

# Grip Strength Assessed using a Hand Grip Dynamometer and Michigan Hand Outcome Questionnaire as Predictors of Work-Related Musculoskeletal Disorders using Rapid Upper Limb Assessment among Power Loom Silk Weavers

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## Abstract

**Background:** Sericulture is a labor-oriented agro-based industry that significantly elevates India's rural economy. During weaving operations, workers adopt awkward postures and work long hours, which is one of the most important factors in their poor working efficiency and prevalence of musculoskeletal disorders.

**Objectives:** This study aimed to find the correlation between grip strength, the Michigan hand outcome questionnaire (MHQ), and work-related postural disorders among power loom silk weavers.

**Design:** Correlation study.

**Methods:** This study was conducted in a community setting. 120 power loom silk weavers were screened for work-related musculoskeletal disorders. A face-to-face interview was conducted to assess Grip strength, hand function, and work-related musculoskeletal disorders using the Hand dynamometer, MHQ, and RULA scales, respectively.

**Results:** By Spearman's correlation, the correlation between Bilateral Hand grip strength and MHQ was statistically significant  $p < 0.001$  and shows a strong positive correlation ( $r = 0.787$ ) for right hand and ( $r = 0.741$ ), a strong negative correlation ( $r = -0.594$ ) for right hand and ( $r = -0.538$ ) for left hand was found between bilateral hand grip strength and RULA and the correlation between MHQ and RULA scores were statistically significant ( $p < 0.001$ ) shows a strong negative correlation ( $r = -0.583$ ). The intercept is 8.298. An increase in MHQ (-0.022) and right-hand grip strength (-0.030) will decrease RULA scores.

**Conclusion:** The study concluded that subjects with reduced hand grip strength and hand function were at higher risks of developing work-related musculoskeletal disorders, and hand grip strength and MHQ are equally good predictors of these disorders.

**Key Words:** RULA, Grip strength, MHQ.

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## Introduction

Weaving is among the foremost tedious professions requiring long hours of static work. Joint and back pain are highly significant thanks to their working postures like bending, stretching, and moving front to back.<sup>4</sup> Despite the national importance of the weaving industry and its impact on the country's overall economy, there needs to be more ergonomic studies of weavers' work.<sup>5</sup>

Musculoskeletal disorders (MSDs) are disorders of the soft tissues and their surrounding structures that do not result from an acute or instantaneous event.<sup>6</sup> Work-related musculoskeletal disorders is a term used to describe a painful or disabling injury to the muscle, tendon, or nerves caused or aggravated by work.<sup>7</sup> Work-related musculoskeletal disorders (WMSDs) of the upper extremities are common causes of pain and functional decline and may cause significant distress and disability. Identifying the factors related to reduced upper extremity function may cause the event of more straightforward interventions. Various risk factors may include biomechanical and environmental conditions such as physical workload, unfavorable body posture, vibration, and psychosocial factors such as time pressure and repetitive or monotonous tasks.<sup>8</sup> One of the most contributing factors to upper extremity work-related musculoskeletal disorders (WMSD) is forceful exertions.<sup>9</sup>

The majority of workers in the power-loom industry are involved in repetitive tasks, unnoticed, and suffering from acute repetitive strain injuries; hence, it was felt essential to explore the prevalence of musculoskeletal disorders<sup>8</sup>.

Many daily activities require grip movements, which are vital in many workplace environments; much research has been done to identify different biomechanical aspects of grip strength. In the workplace, manual activities involving grip represent a continuum of tasks, ranging from relatively dynamic movements that involve concentric and eccentric muscular contractions to relatively static functions that require a continual, steady force, typically producing an isometric contraction over a reasonably prolonged period.<sup>10</sup> For a worker to perform the job without fatigue and possible musculoskeletal

disorders, the worker's strength must meet or exceed the force demanded to finish the tasks. Maximal grip strength is measured using dynamometers, which estimate the muscle strength primarily generated by the hand's flexor muscles and forearm.<sup>8</sup> Literature states that complaining of upper extremity pain in a work environment can result in decreased handgrip power, which can be used as a diagnostic measure of functional decline. Hand function has excellent significance for occupational performance. The greater the difficulties with hand function, the greater the impairment in skills that allow independence and participation in academic and social activities.<sup>11</sup>

Studies showed handgrip strength can be used as a diagnostic tool in musculoskeletal disorders of the upper extremities.

An improved understanding and awareness of potential environmental causes of work-related musculoskeletal problems may contribute to work organization and workplace design improvements. Improved ergonomics could result in reduced stress levels and musculoskeletal complaints.

## Methodology

### Inclusion Criteria:

- The subject population is between the ages of 21 and 65.
- Weaver population in power loom silk industry
- Subjects willing to participate and willing to sign a consent form

### Exclusion Criteria:

- Known cardiovascular/ neuromuscular dysfunction. - Any pain related to trauma or recent fractures (within 2 years).
- History of pre-existing metabolic, endocrine disorder, or infection that might affect the musculoskeletal system.
- Subjects participated in similar studies previously.

### Procedure

This study was done in Channapatna, Kanakapura, Magadi, and Ramanagara Taluka of Ramanagara district. Workers aged 21 to 65 years

were screened for work-related musculoskeletal disorders and requested to participate as volunteers in the study. After explaining the purpose of the study, informed consent was obtained from the selected subjects. Subjects were recruited based on the inclusion and exclusion criteria.

Rapid upper limb assessment for work-related posture- RULA was developed to evaluate the exposure of individual workers to ergonomic risk factors associated with upper extremity MSD. The RULA ergonomic assessment tool considers biomechanical and postural load requirements for job tasks/demands on the neck, trunk, and upper extremities. A single-page worksheet evaluates required body posture, force, and repetition. Based on the evaluations, scores are entered for each body region in section A for the arm and wrist and section B for the neck and trunk. After the data for each area is collected and scored, tables on the form compile the risk factor variables, generating a single score representing the MSD risk level.

Michigan Hand Outcome Questionnaire for hand function- The Michigan Hand Outcomes Questionnaire (MHQ) assesses patients with hand disorders by measuring 6 health domains: overall hand function, activities of daily living (ADLs), pain, work performance, aesthetics, and patient satisfaction. Grip Strength using Charder Handgrip dynamometer. [MG4800]

The participants would be comfortably seated on a seat without an armrest, with the shoulders abducted to the side, the elbow at 90° flexion, and the forearm in a neutral position. Standardized instructions were adopted and used as the American Society of Hand Therapists (ASHT) suggests. Three trials wer given, and an average was obtained for both hands.

**Results**

**Table No. 1: Spearman’s Rank correlation between the variables**

Correlation between	r - value	P-value
Right-hand grip strength and MHQ (Right hand)	0.721	< 0.001
Right-hand grip strength and MHQ (Left hand)	0.738	< 0.001

Continue.....

Right-hand grip strength and MHQ	0.787	< 0.001
Right-hand grip strength and RULA	-0.594	< 0.001
Left-hand grip strength and MHQ (Right hand)	0.697	< 0.001
Left-hand grip strength and MHQ (Left hand)	0.703	< 0.001
Left-hand grip strength and MHQ	0.741	< 0.001
Left-hand grip strength and RULA	-0.538	< 0.001
RULA and MHQ (Right hand)	-0.532	< 0.001
RULA and MHQ (Left hand)	-0.548	< 0.001
RULA and MHQ (Total)	-0.583	< 0.001

This study did not usually distribute the data, so Spearman’s rank correlation was calculated.

- The Spearman’s rank correlation between Right-hand grip strength and MHQ Right hand is (r=0.721, p <0.001), which is a strong positive correlation.
- By Spearman’s correlation, there is a strong positive correlation between Right-hand grip strength and MHQ Left hand (r= 0.738, p <0.001)
- By Spearman’s correlation, there is a strong positive correlation between Right-hand grip strength and MHQ (r= 0.787, p <0.001),
- The Spearman’s rank correlation between Left-hand grip strength and MHQ Right hand is (r=0.697,p<0.001), which is a strong positive correlation.
- By Spearman’s correlation, there is a strong positive correlation between Left-hand grip strength and MHQ Left hand (r=0.703,p < 0.001),
- By Spearman’s correlation, there is a strong positive correlation between Left-hand grip strength and MHQ (r=0.741, p < 0.001)
- By Spearman’s correlation, there is a statistically significant negative correlation between Right-hand grip strength and RULA(r = -0.594, p<0.001),
- The Spearman’s rank correlation between

Left-hand grip strength and RULA is ( $r = -0.538$ ,  $p < 0.001$ ), a moderate negative correlation.

- By Spearman's correlation, there is a moderate negative correlation between RULA and MHQ Right hand ( $r = -0.532$ ,  $p < 0.001$ ),
- By Spearman's correlation, there is a moderate negative correlation between RULA v/s MHQ Left hand ( $r = -0.548$ ,  $p < 0.001$ ) and
- By Spearman's correlation, there is a moderate negative correlation between RULA and MHQ Total ( $r = -0.583$ ,  $p < 0.001$ )

**Table 2: Regression**

Multivariate regression model of RULA with MHOQ, right-hand grip, and left-hand grip	RULA = 8.298 -0.022 = MHQ - 0.030 = Right-hand grip strength + 0.011 = Left-hand grip strength
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Taking RULA as a dependent variable, a multivariate regression model was fitted, taking MHQ, Right-Hand, and left-hand grip strength.

It was observed that the regression of MHQ is  $-0.022$ , for right-hand grip strength  $-0.03$ , and for left-hand grip strength  $+ 0.011$ . Further, the RULA with MHQ and right and grip strength are negatively correlated, while Left-hand grip strength was positively correlated.

## Discussion

The current study assessed grip strength and hand function as predictors of work-related musculoskeletal injuries in power loom silk weavers. Grip strength was evaluated using a hand dynamometer; the Michigan hand outcome questionnaire was used to assess hand functioning, and rapid upper limb assessment was used to evaluate the risk of musculoskeletal injuries in power loom silk weavers. 120 subjects, with a maximum of male workers (80%), participated in this study after signing the informed consent form. All the variables of grip strength, hand functions, and musculoskeletal risks were assessed along with other demographic data, and the findings were recorded.

This study showed a significant correlation between the variables that accepted the alternate hypothesis and those that rejected the null hypothesis.

Sericulture is a labor-oriented agro-based industry that plays a significant role in elevating India's rural economy. India is the largest producer and consumer of silk in the world. During the weaving operation, workers adopt awkward postures and long working hours, which is one of the most critical factors for their poor working efficiency and the prevalence of musculoskeletal disorders. The current study found that 60% of weavers work 10-12 hours daily, whereas 40% work 13-16 hours daily. Musculoskeletal disorders (MSDs) are a common health problem and a significant cause of disability throughout the world. The economic loss due to such disorders affects the individual, the organization, and society.<sup>27</sup> Organizations and individuals can become better informed to reduce MSD injury risk by being aware of risk factors, becoming skilled in recognizing and categorizing these factors, and examining options to reduce the frequency or duration of exposure to the risk factors. Reducing exposure to risk factors should make the task smoother and more predictable. Reducing risk factor exposure should make task performance less variable. Although the causes of any case of MSD are exceedingly difficult to identify with complete accuracy, certain risk factors are typically discussed in the field of ergonomic studies.<sup>28</sup>

Hence, 120 power loom weavers were screened for work-related musculoskeletal disorders in the current study. It was observed that 70% of the workers faced various problems during their working hours, and the remaining 30% were at a high risk for developing work-related musculoskeletal disorders.

Hand grip strength is a practical, functional measure of the integrity of the upper extremity. An association between lower grip strength and future function or functional declines has also been reported.<sup>29</sup> In the present study, a moderate negative correlation was found between the hand grip strength of both hands and the risk of developing work-related musculoskeletal disorders. The results were like studies conducted to find the association between hand grip strength, cardiometabolic markers, and musculoskeletal disorders in Koreans.<sup>30</sup> Thus, it is concluded that hand grip strength is a

convenient and reliable measure to screen for work-related musculoskeletal risks. MHQ questionnaire includes (1) overall hand function, (2) activities of daily living (ADL), (3) pain, (4) work performance, (5) aesthetics, and (6) patient satisfaction with hand function. The MHQ is a reliable and valid instrument for measuring hand outcomes.<sup>13</sup> The present study shows a significant positive correlation ( $r = 0.787$  for right hand &  $r = 0.741$  for left hand) between hand grip strength and hand function; thus, a decreased hand grip strength can affect the hand functioning indirectly affecting the work performance and quality of life. It was also observed that according to Spearman's correlation, there was a moderate negative correlation ( $r = -0.583$ ) between MHQ and RULA. In the regression analysis, the intercept is 8.298. An increase in MHQ and right-hand grip strength will decrease RULA scores. Indicating reduced grip strength and hand function can increase an individual's risk of developing work-related musculoskeletal disorders.

#### Limitations

- A larger geographical area could have been considered for better interpretation.
- Gender could have been equally considered.
- Other factors causing work-related musculoskeletal risks could have been documented.

#### Conclusion

The objectives of the study were to screen for work-related musculoskeletal disorders, assess Grip strength using a hand-held dynamometer and hand function using the Michigan hand outcome measure, fit a regression model of musculoskeletal disorder on grip strength and the Michigan hand outcome measure, and find the correlation between grip strength, the Michigan hand outcome questionnaire, and work-related postural disorders among power loom silk weavers.

By Spearman's correlation, the correlation between Bilateral Hand grip strength and the Michigan Hand Outcome questionnaire was statistically significant  $p < 0.001$  and shows a strong positive correlation ( $r = 0.787$ ) for the right hand and ( $r = 0.741$ ), a moderate negative correlation

( $r = -0.594$ ) for the right hand and ( $r = -0.538$ ) for the left hand was found between bilateral hand grip strength and RULA and the correlation between MHQ and RULA scores were statistically significant ( $p < 0.001$ ) shows a moderate negative correlation. ( $r = -0.583$ ). The intercept is 8.298. An increase in MHQ (-0.022) and right-hand grip strength (-0.030) will decrease RULA scores. Thus, the study concluded that subjects with reduced hand grip strength and hand function were at a higher risk of developing work-related musculoskeletal Conditions.

**Ethical Clearance:** Approval was obtained from the Institutional Ethics Committee (IEC) of RV College of Physiotherapy®. (No: RVCP/RESEARCH/0620, Dated 24.08.2021)

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**Conflict of Interest:** Nil

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