

Analysis of the Use of 12 kg LPG (Liquified Petroleum Gas) Conveyance to Complaints of Household Workers

1) Department of
Mechanical Engineering,
Politeknik Negeri Bali,
Badung, Indonesia

I Nyoman Sutarna¹, I Nengah Ludra Antara¹, Kadek Agus
Mahabojana DP¹

Corresponding email ¹⁾:
sutarnanyoman@yahoo.co.id

Abstract. Manual conveyance is the work of transporting material carried out by workers to move material from an origin location to a destination location. The purpose of the study was to overcome the complaints experienced by housewives in the process of transporting 12kg LPG. The research was conducted using a two-period cross over design method. Musculoskeletal complaints experienced by housewives on the back, waist, knees, and calves. Musculoskeletal complaints were measured using a Nordic Body Map questionnaire with a Likert scale, and the data obtained were tested with independent t-test and t-pair. The results of the analysis showed that the use of 12 kg LPG conveyance could reduce musculoskeletal complaints from an average of 80.1 to 70 or decreased by 12.6%. It was concluded that the use of 12 kg LPG conveyance could reduce musculoskeletal complaints in housewives. It is recommended for those over 30 years of age to lift and carry heavy loads to use assistive devices.

Keywords: 12 kg LPG conveyance. musculoskeletal complaint, household worker

1. INTRODUCTION

There are many routine activities carried out in the household in daily life. One of these activities is transporting 12 kg LPG which is used for cooking. This work is carried out with a non-physiological attitude, so it has the potential to cause musculoskeletal complaints and injuries if not managed ergonomically.

Work positions that are not ergonomic or work attitudes are not physiological, which can cause bone abnormalities in workers [1], [2]. Work positions that are not physiological due to the demands of tasks, work tools, and work positions that are not by the ability of the worker result in increased musculoskeletal complaints [3]–[5]. The implementation of routine activities in a family is usually arranged through the division of tasks to complete them. Knowledge of ergonomic work positions has not been possessed by workers and it is proven that problems are still found related to non-ergonomic work postures in households.

From the survey and initial measurements of 16 housewives in Pupuan District, Tabanan Regency, 75% of respondents stated that the work process that housewives complain about the most when their husband is not at home is the process of transporting 12 kg LPG, so they need to get priority to find a solution immediately.

The musculoskeletal complaints felt in the process of transporting 12 kg LPG contents were on the back, waist, both knees, and calves. Complaints that arise in the process of transporting 12 kg LPG are caused, among other things, because transporting 12 kg LPG is carried out in a work position that is not physiological or with a forced labor attitude, this can result in increased musculoskeletal complaints. Working with a posture that is not physiological will cause many complaints, especially fatigue and musculoskeletal complaints, and will ultimately reduce work productivity [6]–[8].

In overcoming this problem, it is necessary to change the work position and use manual tools such as a 12 kg LPG transporter, in the hope of alleviating the musculoskeletal complaints of housewives.

The objectives to be achieved in this research are to (a) identify the complaints experienced by

housewives in the process of transporting 12 kg LPG, and (b) how to deal with complaints experienced by housewives in the process of transporting 12kg LPG.

The benefits to be achieved in this research are as follows (a) provide information regarding problems in the process of transporting 12 kg LPG, (c) provide information on actions that need to be taken to overcome problems in the process of transporting 12 kg LPG, (c) for scientific treasures, the results of this study are expected to inspire for other researchers to conduct more comprehensive studies.

2. METHODS

2.1 Description of conveyance

This conveyance is used to transport 12 kg LPG contents. In the process of transporting LPG, there are two ways as follows: (1) the manual (human) method without the help of conveyance, (2) the manual (human) method with the help of the conveyance. Of these two ways in the analysis of musculoskeletal complaints.

2.2 Research Design

The method in this research is experimental. The experimental method is to experiment directly on the object, where the researcher wants to know the causal effect between the independent and dependent variables. So the experimental method is a quantitative research method used to determine the effect of the independent variable (treatment) on the dependent variable (outcome) under controlled conditions [9]. The experimental method applied in this study is a treatment-by-subject design which was developed in the form of a two-period cross-over design. A cross-design between periods required washing out, to eliminate the effect of the first treatment on the next treatment [2]. The research design is shown in Figure 1.

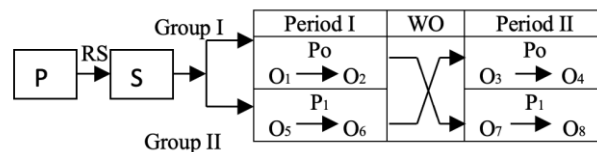


Figure. 1 Two Period Cross Over Design

Description:

P : Population

S : Sample

RS : Random Sampling

Po : Before using the conveyance

P1 : After using the conveyance

Group I : The group that worked before using the conveyance, continued to work to group II who already used the means of conveyance

Group II: The working group is already using the conveyance, proceed to group I before using the conveyance

O1, O3, O5, O7: Initial data collection before work begins on resting pulse and musculoskeletal complaints

O2, O4, O6, O8 : Final data collection after completion of work on musculoskeletal complaints

Wo : Washing Out to remove the effects of previous work, given 2 hours

2.3 Population and Sample

The population in this study was housewives transporting 12 kg LPG in Pupuan, Tabanan, Bali. The target population was 20 housewives, while the reachable population was 16. The number of samples in this study were 16 housewives, who would look for musculoskeletal complaints before and after using the means of transportation.

2.4 Variable classification

The variables in the study can be divided into three as follows:

1. The independent variable is the use of 12 kg LPG conveyance, before and after using the conveyance.
2. The dependent variable was musculoskeletal complaints in 16 housewives, before and after using the conveyance.
3. Control variables are gender, education level, work experience, health.

2.5 Variable operational definition

The definitions of variables related to this research are as follows:

1. Manual transportation means the work of transporting materials carried out by workers to move materials from an origin location to a destination location [8]. The reason for using manual work with human labor in this material moving activity is because there are several advantages that can be obtained, namely more flexibility, in moving materials in irregular work locations, cheaper, and easy to do for light loads [4].
2. Ergonomics is the science, technology and art to harmonize tools, how work is carried out on human abilities, abilities and limitations so that healthy, safe, comfortable and efficient working conditions and environments are obtained so that the highest productivity is achieved [10].
3. Musculoskeletal complaints are complaints in the parts of the skeletal muscles experienced by subjects both before work and after work that are subjective, musculoskeletal complaints are measured using a Nordic Body Map questionnaire with a Likert scale [9].

2.6 Research procedure

To avoid errors in data collection, the following research procedures were made:

1. Preparation stage

The stages of preparation in carrying out research are as follows:

- a. Library studies, books that are appropriate and relevant to the research topic.
- b. Determine the place of research.
- c. Determine the number of samples of 16 housewives transporting 12 kg LPG
- d. Preparing data collectors and tools for research purposes

2.7 Research implementation stage

The stages in the implementation of the research are as follows:

- a. Before starting work, each subject was given a Nordic Body Map questionnaire with four Likert scales and the subjects were asked to fill in themselves by marking grass (√), on the items according to the complaints they felt, then the results were collected.
- b. After completing the work, each subject was given another Nordic Body Map questionnaire with four Likert scales and the subject was asked to fill it out himself by marking grass (√), on the items according to the complaints they felt, then the results were collected.
- c. Record the value of musculoskeletal complaints before work and after work, namely the number of scores of musculoskeletal complaints according to the level of complaints felt by using four Likert scales.
- d. The score of musculoskeletal complaints is calculated based on the difference in the score of musculoskeletal complaints after the 12 kg LPG transfer process minus the musculoskeletal complaint score before the 12 kg LPG transfer process.
- e. The data obtained is then processed and analyzed with the help of a computer program SPSS (Statistical Package for The Social Science) version 22.0.

3. RESULTS AND DISCUSSION

3.1 Musculoskeletal complaints data

The mean value of musculoskeletal complaints was calculated based on the value of complaints after transporting LPG minus the value of complaints before transporting LPG for each treatment. The analysis of significance in this study was carried out in stages which included analysis of comparability, period effects, residual effects, and treatment effects.



Figure 2. Lift and transport 12 kg LPG without conveyance



Figure 3. Lift and transport 12 kg LPG with conveyance

Comparability analysis

The mean difference between musculoskeletal complaints before transporting LPG between treatments in period I was analyzed by independent t-test. The results of the analysis can be shown in table 1.

Table1. Independent t-test data on musculoskeletal complaints before transporting LPG between treatment period I

Subject Groups	N	Mean Score of Musculoskeletal Complaints	Standard Deviation	Average Difference	t	p
Treatment 1	8	37,27	0,98	-0,075	-0,114	0,911
Treatment 2	8	37,25	1,58			

In table 1, the results of the analysis using the independent t-test obtained that the mean between treatment 1 and treatment 2 in period I was not different ($p > 0.05$) with $t = -0.114$ and $p = 0.911$. This situation shows that musculoskeletal complaints carrying LPG groups PO and P1 in the treatment period I can be considered the same.

Analysis of the period effect

The period effect is calculated based on the difference in musculoskeletal complaints in period I PO minus the difference in musculoskeletal complaints in period II for group I compared to the difference in musculoskeletal complaints in period I minus the difference in musculoskeletal complaints in period II for group II. The data from the analysis using the Independent t-test can be seen in Table 2.

Table 2 shows that the results of the analysis using the independent t-test were not different ($p > 0.05$) with $t = -0.154$ and $p = 0.880$. This shows that the treatment period does not affect the subject's musculoskeletal complaints in period I and period II.

Table2. Independent t-test of the difference between musculoskeletal complaints between group I and group II

Subject Group	N	Mean Score of Musculoskeletal Complaints	Standard Deviation	Average Difference	t	p
Treatment 1	8	10,46	2,47	-0,300	-0,154	0,880
Treatment 2	8	10,16	2,92			

Carry-over effect

Table 2 shows that the results of the analysis using the independent t-test were not different ($p > 0.05$) with $t = -0.154$ and $p = 0.880$. This shows that the treatment period does not affect the subject's musculoskeletal complaints in period I and period II.

Table 3. Independent test t-test mean difference in musculoskeletal complaints between group I and group II

Subject Group	N	Mean Score of Musculoskeletal Complaints	Standard Deviation	Average Difference	t	p
Treatment 1	8	9,97	2,08	-0,68	-0,592	0,563
Treatment 2	8	10,65	2,45			

Table 3 shows that the results of the analysis using the Independent t-test were not different ($p > 0.05$) with $t = -0.592$ and $p = 0.563$. This means that there is no effect of the rest of the treatment on the next treatment.

Treatment effect analysis

In this study, the treatment effect was evaluated from the mean difference between musculoskeletal complaints after transporting 12 kg LPG contents minus musculoskeletal complaints before transporting 12 kg LPG at PO, compared to the mean difference between musculoskeletal complaints after transporting 12 kg LPG contents minus musculoskeletal complaints before transporting. LPG content of 12 kg on P1. The results of the analysis of significance with the t-pair test can be seen in Table 4.

Table 4. T-pair test of different mean musculoskeletal complaints before and after transporting 12 kg LPG.

Subject Group	N	Mean Score of Musculoskeletal Complaints	Standard Deviation	Average Difference	t	p
Treatment PO	16	80,09	1,74	-10,08	-15,428	0,000
Treatment P1	16	70,01	1,99			

Table 4 shows that with t-pair analysis the results are different ($p > 0.05$) with $t = -15.428$ and $p = 0.000$. This shows that there is a difference between PO and P1. Therefore, it can be stated that the use of a 12 kg LPG conveyance can reduce musculoskeletal complaints in housewives.

A comparison of musculoskeletal complaints after and before transporting 12 kg LPG contents between PO and P1 can be seen in Table 5.

Table 5 Data analysis of mean musculoskeletal complaints between Group I and Group II

	N	Period I				Period II			
		PO				P1			
		Pre	Post	Average Difference	SD	Pre	Post	Average Difference	DS
Mean musculoskeletal complaints group I	8	37,3	80,2	42,9	1,,8	37,2	70,3	33,1	2,6
	N	Period I				Period II			
		P1				PO			
		Pre	Post	Average Difference	SD	Pre	Post	Average Difference	SD
Mean Musculoskeletal Complaints Group II	8	37,2	69,7	32,5	1,7	36,9	80,0	43,1	3,2

Table 5 shows that musculoskeletal complaints before transporting 12 kg LPG, PO in group I, and PO in group II between period I and period II can be considered the same, after treatment there is a difference between PO and P1. Therefore, it can be stated that the use of a 12 kg LPG conveyance can reduce musculoskeletal complaints in housewives, for more details it can be shown in Figure 4.

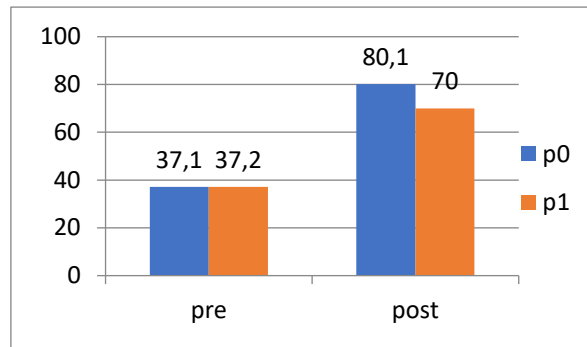


Figure 4. Musculoskeletal complaints before (P0) and after treatment (P1)

The subjects in this study were housewives, the average age of the subjects was 57 years. According to Manuaba [10], a person's physical capacity is directly related to age and reaches its peak at the age of 25 years. The effect of the physiological ability of muscles is in the age range of 20 to 30 years, over the age of 30 years the physiological ability of muscles decreases [2], [11].

The results of the analysis after using the 12 kg LPG conveyance showed a difference ($p > 0.05$) and a decrease in musculoskeletal complaints from the average score of 80.1 to 70, or a decrease of 12.6%. In line with what was stated by Lilik [12], Santosa [13], and Yusuf [14], they stated that the practice position of standing and bending is the wrong position in working especially when using equipment will cause musculoskeletal disorders. Musculoskeletal complaints experienced by housewives are on the back, waist, both knees, and calves. Musculoskeletal disorders experienced by housewives are caused by the accumulation of lactic acid which ultimately causes fatigue or pain in musculoskeletal [15], [16].

4. CONCLUSION

Based on the results of the analysis and discussion, it can be concluded that the use of a 12 kg LPG conveyance can reduce musculoskeletal complaints from an average of 80.1 to 70 or a decrease of 12.6%. At the age of over 30 years to transport and lift heavy loads are advised to be careful, you should use a conveyance or material handling to avoid the occurrence of disturbances in the skeletal muscles.

5. ACKNOWLEDGEMENT

We would like to thank the head of the Bali State Polytechnic research center and our fellow Bali State Polytechnic lecturers who have helped a lot in completing this research until it was published in this journal.

6. REFERENCES

- [1] J. Dul and B. Weerdmeester, *Ergonomics For Beginners A Quick Reference Guide, Second Edition*, 3rd ed. London: Taylor & Francis, 2008.
- [2] K. H. E. Kroemer and E. Grandjean, *Fitting The Task To The Human, Fifth Edition A Textbook Of Occupational Ergonomics*. London: CRC Press, 2009.
- [3] A. A. N. B. Mulawarman, I. K. G. J. Suarbawa, and M. Yusuf, "Slice Tool Model Design Dynamo Drive Tempeh to Increase Work Productivity of Tempeh Chip Craperers," *Am. J. Appl. Sci. Res.*, vol. 8, no. 4, pp. 88–92, 2022.
- [4] I. G. Santosa and M. Yusuf, "The Application of a Dryer Solar Energy Hybrid to Decrease Workload and Increase Dodol Production in Bali," *Int. Res. J. Eng. IT Sci. Res.*, vol. 3, no. 6, Nov. 2017.
- [5] B. Gajšek, A. Draghici, M. E. Boatca, A. Gaureanu, and D. Robescu, "Linking the Use of Ergonomics Methods to Workplace Social Sustainability: The Ovako Working Posture Assessment System and Rapid Entire Body Assessment Method," *Sustain.*, vol. 14, no. 7, 2022.
- [6] M. Yusuf, "Design of Jewel Stone Sharpener to Increase Jewel Worker Work Productivity in Bali," in *International Conference on Engineering, Technology, and Industrial Application (ICETIA)*, 2014, pp. 353–357.
- [7] W. Poochada, S. Chaiklieng, and S. Andajani, "Musculoskeletal Disorders among Agricultural Workers of Various Cultivation Activities in Upper Northeastern Thailand," *Safety*, vol. 8, no. 3, 2022.
- [8] A. Manuaba, "Accelerating OHS-Ergonomics Program By Integrating 'Built-In' Within The Industry's Economic Development Scheme Is A Must-With Special Attention To Small And Medium Enterprises (SMEs)," in *Proceedings the 21st Annual Conference of The Asia Pasific Occupational Safety & Health*

- Organization*, 2005.
- [9] E. A. Gehan and N. A. Lemak, *Statistics in Medical Research, Developments in Clinical Trials*. New York, USA: Springer US, 2012.
- [10] A. Manuaba, "Total Approach is a Must for Small and Medium Enterprises to Attain Sustainable Working Conditions and Environment, with Special Reference to Bali, Indonesia," 2006.
- [11] R. S. Bridger, *Introduction to Ergonomics, 3rd Edition*. London: Taylor & Francis, 2008.
- [12] L. Sudiajeng, T. Tarwaka, K. Sutapa, M. Sudana, and M. Yusuf, "Ergonomic tetrapod reduces the MSDs risk and productivity of steel-bar assembly for reinforcement concrete beams," *Int. Res. J. Eng. IT Sci. Res.*, vol. 9, no. 1, pp. 1–13, Dec. 2022.
- [13] I. G. Santosa, M. Yusuf, I. N. Gunung, and I. K. Rimpung, "Application of Forging Hammer to Increases Productivity of Balinese Blacksmith BT - Proceedings of the International Conference on Innovation in Science and Technology (ICIST 2020)," in *Proceedings of the International Conference on Innovation in Science and Technology (ICIST 2020)*, 2021, pp. 195–199.
- [14] M. Yusuf, M. Santiana, and W. D. Lokantara, "Improvement of work posture to decrease musculoskeletal disorder and increase work productivity jewelry worker in bali," in *Proceeding International Joint Conference on Science and Technology (IJCST) 2017*, 2017, pp. 242–247.
- [15] S. Racinais *et al.*, "Consensus recommendations on training and competing in the heat," *Br. J. Sports Med.*, vol. 49, no. 18, pp. 1164 LP – 1173, Sep. 2015.
- [16] M. Helander, *A Guide to Human Factors and Ergonomics*, vol. 51, no. 6. 2006.