

Gender involvement in manual material handling (mmh) tasks in agriculture and technology intervention to mitigate the resulting musculoskeletal disorders¹

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Abstract. The lifting and carrying of loads in agriculture on small landholdings are unavoidable. Rural communities often lack access to appropriate technologies which may result in various health hazards. The objective was to study gender participation in agricultural activities involving manual material handling tasks, to assess MSDs experienced in various MMH tasks and to evaluate traditional method and designed technology. The study was conducted on 100 agricultural workers. Data on gender participation in MMH tasks in household, animal husbandry and agriculture and resulting MSDs was gathered. Pre and post assessment of technology intervention was done for NIOSH Lifting Index, QEC, and RPE. The results revealed greater susceptibility of females to musculoskeletal problems in most of the household and animal husbandry tasks. The hand trucks designed were pushing type with power grasp handle. The respondents were advised to carry 5 kg of weight per lift instead of lifting more weight in one lift/minute while filling the hand truck. By decreasing the weight and increasing the number of lifts per minute the respondents were seen falling in green zone indicating significant reduction in NIOSH lifting index. QEC scores concluded that for filling the hand truck 5 kg of weight should be carried to keep the exposure level low.

Keywords: Hand trucks, lifting index, rating on work demand, animal husbandry, water fetching

1. Introduction

Agriculture is an occupation framed within the context of family and community. The farm family is the central entity in agricultural production involving every member be it children, women or the elderly. For more than a decade, farming has been rated one of the most dangerous occupations in the developing countries. A considerable number of adverse health conditions, including musculoskeletal disorders, are linked to agricultural work. Occupational risk factors include static positioning, forward bending, heavy

lifting and carrying, kneeling, and vibration.

Manual material handling (MMH) is defined as the unaided moving of objects, often combined with twisting and awkward postures, and contributing to musculoskeletal disorders. Traumatic occurrences (slips, trips, falls, and blows to the body) cause other bodily injuries, pains, and disabilities. Typically, not one specific occurrence but rather the awkward body positions, repetition, force, and duration associated with movement lead to back, neck, and other problems like Cumulative Trauma Disorders [1].

Manual material handling is responsible for the appearance of physical fatigue and injuries, which

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may occur immediately or through the accumulation of minor traumas apparently of little importance. The workers who regularly handle loads and those who do so from time to time may be affected. The most frequent injuries are, inter alia: bruises, cuts, wounds, fractures and, above all, muscle-bone injuries. These injuries may occur to any part of the body but the upper limbs and the back, particularly the dorso-lumbar region, are the most susceptible.

The research work was executed by assessing participation and drudgery involved in various manual material handling tasks in agriculture. On the basis of anthropometric measurements and other ergonomic parameters hand trucks were designed. The physiological cost of work and musculo-skeletal disorders was assessed to check the effectiveness of the designed MMH technology (hand truck).

2. Objectives

The present study was taken up with the following objectives:

1. To study gender participation in agricultural activities involving manual material handling tasks.
2. To assess Musculo-Skeletal Disorders (MSDs) experienced in various manual material handling tasks.
3. To evaluate traditional methods and designed manual material handling technology for harvested vegetable crops.

3. Methodology

The present study was conducted in villages of Udaipur district of Rajasthan. A sample of 100 agricultural workers (50 male and 50 female) engaged in agricultural tasks from last 10 years were selected for collecting data on gender participation in agricultural activities involving manual material handling tasks .

In Phase-I of the study, gender participation in household, agricultural, and animal husbandry activities involving manual material handling tasks was gathered on various parameters like, tasks performed; frequency of performance; and time spent/day. All the parameters were allotted scores to calculate Rating on Work Demand (RWD) to find out most drudgery prone mmh task.

RWD Scale	Psycho- physical Workload
1	Less Demanding
2	Moderately Demanding
3	Demanding
4	Very Demanding

Phase II assessed prevalence of MSD's among respondents using Psychophysical technique developed [2]. Body Map was used to determine musculoskeletal problems and Body Part Discomfort Score on a 5-point continuum. Visual Analogue Discomfort (VAD) scale, which is an adaptation of Corlett and Bishop Technique, was used to assess overall discomfort score of the respondents while performing different agricultural activities.

In Phase III, for designing of hand trucks various anthropometric data were recorded. Anthropometric data of both male and female agricultural workers from primary/secondary sources was used for designing of hand truck. Body measurements which were simple and easy to measure at the same time giving maximum information for designing hand truck were taken for the present study. Two types of hand trucks/ trolleys i.e. Double Wheel Hand Truck (DWTH) and Single Wheel Hand Truck (SWTH) were designed and interventions were conducted to mitigate the adverse effects of manual handling of loads.

Data were collected before and after the designed technology intervention. NIOSH lifting index was calculated using NIOSH software. Quick Exposure Check (QEC), a tool designed by David et al., 2005 was used to assess the changes in musculo-skeletal risk factors before and after intervention of designed MMH technologies.

A sub-sample of 30 workers was purposively selected for evaluation of traditional method and field testing of designed technology. Comparison of traditional method and designed mmh technology for carrying and transporting harvested vegetable crops was done.

The perceived discomfort was recorded in terms of pain felt in various parts of the body by the subjects while performing the activity. The RPE scale developed was used to subjectively assess the exertion perceived [4].

RPE Scale	Psycho- physical Workload
1	Very light
2	Light
3	Moderately Heavy
4	Heavy
5	Very Heavy

4. Results and discussions

4.1. Background information of the respondents

The background information of the respondents showed that majority of the respondents was in the age group of 35-45 years. The educational status of the respondents was low as that majority of female respondents (82%) and more than half of the male respondents (52 per cent) were illiterate. Majority of the male respondents i.e. 60 per cent and 58 per cent of female respondents belonged to scheduled caste/tribes. The percentages of respondents residing in joint families were marginally more and were hav-

ing large size families. About half of the male respondents (48 per cent) and about 44 per cent of female respondents had small landholdings and 16 per cent respondents had marginal landholdings and rest possessed large landholdings. Agriculture was the main occupation of cent per cent respondents. About 70 per cent of the respondents were earning their annual income between Rs. 20001-40,000.

Table 1
Percentage of gender participation in various activities involving manual material handling tasks N=100

Manual Material Handling tasks			Respondents		
			Male	Female	Both
Water fetching for household purposes	Drinking Water		12	72	16
	Cooking Water		12	72	16
	Household Care	Moping/Washing Floor	0	6	0
Plastering		8	80	12	
Water fetching for animal husbandry purposes	Feed Preparation		8	10	6
	Cleaning of Sheds		2	4	2
Household Purposes	Fuel Wood		16	78	6
	Grain for Milling		0	80	20
Animal Husbandry Purposes	Fodder		16	78	6
	Animal dung & dung cakes		0	90	10
Agricultural Purposes	Land Preparation	Stalks & stubbles	30	60	10
		to fill trolley/cart	10	60	30
	Manuring	Manure spreading	20	60	20
		Carrying seeds to field	40	40	20
	Sowing	Seed Broadcasting	0	60	40
		Transportation of fertilizer from home/market	100	0	0
	Fertilizer	Fertilizer Broadcasting	0	60	40
		Harvesting		0	0
	Threshing	Carrying bundles to threshing floor	0	0	100
		Feeding into thresher	0	0	100

4.2. Gender participation in various activities involving manual material handling tasks

The perusal of data from Table 1 clearly shows that female respondents were involved in the tasks of water fetching and material carrying for household and animal husbandry.

The data portrays that female respondents played key role in mmh related to land preparation (carrying stalks & stubbles), manuring (to fill trolley/cart and Manure spreading), fertilizer broadcasting, seed broadcasting whereas both the genders equally participated in mmh of harvesting and threshing.

4.3. Manual material handling involved in household, animal husbandry and agriculture tasks

4.3.1. Fetching water for household purposes:

Females played a key role in fetching water for all household purposes. The source of water for majority was community based hand pumps and Bawri (traditional water storage structure). All females carried water manually using head mode i.e., carrying pitchers or other containers on their head. On the contrary all the males carried water either used head or shoulder mode or made use of bicycle for fetching water for drinking and cooking purposes. A peculiar observation pertaining males was that they brought water from nearby sources i.e., walked less than 2 kms, while it was female who walked long distances. Regarding time demands on water fetching, it was recorded that majority of the respondents spent 2-3 hours in a day in this activity; the percentage of female was certainly high.

Table 2
Rating on Work Demand (RWD) for water fetching for household purposes

Water fetching for animal husbandry purposes	Rating on Work Demand				
	Male	Female	Both	Total	Rank
Water feed preparation	220	196	134	550	I
Water cleaning of Sheds	64	93	29	186	II

Table 3
Rating on Work Demand (RWD) for water fetching for animal husbandry purposes

Water fetching for household purposes	Rating on Work Demand				
	Male	Female	Both	Total	Rank
Drinking & cooking water	732	3186	786	4704	I
Household care	178	1818	247	2243	II

It is clear from Table 2 that fetching water for drinking and cooking was rated first on the scale of work demand whereas the fetching water for household care which included mopping and plastering the house was ranked second. The reason was that cent per cent of the respondents brought water for drinking and cooking on daily basis whereas for household care it was brought weekly or monthly or occasionally.

In this table the scoring was not done for fetching water for personal care as most of the respondents were going to the source of water for completing these activities.

4.3.2. Fetching water for animal husbandry purposes:

The data in the Table 3 shows that fetching water for animal feed preparation was ranked first on work demand rating whereas for cleaning animal shed water was not brought very frequently so it ranked second. In this table the scoring was not done for fetching water for animal drinking and animal bathing as most of the respondents were going to the source of water for completing these activities.

Both the genders (58%) played equal role in fetching drinking water for animals whereas marginally higher percentage of female as compared to males carried water for feed preparation and cleaning of shed. It was observed that the higher percentage of respondents took their animals at the water source for drinking and bathing purposes. The main source of water for drinking and bathing of animals was village pond followed by community hand pumps for drinking purpose only. Water for all the animal husbandry uses was carried manually either on head or shoulder or by hand by both the genders. None of the respondents carried and transported water to their home instead they took the animals to the water source for drinking and bathing

4.3.3. Material carrying activities related to household and animal husbandry:

Majority of the female carried fuel wood, grain to flour mill, fodder, animal dung and dung cakes. More than two-third of female travelled more than 6 km for collecting fuel wood and about 40 per cent of females travelled less than 2 km to collect fodder and carry animal dung and dung cakes. Majority of females brought fuel wood thrice in a week, carried grain monthly to flour mills and dung once in a day and animal dung cakes twice a week. More than half of the female respondents carried fuel wood between 30-45 kg. Majority of female carried less than 15 kg of dung and dung cakes.

Table 4
Rating on Work Demand (RWD) for material carrying tasks for household and animal husbandry purposes

Material carrying		Rating on Work Demand				
		Male	Female	Both	Total	Rank
Household purposes	Fuel wood	257	1725	94	2076	I
	Grains for milling	0	1095	354	1449	II
Animal husbandry purposes	Fodder	194	1275	107	1576	I
	Animal dung & dung cakes	0	1330	152	1482	II

The data in Table 4 on material carrying for household purposes clears that carrying fuel wood was heavier task than carrying grain to flour mill as the frequency of performance and distance travelled for fetching fuel wood was higher than grain milling task.

The task of carrying fodder was rated first on the scale of work demand as fodder was brought in more quantity and distance travelled was more than carrying animal dung and dung cakes.

4.3.4. Material carrying activities related to agriculture:

Land preparation

The female respondents played a key role in carrying of stalks and stubbles of crops during land preparation activity. Cent per cent of the respondents carried stalks and stubbles manually using head mode i.e., putting tagari on their head. It was reported that they travelled less than 2 km and 2 hour for collecting and carrying stalks and stubbles.

Manuring

Majority of the female respondents and 70 per cent of male respondents carried less than 15 kg of weight manually to fill trolley/cart and spent the time between 1-2 hour/day for traveling a distance less than 2 km for crops. The activity of carrying manure and spreading in field was performed by 60 per cent of female respondents. Both the male and female respondents carried the manure manually traveling a

distance of less than 2 km spending 1-2 hours and the weight of manure carried was less than 15 kg once in a season.

Sowing

Majority of the male carried 5-10 kg of seeds while sowing crops travelled a distance between 2-4 km taking less than 1 hour. The activity of seed broadcasting was performed by 60 per cent of females and 40 per cent of both the gender. The activity was performed manually and was seasonal.

Application of fertilizer

The transportation of fertilizer from market was done mainly by male respondents. They carried the fertilizer by the mechanized mode of transportation and spent time between 1-2 hours. Majority of the female respondents (60%) and 40 per cent of both the genders broadcasted the fertilizer in crops by carrying less than 15 kg of fertilizer and covered a distance of less than 2 km in less than 1 hour.

Harvesting and threshing

Cent per cent of both the gender performed the material carrying activities related to harvesting of crops and carrying bundles of crops to the thresher. Cent per cent respondents carried the material manually for less than 1 km in less than 1 hour. Majority of both the male and female respondents carried bundles of crops between 15-30 kg per trip whereas 20 per cent carried more than 30. Cent per cent of males and females carried 5 kg of weight to the thresher.

Table 5
Rating on Work Demand (RWD) for material carrying for agricultural purposes

Material carrying agricultural purposes		Rating on Work Demand				
		Male	Female	Both	Total	Rank
Land preparation		450	1100	190	1740	III
Manuring	Carrying manure to fill trolley/Cart	130	780	420	1330	VIII
	Manure spreading	280	930	320	1530	IV
Sowing	Carrying seeds to field	600	610	320	1530	IV
	Seed Broadcasting	0	732	600	1332	VII
Fertilizer		0	890	590	1480	VI
Harvesting		0	0	2000	2000	I
Threshing	Carrying bundles to the thresher	0	0	1820	1820	II
	Feeding into thresher	0	0	1500	1500	V

The perusal of data in Table 5 shows that the harvesting was ranked first. The reason being harvesting of vegetables is an ongoing task in both rabi and kharif season in addition to harvesting of crops. Carrying of harvested crops from fields to home involved frequent load carrying. The carrying of bundles of crop to the thresher was ranked second; land preparation was third on the scale of work demand.

Manure broadcasting task and seed carrying task from home to field was on fourth rank. This shows

that harvesting was most demanding and carrying manure to fill cart/trolley to transport to the field was least demanding in the agricultural task based on the scoring.

4.4. Musculoskeletal problems of the respondents involving MMH in various tasks related to household, animal husbandry and agriculture.

4.4.1. Body part discomfort score of the respondents for household and animal husbandry tasks

The Body Part Discomfort Score of the respondents for household and animal husbandry task indicated that both the male and female respondents felt severe pain in neck and shoulder while performing all the household tasks whereas in animal husbandry tasks they felt severe pain during water and fodder carrying tasks. Severe pain in lower back was felt by female respondents in tasks of carrying fuel wood, grains, fodder and water fetching whereas male respondents felt severe pain in grain and fodder carrying tasks.

4.4.2. Body part discomfort score of the respondents for agricultural tasks

The Body Part Discomfort Score of the respondents for land preparation task indicated greater susceptibility of females to musculo skeletal problems. The BPDS of the respondents after sowing operation reveal that due to frequent changes in posture and continuous movement all the female respondents experienced severe pain in lower back whereas the scores of males were more than moderate pain. The BPDS of the respondents in manuring task was highest for neck. Besides this, all the male and female respondents reported moderate pain in shoulder, upper arm, lower back, elbow, upper back, lower arm, wrist, thighs, knees, lower leg, ankle/feet and palm/fingers with the score between 2.54 – 3.46. The BPDS of the respondents in weeding task was very low. The total body discomfort scores for plant protection of males was 26/65 and for females it was only 12/65. The Body Part Discomfort Score of the respondents for harvesting task portrays that male and female respondents involved in harvesting reported moderate pain in neck, shoulder, palm/fingers, upper back, thighs and lower leg. Nearly Severe pain was reported by the respondents in upper arm and lower. The BPDS of the respondents in threshing task showed that for both males and females, pain in upper back was nearly severe during this job. Pain in neck, shoulder, upper arm, lower arm, wrist, lower back, thighs and lower leg was moderate whereas the scores for other body parts reveal that there was mild pain.

4.5. Overall discomfort rating experienced by the respondents in various MMH tasks

The Overall Discomfort Rating score for all the manual material handling tasks in household per-

formed by female respondents were in the range of 'high discomfort' and ODR scores were higher for males in grain carrying task. This is because most of these tasks were performed by female respondents only.

Overall Discomfort Rating scores for manual material handling in animal husbandry tasks for females in carrying fodder was 7.36 and for water fetching it was 6.90 and 4.06 in carrying animal dung and dung cakes. The Overall Discomfort Rating score for all the manual material handling tasks in animal husbandry tasks performed by female respondents were in the range of 'more than moderate discomfort to high discomfort' and ODR scores for males were in the range of 'moderate to more than moderate discomfort'.

Overall Discomfort Rating scores for manual material handling tasks in land preparation and sowing were higher for females. 'Light discomfort' was observed by males for manual material handling tasks in weeding. Overall Discomfort Rating scores for male respondents 'more than moderate discomfort' which shows that they had 'high discomfort' as they usually performed the task of plant protection quite frequently. During harvesting the female respondents in comparisons showed more discomfort than males. In threshing crop the ODR of females was higher than males indicating that the respondents perceived 'high discomfort' while performing this task.

4.6. Anthropometric data of male and female agricultural workers for designing hand trucks

The mean weight of both the males and females was taken into consideration while limiting the load to be carried in traditional head loading method. The shoulder height (cm), elbow height (cm), waist height (cm) was considered while designing adjustable handle height of hand trucks. Mean hand breadth (cm) was used for designing handhold width of hand trucks. The 5th, 95th and 50th percentile values of inside grip diameter of male and female agricultural workers were 4.4, 5.7 & 5.0 cm and 3.9, 5.0 & 4.5 cm; respectively [3] which were used for designing handle grip diameter of hand trucks.

4.7. Designing of hand truck.

4.7.1. Direction of motion:

The manual material handling technology designed i.e., hand trucks were pushing type.

4.7.2. Handle grasp:

The handle grasp of SWHT and DWHT was power grasp.

4.7.3. Handle grip diameter:

The handle diameter of the designed manual material handling technology i.e. hand trucks was taken 4.0 cm.

4.7.4. Handhold width (Grip Length):

The grip length was 41.9 cm (16.5 inch) for Double Wheel Hand Truck and 12.7 cm (4.5 inch) for Single Wheel Hand Truck.

4.7.5. Handle height:

The handle height of all the hand trucks was kept adjustable according to the requirement of the respondents. For this reason the handle length was 121.9 cm (48.0 inch) for SWHT, 87.6 cm (34.5 inch) minimum and 132.1 cm (52.0 inch) maximum for DWHT.

4.7.6. Wheel diameter:

The wheel diameter of designed hand trucks was 30.5 cm (12 inch).

4.7.7. Wheel composition:

The wheel composition of designed hand trucks was GI pipe for SWHT and synthetic rubber for modified SWHT and DWHT.

4.7.8. Hand truck weight:

The weight of SWHT was 15kg (approx.) whereas DWHT was 25kg (approx). The weight of DWHT was higher than SWHT as DWHT has two wheels and platform to carry load is also made up of G.I. pipe and iron net which had more weight than SWHT bag which is made of cloth to carry load.

4.8. Evaluation of traditional method and designed MMH technology for lifting and transporting harvested vegetable crops

4.8.1. NIOSH lifting index

The software Ergo Intelligence Series: Manual Material Handling Assessment Tools 1.3.1 was used to calculate the lifting index. The single task lifting index was below 0.85 for lifting 5 kg and 10 kg weight for both male and female respondents which came under green zone which meant no risk involved in lifting these loads using traditional method and DWHT. The data in Table 6 show that single task lifting index was below 0.85 when both the male and female respondents carried load of 15 kg to fill the basket of DWHT and above 1.00 when they carried load of 20 kg. The NIOSH lifting index was above 1.00 when the male respondents carried weight between 15-20 kg in traditional method.

Table 6

NIOSH Lifting Index for respondents lifting loads of various capacities in traditional method and filling SWHT bag and DWHT basket N=30

Load	Frequency (Lift/Minute)	Average NIOSH Lifting Index									
		Pre Intervention		Post Intervention				Change			
		Traditional Method		SWHT		DWHT		SWHT		DWHT	
		Male (n=15)	Female (n=15)	Male (n=15)	Female (n=15)	Male (n=15)	Female (n=15)	Male (n=15)	Female (n=15)	Male (n=15)	Female (n=15)
5 Kg	1	0.40	0.39	0.26	0.26	0.28	0.28	0.14	0.13	0.12	0.11
	2	-	-	0.31	0.31	0.36	0.36	-	-	-	-
	3	-	-	0.32	0.32	0.37	0.37	-	-	-	-
	4	-	-	0.33	0.34	0.39	0.39	-	-	-	-
	5	-	-	0.35	0.36	0.41	0.41	-	-	-	-
10Kg	1	0.79	0.79	0.50	0.50	0.55	0.55	0.29	0.29	0.24	0.24
15Kg	1	1.18	1.18	0.70	0.70	0.84	0.84	0.48	0.48	0.66	0.66
20Kg	1	1.58	1.57	0.75	0.75	1.11	1.11	0.83	0.82	0.47	0.46

The NIOSH lifting equation over estimated the severity of this task before the intervention, but still demonstrated significant improvement. In traditional method the respondents carried weight either on head/shoulder but after the intervention of designed material handling technology i.e. Single wheel Hand Truck (SWHT) and Double wheel hand truck (DWHT) they carried weight at lesser height for filling the bag (4 inch high) and basket (16 inch). It was

seen that both male and female respondents in post intervention (use of SWHT and DWHT) was same because they both carried the same weight for same height whereas in pre intervention the head loading was done where male has to lift the weight at a greater height than female respondents due to their heights.

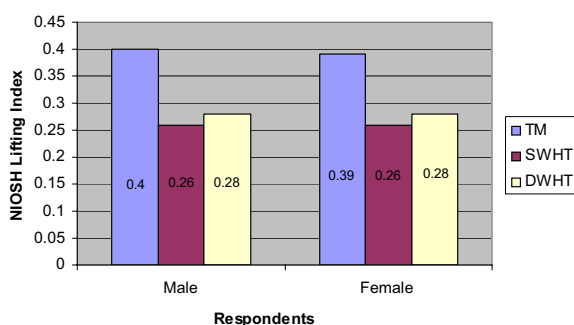


Fig.1: NIOSH Lifting Index for respondents lifting loads of various capacities in traditional method and filling SWHT bag and DWHT basket

The lifting index for lifting 5 kg and 10 kg weight for both male and female respondents was under green zone which means no risk involved in lifting these loads using traditional method and DWHT. The lifting index was below 0.85 when both the male and female respondents carried load of 15 kg to fill the basket of DWHT and above 1.00 when the male respondents carried weight between 15-20 kg in traditional method.

The data for both male and female respondents in post intervention (use of SWHT and DWHT) was same because they both carried the same weight for same height whereas in pre intervention the head loading was done where male has to lift the weight at a greater height than female respondents due to their heights.

4.8.2. Risk zone of NIOSH lifting index:

Cent per cent of male and female respondents fell in green zone when lifting 5-10 kg of weight by traditional method whereas it was found that both the gender fall in green zone when lifting weight 5 kg to 15 kg for filling basket of double wheel hand truck as the reason was that in this they have to carry weight at lower height (basket height 16 inch from floor) while in the traditional method they carried weight up to head/shoulder. Cent per cent of the male and female respondents were in green zone when they carried load ranging from 5-20 kg for filling SWHT bag.

4.8.3. Disc compression force:

The post intervention analysis (after the use of SWHT and DWHT) shows improvement for the disc compression forces, over pre- intervention values (Traditional Method). The disc compression at L5/S1 joint decreased for both males and females respondents while using the single and double wheel hand truck for carrying weight as the height of lift with weight was reduced.

4.8.4. QEC (Quick Exposure Check):

There was no change in scores for back and shoulder/arm while lifting the load on head/shoulder for filling the hand truck. The scores for wrist/hand for cent per cent of both male and female respondents was reduced after intervention of hand trucks and was reduced from 21-30 to 10-20 while lifting 5-10 kg of weight. The scores for neck for cent per cent of both male and female respondents after the intervention of hand truck fall in lower exposure level (4-6) from moderate exposure level (8-10). The exposure levels for body areas have been reduced and especially so for the wrist/hand for lifting 5-10 kg of weight for filling SWHT and DWHT whereas it was observed that the exposure after intervention of single wheel and double wheel hand truck was reduced to low levels for the neck. Thus it can be concluded from the data that for filling the hand truck 5 kg of weight should be carried to keep the exposure level lower. Thus, the intervention was successful.

The exposure level for body areas of cent per cent of both male and female respondents have been reduced from moderate level to lower level in case of back, neck and wrist/hand except shoulder/arm. The score for back of cent per cent of male and female respondents were between 21-30 while pushing 15-20 kg weight by traditional method was reduced to 10-20 and the score for back which fall in the category 8-10 when pushing 5-20 kg of weight for both the gender was reduced to 4-6 after the intervention of single wheel and double wheel hand truck. The reason for this was that the hand truck is pushing type which needs force to be exerted to move the hand truck. The exposure level reaches moderate for should/arm when more than 10 kg of weight is pushed using hand truck. There was no change in scores for wrist/hand. It can be concluded from the above table that the intervention was successful for the body areas like back and neck as it reduced the exposure level of these regions from moderate to lower levels.

The classification of psycho-physical workload [4] of the activity based on Rating of Perceived Exertion (RPE) Scale showed that when both the male and female respondents used improved technology DWHT for carrying load ranging from 5 to 20 kg they perceived 'Light' psycho-physical workload. From this it is clear that DWHT and SWHT are better option for carrying loads than the traditional method of carrying load and also that DWHT was better than SWHT.

5. Conclusion

It was elicited that females were highly involved in manual material handling related to water fetching and material carrying for household and animal husbandry. In agriculture female respondents played a key role in mmh tasks in land preparation, manuring, sowing, fertilizer broadcasting. NIOSH lifting index found that by decreasing the weight and increasing the number of lifts per minute the manual material lifting fall in green zone indicating significant reduction in lifting index. The Rating of Perceived Exertion for lifting and carrying loads of various capacities using traditional method was higher as compared to single and double wheel hand truck. This clearly establishes that the designed technology for material

handling was much better than the traditional method of head loading and DWHT was better than SWHT. Thus it can be concluded that use of mechanical aid reduces musculo skeletal discomfort of work.

References

- [1] Anonymous. 2007. Risk Topics. Cited from www.zurichna.com.
- [2] Corlett, E.N. and Bishop, R.P. 1976. A technique for assessing postural discomfort. *Ergonomics* 19:175-192.
- [3] Meerza Abood Rahi, A. 2003. Ergonomical studies on agricultural workers for selected farm operations. Unpublished M.E. (Agricultural Engineering) Thesis, Deptt. of Farm Machinery and Power Engineering, College of Technology and Engineering, MPUAT, Udaipur.
- [4] Varghese, M.A., Saha, P.N., Bhatnagar, A. and Chauhan, M. 1994. An acceptable workload for Indian workers. *Ergonomics* 22:1059-1071.