

Correlation between age with hand grip strength and hand activity level in Praewa silk weavers

Wuttichai Yota¹, Manida Swangnetr Neubert^{2,3}, and Teeraphun Kaewdok^{4,5*}

¹ Department of Medical Engineering, Thammasat School of Engineering, Thammasat University, Pathum Thani 12121, Thailand

² Human-Robot Collaboration and Systems Integration Research Unit, Faculty of Engineering, Chulalongkorn University, Bangkok 10330, Thailand

³ Department of Industrial Engineering, Faculty of Engineering, Chulalongkorn University, Bangkok 10330, Thailand

⁴ Thammasat University Research Unit in Occupational Ergonomics, Pathum Thani 12121, Thailand

⁵ Faculty of Public Health, Thammasat University, Pathum Thani 12121, Thailand

ABSTRACT

***Corresponding author:**
Teeraphun Kaewdok
teeraphun.k@fph.tu.ac.th

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This study aimed to examine the correlation between age, hand grip strength (HGS), and hand activity level (HAL) among 198 Praewa silk weavers. The participants were divided into three age groups: aged 40–49 years ($n = 42$), 50–59 years ($n = 88$), and 60–70 years ($n = 68$). HGS was measured using a handgrip dynamometer, and HAL was assessed. Data were analyzed using mean distribution and Spearman's rank correlation coefficient. The study found average values for HGS and HAL. A moderate negative correlation was observed between age 50–59 and HAL of both the right and left hands, with statistical significance ($r = -0.287$, $p < 0.01$ and $r = -0.249$, $p < 0.05$); a moderate negative correlation was found between age 60–70 and HAL of the right and left hands ($r = -0.346$, $p < 0.01$ and $r = -0.414$, $p < 0.01$), as well as between age 60–70 and HGS on the dominant and non-dominant sides ($r = -0.373$, $p < 0.01$ and $r = -0.414$, $p < 0.01$). This study concluded that increasing age is associated with decreasing HGS and HAL. Specifically, older individuals using their dominant hand for weaving exhibited reduced muscle strength in the arms and were at greater risk of musculoskeletal injuries.

Keywords: hand grip strength; hand activity level; occupational wellbeing; musculoskeletal disorder

1. INTRODUCTION

In 2024, the number of informal workers in Thailand exceeded that of formal workers by approximately 2.2 million. Of the total labor force of 40 million, informal workers accounted for 21.1 million (52.7%), while formal workers numbered 18.9 million (47.3%). Informal employment was more prevalent among both men and women, especially in northeastern Thailand, where the proportion reached 75.2% (National Statistical Office, 2024). One of the key occupations in this region is Praewa silk weaving, an

indigenous craft of the Phu Thai ethnic group, recognized nationally and internationally. Praewa silk plays a vital economic role, particularly in Kalasin Province, where it is designated as a major strategic product and a symbol of provincial identity (Chooppava & Chooppava, 2021). Praewa silk weaving requires high skill and craftsmanship, with each piece taking three months to one year to complete, depending on the complexity of the pattern and the weaver's daily time commitment. On average, weavers spend 3–6 hours per day weaving, producing only 3–5 centimeters of fabric per day (Queen Sirikit Department of

Sericulture, 2020). The repetitive nature and prolonged postures involved in this craft increase the risk of work-related musculoskeletal disorders (WMSDs), particularly pain and discomfort in the arms, hands, and wrists (Rahman et al., 2017; Hossain et al., 2018; Ramdan et al., 2018; Phengarree et al., 2021). Previous studies indicate that roughly one-third of traditional weavers experience such symptoms, most commonly in the wrists and hands (Banerjee & Gangopadhyay, 2003; Chantaramanee et al., 2014).

Handgrip strength (HGS) is widely recognized as a reliable and practical indicator of upper limb muscular performance, particularly concerning the muscles of the hand and forearm, which are essential for tasks such as textile weaving. Numerous studies have demonstrated that HGS correlates with overall physical health, occupational performance, and the risk of developing musculoskeletal disorders (MSDs) or inflammatory conditions due to repetitive activities (Eidson et al., 2017). The measurement of HGS thus provides a direct assessment of the functional capacity of the hands and arms (Roberts et al., 2011). Various factors influence HGS, including age, body weight, occupation, specific work tasks, and the intensity of hand activity.

In evaluating repetitive hand movements during task performance, the hand activity level (HAL) is frequently utilized. HAL accounts for movement frequency, rest breaks, and pace, making it particularly relevant for assessing both static and dynamic exertion patterns that contribute to the development of MSDs in the hands and wrists. Together, HAL and normalized peak force (NPF) are used to quantify ergonomic risks in manual occupations (Drinkaus et al., 2005). When interpreted in conjunction with threshold limit values (TLVs), these metrics categorize exposure into three levels: below the action limit (AL), which is considered safe; between the AL and TLV, indicating moderate risk and the need for ergonomic adjustments; and above the TLV, representing high risk and requiring immediate intervention. However, there is limited data regarding HGS and HAL among Praewa silk weavers. Therefore, this study aimed to assess handgrip strength levels in this group and examine the correlations among age, handgrip strength, and hand activity level. The findings will provide essential baseline information for occupational health planning and inform the design of ergonomic tools and appropriate working conditions for this specialized workforce in the future.

2. MATERIALS AND METHODS

2.1 Study participants

The population of this study consisted of individuals whose primary occupation is Praewa silk weaving, residing in the provinces of Kalasin, Nakhon Phanom, Sakon Nakhon, and Mukdahan. According to reports from the Queen Sirikit Department of Sericulture (2020), Chiangmai and Mongkolsrisawat (2017), the Northeastern Regional Office of the Department of Sericulture, and community enterprises and cultural offices in the respective provinces, the total population was estimated at 2,640 individuals.

The sample size for this study was calculated based on a known population using the formula by Wayne and Liden (1995) with a margin of error of 5% at a 95% confidence level. The required sample size was determined to be 180 participants. To account for an anticipated 10% non-response rate, the final sample size was increased to 198

participants. This study employed a cross-sectional research design and was conducted in four provinces: Kalasin, Nakhon Phanom, Sakon Nakhon, and Mukdahan, with a total of 198 participants.

2.2 Inclusion and exclusion criteria

Inclusion criteria for participants were selected based on the following criteria: Female individuals aged between 40 and 70 years residing in Kalasin, Nakhon Phanom, Sakon Nakhon, or Mukdahan provinces. At least one year of experience in Praewa silk weaving. In good general health, with no musculoskeletal or neurological injuries requiring medication or affecting daily activities. No history of surgery or treatment related to musculoskeletal disorders. Able to perform silk weaving using both hands. Able to read, write, and communicate in the Thai language.

Exclusion criteria for participants were excluded if they met the following condition: Use of muscle-affecting analgesic medications continuously for a period of 5 consecutive days.

2.3 Research instruments

General information questionnaire: This form was used to collect demographic and background information, including age, work experience, and weaving-related details.

HGS assessment: HGS was assessed using a dynamometer, with measurements taken from both the right and left hands, as commonly implemented in prior research (Leong et al., 2015; Oksuzyan et al., 2017). In addition, dominant-hand testing was emphasized, in accordance with studies indicating that dominant hand use yields higher grip strength values due to frequent use and motor skill development (Alfaro-Acha et al., 2006; Arvandi et al., 2016). The results were interpreted using the physical fitness standards for the Thai population, established by the Sports Authority of Thailand (2000), which categorizes handgrip strength into five levels: very low, low, moderate, good, and very good.

HAL assessment: The HAL was assessed using a modified version of the tool developed by Latko et al. (1997), which has been widely used in both domestic and international studies (Chantaramanee et al., 2014; Dahlgren et al., 2022). The assessment considers two key variables: HAL, NPF. Assessment process the HAL score ranges from 0 to 10, where: A score of 0 indicates no hand activity. A score of 10 represents the highest level of repetitive hand activity.

The assessment comprises three main steps:

- Step 1 rating HAL: This involves scoring the hand activity from 0 to 10 based on the frequency of exertion (repetition) and the duration of each exertion.
- Step 2 rating NPF: NPF is evaluated by observing the peak hand force exerted during a typical work cycle. It is also scored on a scale from 0 to 10. Three recommended methods for estimating NPF include the following: Measuring the percentage of maximum voluntary contraction (%MVC) of hand muscles. Self-reported perception of exertion by workers. Observer-based estimation using the Moore-Garg strain index.
- Step 3 interpreting risk level using the HAL-NPF ratio: The evaluation method proposed by Latko et al. (1997) and adopted by ACGIH involves calculating the risk ratio: $\text{Ratio} = \text{NPF} / (10 - \text{HAL})$. This ratio is then interpreted based on the TLV and AL: If the ratio is below the AL (≤ 0.56). The task is considered safe. If the ratio is between AL

and TLV ($0.56 < \text{ratio} \leq 0.78$), The task poses a moderate risk, requiring monitoring and control measures. If the ratio exceeds the TLV (> 0.78). The task is classified as high-risk or hazardous, and immediate ergonomic interventions are recommended. The combined values of HAL and NPF can also be interpreted using a visual risk chart provided by the American Conference of Governmental Industrial Hygienists 2011 (ACGIH) (Glinskiy et al., 2014).

In this chart: The horizontal axis represents HAL scores. The vertical axis represents NPF scores. The intersection point determines the risk level based on the three threshold zones described above (safe, moderate risk, and high risk) (Budziareck et al., 2008; Wurzelbacher et al., 2010; Ekşioğlu, 2016). This supports the conclusion that grip strength differs between hands, with the dominant hand typically exhibiting greater force. To ensure reliability, handgrip strength for each hand was measured twice, as recommended by several studies (McGrath et al., 2018). The highest value recorded from the two trials was used in the analysis and expressed as kilograms per body weight (kg/kg).

2.4 Research procedures

The researcher scheduled appointments with participants at their convenience across four provinces: Kalasin, Nakhon Phanom, Sakon Nakhon, and Mukdahan. Each participant was invited to attend a single data collection session. The estimated duration of each session was approximately 1 h and 30 min in the laboratory setting. However, if a participant exhibited signs of fatigue or failed to return to their resting physiological state within 20 min, the session was discontinued and rescheduled to ensure participant safety and comfort.

During the session, the researcher collected the following data: general demographic and background information and HGS measurements. Additionally, the researcher recorded both photographs and a 20-min video of each participant while Praewa silk was being woven. These recordings were used to assess the HAL, data processing, and statistical analysis. HGS and HAL data were organized, coded, and analyzed using appropriate statistical methods to evaluate relationships between variables, following established research procedures.

2.5 Data analysis

The data analysis was carried out using SPSS statistics software (v. 23). The normality of data distribution was assessed using the Kolmogorov-Smirnov goodness-of-fit test. The results indicated that the data were not normally distributed. Consequently, the Spearman's rank correlation coefficient was employed to examine the relationships between variables. A p -value of less than 0.05 was considered statistically significant.

2.6 Ethical consideration

The study was approved by the Human Research Ethics Committee at Thammasat University (Science) (code 66EN108; COA No. 100/2566). The date of ethical approval received was October 27, 2024.

3. RESULTS

In Table 1; a total of 198 participants were included in the study, with an average age of 55.76 ± 7.66 years. 90.90% had completed an elementary education and were engaged in a farm-related occupation of 95.45%. Their average work experience in Praewa silk weaving was 34.44 ± 8.79 years. The participants reported an average of 7.13 ± 1.10 hours of silk-weaving work per day.

Figure 1 shows the mean HGS of both the dominant and non-dominant sides, as well as the HAL for the right and left hands, by age group. It was found that the 40–49-year age group had higher mean HGS and HAL values than the 50–59 and 60–70 year age groups, respectively. Additionally, there was a tendency for mean HGS to decrease with increasing age.

In Table 2; the study found a statistically significant moderate negative correlation between age 50–59 and HAL on the right and left sides ($r = -0.287$, $p < 0.01$ and $r = -0.249$, $p < 0.05$, respectively). Additionally, a statistically significant moderate negative correlation was found between age 50–59 and HAL on the right and left sides ($r = -0.346$, $p < 0.01$ and $r = -0.414$, $p < 0.01$, respectively). Furthermore, a statistically significant moderate negative correlation was observed between ages 60–69 and HGS on the dominant and non-dominant sides ($r = -0.373$, $p < 0.05$ and $r = -0.414$, $p < 0.01$, respectively).

Table 1. Demographic characteristics of participants (n = 198)

General information	Mean $\pm$ S.D. / (number / percentage)
Age (years)	55.76 $\pm$ 7.66
40–49	(42/21.21)
50–59	(88/44.45)
60–70	(68/34.34)
Weight (kg)	58.25 $\pm$ 8.92
Height (cm)	153.07 $\pm$ 6.10
Body mass index (BMI)	24.84 $\pm$ 3.44
Education level	
Primary education	(180/90.90)
Junior high school	(11/5.56)
High school	(7/3.54)
Occupational	
Farm	(189/95.45)
Farming	(2/1.01)
Garden	(7/3.54)
Experience in Praewa silk weavers (years)	34.44 $\pm$ 8.79
Hours per day of Praewa silk weavers (h/day)	7.13 $\pm$ 1.10

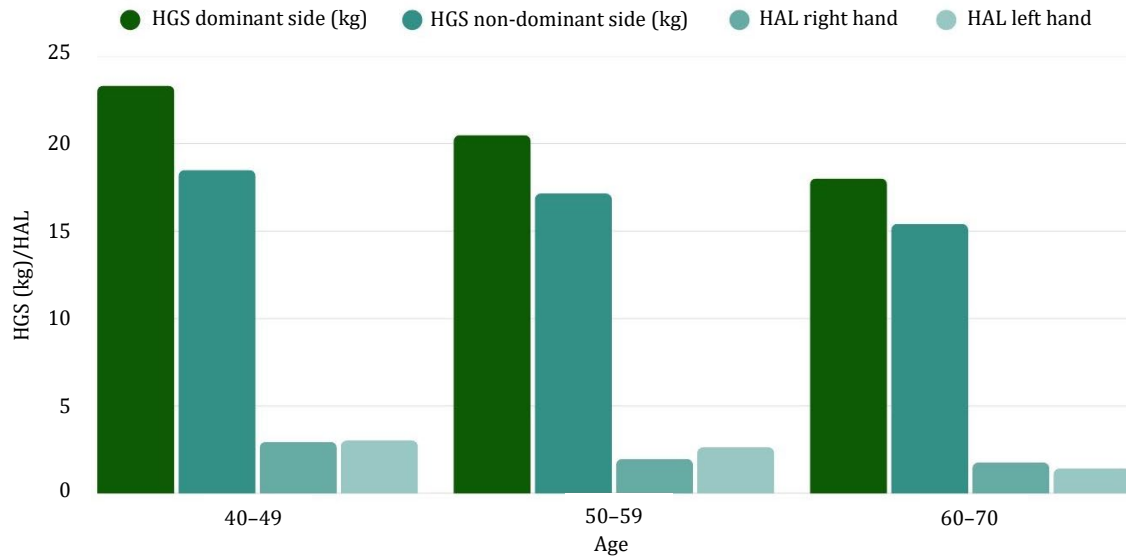


Figure 1. Distribution of hand grip strength mean and hand activity level mean in different age

Table 2. Spearman's rank correlation coefficient between age with HGS and age with HAL in Praewa silk weavers

Age	n	Variable	Mean±S.D.	r	p-value
40-49	42	HGS dominant side	23.32±2.92	-0.136	0.391
		HGS non-dominant side	18.40±2.37	-0.154	0.331
		HAL right hand	2.95±1.55	-0.104	0.511
		HAL left hand	4.94±2.9	-0.010	0.951
50-59	88	HGS dominant side	22.49±3.45	-0.100	0.354
		HGS non-dominant side	17.15±2.74	0.039	0.719
		HAL right hand	1.97±0.90	-0.287	0.007**
		HAL left hand	2.63±1.23	-0.249	0.020*
60-70	68	HGS dominant side	18.01±3.50	-0.414	0.001**
		HGS non-dominant side	15.41±2.85	-0.373	0.002**
		HAL right hand	1.40±0.53	-0.414	0.004**
		HAL left hand	1.73±0.91	-0.346	0.002**

* $p < 0.05$ ** $p < 0.01$

4. DISCUSSION

According to the findings, there was no statistically significant association between age and HGS, nor between age and HAL, among Praewa silk weavers aged 40–49 years. This suggests that individuals within this age range retain sufficient hand muscle strength for their work and that the hand activities involved in weaving are neither excessively forceful nor highly repetitive to the extent that they pose a musculoskeletal risk. The weavers in this age group typically possess well-developed skills and experience, enabling them to perform hand movements efficiently and in a controlled manner, which may help mitigate the risk of injury despite the repetitive nature of the tasks. Additionally, it is possible that the working environment or tools used are adapted in ways that reduce physical workload.

Among Praewa silk weavers aged 50–59 years, a statistically significant negative correlation was found between age and bilateral HGS, as well as between age and HAL. This result indicated that as age increases, hand

muscular strength begins to decline, while the HAL increases to a level that is considered ergonomically high risk. This may be due to prolonged and repetitive hand use, which is a significant risk factor for the development of MSDs, especially in the context of Praewa silk weaving that requires extended duration in repetitive positions.

For the group aged 60–70 years, there was a clear trend of decreasing grip strength and HAL levels reached a range associated with high risk for work-related injuries. This decrease may reflect greater muscle and tendon degeneration in the hands and wrists compared to younger age groups. Moreover, prolonged repetitive tasks such as warping threads, pulling the reed, and continuous finger movements further increase the risk of developing MSDs in this population. These findings are consistent with previous research, which suggests that decreased HGS together with elevated HAL in older adults significantly increases the risk of MSDs.

Additionally, the observed reduction in hand grip strength in these age groups may reflect degenerative changes in

the muscles or tendons of the hands and wrists, which are closely related to the characteristics of Praewa silk weaving work that requires repetitive hand use over prolonged periods. Repetitive movements in fixed postures, such as warping threads, pulling the reed, or performing continuous finger motions, may lead to chronic inflammation or accumulated tension in the musculoskeletal structures of the upper extremities over time. These findings are consistent with previous studies, which have indicated that decreased grip strength, together with elevated HAL in older adults, represents a significant risk factor for the development of MSDs. HAL is regarded as an important indicator for assessing the risk of work-related MSDs (WMSDs), particularly in the distal upper extremities. According to Radwin et al. (2015), when the threshold limit value (TLV) for hand activity is exceeded, immediate ergonomic interventions are required to mitigate health risks. In the context of Praewa silk weaving, the work involves continuous manual handling of individual silk threads to create intricate patterns, necessitating the maintenance of repetitive and constrained postures. This includes frequent wrist rotations during thread insertion and the absence of assistive devices to reduce physical workload. Consequently, the weavers are required to exert significant hand and wrist force, particularly involving sustained finger flexion and wrist deviation. Analysis indicates that Praewa silk weaving presents a high ergonomic risk, especially to the wrist and finger regions, which may result in an increased incidence of work-related musculoskeletal disorders.

Ergonomic implications from risk assessment using the rapid upper limb assessment (RULA) tool indicated that most Praewa silk weavers are classified at the highest risk level (Level 4). This finding suggests that their working conditions pose serious ergonomic hazards to the musculoskeletal system and require urgent ergonomic interventions. Specifically, the study found that 89.39% of participants were at high risk, highlighting the immediate need for improvements in their working environment. These results are consistent with those reported by Bori and Bhattacharyya (2020), who found that weavers typically spend more than 5–6 h per day working continuously in a seated posture and performing repetitive movements. Such working conditions do not conform to ergonomic principles and can result in cumulative musculoskeletal fatigue as well as long-term psychological stress. Furthermore, the study by Mallapiang et al. (2021) confirmed that weaving-related tasks are associated with musculoskeletal discomfort and disorders among workers in the textile and skilled labor sectors. Their findings indicated that factors such as age, upper limb strength, and weaving experience are significantly associated with the prevalence of WMSDs. These factors influence muscle mass and the efficiency of muscle contraction and relaxation, thereby increasing the risk of developing muscle fatigue or musculoskeletal disorders during prolonged repetitive activities.

The present findings are further supported by the study of Hossain et al. (2018), which identified several workplace-related factors significantly associated with musculoskeletal pain and discomfort. These factors include repetitive work patterns, suboptimal loom design, constrained working postures, prolonged working hours, and inadequate seating conditions. Such ergonomic limitations contribute to the high prevalence of WMSDs among individuals engaged in traditional weaving practices. Weaving, recognized as one of the oldest

artisanal occupations, inherently entails repetitive tasks that substantially increase physical demands on the upper limbs, particularly under poorly designed working conditions. Consistent with these observations, Muhamad Ramdan et al. (2018) examined the relationship between occupational musculoskeletal injuries and various ergonomic risk factors, revealing that age, duration of work experience, and the number of hours spent sitting during weaving tasks are significantly associated with the development of WMSDs. Notably, a significant decline in hand muscle strength was observed among individuals aged over 50 years, in contrast to those in middle adulthood, who generally maintain muscle strength more effectively with regular and appropriately managed physical activity. These findings underscore the critical need for targeted ergonomic interventions and preventive strategies to preserve musculoskeletal health, particularly among aging workers in artisanal and textile-based industries.

5. CONCLUSION

The study found no significant correlation between age and HGS or HAL among Praewa silk weavers aged 40–49 years, indicating that individuals in this age group maintain sufficient muscular capacity and hand function to perform their tasks safely without increased risk of WMSDs. However, among weavers aged 50–59 and 60–70 years, significant associations were observed between age and bilateral hand grip strength as well as HAL scores. This is the first empirical study to report HGS and HAL correlations among Praewa silk weavers in Thailand. These changes suggest a decline in muscular function and an elevated risk of musculoskeletal injury. The findings highlight the necessity for ergonomic job and tool design tailored to older Praewa silk weavers, alongside appropriate health management and workplace modifications to prevent cumulative trauma from repetitive work activities over time.

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AUTHOR CONTRIBUTIONS

W.Y. Data Curation, Formal Analysis, Investigation, Methodology, Resources, Visualization, Writing – Original Draft Preparation. M.S.N. Data Curation, Investigation, Methodology, Supervision, Validation, Writing – Review. T.K. Conceptualization, Formal Analysis, Funding Acquisition, Project Administration, Supervision, Writing – Review & Editing.

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