Age						**30.28**
	S.D.						**± 6.006**
3.	Educational Qualification						
	(a) Illiterate	13	10.83	6	5.0	19	15.83
	(b)Primary	15	12.5	14	11.67	29	24.17
	(c) Middle	8	6.67	26	21.67	34	28.33
	(d) Matric	-		25	20.83	25	20.83
	(e) Intermediate	2	1.67	11	9.17	13	10.83
4.	Occupational						
	(a) Farming	30	25.0	52	43.33	82	68.33
	(c) Business	8	6.67	30	25.0	38	31.67
5.	Work Status						
	(a) Paid worker	5	4.17	-	-	5	4.17
	(b) Self	8	6.67	30	25.0	38	31.67
	(c) Unpaid	12	10.0	25	20.83	37	30.83
	(d) Unemployed	13	10.83	27	22.5	40	33.33
6.	Women's Relational Position						
	(a) Daughter	7	5.83	18	15.0	25	20.83
	(b) D.-in-law	26	21.67	48	10.0	74	61.67
	(c) Wife	5	4.17	10	8.33	15	12.5
	(d) Any other	-		6	5.0	6	5.0
7.	Women's Ordinal Position						
	(a) Eldest	8	6.67	32	26.67	40	33.33
	(b) Middle	8	6.67	32	26.67	40	33.33
	(c) youngest	22	18.33	18	15.0	40	33.33

Anthropometric Data

Anthropometric measurement is the measurement of human body including body dimensions and the mechanical aspects of human motions including consideration of range of frequency in an ergonomic model. The Anthropometric measurements taken in this study were weight in kg, height in cm, Body Mass Index (BMI) in kg/m2, eye height in cm, shoulder height, standing elbow height and standing knuckle height in cm. The readings of the selected sample for the women are depicted in Table 2. The selected sample comprised of the women who carry out the various manual material handling activities in India in their daily activities.

TABLE 2. Data on Anthropometric Measurement of Participants

Anthropometric measurements (mean)						
Weight (kg)	Height (cm)	BMI (kg/m^2)	Eye height (cm)	Shoulder height (cm)	Standing elbow height (cm)	Standing knuckle height (cm)
47.39	152.2	20.34	140.2	126.2	98.91	68.91

Participants' Perceived feeling of fatigue

The Table 3 shows a subjective feeling towards fatigue and ailments in carrying water by ergonomically designed water carrying bag. Usually, the sample women reported back ache (92.5%), head ache (72.5%), limb pain (86.67%), chest pain (48.33%), palm pain (95.83%) and fore arm pain (82.5%) during and after the manual material handling while water carrying and fuel wood for their households. However it was reduced to a noticeable number when the ergonomically designed water carrying bag was used to perform the same activities viz., back ache to 65.83%, head ache to 56.67%, limb pain to 66.67%, chest pain to 41.67%, palm pain to 65.0% and fore arm pain to 67.5%.

TABLE 3. Musculo Skeletal Problems Reported by Participants

S. No.	Ailments	Traditional method		Improved method	
		Frequency	%	Frequency	%
1	Back ache	111	92.5	79	65.83
2	Head ache	87	72.5	68	56.67
3	Limb pain	104	86.67	80	66.67
4	Chest pain	58	48.33	50	41.67
5	Palm pain	115	95.83	78	65.0
6	Fore arm pain	99	82.5	81	67.5

To check the design incompatibility and risk potential of hand tools and manually operated machinery firstly anthropometric data were collected and the water carrying bag was designed as per the 90th percentile of the data collected to include most of the women in purview of the intervention. Working conditions and environment were taken into consideration by setting up the experiment in winter as well as summer season in India so that climatic stressors and strenuousness of the work can be worked out.

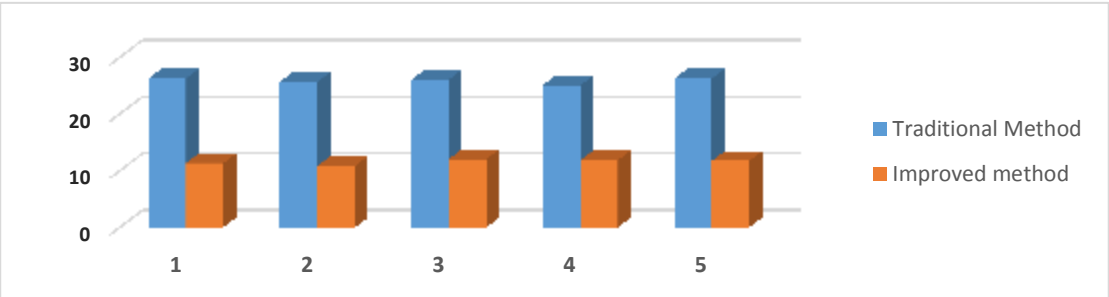
Table 4. Drudgery Experience Matrix for Water carrying

S. No.	Traditional method					Improved method				
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 1	Year 2	Year 3	Year 4	Year 5
1	27	28	25	26	25	10	12	9	10	10
2	28	26	26	26	26	8	10	9	10	9
3	26	29	25	27	25	12	14	11	12	12
4	24	24	24	24	26	13	12	12	12	11
5	23	25	23	22	28	15	10	15	10	14
6	25	27	25	27	25	8	14	9	14	13
7	27	23	26	24	29	12	14	12	15	13
8	28	22	28	22	27	15	9	14	9	14
9	26	27	25	27	22	8	11	8	11	9
10	28	29	29	25	21	12	14	12	15	12
Total	**262**	**260**	**256**	**250**	**262**	**113**	**120**	**108**	**118**	**117**
Mean	**26.2**	**26.0**	**25.6**	**25.0**	**26.2**	**11.3**	**12.0**	**10.8**	**11.8**	**11.7**

The table 4 shows data on drudgery experience matrix for water carrying by the forty respondents through the four consecutive years. The drudgery experience matrix was calculated on the basis of A. Rating on work demand, B. Rating on feeling of exhaustion,

C. Rating on posture assumed in work, D. Preparation on manual loads operative, E. Rating on difficulty perception and F. Rating on work load perception. The responses were recorded in both the ttraditional method of water carrying as well improved method of water carrying as per (A)5-Very demanding, 4-demanding, 3-Moderately demanding, 2-Less Demanding, 1-very less demanding, (B) 5-Very exhausted, 4-exhausted, 3-Moderately exhausted, 2-midly exhausted, 1-comfortable, (C) 5-Very painful, 4-Painful, 3-Moderately low, 2-Low painful, 1-No pain, (D) 5-Very heavy, 4-Heavy, 3-Moderately low, 2-Light loads, 1-No loads, (E) 5-Very heavy, 4-Heavy, 3-Moderately heavy, 2-Low, 1-Very low and (F) 5-Very heavy, 4-heavy, 3-Moderately heavy, 2-Low, 1-Very low for the aforesaid ranks, respectively. The scores were then summed and mean scores were calculated. The lower values for all the years from 2010 to 2013-14 i.e. 11.3<26.2, 10.8<25.6, 11.8<25.0 and 11.7<26.2 shows a reduced drudgery in fetching of water with water carrying bag instead of traditional containers by the respondents.

Graph 1. Drudgery Experience Matrix for Water carrying



The water carrying bag eases out manually handling the materials in the same manner in every climatic condition. The water carrying bag has been tested for solid material handling as per the ILO (International Labour Organization) guidelines, according to which it is limited to 15 kg in a single load for the age group of the selected sample women. Various accidents of cuts, wounds, musculo skeletal stretch, piercing in body, back ache, falling on the path due to over loaded body were minimized. A comfortable posture near to gravity, right grip of material on the body and proper amount of load facilitated the day to day work of women.

V. CONCLUSION

It is concluded that the use of ergonomically designed water carrying bag is very much convenient, cost effective and making the water carrying activity less drudgery prone. The design compatibility and risk potential of the bag allows the load which is permissible for the body thus leading no drudgery. It did not resulted in any kind of pain or pinching in the back. The back mode of load carrying have biomechanical and metabolic advantages over other modes of load carrying loads. Drudgery, musculoskeletal strains and accidents suggested that the developed external frame with cloth strips resulted in reduced heart rate. The participants shows how the introduction of a simple bag can reduce drudgery and great benefit can be assumed for health. Further investigations have to show whether individual sizing is necessary. The present findings of the study paves the path for further investigation on a bigger sample and may be other research questions are still open.

VI. ACKNOWLEDGEMENT(S)

We are grateful to Indian Council of Agricultural Research, New Delhi for financing the research and G.B. Pant University of Agriculture & Technology Pantnagar, India for technology and facilities for the conduct of the research.

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