



# International Journal of Research in Agronomy

E-ISSN: 2618-0618

P-ISSN: 2618-060X

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2025; SP-8(1): 484-487

Received: 12-12-2024

Accepted: 18-01-2025

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## Ergonomic assessment of handgrip strength and workload among farm women engaged in bundling of leafy vegetables in Telangana

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DOI: <https://doi.org/10.33545/2618060X.2025.v8.i1Sg.2476>

### Abstract

The manual bundling of coriander and other leafy vegetables is a labor-intensive activity performed predominantly by farm women in rural agricultural systems. This study aims to evaluate the handgrip strength and heart rate variations of 50 farm women engaged in this task in Tholkatta village, Rangareddy district, Telangana. Anthropometric variables, like height, weight, BMI, hand length and hand breadth were measured to assess their relationship with grip strength and physical performance. The study highlighted that 76 per cent of the respondents bundled over 600 coriander bunches per day, a significant workload that poses ergonomic challenges. Handgrip strength was measured using a digital handgrip dynamometer which revealed an average decrease of 7.09 per cent in the dominant hand and 10 per cent in the non-dominant hand post-activity, reflecting task-induced fatigue. Resting and maximum heart rates were recorded to monitor cardiovascular stress levels during work, with average values of 64.15 beats per minute and 126.76 beats per minute, respectively. The findings indicate a strong correlation between hand length, breadth and grip strength, particularly in the non-dominant hand, while BMI showed a weaker association. These results emphasized the impact of physical workload, repetitive tasks and inadequate ergonomic conditions on the health and productivity of farm women.

**Keywords:** Occupational health, handgrip strength, farm women, anthropometric variables, heart rate, bundling of leafy vegetables

### 1. Introduction

Manual harvesting of leafy vegetables, particularly coriander, is a labor-intensive task performed by farm women in rural agricultural systems. This activity demands significant physical exertion, characterized by repetitive motions, sustained postures and the need for fine motor skills to bundle the crops. Such tasks are integral to small-scale agriculture, where mechanization is limited due to economic and infrastructural constraints. Farm women, who constitute a substantial portion of the agricultural workforce, play a pivotal role in post-harvest operations, yet often face ergonomic challenges that may impact their health and productivity. Agriculture-related activities like bundling are linked to musculoskeletal disorders (MSDs) due to repetitive strain, awkward hand positions and extended working hours (Nguyen and Park, 2021)<sup>[6]</sup>. Research by Kumar and Kumar (2018)<sup>[4]</sup> highlights that prolonged repetitive tasks lead to muscle fatigue and reduced grip strength, emphasizing the necessity of assessing physical workload and developing ergonomic interventions. Specifically, the study of handgrip strength, an indicator of manual dexterity and endurance, is crucial in understanding the physiological impact of such tasks on farm women.

Physical attributes like hand size, BMI and muscle strength influence the performance of labor-intensive activities. Studies by Singh and Tajsvita (2020)<sup>[10]</sup> have demonstrated a positive correlation between BMI within the normal range and grip strength, suggesting that individuals with adequate muscle mass can perform better in tasks requiring repetitive hand movements. Similarly, research by Koley *et al.* (2013)<sup>[3]</sup> indicates that hand length and breadth are strong determinants of grip strength, particularly in repetitive agricultural tasks, emphasizing the role of anthropometric parameters in ergonomic assessments. Repeated forceful gripping and exposure to long hours without adequate recovery may lead to cumulative strain, reducing productivity

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and quality of life. Smith & Brown (2019) [13] underlined the importance of understanding dominance-related muscle fatigue, which directly affects the grip strength of the dominant and non-dominant hands. cardiovascular fitness influences physical performance in agriculture-related tasks. It suggests that individuals with higher cardiovascular fitness tend to have better endurance and performance in physically demanding activities (Taylor and Lopez, 2018) [14]. The present study, conducted among farm women evaluated handgrip strength and heart rate variations during coriander bundling.

## 2. Methodology

The present study was conducted among 50 purposively selected farm women engaged in bundling leafy vegetables, particularly coriander, in Tholkatta village, Moinabad Mandal, Rangareddy district, Telangana. These respondents were selected to evaluate the relationship between physical factors and their handgrip strength during the bundling activity. The independent variables included education, family size, type of family and monthly family income. The dependent variables were handgrip strength and heart rate. Anthropometric traits such as height, weight, body mass index (BMI), hand length and hand breadth were measured for each subject. BMI was calculated using the standard formula:

$$\text{BMI} = \frac{\text{Height in meters (m)}^2}{\text{Weight in kilograms (kg)}}$$

Handgrip strength was measured for both right and left hands using a standard digital handgrip dynamometer. The measurements were taken in a standing position with the shoulders adducted, arms in downward position and elbows fully extended. Each subject was instructed to exert maximum force on the dynamometer thrice with both the dominant and non-dominant hands. To avoid muscle fatigue and ensure accuracy, a rest interval of 3–5 minutes was provided between consecutive tests. Two readings were recorded for each hand and the average value was calculated in kilograms. For accurate readings, the tests were repeated with ample rest intervals, and only the average values from the two trials for each hand were considered.

Heart rate was measured at rest and post-activity using a heart rate polar monitor. This allowed the study to evaluate any significant changes or stress-induced variations during and after bundling work. The collected data was analyzed using frequency, percentages, descriptive statistics and Pearson's correlation coefficient to determine the relationship between handgrip strength and other anthropometric variables among the respondents.

## 3. Results and Discussion

### 3.1 Background information of the respondents

The demographic information of respondents is presented in Table 1. A substantial proportion of the respondents (30%) were illiterate and 24 per cent studied up to higher secondary education. In terms of family size, 42 per cent of respondents had up to four family members and 36 per cent belonged to families of five to seven members. The prevalence of nuclear families (42%) exceeded that of joint (32%) and extended families (26%), highlighting the transition toward smaller family units in rural areas.

Majority of the respondents (38%) have work experience between 31–40 years. These background factors may influence the physical workload and performance of farm women,

particularly during activities like bundling coriander. Studies have shown that literacy and economic status play a crucial role in adopting ergonomic technologies and improving occupational efficiency (Sharma and Biswas (2018) [9]; Patel and Kumar (2019) [7]; Singh and Kaur (2021) [11]).

**Table 1:** Background information of the respondents

Variable	Particular	F (%)
Education	Illiterate	15 (30.0)
	Primary school education	9 (18.0)
	Secondary school education	26(52.0)
Size of family	Small (up to 4 members)	21 (42.0)
	Medium (5 to7 members)	18 (36.0)
	Large (Above 8 members)	11 (22.0)
Type of family	Nuclear	21 (42.0)
	Joint	16 (32.0)
	Extended	13 (26.0)
Work experience	Below 10 years	8 (16.0)
	Between 11-20 years	4 (8.0)
	Between 21-30 years	13 (26.0)
	Between 31-40 years	19 (38.0)
	Above 41 years	6 (12.0)

### 3.2 Physical Parameter of respondents

The mean age of the respondents is approximately 25.51 years, indicated that the majority of the participants were young adults. The average BMI of 19.56 was within the normal weight range, suggesting that the participants were likely to have adequate muscle mass, which was essential for optimal grip strength. Studies have shown a positive correlation between BMI and muscle strength, indicating that individuals with a healthy BMI may perform better in strength-related tasks, including those involving grip strength (Singh and Tajessvita, 2020) [10].

**Table 2:** Physical Parameter of respondents

Parameter	Range	Mean Value
Age	23-56	25.51±3.427
Body Mass Index	15.36-2.95	19.56±3.73
HR Rest beat/min	68.73-86.79	67.15±3.261
HR Max beat/min	117.20-152	126.76±5.25

The mean resting heart rate of 64.15 beats per minute is indicative of good cardiovascular fitness, which is often associated with better physical performance and endurance in tasks requiring grip strength. The maximum heart rate recorded is 126.76 beats per minute, suggesting that the participants can achieve a reasonable level of exertion during physical activities such as bundling coriander or other leafy vegetables. The physiological demands placed on farm women during activities such as bundling vegetables can lead to significant variations in grip strength due to factors such as fatigue and muscle recovery. studies have shown that repetitive tasks can lead to muscle fatigue, which may subsequently decrease hand grip strength over time (Nguyen and Park, 2021) [6].

### 3.3 Distribution of Respondents Based on Leafy vegetable Bundling Quantity per Day

The data presented in Table 3 showed the distribution of respondents based on their daily leafy vegetable bundling quantity. The majority of respondents (76%) reported bundling above 600 bunches per day, while smaller proportions bundled 400-600 (16%), 200-400 (4%), and 100-200 (4%) bunches daily. The high volume of work, particularly for those bundling over 600 bunches daily, poses significant ergonomic challenges.

Research indicated that repetitive motions, awkward postures, and prolonged periods of physical exertion are common in agricultural settings, contributing to a high incidence of MSDs among workers (Kim *et al.*, 2018)<sup>[2]</sup>.

**Table 3:** Distribution of Respondents Based on Leafy vegetable Bundling Quantity per Day

Bundling quantity range	F(%)
100-200 per day	2(4.0)
200-400 per day	2(4.0)
400-600 per day	8(16.0)
Above 600 bunches per day	38(76.0)

### 3.4 Anthropometric variables of farm women

The mean height of the respondents was 152.90 cm, with a standard deviation (SD) of 5.65 cm. Previous studies have shown that height was positively correlated with grip strength; taller individuals often possessed greater muscle mass, which can enhance their grip strength capabilities.

**Table 4:** Descriptive statistics of selected anthropometric variables of farm women

Variables	Mean	SD	SE
Height (cm)	152.90	5.65	0.59
Weight (kg)	51.44	8.75	1.24
Hand length(cm)	16.34	0.80	8.54
Hand breadth (cm)	7.48	0.40	4.14

The average weight recorded was 51.44 kg, with an SD of 8.75 kg. Research indicated that higher body weight can correlate with increased muscle mass, thereby potentially improving hand grip strength (Zaccagni *et al.*, 2020)<sup>[16]</sup>. The mean hand length was 16.34 cm and hand breadth were 7.48 cm, with relatively low standard deviations (SDs) of 0.80 cm and 0.40 cm, respectively.

### 3.5 Hand grip strength (kg) of respondents during bundling of leafy vegetables

The average hand grip strength before work for the right hand was 21.58 kg and for the left hand was 20.00 kg. These values indicate a baseline level of strength that the respondents possess, which is essential for performing tasks that require significant manual dexterity and strength, such as bundling leafy vegetables (Murray *et al.*, 2016)<sup>[5]</sup>.

After engaging in work, the average grip strength decreased to 20.05 kg for the right hand and 18.00 kg for the left hand. This reduction in grip strength reflected the physical demands of the task and suggested that the respondents experienced fatigue as a result of their labor-intensive activities (Smith & Brown, 2019)<sup>[13]</sup>.

**Table 5:** Hand grip strength (kg) of respondents during bundling of leafy vegetables

Particulars	Right hand (Kg)	Left hand (Kg)
Before Work	21.58±3.87	20±2.79
After Work	20.05±3.71	18±2.64
Percentage change in grip strength	7.09	10.00

### 3.6 Correlation coefficient of right and left handgrip strength with anthropometric variables in farm women

The left hand showed a weaker correlation (0.123), indicating that height may have a more pronounced effect on the dominant hand's strength. Puh (2020)<sup>[8]</sup> found that anthropometric characteristics, such as height and hand dimensions,

significantly influenced physical fitness, including grip strength, in farm workers the correlation coefficients for weight were relatively low (0.068 for the right hand and 0.155 for the left hand), suggesting that weight does not have a significant impact on grip strength in this population. This finding aligned with previous studies that report inconsistent associations between weight and grip strength, indicating that other factors may play a more critical role. The negative correlation for BMI with the right hand (-0.126) suggested that higher BMI might not necessarily correlate with increased grip strength. Wang and Li (2019)<sup>[15]</sup> research examined the relationship between handgrip strength and body composition among female laborers. It emphasized that while body composition factors such as BMI show slight correlation with grip strength, hand dimensions have a significant impact.

**Table 6:** Correlation coefficient of right and left handgrip strength with anthropometric variables in farm women

Variables	Right Hand	Left Hand
Height	0.403**	0.123
Weight	0.068	0.155
BMI	- 0.126	0.121
Hand length	0.331**	0.730*
Hand breadth	0.287**	0.461

\*indicates  $p < 0.001$

A significant correlation of 0.331 for the right hand and 0.730 for the left hand indicated a strong positive relationship between hand length and grip strength, particularly for the non-dominant hand. The correlation coefficients of 0.287 for the right hand and 0.461 for the left hand indicated a moderate to strong relationship between hand breadth and grip strength, particularly for the left hand. Smiljanic and Bozic (2015)<sup>[12]</sup> explored correlations between handgrip strength and various anthropometric measures in rural populations. Their findings aligned with the notion that hand length and breadth are more indicative of grip strength than weight or BMI.

## 4. Conclusion

The study underscores the significant physical demands placed on farm women engaged in the manual bundling of coriander and other leafy vegetables. The majority of their respondents, bundling over 600 bunches per day, experienced fatigue and decreased handgrip strength, with reductions of 7.09 per cent in the dominant hand and 10 per cent in the non-dominant hand. These findings highlighted the repetitive and strenuous nature of their tasks, which contributed to musculoskeletal strain and potential long-term health implications. Anthropometric factors, such as hand length and breadth, showed strong correlations with grip strength, suggesting that physical attributes play a critical role in task performance. However, weaker associations between BMI and grip strength indicated that body composition alone is insufficient to predict work efficiency, emphasizing the need for a multifaceted approach to workload assessment. The study highlighted the urgent need for ergonomic interventions tailored to the physical and physiological needs of farm women. Recommendations include the design of user-friendly tools, provision of regular breaks to reduce fatigue and awareness programmes on proper working postures. Such measures can mitigate health risks, enhance productivity and improve the quality of life for women in agriculture, contributing to sustainable farming practices and rural development.

### Acknowledgement

The authors would like to thank AICRP on WIA, PJTAU, Hyderabad, for providing an opportunity to carry out this research work.

### Conflict of Interest

All the authors declare that they have no conflicts of interest.

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