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*Original Article*

# Stretching exercises for low back pain among dump truck operators in Indonesia

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## ABSTRACT

**Introduction:** Dump truck operators are at a greater risk of developing low back pain due to their occupational exposures. This study aimed to determine the effect of stretching exercises, especially pain intensity and flexibility, on low back pain among dump truck operators.

**Methods:** A descriptive study with a pretest-posttest control group design was conducted from February 2020 to March 2022, involving 76 dump truck operators with low back pain. A total of 38 operators were assigned for the control and intervention groups through purposive sampling. The control group only received an educational video for low back pain prevention, while the intervention group received an educational video with additional low back stretching exercises. Pain intensity and flexibility were assessed at baseline and weekly using the Numeric Rating Scale and the V-Sit and Reach Test. The collected data were analyzed using univariate, bivariate, and general linear models.

**Results:** At the end of the intervention, a significant difference ($p<0.001$) was found in pain intensity and flexibility between the control and intervention groups. Pain intensity reduction and increased flexibility were greater in the intervention group. There is no significant relationship ($p>0.05$) between pain intensity reduction and increased flexibility during stretching exercises.

**Conclusion:** Low back stretching exercises can significantly reduce pain intensity and increase flexibility in low back pain. Dump truck operators or heavy equipment operators with low back pain should routinely do low back stretching exercises.

**Keywords:** Dump Truck Operator, Low Back Pain, Muscle Stretching Exercises, Occupational Therapy, Preventive Medicine

## Introduction

Low back pain (LBP) is one commonest problems experienced by the general population, with an incidence rate of 80% among the productive age population. Occupational exposure is one major cause of LBP.[1] In Indonesia, the prevalence of LBP among heavy equipment operators ranges around 55-65%.[2,3] Heavy equipment operators are at a greater risk of developing LBP due to their working activities, such as prolonged sitting position, poor posture, limited workplace, long working hours, and exacerbation by whole-body vibration.[4–6]

Several modalities have been used to prevent LBP, one of which is stretching exercises.[7] Not only effective in improving neuromuscular coordination and flexibility, but stretching exercises also reduce muscle pain and weakness.[7] The active mechanism starts when the sarcomere contracts until fully stretched, followed by a passive motion in which the contracting sarcomere exerts pressure on the surrounding connective tissue.[8] As a result, there is a change in the viscoelasticity of the muscle-tendon unit, which increases the Range of Motion (ROM), and less force will be required to achieve a pain-free range of motion of the joint.[8]

Considering the price-free and accessibility benefits, routine stretching exercises could be the solution for most LBP heavy equipment operators.[7,9] However, the types and benefits of stretching exercises for heavy equipment operators, especially dump truck operators, have yet to be widely studied. This study aims to determine the effect of stretching exercises on LBP in dump truck operators in one of Indonesia's coal mining industries.

## Methods

A descriptive study was conducted from February 2020 to March 2022, comparing the pre-intervention and post-intervention between the control group and the intervention group. The participants were recruited from two construction sites: Long Loreh, Malinau, North Kalimantan, Indonesia and Kaliorang, East Kutai, East Kalimantan, Indonesia. Inclusion criteria were active workers aged 20–55 years, experiencing complaints of LBP, working as a dump truck operator for at least one year, and not currently taking any pain medication. LBP is defined as pain between the lower rib angle and above the lower buttocks, with or without radiating leg pain. The exclusion criteria were previous history of musculoskeletal or neurological pathology, history of traumatic injuries or surgery in the lower back region, any contraindication to do the physical exercise, and refusal to join the study. Contraindications for physical exercise were evaluated using the Physical Activity Readiness Questionnaire (PAR-Q+).[10] Participants with any unfitness check were excluded from the study. The dropout criteria were not being able to complete the exercise time already determined and not complying with the ongoing research protocol.

The sample size for each group was calculated using the categorical comparative formula for interventional study $([Z_{1-\alpha/2}-Z_{1-\beta})(\sigma_1^2+ \sigma^2/r)]/[(\mu_1-\mu_2)^2])$, resulting in 38 subjects for each group. A total of 228 operators in the Long Loreh site and 446 operators in the Kaliorang site were screened with the inclusion and exclusion criteria. The total eligible participants willing to join the study were 76 subjects in the Long Loreh site and 98 in the Kaliorang site. A simple random sampling method was used to choose 38 subjects from both sites. Computer-generated random numbers were assigned to each subject in both sites, followed by adequate sample selection through subsequent computer-generated random numbers. The computer-generated random numbers method was also used to allocate the samples equally into the control and intervention groups.

The demographic characteristics collected include age (years), body mass index (BMI [kg/m$^2$]), physical activity level (Metabolic Equivalent Task [MET]-min/week), experience of work (months), duration of driving (hours/day), and whole-body vibration level (m/s$^2$). Physical activity level was measured using the validated Indonesian version of The International Physical Activity Questionnaire (IPAQ).[11] Whole-body vibration level was measured using a vibrometer placed in a working position.

Standard intervention was given to the control and intervention groups through an educational video about low back pain. The educational video contains information regarding low back pain's definition, causes, treatments, and prognosis. Initial assessments (week 0) were conducted by measuring pain intensity and flexibility. Pain intensity was measured using the Numerical Rating Scale (NRS). Respondents were asked to write the pain level on a numerical scale from 0 to 10, with zero (0) representing no or no pain and ten (10) illustrating the most extreme pain. Lower back flexibility was measured with the V-Sit and Reach (VSR) test. Respondents were asked to take off their shoes, sit along the measuring line with the feet and soles of the feet right in the middle of the baseline, 20-30 cm apart, knees straight, and slowly reach in front as far as possible three times.

The intervention group was instructed to do the lower back stretching exercises for five days/week, two sessions/day (before and after driving), 10 minutes/session, with each motion repeated twice and held for 20 seconds. The lower back stretching exercises consist of (1) standing lower trunk stretch, (2) standing lower trunk lateral flexor stretch, (3) seated lower trunk extensor stretch, (4) seated lower trunk lateral extensor-flexor stretch, and (5) seated lower trunk lateral flexor stretch (**Figure 1**). Follow-up measurements of pain intensity with NRS and flexibility with VSR in both groups were carried out weekly until four weeks. The instructors monitored the exercises and follow-up measurements documented in personal logbooks.

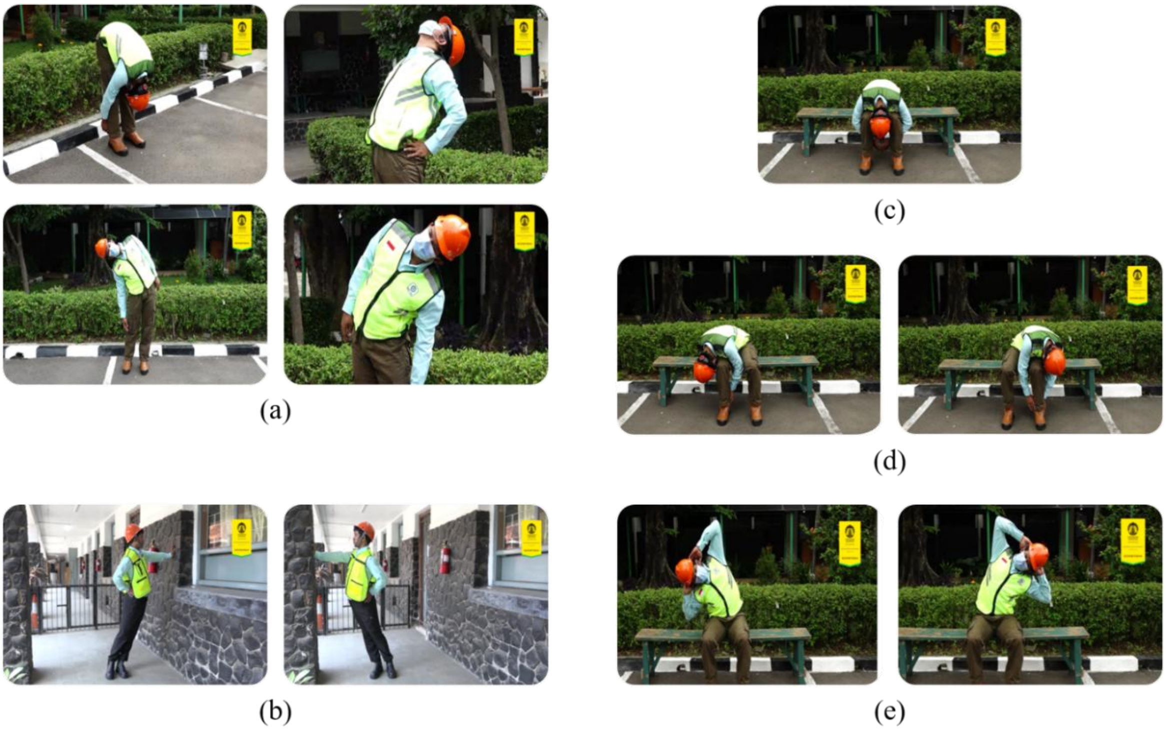



**Figure 1.** Lower back stretching exercise: (a) standing lower trunk stretch, (b) standing lower trunk lateral flexor stretch, (c) seated lower trunk extensor stretch, (d) seated lower trunk lateral extensor-flexor stretch, and (e) seated lower trunk lateral flexor stretch.

Data was analyzed using IBM Statistical Package for the Social Sciences (SPSS®) for Windows, version 20.0 (IBM Corp., Armonk, N.Y., USA). Individual characteristics of the respondents and work factors affecting the results were presented with mean, except for physical activity level, in which data was presented with median based on the inhomogeneity of the data. Bivariate analyses were used to determine the differences in demographic characteristics, pain intensity, and flexibility between both groups. The unpaired t-test was used for the parametric test, and the Mann-Whitney test was used for the non-parametric alternative test (only the physical activity level). Assuming the inhomogeneity and small sample size, Pillai's Trace analysis in the General Linear Model (GLM) Repeated Measure test was used to analyze the differences of pain intensity reduction and flexibility increment between both groups. The correlation between pain intensity and flexibility was analyzed using the Pearson's test. Statistical significance was defined as a p-value below 0.05 for all tests.

## Results

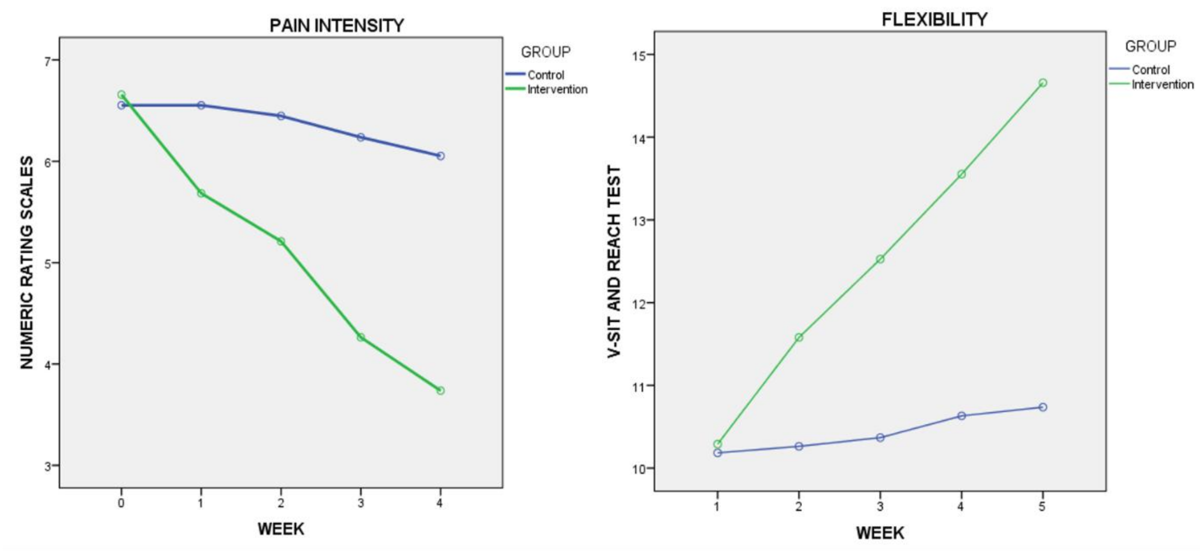
The demographic characteristics consisting of individual factors (age, body mass index, and physical activity level) and occupational factors (working experience, driving duration, and whole-body vibration) were shown in **Table 1**. None of the demographic variables showed significant differences (p>0.05) between the control and the intervention groups.

All participants successfully went through the study without any dropouts. A weekly comparison of both groups showed perceptible trends of pain intensity reduction and flexibility increment in the intervention group compared to the control group (**Figure 2**).

**Table 1.** Demographic Characteristic

| Demographic variables | Control (n=38) Mean±SD/ Median (IQR) | Intervention (n=38) Mean±SD/ Median (IQR) | p-value |
|---|---|---|---|
| **Individual Factors** | | | |
| Age (years) | 27.2 ± 4.1 | 28.4 ± 4.2 | 0.201* |
| Body Mass Index (kg/m²) | 23.0 ± 4.5 | 24.4 ± 3.0 | 0.127* |
| Physical Activity Level (MET-min/week) | 990 (525.8 - 1,468) | 1,010 (501 - 1,611) | 0.934† |
| **Work Factors** | | | |
| Working Experience (months) | 73.2 ± 9.4 | 74.2 ± 8.8 | 0.635* |
| Driving Duration (hours/day) | 10.0 ± 1.1 | 9.8 ± 1.2 | 0.430* |
| Whole-body Vibration (m/s²) | 0.74 ± 0.1 | 0.78 ± 0.1 | 0.270* |

* Unpaired t-test; †)Mann-Whitney test; MET = metabolic equivalent task




(a) (b)

**Figure 2.** Weekly Comparison Graph of (a) Pain Intensity and (b) Flexibility between the Control and Intervention Groups

**Table 2.** Weekly Comparation of Pain Intensity in the Control Group and Intervention Group

| Pain Intensity (NRS) | Week 0 Mean±SD | Week I | Week II | Week III | Week IV | *p-value** |
|---|---|---|---|---|---|---|
| **Control** | 6.5±1.1 | 6.5±1.1 | 6.4±1.0 | 6.2±1.0 | 6.0±1.1 | <0.001 |
| **Intervention** | 6.6±1.1 | 5.6±1.1 | 5.2±1.1 | 4.2±1.2 | 3.7±1.3 | |
| **p-value between group†** | 0.688 | 0.002 | <0.001 | <0.001 | <0.001 | |

*GLM repeated measure test; †Unpaired t-test; NRS=numeric rating scale

Compared to the control group, the intervention group had pain intensity significantly reduced from the first week of follow-up (**Table 2**). The intervention groups also gained significant flexibility increment from the first week of follow-up compared to the control group (**Table 3**).

**Table 3.** Weekly Comparation of Flexibility in the Control Group and Intervention Group

| Flexibility (VSR) | Week 0 | Week I | Week II | Week III | Week IV | *p-value** |
|---|---|---|---|---|---|---|
| | Mean±SD | | | | | |
| **Control** | 10.1±1.3 | 10.2±1.2 | 10.3±1.4 | 10.6±1.5 | 10.7±1.6 | <0.001 |
| **Intervention** | 10.2±1.1 | 11.5±1.4 | 12.5±1.4 | 13.5±1.6 | 14.6±2.2 | |
| **p-value between groups†** | 0.712 | <0.001 | <0.001 | <0.001 | <0.001 | |

*GLM repeated measure test; †Unpaired t-test; VSR=v-sit and reach test

The Pillai's Trace analysis in the GLM repeated measure test showed a significant overall reduction of pain intensity and significant flexibility increment in the intervention group compared to the control group (**Tables 2 and 3**). The Pearson's test between the control and intervention groups showed a very low negative correlation without significance between pain intensity and flexibility (r=-0.02; p=0.87).

## Discussion

Low back pain (LBP) is a substantial global burden greatly affected by occupational factors.[12] Ergonomic exposures at work cost around 21.7 million disability-adjusted life years worldwide, with East and South Asia suffering the most.[13] A recent guideline from the World Health Organization for chronic primary low back pain in adults recommends stretching/flexibility exercise as one exercise that benefits pain and function outcomes.[14] In this study, we successfully showed significant benefits in pain intensity and flexibility reductions after a stretching exercise program for heavy equipment operators, specifically dump truck operators.

The mean age of each group who experienced low back pain complaints was around productive age, 27.2 and 28.4 years in the control group and intervention group, respectively. In line with Kresal et al., LBP is a spinal problem with around 80% incidence rate experienced by the productive age population.[4] In this study, the mean BMI between the control and intervention groups was 23.0 and 24.4 kg/m$^2$, while the median physical activity level were 990 MET-min/week and 1,010 MET-min/week. Although overweight might be reasonable as one of the low back pain factors, the direct effect of high BMI in truck drivers has not yet been established, supported by the facts that high BMI does not contribute to low back pain among driving-related occupations.[15] Similarly, Alzahrani et al. in their meta-analysis study showed a no-to-minimal association between physical activity, also in MET-min/week, with pain intensity in LBP.[16]

The mean working experience of the control and intervention groups was 73.2 and 74.2 months (around five years), respectively. This result is slightly different from the research by Mozafari et al. on truck operators in Iran, which shows 8.8 years of mean working period for truck operators who experience complaints of LBP.[17] An observational study by Atallah et al. showed that driving experience >15 years was not an independent risk factor for LBP, in contrast with driving duration >6 hours/day, an independent risk factor for LBP.[18] In our study, the control and intervention groups were experiencing prolonged static sitting positions with a mean duration of 10.0 hours/day and 9.8 hours/day, contributing to the development of LBP.[19]

In this study, the intervention group experienced a significant decrease in pain levels compared to the control group, which only received an educational video. As confirmed in a previous meta-analysis by Steffens et al., it is essential to note that education alone, without any other intervention, is inadequate to reduce LBP episodes.[20] On the other hand, Zhang et al. showed a significant decrease in chronic LBP pain levels in the group that was given health promotion education plus physical exercises compared to the group that only carried out physical exercises.[21] While the educational video in our study demonstrated a broad view of LBP, the World Health Organization guideline recommends a structured education emphasizing the benefits of being physically active and at least two education topics, such as physical exercise, ergonomic advice, etc.[14]

There was also a significant increment of flexibility in the intervention group compared to the control group. Among many stretching methods, static stretching exercises are considered safer because they do not exceed the normal range of motion of the joints, do not require a high fitness level, and cause less muscle soreness.[22] Similar to this study, Bae et al. also found a significant effect of static stretching exercises in reducing pain, increasing flexibility, and increasing life quality in LBP.[23] As seen in our study, previous studies by Kuukkanen et al. and Hargiani et al. also showed no correlation between flexibility and pain intensity in low back pain.[24,25] Nonetheless, increased flexibility would result in an increased range of motion, aerobic fitness, and core strength.[26,27]

There are several limitations in this study. To increase the range of sampling chances, a non-randomized study was conducted by purposively choosing two sites for each control and intervention group after negotiating with the management of the site. Samples in each site were randomly selected, followed by another group allocation randomization to overcome the consequent sampling bias. Demographic characteristics were also analyzed to detect any significant differences between both groups. There was also a limitation regarding the exclusion of any structural abnormality of the workers because we did not have the opportunity to conduct additional medical check-ups for all the workers. Previous medical check-up results were used as a replacement to exclude any structural abnormalities.

## Conclusions

This study showed that stretching exercises significantly reduced low back pain intensity and increased muscle flexibility among dump truck operators. Surprisingly, assigning educational videos for LBP prevention also gave beneficial result in reducing pain intensity. In the future, operators can do this stretching exercise regularly to prevent and reduce complaints of LBP at work. These lower back stretching exercises can also be used as one of the workplace-based LBP prevention programs for heavy equipment operators, especially dump truck operators in mining industries.

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