# Comparative Analysis of Musculoskeletal Disorder Between Female and Male Mechanical Pickers in Gambung Tea Plantation, West Java

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**Abstract** — Previous research has shown that musculoskeletal disorders (MSDs) are one of the barriers for women to adopting tea-picking mechanization technology. Musculoskeletal disorders (MSDs) are defined as a group of injuries that affect the musculoskeletal system including nerves, tendons, muscles, and supporting structures. MSDs are also referred to as injuries due to overactivity or from using a device excessively. Some research results significantly show that gender greatly affects the level of risk of autonomic complaints and that women are more likely to show musculoskeletal symptoms than men. This study examines the comparison of musculoskeletal disorders due to the use of tea picking machines for male and female pickers. Data collection on musculoskeletal disorders (MSDs) complaints was carried out using the Nordic Body Map instrument, in the form of an open questionnaire by interviewing mechanical tea pickers directly. From the data obtained, the average difference in scores for male mechanical tea pickers is 5.3 while the average difference in scores for female mechanical tea pickers is 9. This means that the average female mechanical tea pickers experience musculoskeletal complaints 70% more height than male mechanical tea pickers. MSDs complaints comparison between male and female tea pickers with NBM measurement is 5:9. In conclusion, female mechanical tea pickers suffer from MSDs almost twice as much as males. Considering that the majority of tea pickers are women, gender-responsive machine design interventions are needed.
**Keywords:** Musculoskeletal disorders, tea pickers, tea picking machines, tea-picking mechanization

**Abstrak** — Penelitian sebelumnya menunjukkan bahwa gangguan muskuloskeletal (MSDs) adalah salah satu hambatan bagi perempuan untuk mengadopsi teknologi mekanisasi pemetik teh. Gangguan muskuloskeletal (MSDs) didefinisikan sebagai sejumlah cidera yang mempengaruhi sistem muskuloskeletal termasuk saraf, tendon, otot, dan struktur pendukung. MSD juga disebut sebagai cedera karena aktivitas berlebihan atau penggunaan perangkat secara berlebihan. Beberapa hasil penelitian secara signifikan menunjukkan bahwa jenis kelamin sangat mempengaruhi tingkat risiko keluhan otonom dan bahwa wanita lebih cenderung menunjukkan gejala muskuloskeletal daripada pria. Penelitian ini mengkaji perbandingan gangguan muskuloskeletal akibat penggunaan mesin pemetik teh pada pemetik pria dan wanita. Pengumpulan data keluhan musculoskeletal disorders (MSDs) dilakukan dengan menggunakan instrumen Nordic Body Map, berupa angket terbuka dengan mewawancarai mekanik pemetik teh secara langsung. Dari data yang diperoleh, rata-rata selisih skor pemetik teh mekanik pria adalah 5,3 sedangkan perbedaan rata-rata skor pemetik teh mekanik wanita adalah 9. Artinya rata-rata pemetik teh mekanik wanita mengalami keluhan muskuloskeletal 70% lebih tinggi daripada mekanik pria. pemetik teh. Perbandingan keluhan MSDs antara pemetik teh pria dan wanita dengan pengukuran NBM adalah 5:9. Kesimpulannya, perempuan pemetik teh mekanik menderita MSDs hampir dua kali lipat laki-laki. Mengingat mayoritas pemetik teh adalah perempuan, diperlukan intervensi desain mesin yang responsif gender.
**Kata Kunci:** ergonomi, muskuloskeletal, pemetik teh, mekanisasi

## INTRODUCTION

Indonesia's agricultural development agenda has led to capital-intensive technology and mechanization in recent years. This shifted from labor-intensive technology to improving business efficiency and competitiveness (Solahuddin, 2018). According to Olmstead and Rhode, mechanization is the replacement of simple hand tools and human power by more complicated machinery powered by animals, fossil fuels, and electricity (Olmstead & Rhode, 2014, p. 168). Robbins in Adillah (2016) states that conceptually, agricultural mechanization is the process of introducing and using mechanical assistance to carry out agricultural operations. Such mechanical assistance includes all types of tools or equipment driven by human power, animals, combustion engines, electric motors, wind, water, and other energy sources. In general, agricultural mechanization can also be interpreted as the application of engineering science to develop, organize and control operations in agricultural production. Adillah (2016) explained that the use of agricultural machinery is one way to increase productivity and efficiency of farming, improve product quality and added value, and empower farmers. Wijanto in Adillah (2016) states that in essence, the use of machines in agriculture is to increase human work power in the agricultural production process, where each stage of the production process can use agricultural tools and machines. Thus, agricultural mechanization is expected to increase the efficiency of human labor, the degree and standard of living of farmers, the quantity and quality of agricultural production, enable the growth of farming types from subsistence farming to commercial farming, as well as accelerate the transition of the economic form Indonesia from an agrarian to an industrial.

Mechanization of tea harvesting also began to occur in tea plantations. Sita's research (2019) shows that there are women's efforts to join mechanical tea picking groups to maintain their role and existence in the tea production chain to maintain the socio-economic conditions of their households. Sita's (2019) shows complaints of musculoskeletal disorders (MSDs) of female mechanical pickers as barriers for women to adapt to mechanization. Musculoskeletal disorders (MSDs) are defined as a group of injuries that affect the musculoskeletal system including nerves, tendons, muscles, and supporting structures (Davis & Kotowski, 2007). Tarwaka cites Granjean (1993) explaining that musculoskeletal complaints are complaints in the parts of the skeletal muscles that are felt by a person ranging from very mild complaints to very sick. If the muscles receive static loads repeatedly and for a long time, it can cause complaints in the form of damage to joints, ligaments, and tendons. These complaints of damage are usually termed musculoskeletal disorders (MSDs) or injuries to the musculoskeletal system.

Broadly speaking, muscle complaints can be grouped into two, namely: 1). Temporary complaints (reversible), namely muscle complaints that occur when the muscles receive a static load, however, these complaints will immediately disappear when the loading is stopped; 2). Persistent complaints, persistent muscle complaints, and muscle pain are still felt even though the loading is stopped (Tarwaka et al., 2004, p. 117).

Furthermore, Tarwaka explained that skeletal muscle complaints generally occur due to excessive muscle contraction due to giving too heavy a workload with a long duration of loading. On the other hand, muscle complaints may not occur if muscle contractions are only between 15 - 20% of maximum muscle strength. However, if the muscle contraction exceeds 20%, then the blood circulation to the muscle decreases according to the level of contraction which is influenced by the amount of force required. Excessive muscle stretching, repetitive activities and unnatural work attitudes are factors that cause MSDs. Gender is also a factor in the occurrence of MSDs. Tarwaka said that several research results significantly showed that gender greatly affected the level of risk of muscle complaints (Tarwaka et al., 2004). In a previous study entitled "Musculoskeletal symptoms among tea pluckers in India" (Dihingia & Dewangan, 2012), women are more likely to show musculoskeletal symptoms than men. Subjects with a body mass index (BMI) <18.5 kg/m2 were more likely to develop musculoskeletal symptoms than subjects with a BMI >18.5 kg/mm2.

According to Tarwaka's conclusion, in general, women only have physical strength 2/3 of the physical ability or muscle strength of men, but in certain cases, women are more thorough than men. Tarwaka cites Konz (1996) who states that for physical work, women have a VO2 max of 15-30% lower than men. This condition causes women's body fat percentage to be higher and blood Hb levels to be lower than men's. Furthermore, Tarwaka cites Waters & Bhattacharya (1996) explaining that women have a maximum aerobic power of 2.4 L/minute, while men are slightly higher at 3.0 L/minute. In addition, Priatna stated that women are more resistant to cold temperatures than hot temperatures. This is because the body of a woman has a tissue with a higher conductivity to heat when compared to women. s. (Tarwaka et al., 2004). Some research results significantly show that gender greatly affects the level of risk of autonomic complaints and that women are more likely to show musculoskeletal symptoms than men. This study examines the comparison of musculoskeletal disorders due to the use of tea picking machines for male and female pickers, to prove whether MSDs complaints in mechanical tea pickers in Gambung tea plantations are influenced by sex or gender.

| No. | Responden | Gender | Age |
|-----|-----------|--------|-----|
| 23 | GU/23/P | F | 46 |
| 24 | GU/24/P | F | 48 |
| 25 | GU/25/L | M | 24 |
| 26 | GU/26/P | F | 42 |

## RESEARCH METHOD

### Location

The research was conducted from January 2022 to March 2022 at Gambung Tea Plantation, which is located in Pasir Jambu District, Bandung Regency, West Java Province, Indonesia. The selection of the research locus in the Gambung Tea Plantation was considered as one of the tea plantations with a large number of male and female workers and applying semi-mechanical (picking scissors) and mechanical (picking machine). The reason above is because there are groups of women pickers that are very rarely found in other tea plantations. The Gambung Tea Plantation has a tea area of 356.87 ha at an altitude of ± 1,400 meters above sea level with an average temperature ranging from 12-30°C and has a hilly topography with a slope of 20-70 degrees. (Sita & Herawati, 2017).

### Type of Research

Based on the research objectives, the research method chosen to fulfill the research objectives is quantitative research.

### Determination of Research Sample

Quantitative research will involve the entire population in mechanical plucking groups, both men and women who work at the time of the research, which is 26 people.

**Tabel 1.** Research Respondents

| No. | Responden | Gender | Age |
|-----|-----------|--------|-----|
| 1 | GS/01/L | M | 22 |
| 2 | GS/02/P | F | 44 |
| 3 | GS/03/P | F | 47 |
| 4 | GS/04/P | F | 39 |
| 5 | GS/05/L | M | 27 |
| 6 | GS/06/L | M | 18 |
| 7 | GS/07/P | F | 49 |
| 8 | GS/08/L | M | 38 |
| 9 | GS/09/P | F | 43 |
| 10 | GS/10/P | F | 47 |
| 11 | GS/11/L | M | 28 |
| 12 | GS/12/P | F | 42 |
| 13 | GU/13/L | M | 38 |
| 14 | GU/14/L | M | 56 |
| 15 | GU/15/L | M | 25 |
| 16 | GU/16/P | F | 26 |
| 17 | GU/17/L | M | 32 |
| 18 | GU/18/P | F | 42 |
| 19 | GU/19/L | M | 40 |
| 20 | GU/20/P | F | 47 |
| 21 | GU/21/L | M | 42 |
| 22 | GU/22/P | F | 60 |

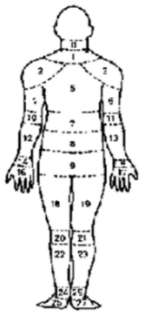### Research Instrument

Nordic Body Map is a system for measuring complaints of pain in the body known as musculoskeletal. A musculoskeletal system (motion system) is an organ system that gives animals (and humans) the ability to move using the muscular and skeletal systems (Yudiyanta et al., 2015). Muscle complaints that occur in certain body organs can be traced using several ergonomic measuring tools ranging from simple tools to using computer equipment. This Nordic Body Map questionnaire is widely used by experts to assess the severity of disorders of the musculoskeletal system and has sufficient validity and reliability (Tarwaka et al., 2004). The purpose of filling out the Nordic Body Map questionnaire is to find out which body parts of the respondents feel pain during activities before and after using the tea picking machine.

Assessment using the Nordic Body Map questionnaire can be done in various ways, for example by using 2 answers, namely "Yes" (if there are complaints of pain in the skeletal muscles) and "No" (if there are no complaints or pain in the skeletal muscles). But according to Tarwaka (Tarwaka et al., 2004) it is more important to use a research design with a score such as a 4 Likert scale. When using a Likert scale, each score or value must have a clear operational definition and be easily understood by the respondent Tarwaka (Tarwaka et al., 2004). So in the Nordic Body Map questionnaire used in this study, the answers have a gradation from "not felt" to "pain that requires special treatment to stop the pain" which is arranged in the following checklist options:

1 = Doesn't feel
2 = A little sore
3 = pain that interferes with activities but can go away or heal on its own
4 = pain that requires special care to stop the pain

**Picture 1. Nordic Body Map questionnaire**

## Data Validation

The validity of the data is needed in research. The validity of the data adds to the scientific weight of the research and strengthens aspects of the truth of information, news, and knowledge. The quantitative research conducted in this thesis uses the Nordic Body Map instrument which is neatly structured, standardized, and guaranteed its validity. As long as data collection is carried out with the correct procedure, the validity of the data obtained can be accounted for its validity.

## Data Analysis

Individual data collection was carried out twice, before using the machine and after the activity using the machine was completed. Individual data will be analyzed, and data that does not show complaints due to the use of the tool will be reduced. Then the data are grouped by gender and the analysis is carried out by comparing the data for men and women.

## RESEARCH RESULTS AND ANALYSIS

Changing tea plucking technology from the past to the present involved manual plucking or hand plucking, semi-mechanical tea picking (shear plucking) using plucking scissors (widely used), especially in large-scale tea plantations doing mechanical plucking using a plucking machine. Applying mechanization technology using machines to harvest tea has changed how tea picking groups work. Originally, it was manual or semi-mechanical with an individual work performance system of 15-20 pickers compared to a machine picking group with 5 pickers. The mechanical tea picker group consisted of four people with a division of labor: two people holding the machine from left and right, one person holding the balloon holding the tea leaves, and one person in charge of carrying the basket. The machine holder is referred to as the machine operator. The operator requirements at the Gambung Plantation are as follows: (1) male operators are prioritized; (2) age 20-50 years; (3) a minimum height of 160 cm; (4) physically and mentally healthy; and (5) have received previous training and coaching. Women are usually positioned as balloon holders. However, women can become tea-picking machine operators. Picking usually starts at 07.00 WIB until 14.00.

The purpose of filling out the Nordic Body Map questionnaire is to find out which parts of the body feel sore before and before doing mechanical picking. Therefore, data collection was carried out twice, namely before the activity of using the picking machine, namely before 07.00 WIB, and after the picking time, at 14.00 WIB. The population in this quantitative study is mechanical pickers, because the population is not large, data collection is carried out for the entire population as many as 26 people consisting of 12 male mechanical pickers and 14 female mechanical pickers. The results of filling out the questionnaires are shown in Table 1 and Table 2 below.

**Tabel 2.** NBM Measurement Results on Male Mechanical Tea Pickers

| Subject | Score before work | Score after work | Score difference |
|---|---|---|---|
| GS/01/L | 2 | 5 | 3 |
| GS/05/L | 9 | 12 | 3 |
| GS/06/L | 3 | 9 | 6 |
| GS/08/L | 12 | 16 | 4 |
| GS/11/L | 3 | 3 | 0 |
| GU/13/L | 2 | 9 | 7 |
| GU/14/L | 1 | 4 | 3 |
| GU/15/L | 0 | 1 | 1 |
| GU/17/L | 41 | 72 | 31 |
| GU/19/L | 30 | 30 | 0 |
| GU/21/L | 28 | 31 | 3 |
| GU/25/L | 35 | 38 | 3 |
| Total | 166 | 230 | 64 |
| Median | 13.8 | 19.2 | 5.3 |
| SD $\pm$ | 15 | 21 | 8 |

From the data obtained, the average difference in scores for male mechanical tea pickers is 5.3 while the average difference in scores for female mechanical tea pickers is 9. This means that the average female mechanical tea pickers experience musculoskeletal complaints 70% more height than male mechanical tea pickers. Ergonomics risk comparison between male and female tea pickers with NBM measurement is 5:9. It turned out that female mechanical tea pickers experienced almost twice the ergonomic risk as male mechanical tea pickers. This

finding complements Simarmata's research results in "Anthropometric and Biomechanical Analysis of the Use of the OCHIAI GT 120 Tea Leaf Harvesting Machine" which stated that machine operators have the potential to suffer from skeletal, muscle, and peripheral nerve disorders. disorders commonly known as Musculoskeletal disorders (based on data analysis conducted using Rapid Entire Body Assessment and Ovako Working Posture Analysis methods in Gambung Tea Plantation) (Simarmata et al., 2020).

**Tabel 3.** NBM Measurement Results on Female Mechanical Tea Pickers

| Subject | Score before work | Score after work | Score difference |
|---|---|---|---|
| GS/02/P | 5 | 7 | 2 |
| GS/03/P | 6 | 23 | 17 |
| GS/04/P | 7 | 8 | 1 |
| GS/07/P | 4 | 9 | 5 |
| GS/09/P | 16 | 21 | 5 |
| GS/10/P | 2 | 36 | 34 |
| GS/12/P | 8 | 12 | 4 |
| GU/16/P | 12 | 42 | 30 |
| GU/18/P | 40 | 41 | 1 |
| GU/20/P | 34 | 42 | 8 |
| GU/22/P | 33 | 45 | 12 |
| GU/23/P | 33 | 32 | -1 |
| GU/24/P | 35 | 43 | 8 |
| GU/26/P | 40 | 40 | 0 |
| Total | 275 | 401 | 126 |
| Median | 19.6 | 28.6 | 9.0 |
| SD $\pm$ | 15 | 15 | 11 |

Farming has long-term health consequences. Farming is one of the jobs that is considered potentially hazardous due to the risk of injury and musculoskeletal disorders (Davis & Kotowski, 2007)(Singh & Arora, 2010). In a previous study entitled "Musculoskeletal symptoms among tea pluckers in India" (Dihingia & Dewangan, 2012), women are more likely to show musculoskeletal symptoms than men. The results of the analysis in this research show the same thing that women suffer from MSDs more severely than men.

## CONCLUSION

In conclusion, female mechanical tea pickers suffer from MSDs almost twice as much as males Therefore, a gender-responsive picking machine design intervention is needed considering that the majority of tea pickers are women so that the transition from manual harvesting to mechanical harvesting can occur without marginalizing the existence of female tea pickers. Future research should pay strong attention to gender relations and gender equity in the shift from manual work to machine-based work. There is a need to design technologies that are more beneficial, equitable, and sustainable for women, which can be achieved by including gender aspects in the development and modification of mechanization technology.

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## DAFTAR PUSTAKA

Davis, K. G., & Kotowski, S. E. (2007). Understanding the ergonomic risk for musculoskeletal disorders in the United States Agricultural Sector. *American Journal of Industrial Medicine*, *50*(7), 501–511. https://doi.org/10.1002/ajim.20479

Dihingia, P. C., & Dewangan, K. N. (2012). Musculoskeletal symptoms among tea pluckers in India. *Occupational Ergonomics*, *10*(3), 69–81. https://doi.org/10.3233/OER-2012-0193

Simarmata, A. H., Sita, K., Herwanto, T., & Thoriq, A. (2020). Analisis Antropometri dan Biomekanik Penggunaan Mesin Pemetik Daun Teh Tipe GT 120 Ochiai. *Jurnal Tanaman Industri Dan Penyegar*, *7*(3), 149. https://doi.org/10.21082/jtidp.v7n3.2020.p149-162

Sita, K. (2019). Gender dan Mekanisasi: Pengalaman Pekerja Perempuan Berpartisipasi dalam Kelompok Petik Mesin di Perkebunan Teh Gambung, Jawa Barat. *Umbara*, *4*(2), 76. https://doi.org/10.24198/umbara.v4i2.20461

Sita, K., & Herawati, E. (2017). Gender Relation in Tea Plucking Workers: A Case Study of Gender Division of Labour and Gender Relation in Gambung Tea Plantation, West Java. *Sodality: Jurnal Sosiologi Pedesaan*, *5*(1). https://doi.org/10.22500/sodality.v5i1.16266

Sugiyono. (2016). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Alfabeta.

Tarwaka, Bakri, S. H. A., & Sudiajeng, L. (2004). *Ergonomi untuk Keselamatan, Kesehatan Kerja dan Produktivitas*. UNIBA PRESS. http://shadibakri.uniba.ac.id/wp-content/uploads/2016/03/Buku-Ergonomi.pdf

Yudiyanta, Khoirunnisa, N., & Novitasari, R. W. (2015). Assessment Nyeri. *Cermin Dunia Kedokteran*, *42*(3), 214–234. https://doi.org/10.55175/CDK.V42I3.1034