Asian Journal of Epidemiology

ISSN 1992-1462

science alert
http://www.scialert.net

ANSInet
an open access publisher
http://ansinet.com

OPEN ACCESS Asian Journal of Epidemiology

ISSN 1992-1462
DOI: 10.3923/aje.2019.45.52

Research Article
Correlation Power of Related Factors Affected Musculoskeletal Disorders Complaints Amongst Rice Mill Unit Operators

[1]Iwan Muhamad Ramdan, [2]Agus Wiranto and [3]Krishna Purnawan Candra

[1,2]Department of Occupational Health and Safety, Faculty of Public Health, Mulawarman University, Jl. Sambaliung, Kampus Gunung Kelua, Samarinda, Indonesia
[3]Department of Agricultural Product Technology, Faculty of Agriculture, Mulawarman University, Jl. Pasir Belengkong, Kampus Gunung Kelua, Samarinda, Indonesia

Abstract

Background and Objective: Musculoskeletal disorders (MSDs) is an occupational health problem that still needs to be analyzed in order to find out the prevention. The agroindustry workers are one group of workers at risk of experiencing MSDs. The aims of this study was to investigate the MSDs prevalence in rice mill operators and their related factors. **Materials and Methods:** A cross-sectional study has been conducted on 35 rice mill operators from 16 rice mill units in Penajam District of Indonesia. The MSDs severity was plotted by Nordic Body Map, while physical workload, work posture, risk of manual handling, holding and carrying as wells as health status of the rice mill operators were measured by the percentage of cardiovascular load, Ovako working posture assessment system, key indicator method for lifting and body mass index, respectively. Product moment Pearson and Rank Spearman were applied to identify the correlation between MSDs prevalence and parameters observed. **Results:** The MSDs prevalence was found on all of the rice mill operators, which categorized as low, moderate and high level of 17.1, 62.9 and 20.0%, respectively. It correlated significantly with workload ($p = 0.009$, $r = 0.287$), age ($p = 0.026$, $r = 0.377$), working period ($p = 0.017$, $r = 0.401$), working hours ($p = 0.008$, $r = 0.441$), work posture ($p = 0.000$, $r = 0.671$) and manual handling risk ($p = 0.000$, $r = 0.689$). **Conclusion:** The first four variables show low association (minor factors) with MSDs prevalence, while the latter two variables (work posture and manual handling risk) show strong association (major factors).

Key words: Rice mill operators, agroindustry workers, working period, working hours, body mass index, workload, work posture, manual handling risk

Citation: Iwan Muhamad Ramdan, Agus Wiranto and Krishna Purnawan Candra, 2019. Correlation power of related factors affected musculoskeletal disorders complaints amongst rice mill unit operators. Asian J. Epidemiol., 12: 45-52.

Corresponding Author: Iwan Muhamad Ramdan, Department of Occupational Health and Safety, Faculty of Public Health, Mulawarman University, Jl. Sambaliung, Kampus Gunung Kelua, Samarinda, Indonesia Tel: +625417031343

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Musculoskeletal disorders (MSDs) is a leading cause of occupational injury and disability[1] and has caused considerable economic losses due to medical costs[2] and the impact of decreasing work productivity[3,4]. In Indonesia, 16% of workers (study on 9,482 workers in 12 cities in 2014) experienced MSDs, which is the highest rate of occupational illnesses[5]. However, the data do not describe a specific type of work on MSDs prevalence caused by. Workplace risk, e.g., heavy physical work, forceful overexertion, awkward and sustained postures, repetitive movement and vibration are reported to be as one of the factors responsible for MSDs prevalence[6]. Other factors like unsuitable body size to equipment and working position[7], high frequency of repetitive motion[8], high workload[9], vibration exposure[10] and working overtime[11] are also responsible for MSDs prevalence.

Working characteristics in the agroindustry sector, in which various equipment and machinery are being used, exposure to chemical and biological agents, awkward/non-ergonomic work positions, lifting heavy loads manually and doing repetitive-work have placed the agroindustry workers in high-risk workers having MSDs, especially when there is a lack between work-type and facilities[12,13]. In the case of Indonesia as shared in other developing countries, the agroindustry sector shares an enormous number of workers, while they still use low technology and employ a large number of low-skilled workers[14]. This condition becomes exciting to be studied to formulate the solution to overcome the MSDs prevalence among the agroindustry workers.

Rice (*Oryza sativa*) is a critical commodity in Indonesia, considering that it is the leading staple food in Indonesia so that the sustainability of its products have to be maintained[15,16]. Rice processing (the process that helps in the removal of hulls and bran from paddy grains to produce polished rice) has long been known in Indonesia. According to Patiwiri[17], rice processing in Indonesia has not been as advanced as other rice-producing countries such as Thailand, Japan, China and Vietnam. At present rice processing in Indonesia still uses simple technology where most still rely on human power, mainly to lift and transport the rice to the milling unit, this condition may cause the rice mill operator at risk of MSDs.

Several studies on various types of work have proven the strength of the correlation between demographic and work environment factors with the incidents of MSD. Study on MSD prevalence on dental surgeon by Shaik *et al.*[18] showed that the most influential variables on MSDs prevalence were physical energy demands (r = 0.212), manual material handling (r = 0.091) and instruments. In emergency workers, the most influential variables on MSDs prevalence were the work demand factor (r = 0.288), working hours (r = 0.150) and work stress (r = 0.180)[19]. In IT professionals, it was found that the most influencing variables on MSDs prevalence were namely work posture (r = 0.62), working time/day (r = 0.46) and micro-breaks (r = 0.87)[20]. In electronic components manufacturing company, the most influential variables on MSDs prevalence were years of experience (r = 0.556) and age of workers (r = 0.500)[21].

The study on MSDs among the agroindustrial workers, especially the rice mill operators, had been reported by Darbastwar *et al.*[22]. However they did not explain the correlation between MSDs with demographic and work-risk factor as already reported for other industrial sectors. To enrich the previous studies, here an investigation on the level of MSDs prevalence and analysis of its correlation power with demographic characteristic and work-risk factor among rice mill operators are presented.

MATERIALS AND METHODS

Sampling and study design: A cross sectional study was conducted on all of rice mill operators (35 operators) at 16 rice mill units (RMU) (2-3 respondents per RMU) in Penajam district of Indonesia from January-March, 2019. The census sampling was applied in this research. Demographic characteristics and work-risk factors of the rice mill operators as well as the MSDs prevalence were collected by questionnaire. The association between the demographic and work-risk factor data with the MSDs prevalence were analyzed.

Location: Penajam is the most important rice production centre in East Kalimantan province, Indonesia. In the last 5 years, the district produced rice at an average of about 4,5 t/year[23]. The district located in the south part of east Kalimantan Province, Indonesia. Geographically, the area of Penajam located between 0°48′29″-1°36′37″ south latitude and 116°19′30″-116°56′35″ east longitude. In the north, it borders with district of Kutai Kartanegara Regency, in the east with Balikpapan City and Makassar Strait, in the west with district of Kutai Barat and district of Paser. The land area of Penajam is 3,060.82 km^2 of a total area of 3,333,065 km^2.

The MSDs prevalence of the rice mill operators was measured by standardised nordic body map questionnaire[24]. Questions included in the questionnaire were nine different body anatomy, e.g., neck, shoulder, elbow, arm wrist/arm, upper back, lower back, hips/thighs, knees and leg wrist/leg.

Three questions provided were: (1) Do you have any MSDs complain (illness, painful, inconvenience, insensitive) in the last of 12 months?, (2) Do you have any difficulties in making daily activity (inside and outside home) in the last of 12 months? and (3) Do you have any MSDs on your body in the last of 7 days?.

Parameters and measurements: Demographic characteristics (age, education, working period as well as working, exercise and smoking habits) were measured using a questionnaire except for the health status of the rice mill operator, which is measured using the body mass index (BMI). The BMI consisted of 7 categories[25], i.e., underweight, normal, overweight, obese I, obese II and obese III for <18.5, 18.5-24.9, ≥25, 25-29.9, 30-34.9 and ≥40 kg m^{-2}, respectively.

The work-risk factors observed were physical workload, work posture and manual handling. The physical workload was measured by the percentage of cardiovascular load (CVL)[26,27], the measurement results are categorized into 5 levels, i.e. light workload if CVL <30% (no improvement effort is needed), moderate workload if CVL is between 30-<60% (repairs are needed), rather heavy workload if CVL is between 60-<80% (work in a short time), heavy workload if CVL is between 80-<100% (immediate corrective action is needed) and very heavy workload if CVL is ≥100% (not allowed to move).

The work posture of the rice mill operators musculoskeletal system was determined by Ovako working posture assessment system (OWAS)[28]. The OWAS defines the movement of the body parts of the back, arms, legs and weight of the lifting. The risk of manual handling was measured using the key indicator method for lifting, holding and carrying (KIM LHC)[29]. The KIM LHC assesses manual handling risk based on 4 parameters during work (time indicator, mass indicator, body posture indicator and working condition indicator). Calculation of final score produces manual handling risk categories <10 (low risk), 10-<25 (medium risk), 25-<50 (high risk) and >50 (extreme risk).

Statistical analysis: Product moment Pearson and Rank Spearman were applied to see the correlation between MSDs and parameters observed (age distribution, education background, body mass index, working period, working hours, exercise and smoking habits, workload, work posture and manual handling risk). The power of correlation was formulated as recommended by Taylor[30], i.e., correlation coefficients (r-values) of ≤0.35, 0.36-0.67 and 0.68-1.00 are considered to represent weak, moderate and strong/high correlation, respectively.

RESULTS

Characteristics of rice mill unit: The rice mill units observed in this research are permanent buildings made of cement with adequate ventilation and natural lighting conditions. Each rice mill has one engine (diesel engine), one rice husk breaking machine and one rice bleaching machine. At each rice mill there is 1-2 workers with various working time. The rice milling operators had to manually lift the sack of rice with a weight of 50 kg or more, i.e., lifting the grain-filled sacks from cars to weighing stations, lifting the grain-filled sacks to dehulled machines and bleaching machines and pack the rice into a sack and lifting it to the warehouse.

Demographic characteristics of rice mill operators: The characteristics of the rice mill operators was shown in Table 1. The characteristic of rice mill operators were dominated by ≥35 years old workers (71.4%) (min, max and mean are 20, 60 and 43.06 years, respectively), graduated from senior high school (45.7%), normal body mass index (71.4%), did not used to sports/exercise (80.0%), active smokers (57.1%), having working period of more than 7 years (57.1%), having working hours of 3-5 h per day (51.4%) and moderate workload (85.7%), medium risk work posture (62.9%) and medium risk of manual handling (65.7%).

Musculoskeletal disorder (MSDs) prevalence among rice mill operators: All of the rice mill operators experience musculoskeletal disorders. They complain about a moderate level of MSDs (62.9%). Complain of much pain (4 from the score of 1-4) on musculoskeletal were mostly found for waist, bottom, back and left shoulder. Complain of pain (score 3) on musculoskeletal were mostly found for the bottom, waist, back and upper right hand. Complain of moderate pain on musculoskeletal (score 2) was found for bottom upper left thigh, left knee and right thigh. It indicates that the musculoskeletal disorders experienced by rice milling operators are severe and need to be addressed immediately.

Table 2 shows the distribution of MSDs prevalence level for each body section. Low level of MSDs prevalence were

Table 1: Association between MSDs prevalence with characteristics of rice mill operator (n = 35) and risk factors

Variables	Number	Percentage	Correlation	
			r-values	p-value
Demographic characteristic of rice mill operator				
Age (years)				
<35	10	28.6	0.377*	0.026*
≥35	25	71.4		
Education background				
Elementary school (graduated 6th class)	9	25.7	0.175**	0.315**
Secondary high school (graduated 9th class)	10	28.6		
Senior high school (graduated 12th class)	16	45.7		
Body mass index				
Thin	1	2.9	0.076*	0.665*
Normal	25	71.4		
Fat	2	5.7		
Obesity	7	20.0		
Exercise habits				
Yes	7	20.0	0.140**	0.432**
No	28	80.0		
Smoking habits				
Yes	20	57.1	0.101**	0.564**
No	15	42.9		
Working period				
<7	15	42.9	0.401*	0.017*
≥7	20	57.1		
Working hours				
1-3	12	34.3	0.441*	0.008*
>3-5	18	51.4		
>5-8	5	14.3		
Work-risk factors				
Workload				
Light	5	14.3	0.287*	0.009*
Moderate	30	85.7		
Weight	0	0.0		
Very heavy	0	0.0		
Work posture				
Normal	0	0.0	0.676*	0.000*
Low risk	13	37.1		
Medium risk	22	62.9		
High risk	0	0.0		
Manual handling risk				
Low risk (<10)	0	0.0	0.689*	0.000*
Medium risk (10 -<25)	23	65.7		
High risk (25 -<50)	12	34.3		
Extreme risk (>50)	0	0.0		
MSDs category				
No	0	0.0		
Low	6	17.1		
Moderate	22	62.9		
High	7	20.0		

*Product Moment Pearson, **Rank Spearman, data were normally distributed (Shapiro Wilk test, p = 0.870)

reported for buttock, left hand wrist, right hand wrist, right leg wrist, left leg wrist, arm, elbow and right knee of 94.3, 77.1, 74.3, 71.4, 65.7, 60, 42.3 and 14.3%, respectively. Moderate level of MSDs prevalence were reported for upper neck, left thigh, left knee, right thigh, right knee, lower right hand, lower left hand, lower neck, elbow and left-right upper hand for 82.9, 77.1, 77.1, 74.3, 74.3, 68.6, 65.7, 62.9, 48.6%, respectively. High level of MSDs prevalence was reported for bottom, waist, back, upper right hand, upper left hand, right shoulder, left shoulder, leg, calf and lower left hand of 74.3, 71.4, 68.6, 48.6, 45.7, 42.9, 40, calf and 25.7%, respectively. Very high level of MSDs prevalence was reported for waist, bottom, back and shoulder for 25.7, 22.9, 11.4 and 8.6%, respectively.

Factors-related to MSDs prevalence among rice mill operators: Age, working period, working hours, workload,

Table 2: Distribution of musculoskeletal disorders (MSDs) types prevalence level of rice mill operator in Penajam Paser Utara District of Indonesia (N = 34)

	Low		Moderate		High		Very high	
Body sections	n	%	n	%	n	%	n	%
Neck								
Upper	2	5.7	29	82.9	4	11.4	0	0.0
Lower	1	2.9	22	62.9	12	34.3	0	0.0
Shoulder								
Left	0	0.0	17	48.6	15	42.9	3	8.6
Right	0	0.0	16	45.7	16	45.7	3	8.6
Hand								
Upper left	1	2.9	17	48.6	17	48.6	0	0.0
Upper right	1	2.9	17	48.6	17	48.6	0	0.0
Lower left	3	8.6	23	65.7	9	25.7	0	0.0
Lower right	3	8.6	24	68.6	8	22.95	0	0.0
Elbow								
Left	15	42.3	19	54.3	1	2.9	0	0.0
Right	15	42.3	19	54.3	1	2.9	0	0.0
Hand wrist								
Left	27	77.1	7	20.0	1	2.9	0	0.0
Right	26	74.3	8	22.9	1	2.9	0	0.0
Arm								
Right	21	60.0	13	37.1	1	2.9	0	0.0
Left	21	60.0	14	40.0	1	2.9	0	0.0
Back	0	0.0	7	20.0	24	68.6	4	11.4
Waist	0	0.0	1	2.9	25	71.4	9	25.7
Buttock	33	94.3	2	5.7	0	0.0	0	0.0
Bottom	0	0.0	1	2.9	26	74.3	8	22.9
Leg								
Left	0	0.0	21	60.0	14	40.0	0	0.0
Right	0	0.0	21	60.0	14	40.0	0	0.0
Thigh								
Left	1	2.9	27	77.1	7	20.0	0	0.0
Right	1	2.9	26	74.3	8	22.9	0	0.0
Knee								
Left	3	8.65	27	77.1	7	20.0	0	0.0
Right	5	14.3	25	74.3	8	22.9	0	0.0
Calf								
Left	0	0.0	21	60.0	14	40.0	0	0.0
Right	0	0.0	21	60.0	14	40.0	0	0.0
Leg wrist								
Left	23	65.7	12	34.3	0	0.0	0	0.0
Right	25	71.4	10	28.6	0	0.0	0	0.0

N: Number of respondents, n: Number of respondents with for specific MSDs type

work posture and manual handling risk were related-factors, those are significantly associated with MSDs prevalence among the rice mill operators. Meanwhile, education background, body mass index, exercise habits and smoking habits were related factors and those are not significantly associated with MSDs prevalence among the rice mill operators (Table 1).

DISCUSSION

Similar MSDs incidents were reported in agroindustry sector in India (Karimnagar[22], Kanpur[31], Tumkur[32]), Thailand[33] and South Kalimantan province of Indonesia[34].

Based on the power of correlation suggested by Taylor[30] (*pustaka*), the related-factors associated with the MSDs prevalence can be categorised into two levels, i.e., minor related-factors, which show moderate correlation (r = 0.36-0.67) and major related-factors, which show a strong/high correlation (r = 0.68-1.00). Age, working period, working hours and workload are categorised into minor related-factors to MSDs prevalence among the rice mill operators, while work posture and manual handling risk are categorised into major related-factors.

Minor factors-related to MSDs prevalence: In this research, the age of the rice mill operators was significantly associated

with the MSDs prevalence as also reported for agroindustry sector in Korea[35], Rajasthan (India)[36] and in various places[37]. It is critical information that should be of concern to stakeholders in the occupational health sector. By approaching the proper retirement time, workers would be free from the risk of various occupational illnesses so that they can enjoy their full-time welfare.

The working period of the rice mill operators was associated with the MSDs prevalence. The working experience affected the MSDs prevalence ($p = 0.017$) significantly. The more working experience gave lower MSDs prevalence. This fact is similar to other MSD studies in the agricultural workers in India[36,38], South Africa[39], Indonesia[34] and Thailand[40,41].

The working hours were significantly associated with MSDs prevalence ($p = 0.008$). The higher working hours caused more prevalences of MSDs. The results of this study show the same thing as the research of Keawduangdee *et al.*[40], which proves work time (in units of working days) is significantly associated with MSD in rice farmers in Thailand.

The workload was categorised as moderate workload and statistically showed a significant correlation with MSDs ($p = 0.009$). The workload included the lifting and transporting rice from a car carrier, moving the paddy to the crusher grain, transfer the rice to a machine bleach and move the rice to the car carrier, the burden to be lifted more than 50 kg. This study shows a similar result on a study of MSDs in rice mill operators in West Godavari District of India[42], which showed that most rice mill workers have a moderate workload (76.9%). The MSDs complaints most commonly found in low body parts back, knee, leg, chest and shoulder. More working experience gave a lower MSDs prevalence. Similar results were reported by Ojha and Kwatra[43], which showed that the workload of rice transplanting workers is associated with MSDs incidents.

Based on these findings, the effort on reducing the risk of MSDs in rice mill operators could be applied by running proper administrative control and ergonomic intervention. According to Luttmann *et al.*[44], several solutions that can be done to reduce the risk of MSD occurrences related to age, working period, working hours and workload are reducing the workload by reducing the mass of object or number of handling per day and reducing the repetition frequency of repeated change between activation and relaxation of muscles.

Major factors-related to MSDs prevalence among the rice mill operators: Work posture of the rice mill operators was very significantly associated with the MSDs ($p = 0.000$). The most rice mill operators (62.9%) classified in medium risk and the rest was classified as low risk. This results reinforce scientific evidence from previous agricultural sector research which concludes work posture is a risk factor for the prevalence of MSDs as reported in agricultural industry[13,12] and rice mill workers[45].

Manual handling work among the rice mill operators was very significantly associated with MSDs prevalence ($p = 0.000$). It was categorised in the medium risk (65.7%) and high-risk categories (34.4%). These results complement the previous report of rice mill operators in Indonesia, which showed that manual handling was associated with MSDs so that ergonomic engineering was needed[46].

These results showed that manual handling task in rice mill operators in this study needs priority to be solved. NIOSH/CDC[47] provides several suggestions, including reducing reach and bending, reduce stress in the back and shoulder, reduce the effort and force needed to perform work tasks and improve the grip of tools. Besides, Luttmann *et al.*[44] suggested to avoid or reduce the manual handling of heavy objects, reducing the number of handling per day, reducing repetition frequency, working with upright trunk and the arms close to the body.

CONCLUSION

Some demographic characteristics (education background, exercise habits, smoking habits and body mass index) of the rice milling operators are not significantly associated with the MSDs. However, there are 2 types (minor and major) of related-factor to MSDs among the rice mill operators detected. The minor related-factors are age ($p = 0.026$, $r = 0.377$), working period ($p = 0.017$, $r = 0.401$), working hours ($p = 0.008$, $r = 0.441$) and workload ($p = 0.009$, $r = 0.287$). Meanwhile the major related factors are work posture ($p = 0.00$, $r = 0.676$) and manual handling-risk ($p = 0.00$, $r = 0.689$). It is recommended to improve the workstation environment to be more ergonomic and using proper tools to minimise the muscle work-load.

SIGNIFICANCE STATEMENT

This study discovered the main risk-factor related to MSDs among the rice mill operators that can be beneficial for the prevention of MSDs prevalence of agricultural sector, especially for "off-farm" activities. This study will help the researchers to uncover the critical areas of reducing the MSDs among the agro-industrial sector, mainly in "off-farm" activities that many researchers were not able to explore yet. Thus a new theory on health and safety in the agro-industrial sector may have arrived more precisely.

ACKNOWLEDGMENT

The authors are grateful to all rice mill operators who participated in this research.

REFERENCES

1. Bevan, S., 2015. Economic impact of musculoskeletal disorders (MSDs) on work in Europe. Best Pract. Res. Clin. Rheumatol., 29: 356-373.
2. Yasobant, S. and P. Rajkumar, 2014. Work-related musculoskeletal disorders among health care professionals: A cross-sectional assessment of risk factors in a tertiary hospital, India. Indian J. Occup. Environ. Med., 18: 75-81.
3. Daneshmandi, H., A.R. Choobineh, H. Ghaem, M. Alhamd and A. Fakherpour, 2017. The effect of musculoskeletal problems on fatigue and productivity of office personnel: A cross-sectional study. J. Prevent. Med. Hygiene, 58: E252-E258.
4. Choobineh, A., S.H. Tabatabaee and M. Behzadi, 2009. Musculoskeletal problems among workers of an iranian sugar-producing factory. Int. J. Occup. Safety Ergonomics, 15: 419-424.
5. Indonesian Health Profile, 2015. Profil Kesehatan Indonesia 2015. Indonesian Minister of Health, Republic of Indonesia.
6. Putz-Anderson, V., B.P. Bernard, S.E. Burt, L.L. Cole and C. Fairfield-Estill *et al*., 1997. Musculoskeletal disorders and workplace factors. DHHS (NIOSH) Publication No. 97-141, July 1997, U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, Cincinnati, OH., USA.
7. Haile, E.L., B. Taye and F. Hussen, 2012. Ergonomic workstations and work-related musculoskeletal disorders in the clinical laboratory. Lab. Med., 43: e11-e19.
8. Rahman, M.N.A., N.F. Awalludin, I. Masood and M.F. Hassan, 2017. Ergonomic risk factors associated with muscuslokeletal disorders in computer workstation. Int. J. Applied Eng. Res., 12: 1355-1359.
9. Bazazan, A., I. Dianat, S. Bahrampour, A. Talebian, H. Zandi, A. Sharafkhaneh and A. Maleki-Ghahfarokhi, 2019. Association of musculoskeletal disorders and workload with work schedule and job satisfaction among emergency nurses. Int. Emerg. Nurs., 44: 8-13.
10. Charles, L.E., C.C. Ma, C.M. Burchfiel and R.G. Dong, 2018. Vibration and ergonomic exposures associated with musculoskeletal disorders of the shoulder and neck. Safety Health Work, 9: 125-132.
11. Lee, J.G., G.H. Kim, S.W. Jung, S.W. Kim, J.H. Lee and K.J. Lee, 2018. The association between long working hours and work-related musculoskeletal symptoms of Korean wage workers: Data from the fourth Korean working conditions survey (a cross-sectional study). Ann. Occup. Environ. Med., Vol. 30. 10.1186/s40557-018-0278-0.
12. Chapman, L. and J. Meyers, 2001. Ergonomics and musculoskeletal injuries in agriculture: Recognizing and preventing the industry's most widespread health and safety problem. Proceedings of the Agricultural Safety and Health Conference, March 2001, USA., pp: 2-3.
13. Sukadarin, E.H., B.M. Deros, J.A. Ghani and A.R. Ismail, 2014. A review of work related musculoskeletal problems in agricultural industry. Aust. J. Basic Applied Sci., 8: 56-59.
14. ILO., 2018. Improving the safety and health of young workers. (Meningkatkan keselamatan dan kesehatan pekerja muda). International Labour Organization, Indonesia.
15. Mariyono, J., 2014. The economic performance of Indonesian rice-based Agribusiness. Int. J. Admin. Sci. Organ., 21: 35-43.
16. Ishaq, M., A.T. Rumiati and O. Permatasari, 2017. Analisis faktor-faktor yang mempengaruhi produksi padi di provinsi jawa timur menggunakan regresi semiparametrik spline. (Analysis of factors affecting rice production in East Java province using semiparametric spline regression). J. Sains Seni ITS., 6: 101-107, (In Indonesian).
17. Patiwiri, A.W., 2004. Kondisi dan permasalahan perusahaan pengolahan padi di Indonesia. (Conditions and problems of padi processing companies in Indonesia). Prosiding Lokakarya Nasional Upaya Peningkatan Nilai Tambah Pengolahan Padi, July 20-21, 2004, Jkarta, pp: 22-41.
18. Shaik, A.R., S. Rao and A. Husain, 2016. Correlation between ergonomic risk factors and work-related musculoskeletal disorders in dental surgeons. Int. J. Healt Sci. Res., 6: 114-120.
19. Kodom-Wiredu, J.K., 2019. Work demand, stress and work-related musculoskeletal disorders among emergency workers. Int. J. Workplace Health Manage., 12: 85-98.
20. Sharan, D. and P.S. Ajeesh, 2012. Effect of ergonomic and workstyle risk factors on work related musculoskeletal disorders among IT professionals in India. Work, 4: 2872-2875.
21. Yahya, N.M. and M.N.O. Zahid, 2018. Work-related musculoskeletal disorders (WMDs) risk assessment at core assembly production of electronic components manufacturing company. IOP Confer. Ser.: Mater. Sci. Eng., Vol. 319. 10.1088/1757-899X/319/1/012036.
22. Darbastwar, M.A., B. Kumar and A. Ravinder, 2016. A study of prevalence of musculoskeletal disorder among the rice mill workers in Karimnagar. J. Evol. Med. Dental Sci.-Jemds, 5: 1106-1110.
23. Widarie, S., 2019. Ketersediaan beras Penajam tidak terganggu musim kemarau (The availability of rice is not disturbed by the dry season in Penajam). Kaltim, Antara News, No. 1.
24. Kuorinka, I., B. Jonsson, A. Kilbom, H. Vinterberg, F. Biering-Sorensen, G. Andersson and K. Jorgensen, 1987. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Applied Ergon., 18: 233-237.
25. Nuttall, F.Q., 2015. Body mass index. Obesity, BMI and health: A critical review. Nutr. Today, 50: 117-128.

26. Lunde, L.K., M. Koch, K. Veiersted, G.H. Moen, M. Waested and S. Knardahl, 2016. Heavy physical work: Cardiovascular load in male construction workers. Int. J. Environ. Res. Public Health, Vol. 13. 10.3390/ijerph13040356
27. Yoopat, P., P. Toicharoen, T. Glinsukon, K. Vanwonterghem and V. Louhevaara, 2002. Ergonomics in practice: Physical workload and heat stress in Thailand. Int. J. Occup. Safety Ergon., 8: 83-93.
28. Gomez-Galan, M., J. Perez-Alonso, A.J. Callejon-Ferre and J. Lopez-Martinez, 2017. Musculoskeletal disorders: OWAS review. Industrial Health, 55: 314-337.
29. Steinberg, U., 2012. New tools in Germany: Development and appliance of the first two KIM ("lifting, holding and carrying" and "pulling and pushing") and practical use of these methods. Work, 41: 3990-3996.
30. Taylor, R., 1990. Interpretation of the correlation coefficient: A basic review. J. Diagn. Med. Sonogr., 6: 35-39.
31. Gupta, G. and Tarique, 2013. Prevalence of musculoskeletal disorders in farmers of Kanpur-rural, India. J. Commun. Med. Health Edu., Vol. 3. 10.4172/2161-0711.1000249.
32. Prakash, S., S. Manjunatha and C. Shashikala, 2010. Morbidity patterns among rice mill workers: A cross sectional study. Indian J. Occup. Environ. Med., 14: 91-93.
33. Kaewboonchoo, O., P. Kongtip and S. Woskie, 2015. Occupational health and safety for agricultural workers in Thailand: Gaps and recommendations, with a focus on pesticide use. New Solut.: J. Environ. Occupat. Health Policy, 25: 102-120.
34. Oktaviannoor, H., Z.N. Helmi and R. Setyaningrum, 2015. Correlation between age and period of working with the musculoskeletal disorders complaints on palm farmers in Pt. X. Asian J. Epidemiol., 8: 78-83.
35. Kang, M.Y., M.J. Lee, H. Chung, D.H. Shin and K.W. Youn *et al*., 2016. Musculoskeletal disorders and agricultural risk factors among Korean farmers. J. Agromed., 21: 353-363.
36. Jain, R., M.L. Meena, G.S. Dangayach and A.K. Bhardwaj, 2018. Risk factors for musculoskeletal disorders in manual harvesting farmers of Rajasthan. Indust. Health, 56: 241-248.
37. Osborne, A., C. Blake, B.M. Fullen, D. Meredith, J. Phelan, J. McNamara and C. Cunningham, 2012. Prevalence of musculoskeletal disorders among farmers: A systematic review. Am. J. Ind. Med., 55: 143-158.
38. Das, B. and S. Gangopadhyay, 2015. Prevalence of musculoskeletal disorders and physiological stress among adult, male potato cultivators of West Bengal, India. Asia Pac. J. Public Health, 27: NP1669-NP1682.
39. Naidoo, S., H. Kromhout, L. London, R.N. Naidoo and A. Burdorf, 2009. Musculoskeletal pain in women working in small scale agriculture in South Africa. Am. J. Ind. Med., 52: 202-209.
40. Keawduangdee, P., R. Puntumetakul, M. Swangnetr, W. Laohasiriwong, D. Settheetham, J. Yamauchi and R. Boucaut, 2015. Prevalence of low back pain and associated factors among farmers during the rice transplanting process. J. Phys. Ther. Sci., 27: 2239-2245.
41. Swangnetr, M., D.B. Kaber, R. Puntumetakul and M.T. Gross, 2014. Ergonomics-related risk identification and pain analysis for farmers involved in rice field preparation. Work, 49: 63-71.
42. Pradhan, C.K., S. Thakur and A.R. Chowdhury, 2007. Physiological and subjective assessment of food grain handling workers in West Godavari district, India. Indust. Health, 45: 165-169.
43. Ojha, P. and S. Kwatra, 2012. An ergonomic study on human drudgery and musculoskeletal disorders by rice transplanting. Stud. Home Commun. Sci., 6: 15-20.
44. Luttmann, A., I.M. Jager, B. Griefahn, G. Caffier, F. Liebers and World Health Organization, 2003. Preventing Musculoskeletal Disorders in the Workplace. World Health Organisation, Geneva.
45. Puttewar, A.S. and S.B. Jaiswal, 2014. An empirical study of posture related discomforts in rice mill workers. Int. J. Res. Aeronaut. Mech. Eng., 2: 50-54.
46. Astuti, R.D., S. Susmartini and A.P. Kinanthi, 2017. Improving the work position of worker based on manual material handling in rice mill industry. AIP Confer. Proc., Vol. 1902. 10.1063/1.5010660.
47. CDC., 2007. Ergonomic Guidelines for Manual Material Handling. National Institute for Occupational Safety and Health (NIOSH) Centers for Disease Control and Prevention, USA.