# PREVALENCE OF LOW BACK PAIN AMONG INDUSTRIAL WORKERS WITH PROTECTIVE FOOTWEAR

**Suzan Marouf[1], Mushira Darweesh[2], Enas Elsayed[2,3], Mohamed Abdel Hady[4], Wael Shendy[2]**

**Article History: Received:** 10.06.2023 **Revised:** 25.07.2023 **Accepted:** 01.08.2023

## ABSTRACT

**Background:** As industrialization develops around the world, it causes a number of work-related disorders as well as diseases, such as musculoskeletal problems. Low back pain remains a frequent health disorder and one of the most prevalent musculoskeletal conditions in industrial countries. To our knowledge, the prevalence of low back pain within industrial workers with protective footwear has not been carried out previously

**Purpose of Study:** To detect the prevalence of LBP within industrial workers with protective footwear and to determine the causes of low back pain within the industrial population, both occupational and non-occupational.

**Methods:** Two hundred industrial workers, who use protective footwear, took part in the present study. The mean ± SD BMI of the study group was 25.95 ± 4.27 kg/m². Forty four percent of the sample were with normal weight, 34.5% were overweight, and 21.5% were obese. Also, 37.5% of the study group wear heavy-duty protective footwear, 28.5% wear medium-duty protective footwear, and 34% of the study group were light-duty protective footwear. All participants underwent three main measures; the Oswestry disability index (ODI), visual analog scale for pain (VAS), as well as straight leg raising test (SLR).

**Results:** The results showed that overweight and obese, wearing heavy-duty footwear, 8-9 hrs./day of wearing protective footwear, not participating in physical activity, frequent bending, twisting, and sudden movements were the significant predictors for LBP ($p<0.01$).

**Conclusion:** According to this study results, body weight, type of protective shoes, hours of wearing protective footwear, standing hours, participation in physical exercise, and frequent bending, twisting, and sudden movements had a significant relationship with LBP; whereas sex, working hours as well as working years had no significant association with LBP.

**Keywords:** Low Back Pain, Protective Footwear, Work-related injury, Safety Shoes.

1.Department of Physical Therapy, El-Sheikh Zayed Specialized Hospital.
2.Department of physical therapy for Neurology, Faculty of Physical Therapy, Cairo University.
3.Department of Neurorehabilitation, Faculty of Physical Therapy, Galala University, Suez, Egypt.
4.Neurosurgery fellow, General Organization of Teaching Hospitals and Institutes.

**DOI: 10.48047/ecb/2023.12.8.795**

## I. INTRODUCTION

One of the most significant worldwide health problems today is low back pain (LBP) **(Beyera et al., 2019)**. Musculoskeletal disorders (MSDs) and other work-related injuries as well as diseases are caused by the development of industry around the world (**Schaafsma et al., 2015)**. According to a 2019 study by Fatoye et al., LBP is among the most prevalent healthcare problems in industrial nations. From the perspective of occupational medicine, LBP is the leading cause of work absences, impairments, disabilities, as well as compensation claims **(Nastasia et al., 2014)**. Reduced productivity and huge financial burdens are the results of LBP for patients, families, communities, industries, and governments around the world **(Shiri et al., 2019)**.

Personal, occupational, and environmental factors all have the potential to increase the risk of developing LBP. Individual differences in age, gender, BMI, working hours, smoking, education, financial status, as well as physical activity levels. Factors related to the workplace include long hours and uncomfortable working positions. Whole-body vibration as an environmental element **(Andini, F. 2015)**

Risk factors for developing occupational LBP at work include physical demands such frequent bending and twisting or lifting heavy objects **(Jaffar et al., 2017)**. Many environmental and individual characteristics have been reported to increase the risk of LBP. These characteristics can be aggregated into categories including age and gender, physical stressors at the spine and poor general condition (e.g. smoking and obesity) **(Heidari et al., 2016)**.

Following the First World War, the need for protective footwear in the workplace was recognized, and by the end of the 1970s, safety shoes were being worn by nearly everyone in the industry (Baloh et al. 2019). Crushing injuries to the foot are a frequent occurrence in industrial settings and a major cause of disability **(Hong et al., 2015)**. Protective footwear (safety shoes) consisting of polymer materials that act as a barrier between the wearer and potentially hazardous workplace conditions have been recommended by regulatory bodies as well as Occupational Safety and Health Administration (OSHA), which including steel toe caps and steel plates for the sole of the foot to protect against occupational hazards **(Kaynak et al., 2016)**.

The design of protective footwear caters more to safety instead of functionality and comfort **(Dobson et al., 2017)**. Abnormal foot posture and function have been proposed as possible risk factors for LBP **(Peixinho et al., 2018)**. According to our knowledge, there is a lack of studies examining the effect of safety shoes on the development of musculoskeletal diseases specifically LBP.

Within an industrial population, LBP is a major concern, and this study seeks to provide a clear picture of the scope of the problem by identifying the work-related as well as lifestyle risk factors that contribute to this condition.

## AIM OF THE WORK

This study was conducted to detect the prevalence of LBP among industrial workers with protective footwear in addition to detect work-related and lifestyle risk factors for LBP within an industrial population.

## II. PATIENTS AND METHODS

The approval of the protocol of the study was done by the Research Ethical Committee of Cairo University's Faculty of Physical Therapy. the study was carried-out from December 2019 to January 2022.

Two hundred workers of both genders have been selected from two different industries in the $6^{th}$ of October city. The study included three popular tools used by primary care physicians: the Oswestry disability index (ODI), the Visual analog scale (VAS), as well as the Straight leg raising test (SLR).

- ***Inclusion criteria***

The patients participated in this study according to the following criteria: workers from both genders who use protective footwear, age ranges from 21- 49 years old, and years of employment: at least 1 year.

- ***Exclusion Criteria***

Pregnant females. Subjects with a BMI equal to or more than 30. A History of fractures in the spine. History of rheumatoid arthritis disease.

### Assessment procedures

Every participant was asked to answer every domain of the Arabic or English version of ODI (as preferred). Six statements, one for each possible topic group, describe the patient's life in relation to the topic. On a scale from 0 to 5, each question was given a score. The index (from 0 to 100) is calculated by summing the scores from each question and then multiplying by two. A score of 0 meant no disability, while 100 indicated complete disability.

The VAS was used to measure the intensity of pain. The patient was instructed to place a mark online from 0 to 10 to indicate the intensity of pain.

The straight leg raise test was performed to rule out hamstring or lumbar nerve root contribution to the patient's LBP. While lying on his or her back, the patient is instructed to lift the straight leg. To do this, flex the hip to an elevation of 70 to 90 degrees. A positive straight leg raising reproduces the patient's symptoms radiating pain from the low back to the ankle; if the pain is limited to the back of the thigh, hamstring tightness is likely to be the cause.

## STATISTICAL ANALYSIS

The SPSS Package, Edition 25 for Windows (SPSS Inc., Chicago, IL) was used to perform the statistical analyses. Mean, standard deviation, frequencies, as well as percentages were used as descriptive statistics for displaying the demographic as well as LBP information for the individuals. Means and standard deviations were used to summarize quantitative data, whereas frequencies as well as percentages were used for qualitative data. Chi-square analysis was used to check for correlations between LBP, demographic data as well as work-loads. The characteristics that are predictors of LBP within the participants were identified using logistic regression analysis. All statistical tests were performed at the $p<0.05$ level of significance. The Windows version of the statistical software for the social sciences (SPSS) version 25 was used for all analyses.

Variables shown to have a statistically significant association with LBP have been inserted into a multivariate logistic regression model. Being overweight and obese, wearing heavy-duty footwear, 8-9 h/day of wearing protective footwear, not participating in physical activity and Frequent bending, twisting, and sudden movements were the significant predictors for LBP ($p < 0.01$).

## III. RESULTS

In the current study, the prevalence of LPB among industrial workers with protective footwear was 52% with a 95% CI of 45.1- 58.82%.

There was no significant association sex ($p = 0.25$), working years ($p = 0.74$), and LBP.

A significant improvement has been detected in the percentage of LBP in overweight and individuals with obesity compared with subjects with normal weight ($p = 0.001$), in individuals wearing protective footwear 8-9 h/day in comparison with individuals wearing protective footwear 2-7 h/day ($p = 0.01$), in individuals working 12 h/day compared with individuals working 8 h/day ($p = 0.003$), in individuals who stands for 5-8 h/day compared with individuals stands for 1-4 h/day ($p = 0.01$), in individuals who didn't participate in physical exercise in comparison with individuals who participate in physical exercise ($p = 0.01$), in individuals with frequent bending, twisting, and sudden movement ($p = 0.02$), in individuals with heavy-duty footwear in comparison with other types ($p = 0.001$).

**Demographic characteristics:**
Two hundred industrial workers who use protective footwear took-part in this study. The mean ± SD of age in the study group was 30.76 ± 5.15 years ranging from 21 years to 39 years. 95 (47.5%) subjects were 21-30 years old and105 (52.5%) subjects were 31-39 years old.
The mean ± SD of BMI in the study group was 25.95 ± 4.27 kg/m² with minimum of 18.5 kg/m² and maximum of 33.6 kg/m². 88 (44%) subjects were with normal weight, 69 (34.5%) subjects were overweight, and 43 (21.5%) subjects were obese (table 1).

**Table 1:** Demographic characteristics of the study group

| | $\bar{x}$ ±SD | Minimum | Maximum | Range |
|---|---|---|---|---|
| **Age (years)** | 30.76 ± 5.15 | 21 | 39 | 18 |
| **BMI (kg/m²)** | 25.95 ± 4.27 | 18.5 | 33.6 | 15.1 |
| **Age classes** | **Frequency** | | | |
| **21-30 years** | 95 (47.5%) | | | |
| **31- 39 years** | 105 (52.5%) | | | |
| **Weight classes** | Frequency | | | |
| **Normal weight (18.5–24.9 kg/m²)** | 88 (44%) | | | |
| **Overweight (25.0–29.9 kg/m²)** | 69 (34.5%) | | | |
| **Obese (≥ 30 kg/m²)** | 43 (21.5%) | | | |

**$\bar{x}$:** Mean **SD:** Standard deviation

- ***Gender distribution:***

The gender distribution of the study group was as follows: fifty-five females (27.5%) and one hundred and forty-five males (72.5%).

- ***Type of protective footwear:***

Seventy five (37.5%) subjects of the study group wear heavy duty protective footwear, 57 (28.5%) subjects wear medium duty protective footwear, and 68 (34%) subjects of the study group were light duty protective footwear.

- ***Hours of wearing protective footwear:***

The mean ± SD hours of wearing protective footwear per day of the study group was 6.52 ± 1.97 hours ranging from 2 hrs/day to 9 hrs/day. The hours of wearing protective footwear hours distribution of the study group revealed that 106 (53%) subjects wear protective footwear 2-7 hrs/day and 94 (47%) subjects wear protective footwear 8-9 hrs/day (table 2).

**Table 2:** The frequency distribution of hours of wearing protective footwear per day of the study group.

| **Hours of wearing protective footwear per day** | $\bar{x}$ ±SD | Minimum | Maximum | Median |
|---|---|---|---|---|
| | 6.52 ± 1.97 | 2 | 9 | 7 |
| | **Frequency** | | | |
| **2-7h/day** | 106 (53%) | | | |
| **8-9 h/day** | 94 (47%) | | | |
| **Total** | 200 (100%) | | | |

**$\bar{x}$:** Mean **SD**: Standard deviation

- ***Working hours per day of the study group:***

The mean ± SD work hours per day of the study group was 9.14 ± 1.81 hrs/day with minimum of 8 hrs/day and maximum of 12 hrs/day. The work hours per day distribution of the study group revealed that 143 (71.5%) subjects worked 8hrs/day and 57 (28.5%) worked more than 12 hrs/day.

- ***Standing hours:***

The mean ± SD standing hours per day of the study group was 4 ± 1.39 hrs /day with minimum of 1 hrs /day and maximum of 8 hrs /day. The standing hours per day distribution of the study group revealed that 107 (53.5%) subjects stand for 1-4 h/day and 93 (46.5%) subjects stand for 5-8 hrs/day.

- ***Number of working years:***

The results showed that 150 (75%) subjects of the study group had less than 10 working years and 50 (25%) subjects had more than 10 working years.

- ***Participation in physical exercise:***

Also, 31 (15.5%) individuals of the study group participate in physical exercise and 169 (84.5%) individuals of the study group do not participate in physical exercise.

- ***Frequent bending, twisting, as well as sudden movements:***

77 (38.5% individuals of the study group had frequent bending, twisting, as well as sudden movements and 123 (61.5%) individuals of the study group were not participating in frequent bending, twisting, as well as sudden movements.

- ***Pain and disability among industrial workers with protective footwear with LBP:***

The mean ± SD VAS among industrial workers with LBP was 4.05 ± 1.58 ranging from 1 to 7.
The mean ± SD ODI among industrial workers with LBP was 24.06 ± 12.69 with minimum value of 0% and maximum value of 58%.

- ***Straight leg raising (SLR) test:***

Six of industrial workers with LBP (5.8%) had positive SLR and 98 (94.2%) had negative SLR.

- ***Association between weight status and LBP:***

Low back pain was found in 23 (26.1%) subjects with normal weight, in 42 (60.9%) subjects with overweight and in 39 (90.7%) subjects with obesity. There was a significant rise in percentage of LBP in overweight and individuals with obesity compared with subjects with normal weight (p = 0.001).

- ***Association between sex and LBP:***

Low back pain was also found in 25 (45.5%) of female individuals and in 79 (54.5%) of male individuals. no significant correlation was found between sex and LBP (p = 0.25).

- ***Association between type of protective footwear and LBP:***

LBP was present in 51 (68%) individuals with heavy duty footwear, in 29 (50.9%) subjects with medium duty footwear and in 24 (35.3%) individuals with light duty footwear. There was a significant association between type of protective footwear and LBP. a significant rise in percentage of LBP in individuals with heavy duty footwear in comparison with other types (p = 0.001) (table 3).

**Table 3**: The prevalence of LBP with type of protective footwear.

| **Type of protective footwear** | **Percentage of LBP** | | **$\chi^2$ value** | **p -value** | **Sig** |
|---|---|---|---|---|---|
| | **Yes** | **No** | | | |
| **Heavy-duty** | 51 (68%) | 24 (32%) | 15.32 | 0.001 | S |
| **Medium-duty** | 29 (50.9%) | 28 (49.1%) | | | |
| **Light-duty** | 24 (35.3%) | 44 (64.7%) | | | |

$\chi^2$ :Chi-squared Test  **p value:** Probability value  **S:** Significant

- ***Association between hours of wearing protective footwear per day and LBP:***

The LBP was existing in 46 (43.4%) of individuals wear protective footwear 2-7 h/day and in 58 (61.7%) of subjects wear protective footwear 8-9 h/day. a significant rise in the percentage of LBP in individuals wear protective footwear 8-9 h/day compared with subjects wear protective footwear 2-7 h/day (p = 0.01) (table 4).

**Table 4:** The prevalence of LBP with hours of wearing protective footwear per day.

| **Hours of wearing protective footwear per day** | **Percentage of LBP** | | **$\chi^2$ value** | **p -value** | **Sig** |
|---|---|---|---|---|---|
| | **Yes** | **No** | | | |
| **2-7 h/day** | 46 (43.4%) | 60 (56.6%) | 6.68 | 0.01 | S |
| **8-9 h/day** | 58 (61.7%) | 36 (38.3%) | | | |

**$\chi^2$ :**Chi-squared Test  **p value:** Probability value  **S:** Significant

**Association between working hours per day and LBP:**
The LBP was existing in 65 (45.5%) of individuals working 8 h/day and in 39 (68.4%) of subjects working 12 h/day. a significant rise in the percentage of LBP in individuals working 12 h/day in comparison with individuals working 8 h/day (p = 0.003) (table 5).

**Table 5:** The prevalence of LBP with work hours per day.

| **Work hours per day** | **Percentage of LBP** | | **$\chi^2$ value** | **p - value** | **Sig** |
|---|---|---|---|---|---|
| | **Yes** | **No** | | | |
| **8h/day** | 65(45.5%) | 78 (54.5%) | 8.61 | 0.003 | S |
| **12 h/day** | 39 (68.4%) | 18 (31.6%) | | | |

**$\chi^2$ :**Chi-squared Test **P value:** Probability value **S:** Significant

- ***Association between standing hours per day and LBP:***

The LBP was existing in 47 (43.9%) of individuals stands for1-4 h/day and in 57 (61.3%) of individuals stands for 5-8 h/day. There was a significant rise in the percentage of LBP in individuals who stands for 5-8 h/day compared with individuals stands for 1-4 h/day (p = 0.01) (table 6).

**Table 6:** The association of LBP with standing hours per day.

| Standing hours per day | Percentage of LBP | | $\chi^2$ value | p -value | Sig |
|---|---|---|---|---|---|
| | Yes | No | | | |
| **1-4 h/day** | 47 (43.9%) | 60 (56.1%) | 6.01 | 0.01 | S |
| **5-8 h/day** | 57 (61.3%) | 36 (38.7%) | | | |

**$\chi^2$ :**Chi-squared Test **P value:** Probability value **S:** Significant

- ***Association between working years as well as LBP:***

The LBP was existing in 79(52.7%) of individuals with less than 10 working years and in 25 (50%) of individuals with more than 10 working years. no significant correlation has been detected between working years and LBP (p = 0.74).

- ***Association between participation in physical exercise as well as LBP:***

The LBP was existing in 10 (32.3%) of individuals who participated in physical exercise and in 94 (55.6%) of individuals who didn't participate in physical exercise. There was a significant rise in the percentage of LBP in individuals who didn't participate in physical exercise in comparison with individuals who participate in physical exercise (p = 0.01).

- ***Association between frequent bending, twisting, and sudden movements and LBP:***

The LBP was existing in 48 (62.3%) of individuals with frequent bending, twisting, as well as sudden movement and in 56 (45.5%) of individuals without frequent bending, twisting, as well as sudden movement. There was a significant rise in the percentage of LBP in individuals with frequent bending, twisting, as well as sudden movement (p = 0.02).

- ***Regression analysis***

A Binary logistic regression was conducted to determine the variables which can expect LBP in individuals. Univariant analysis indicated that weight status, type of protective shoes, hours of wearing protective footwear, standing hours, participation in physical exercise, frequent bending, twisting, and sudden movements had significant correlation with LBP; while sex, working hours and working years had not significant correlation with LBP.

Overweight individuals were found to be 4.39 times more probable to experience LBP than their normal weight counterparts (95% Confidence Interval [CI]: -2.23-8.66, p = 0.001). Obese people were 27.55 times more probable to experience LBP than normal-weight individuals. (Odds Ratio = 27.55, 95% CI -8.86-85.6, p = 0.001). Subjects wearing heavy duty footwear were 3.89 times more probable to experience LBP in comparison with light duty footwear (Odds Ratio = 3.89, 95% CI 1.94-7.81, p = 0.001).

Subjects wearing footwear 8-9 h/day were 2.1 times more probable to experience LBP in comparison with individuals wearing footwear2-7 h/day (Odds Ratio = 2.1, 95% CI 1.19-3.7, p = 0.01). Subjects stands for5-8 h/day were 2.02 times more probable to experience LBP in comparison with individuals stands for 1-4 h/day (Odds Ratio = 2.02, 95% CI 1.14-3.55, p = 0.01). Subjects who did not engage in regular physical activity were 2.63 times more probable to suffer from LBP than those who did (Odds Ratio = 2.63, 95% CI 1.16-5.92, p = 0.01). individuals with frequent bending, twisting, and sudden movements were 1.98 times more probable to suffer from LBP in comparison with individuals without frequent bending, twisting, and sudden movements (Odds Ratio = 1.98, 95% CI 1.11-3.54, p = 0.02).

Variables shown to have a significant correlation with LBP have been inserted into a multivariate logistic regression model. Overweight and obesity, wearing heavy duty footwear, 8-9 h/day of wearing protective footwear, not participating in physical activity and Frequent bending, twisting, and sudden movements were the significant predictors for LBP ($p < 0.01$)

## IV. DISCUSSION

The current study was conducted to determine the prevalence of LBP among industrial workers with protective footwear in addition to detect the probable risk factors for developing LBP. Two hundred workers of both genders have been selected from two different industries in 6th October city

The results showed that overweight and obese, wearing heavy-duty footwear, 8-9 hrs./day of wearing protective footwear, not participating in physical activity, frequent bending, twisting, and sudden movements were the significant predictors for LBP ($p < 0.01$).

Our findings show that overweight and obesity are risk factors for LBP in men and women. This came in agreement with the study conducted by **Zhang et al. (2018**) which stated that being overweight and obese was accompanied with high prevalence of LBP in both genders.

Based on a cross-sectional study conducted by **Rafeemanesh et al. (2017)** on steel industry workers in Iran there was a significant association among LBP, BMI as well as leisure time physical activity ($p \leq 0.05$), which agrees with our study. on the contrary, they did not discover any association among LBP as well as a person's current work, indicating that overall health-related factors, including weight, age, as well as level of physical activity, are more essential than occupational variables in developing LBP.

There is another difference in the results of the two studies, the findings of the previous study revealed that there was a significant association among LBP as well as the duration of employment, which go against our findings. Among these difference **Rafeemanesh et al. (2017)** conducted their study on workers aged from 21 to 60 years old , while the present study was conducted on workers with maximum age of 39 years old to avoid the effect of aging process over the lumbar spine.

Our results showed no statistically significant correlation among sex and LBP. Though being female was found to increase the risk of experiencing LBP in several studies conducted prior to 1990, Riihimäki's (1995) review did not include report gender as a predisposing factor. More additional studies have also shown conflicting findings. In a cross-sectional study by **Aasa et al. (2005)** on a random sample of 1500 ambulance personnel, gender didn't appear to be associated with LBP, which agree with our results.

Also, **Shabrina et al. (2018)** examined the effect of shoes on lower back pain based on the Surface-Electromyography method, they tested two types of shoes, Safety Shoes and Slip-On Shoes. The activation of the medial Gastrocnemius muscle was found to be affected by both shoe type and time considerations. They found that the muscles were activated differently between the two pairs of shoes, with the safety shoes showing higher activation. This increased activity in the lower limbs is likely compensating for the reduced flexibility of the safety shoes, agreeing with our results.

In agreement of the current study, the impact of various safety shoes on gait as well as plantar pressure distributions over industrial flooring were investigated by Ochsmann et al. (2016). The results showed that wearing one pair of safety shoes vs another can affect how your feet and legs move and how your body responds to pressure. Safety shoes incorporating cushioning elements and ergonomically built outsoles reduced plantar pressure loadings as well as increased plantar inclination angles and hip flexion angles, respectively, compared to plain safety shoes. Workers' health can be protected, especially the musculoskeletal system, from potential risks of standing and walking for long periods of time on hard surfaces, as was suggested, along with the recommendation that wearing safety shoes could be one solution, which also agree with our findings.

In our study, there was a significant rise in the percentage of LBP in individuals wear protective footwear 8-9 h/day compared with subjects wear protective footwear 2-7 h/day, which agreed with the study that was conducted by **Lee et al. (2016)** that examined the impact of different types of underground coal mining safety boots upon plantar pressures while they walked through a replicated underground coal mine surface (gumboot vs. leather lace-up boot). They declared that, there is an increased risk of musculoskeletal pain and overuse problems including stress fractures when wearing safety boots for extended periods of time.

The percentage of participants reporting LBP was found to be significantly higher in the 12-hour group compared to the 8-hour group. In line with the findings of Dembe et al.'s (2005) study on the effect of excessive working time on the incidence of work-related injuries and illnesses among American workers. They discovered that shifts that included overtime presented a 61% greater risk of injury than regular periods. An increase in risk of 37% was seen in those who worked at least 12 hours a day, while a 23% increase in risk was seen in those who worked a minimum of sixty hours a week.

According to our study awkward postures, sudden movement, lifting, bending or twisting are risk factors for LBP. Consistent with the findings of a study by Lis et al. (2007), this finding suggests that prolonged sitting at work—especially when combined with poor posture can lead to low back pain.

## CONCLUSION

Based on the results of this study, weight status, type of protective shoes, hours of wearing protective footwear, standing hours, participation in physical exercise, and frequent bending, twisting, and sudden movements had a significant correlation with LBP; whereas age, sex, working hours, as well as working years had no significant correlation with LBP.

**Conflict of interest:** There is no conflict of interest.

**REFERENCES**

1 **Aasa, U., Barnekow-Bergkvist, M., Ängquist, K. A., & Brulin, C. (2005).** Relationships between work-related factors and disorders in the neck-shoulder and low-back region among female and male ambulance personnel. *Journal of occupational health*, *47*(6), 481-489.

2 **Andini, F. (2015).** Risk factors of low back pain in workers. *Jurnal Majority*, *4*(1).

3 **Baloh, J., Reisinger, H. S., Dukes, K., da Silva, J. P., Salehi, H. P., Ward, M., ... & Herwaldt, L. (2019).** Healthcare workers' strategies for doffing personal protective equipment. *Clinical infectious diseases*, *69*(Supplement_3), S192-S198.

4 **Beyera, G. K., O'Brien, J., & Campbell, S. (2019)**. Health-care utilisation for low back pain: a systematic review and meta-analysis of population-based observational studies. Rheumatology international, 39(10), 1663-1679.

5 **Dembe, A. E., Erickson, J. B., Delbos, R. G., & Banks, S. M. (2005).** The impact of overtime and long work hours on occupational injuries and illnesses: new evidence from the United States. *Occupational and environmental medicine*, *62*(9), 588-597.

6 **Dobson, J. A., Riddiford-Harland, D. L., Bell, A. F., & Steele, J. R. (2017)**. Work boot design affects the way workers walk: A systematic review of the literature. Applied ergonomics, 61, 53-68.

7 **Fatoye, F., Gebrye, T., & Odeyemi, I. (2019).** Real-world incidence and prevalence of low back pain using routinely collected data. Rheumatology International, 39, 619-626.

8 **Phillips, C. J. (2006).** Economic burden of chronic pain. *Expert review of pharmacoeconomics & outcomes research*, *6*(5), 591-601.

9 **Goto, K., & Abe, K. (2017).** Gait characteristics in women's safety shoes. Applied ergonomics, 65, 163-167.

10 **Heidari, J., Mierswa, T., Kleinert, J., Ott, I., Levenig, C., Hasenbring, M., & Kellmann, M. (2016)**. Parameters of low back pain chronicity among athletes: associations with physical and mental stress. Physical Therapy in Sport, 21, 31-37.

11 **Hong, C. C., Nashi, N., Kuan, W. S., Teh, J. W. D., & Tan, K. J. (2015)**. Forklift-related crush injuries of the foot and ankle. Foot & ankle international, 36(7), 806-811.

12 **Jaffar, N. A. T., & Rahman, M. N. A. (2017, August).** Review on risk factors related to lower back disorders at workplace. In IOP Conference Series: Materials Science and Engineering (Vol. 226, No. 1, p. 012035). IOP Publishing.

13 **Kaynak, R., Toklu, A. T., Elci, M., & Toklu, I. T. (2016)**. Effects of occupational health and safety practices on organizational commitment, work alienation, and job performance: Using the PLS-SEM approach. International Journal of Business and Management, 11(5), 146-166.

14 **Lee, K. S., Oh, Y. S., Oh, S. L., Chae, H. S., & Kim, K. R. (2016).** A Design for Summer Safety Shoes for Agricultural Work Using a Survey. *대한인간공학회지*, *35*(1), 1-10.

15 **Lis, A. M., Black, K. M., Korn, H., & Nordin, M. (2007).** Association between sitting and occupational LBP. *European spine journal*, *16*(2), 283-298.

16 **Nastasia, I., Coutu, M. F., & Tcaciuc, R. (2014).** Topics and trends in research on non-clinical interventions aimed at preventing prolonged work disability in workers compensated for work-related musculoskeletal disorders (WRMSDs): a systematic, comprehensive literature review. *Disability and Rehabilitation*, *36*(22), 1841-1856.

17 **Peixinho, N., COSTA, S., & MENDONÇA, J. (2018)**. Impact behavior of safety shoe high strength steel parts. Engineering Transactions, 66(2), 175-185.

18 **Rafeemanesh, E., Kashani, F. O., Parvaneh, R., & Ahmadi, F. (2017).** A survey on low back pain risk factors in steel industry workers in 2015. Asian Spine Journal, 11(1), 44

19 **Riihimäki, H. (1995).** Hands up or back to work—Mure challenges in epidemiologie research on musculoskeletal diseases. *Scandinavian journal of work, environment & health*, 401-403.

20 **Schaafsma, F. G., Anema, J. R., & van der Beek, A. J. (2015)**. Back pain: prevention and management in the workplace. Best Practice & Research Clinical Rheumatology, 29(3), 483-494.

21 **Shabrina, G., Iqbal, B. M., & Syaifullah, D. H. (2018, October).** Effect of shoes on lower extremity pain and low back pain during prolonged standing on a sloping medium. In 2018 International Conference on Intelligent Informatics and Biomedical Sciences (ICIIBMS) (Vol. 3, pp. 181-187). IEEE.

22 **Shiri, R., Falah-Hassani, K., Heliövaara, M., Solovieva, S., Amiri, S., Lallukka, T., ... & Viikari-Juntura, E. (2019).** Risk factors for low back pain: a Population-Based longitudinal study. *Arthritis care & research*, *71*(2), 290-299.

23 **Zhang, T. T., Liu, Z., Liu, Y. L., Zhao, J. J., Liu, D. W., & Tian, Q. B. (2018).** Obesity as a risk factor for low Back pain. Clinical spine,surgery 31(1),) 22-27.