Risk Factors of Head-Load Carriage among Farmers: An Analysis of Physiological and Perceptual Responses

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ABSTRACT

Musculoskeletal Disorders (MSDs) significantly threaten the health and well-being of farmers who carry head loads. Despite the prevalence of MSDs, a major barrier to preventing this issue is the lack of awareness and training among farmers. In Mantalongon, Dalaguete, Cebu, vegetables are predominantly transported by head-load carriages, exposing farmers to substantial health risks. This study aimed to evaluate the perceptual and physiological responses of farmers to identify risk factors associated with head-load carrying. The research involved 36 farmers, examining the relationship between MSDs and various task-related variables, health history, and personal profiles. The results indicated that the farmers rated their work intensity as "moderate" on the Borg scale and could carry loads averaging 147% of their body weight. Despite these strenuous conditions, no significant statistical correlation was found between personal profiles, health histories, and reported pain and discomfort. Four primary risk factors were identified: (i) the load weight carried significantly affected the Rating of Perceived Exertion (RPE) (p=0.003), neck discomfort (p=0.002), upper back discomfort (p=0.001), and heart rate variation (p=0.025), (ii) the terrain traveled was associated with upper back discomfort (p=0.025), lower back discomfort (p=0.046), and leg discomfort (p=0.031), (iii) the distance traveled significantly influenced heart rate variation (p=0.001), and (iv) the lifting technique was correlated with lower back discomfort (p=0.023). These findings underscore the urgent need for targeted interventions to mitigate MSD risks among farmers. Implementing comprehensive awareness and training programs can provide farmers with the necessary knowledge and skills to reduce the physical strain associated with carrying head loads, thus improving their health and overall well-being.

Keywords-head load carriage; ergonomics; risk factors; subjective response; physiological response

I. INTRODUCTION

Manual labor remains a dominant practice in agriculture, leading to a high prevalence of Work-related Musculoskeletal Disorders (WMSDs) and injuries among farm workers. Globally, approximately 866 million people, or 25% of the workforce, are employed in agriculture. Despite advances in mechanization in some parts of the world, many regions, including the Philippines, still rely heavily on manual labor for agricultural production. This dependency has been consistently associated with a high incidence of MSDs and other related injuries, especially in tasks that involve intensive manual labor [1-8]. In 2017, the agricultural sector in the Philippines employed 27.7% of the labor force, with work-related injuries comprising 6.35% of all reported injuries. The most common injuries include those to the lower limbs, arm, shoulder, back, head, and neck, primarily due to carrying and lifting agricultural items and supplies[7].

Head-load carriage is a common practice among farmers in the Philippines, particularly in Mantalongon, Dalaguete, Cebu. As shown in Figure 1, head-load carriage involves transporting vegetables and crops using large baskets called bukag, which are locally crafted. The use of bukags highlights the physically demanding nature of this work. The typical vegetables and crops carried include tomatoes, cabbage, and other leafy greens, with the average weight of these loads ranging from 70 to 100 kg. Farmers often engage in these carrying and lifting activities throughout the day, spending several hours performing such tasks during the harvest period.

A review of related studies on lifting and carrying, particularly in agriculture, underscores the risks associated with these activities. Labor-intensive practices pose significant risks to musculoskeletal health, leading to conditions that affect the neck, shoulders, and back [6-9]. In addition, these activities, involving lifting and carrying, have substantial perceptual [9-12] and physiological [13-15] impacts on farmers. Research on lifting and carrying loads suggests that both perceptual and physiological assessments are necessary [16-20]. Many studies have identified the main risk factors for WMSDs, such as the weight of the loads, the duration of carrying, and the posture adopted during these tasks. Research on lifting and carrying in other sectors, including the military [9, 10, 17, 21, 22], schoolchildren [20, 23-26], porters [15, 19, 27, 28], and hikers [28, 29], has shown the need for both perceptual and physiological assessments to fully understand the impacts on workers. However, there is a notable gap in the literature on the risk factors associated with head-load carriage in agriculture, particularly in the context of farmers in Mantalongon.

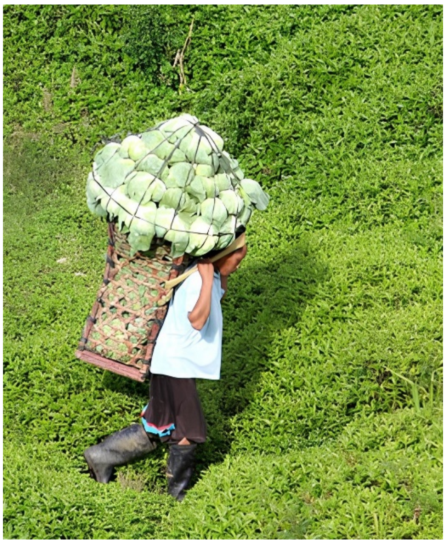

Fig. 1. Head-load carriage in Mantalongon, Dalageuete, Cebu, Philippines.

II. METHODOLOGY

A. Research Procedure

This study implemented census sampling due to the small and manageable population size of 53 registered farmers in Mantalongon, Dalaguete, Cebu. Census sampling involves trying to collect data from each member of the population, ensuring that each farmer has the same opportunity to participate and be represented in the study. Once the necessary instruments and equipment were ready, the researcher began collecting data. The research began by looking for farms that were ready for harvest. Following consent, specific instruments and gadgets were used to measure the farmer's blood pressure and pre-work heart rate. Instruments included the Omron HEM-7121 automatic blood pressure monitor for blood pressure measurement and a heart rate sensor (e.g., Polar H10 heart rate sensor) for heart rate measurement. These measurements were recorded along with task-related variables, such as land terrain (uphill, flat, or downhill), distance traveled, and lifting technique (pre-positioned or on-ground). When the farmer left the basket, the load weight was recorded using a digital hanging scale with a precision of ±0.1 kg. The farmer was then asked about his age and experience in the job, and his height and weight were measured after he had rested. Finally, the farmer was asked to complete the forms on the perceived exertion rating, using [30], and the level of pain and discomfort for the following body regions: neck, shoulder, upper back, lower back, hips, thighs, and legs, using [22, 30]. The responses to perceived exertion and discomfort were summarized to understand farmers' exertion levels and specific areas of pain and discomfort. This provided insight into the physiological and perceptual impacts of head-load carriage on farmers. This process was repeated until the desired sample size was obtained, ensuring a comprehensive representation of the farmer population.

B. Data Treatment

SPSS v.23 was used to perform a cluster analysis of the collected data. The data were analyzed using k-means clustering, which is a technique for categorizing or grouping objects into k groups, where k is the number of pre-selected groupings. The process of grouping objects and related centroids involves reducing the sum of square distances between them. Iterations are necessary to arrive at statistically meaningful clusters, which group data according to commonalities.

III. RESULTS

A. Physical and Health Background of the Respondents

The 53 registered farmers in Mantalongon, Dalaguete, Cebu, were approached to participate in the survey. However, only 36 of them responded, resulting in a response rate of 68%. This response rate is considered high and indicates a strong level of participation from the population. This means that the data collected from the sample is likely to closely reflect the characteristics of the entire population [31]. The participants had an average BMI of 23.08, which is within the healthy range for Filipinos [32]. Their average height was 158.17 cm, which is less than the average height of adult Filipinos (165.6 cm). Participants' heart rate and blood pressure were measured before and after head-load transport, with notable variations indicating physiological responses to the task.

TABLE I. BIOGRAPHIC DATA OF THE RESPONDENTS

Specifics	Min.	Max.	Mean	Std. Dev
Age	17.00	63.00	34.7778	12.708
Height	146.00	168.00	158.166	6.367
Weight	42.00	73.00	57.8611	7.7169
BMI	18.44	29.67	23.0833	2.4748
Years of head-load carriage experience	1.00	50.00	16.3333	12.266
HeartRateBefore	61.00	111.00	80.33	12.158
SystolicBefore	93.00	142.00	119.261	12.067
DiastolicBefore	51.00	100.00	79.167	12.048
HeartRateAfter	68.00	158.00	97.972	20.079
SystolicAfter	99.00	150.00	122.417	11.119
DiastolicAfter	55.00	109.00	79.50	13.675

B. Previously Experienced Pain and Discomfort

All participants previously reported having bodily aches and pains. They claimed that this is referred to as strain, or "pamaol" in the native language. Figure 2 shows that the neck and hips are the main areas where people experience pain and discomfort. The findings in [12], which examined the perceptual impressions on head and back loading, are consistent with the suggestion that farmers' neck and hip areas are more vulnerable to MSD hazards than other regions of the body. The head-load carriage is a physically demanding job that requires the entire body to support the weight transported. Farmers are more susceptible to MSDs because when lifting and carrying, the neck only supports the weight of the head and the hips hold the full weight of the upper body.

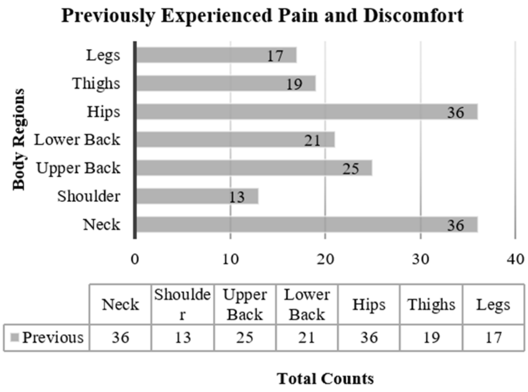

Fig. 2. Previously experienced pain and discomfort.

C. *Perceptual Responses*

Based on a scale of 0-10 for the level of pain and discomfort after head load carriage, the farmers gave the hips and neck the highest scores (2.5 and 2.2, respectively), although they were only considered to be light pain and discomfort.

TABLE II. STATISTICAL SUMMARY OF SUBJECTIVE RESPONSES AFTER HEAD-LOAD CARRIAGE

Subjective Responses	Min.	Max.	Mean	Std. Dev.
RPE Score	0.50	5.00	2.8333	1.22474
Discomfort on neck	0.00	6.00	2.2778	1.87634
Discomfort on shoulder	0.00	6.00	0.6111	1.24849
Discomfort on upper back	0.00	4.00	1.4444	1.31897
Discomfort on lower back	0.00	4.00	0.9722	1.15847
Discomfort on hips	0.00	6.00	2.5000	2.10442
Discomfort on thighs	0.00	4.00	0.8889	1.30445
Discomfort on legs	0.00	4.00	0.9167	1.25071

As shown in Table II, farmers assessed the RPE of head-load carriage work as 2.83 on average, which is classified as a "moderate" task according to [29]. Compared to the findings of [28], which indicated that the RPE rate of "hard" was comparable to 40% of participants' body weight, the farmers' ability to support load was 147% of their body weight. The findings possibly demonstrate that the farmers had already physically and mentally adjusted to the demands of head-load carriage, which is consistent with [19], which found that porters could control work intensity and lift very heavy loads without developing long-term health issues. Figure 3 provides more evidence for this, demonstrating that counts on before body pain and suffering are higher than numbers after the head-load carriage. This might imply that some of the farmers had become used to the suffering they had endured. After interviews, 78% of farmers claimed that since they carry head loads regularly, their bodies are accustomed to doing so.

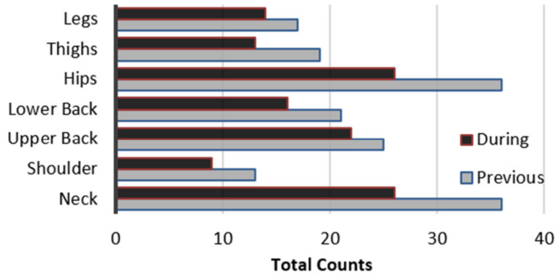

Fig. 3. Comparison of pain and discomfort in previous experience and after head-load carriage.

TABLE III. SIGNIFICANCE OF PAIRED T-TESTS OF HEART RATE AND BLOOD PRESSURE

Pairing	Paired Differences					df	Sig. (2-tailed)
	Mean	Std. Dev	Std. Error Mean	95% Confidence Interval of the Difference			
				Lower	Upper		
Heartrate before - after	-17.64	14.01	2.33	-22.38	-12.89	35	.000
Systolic before - after	-3.06	5.79	.96	-5.01	-1.09	35	.003
Diastolic before - after	-.33	9.41	1.57	-3.52	2.85	35	.833

D. *Physiological Responses*

As shown in Table I, the heart rate and blood pressure of the respondents varied before and after head-load transport. The average heart rate increased from 80.33 to 97.97 bpm and the p-value of zero in Table III indicates that this increase is statistically significant. Systolic and diastolic blood pressure readings were recorded simultaneously. The paired t-test indicated that the increase in systolic blood pressure from 119.36 to 122.42 mmHg was statistically significant, with a p-value of 0.003. Diastolic blood pressure, on the other hand, decreased from 79.17 to 79.5 mmHg, almost unchanged, and the difference was not statistically significant (p-value=0.833). These findings contradict those of [18], which showed that the diastolic blood pressure of the individuals increased significantly while carrying loads weighing more than 20% of their body weight. These findings substantiate the notion that farmers have already adapted to the head-load carrying duty.

TABLE IV. SIGNIFICANCE OF PAIRED T-TESTS OF HEART RATE AND BLOOD PRESSURE BEFORE AND AFTER

Dependent variable	Independent variable (risk factor)	Relational significance of the independent to the dependent variable	
		p-value	Standardized coefficient (weight contribution)
RPE	Load weight carried	0.003	0.509
Discomfort on the neck	Load weight carried	0.002	0.531
Discomfort on the upper back	Terrain travelled	0.025	-0.340
	Load weight carried	0.001	0.502
Discomfort on the lower back	Lifting technique	0.023	0.376
	Terrain travelled	0.046	-0.350
Discomfort on the legs	Terrain travelled	0.031	-0.405
Difference on heart rate	Distance travelled	0.001	0.534
	Load weight carried	0.025	0.361

IV. DISCUSSIONS

Cluster analysis carried out on individual farmer profiles, including age, BMI, and task experience, along with their health background, did not reveal any significant correlations with their physiological and perceptual reactions, indicating that these factors do not significantly influence how farmers perceive and physically respond to their workload. However, this analysis identified several work-related variables that had a significant impact on farmers' physiological and psychological reactions. These variables included the weight of the load carried, the lifting technique employed, and the distance and terrain covered during work activities.

Regression analysis also confirmed the importance of these risk factors, showing statistically significant correlations with dependent variables. Specifically, lifting style, distance traveled, terrain traveled, and load weight carried were identified as key factors that affect farmers' physiological and psychological responses. For instance, the weight of the load carried accounted for a substantial portion of the variance in RPE, neck discomfort, upper back discomfort, and heart rate variation. This indicates that the heavier the load, the more effort and strength farmers perceive to be required, leading to increased discomfort and elevated heart rate. Similarly, the terrain traversed was responsible for a significant portion of upper back discomfort, lower back discomfort, and leg discomfort. Farmers experienced more pain and discomfort in these areas when traveling on lower or downhill terrain while carrying a head load. Additionally, the lifting technique was found to contribute significantly to lower back discomfort, emphasizing the importance of proper lifting techniques to prevent injury and discomfort.

Comparing these findings with other studies, there is a consistent emphasis on load weight, terrain, and distance as critical factors affecting WMSDs. For example, in [33], the significant risk of neck and back pain with increased load weight was highlighted. In [28], the impact of uneven terrain on lower back discomfort was emphasized. However, unlike these studies, this research found no significant correlation between individual characteristics, such as age and BMI, and physiological and perceptual reactions, suggesting that work-related factors play a more dominant role. These results suggest that work-related factors, such as load weight, terrain, and lifting technique, play a more significant role in influencing farmers' physiological responses. These findings have important implications for designing interventions to improve farmers' work conditions and reduce the risk of musculoskeletal injuries.

V. CONCLUSION

Farmers in Mantalongon, Dalaguete, Cebu, need to be aware of task-related risk factors to prevent injuries and serious health conditions, although they may have adapted to carrying head loads based on their physiological and perceptual responses. These risk factors include the weight of the cargo they carry, the terrain they travel over, the distance they cover, and the lifting techniques they use. Reducing the severity of these risk factors is advisable for their long-term health and well-being. Although this study identified critical risk factors associated with head-load carrying, it does not provide specific calculations for maximum load, ideal terrain, or maximum distance to minimize discomfort and risk of injury. Future research should focus on these aspects to develop more precise guidelines. Studies should aim to determine the optimal weight that can be carried safely without significantly increasing the risk of WMSDs, identify the most suitable types of terrain for head-load carriage to minimize discomfort and risk of injury, and establish safe distances that can be traveled while carrying a load to avoid excessive strain and fatigue. Additionally, further research should investigate other potential hazards in the workplace that could affect head-load carrying, including environmental factors, work practices, and the use of ergonomic interventions. By addressing these areas, future studies can contribute to the development of comprehensive strategies to improve the safety and well-being of farmers engaged in head-load carriage.

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