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Risk of Musculoskeletal Disorder in the Working Posture of Online Motorcycle Drivers (Case Study: Drivers at Malang District)

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ABSTRACT

Variations in the dimensions of each type of motorcycle and variations in the anthropometry of the rider's body often cause complaints of discomfort in the body which can eventually lead to musculoskeletal disorders. The purpose of this study is to determine the value of the driver's body point complaints using Nordic body maps, determine the improvement of body posture in terms of the risk level of the driver's musculoskeletal disorders using the integration of rapid upper limb assessment and rapid whole body assessment. The research methodology uses a sample of 30 respondents, with 3 types of motorcycles. Stages of data analysis using Nordic body maps, RULA, REBA and Body Mass Index. The results of the study stated that there were 7 points of complaints of musculoskeletal disorders with the role of repetitive static activities. The working posture condition of the integration of RULA and REBA is stated that there is an improvement in body posture in the dimensions of RULA and REBA with the achievement of the need for the role of changing the dimensions of the motorcycle seat and handlebar as a development to suppress the occurrence of musculoskeletal disorders.

1. INTRODUCTION

Transportation is a tool that has a level of importance in the industrial era 4.0. The existence of transportation gives the role of activities to other places easier and faster. The level of transportation benefits that has become an issue lately is online motorcycle taxi transportation services. Online motorcycle taxi transportation is carried out by drivers between 8 hours to 12 hours per day. Transportation service activities are focused on passenger pick-up. There are vehicles used, namely supra-125, v-ixion and vario-125 at one of the motorcycle taxi bases in Malang Regency, East Java. Vehicles used by drivers definitely have a negative impact, in terms of ergonomics. The negative impact in the spotlight is musculoskeletal disorders.

Arunachalam et al. indicate that the dimensions of the rider and the motorcycle used have a general impact on musculoskeletal disorders [1-3]. The test equipment used is the Taguchi design of experiments. The advantages obtained are more focused on motorcycle products in India. Meanwhile, the complaints of musculoskeletal disorders were compared with previous studies of 10 body joints. This is a research gap to be updated again. Joint complaints in the research that will be carried out use Nordic body maps as a reference to assess 27 points of body complaints. Then focus on determining the value of the upper arm, forearm and wrist, neck, spine and legs using the integration of Rapid Upper Limb Assessment and Rapid Entire Body Assessment. Wargiono et al. [4] have the number of respondents < 10 people. This is a research gap where the prevalence will be carried out to 30 respondents with an assessment of 3 different types of vehicles, namely supra-125, v-ixion and vario-125 [4-6]. Kee et al. stated that reducing musculoskeletal disorders by reviewing how much work risk and level of interest in work comfort are important indications [7-11]. According to Pradana et al. [10] states that the occurrence of body complaints waist by 96%, buttocks by 83%, left knee by 92%, right knee 100 of 24 workers. Based on the findings of the predecessors, the issue of this research is about the work of online motorcycle taxis which often pose a risk of musculoskeletal disorders. The degree of importance of the situation in observation in achieving research findings is very important. The situation that becomes a parameter is the situation of the driver during piggybacking on passengers with a history of working hours of up to 12 hours per day. The risks that arise during this 2 months observation period are complaints on the back due to motorbikes which are most likely not according to their body posture. This complaint should not be allowed to drag on, because it can have a dangerous impact on the driver. In addition, this also needs to be reviewed from the position of the body when driving. Complaints of musculoskeletal disorders can attack areas in 27 points of the body from mild pain to severe pain. Activities carried out by online motorcycle taxi drivers dominate on repeated static loads with an estimated time of 8 hours to 12 hours per day. When the muscles of the body receive repeated static loads, it will cause complaints from the joints, ligaments and tendons. A driver is more dominant sitting while driving with less energy use than when standing. This driving condition, which causes musculoskeletal disorders can occur.

Based on the findings of the predecessors and the issues to be solved, the purpose of this study is to determine the value

of the driver's body point complaints using Nordic body maps, determine the improvement of body posture in terms of the risk level of the driver's musculoskeletal disorders using the integration of rapid upper limb assessment and rapid entire body assessment. The scope of this research is online motorcycle taxi drivers, with the hope that it can provide benefits for motorists to be more concerned about the right way of driving according to ergonomics.

2. MATERIAL AND METHOD

2.1 Research design

This research design uses a case study. Case studies are an effort to investigate by conducting surveys and historical processes to explain cause - effect. The survey was conducted on gojek drivers within the scope of ergonomics topics, namely musculoskeletal disorders [4, 12-15]. The process in this study is to determine the location and time of the study, identify samples using inclusion and the number of respondents used, measure the working posture of riders with 3 types of motorcycles using RULA- REBA sheet and Nordic body maps questionnaire. Then the process is used to answer the research objectives by analyzing data analysis of Nordic body maps, determining the risk value of RULA- REBA sheet to work posture from the number of sampling and designing design recommendations for improving RULA and REBA postures using angular and body part designs based on the process in this study.

2.2 Research place and time

This research was conducted at the Singosari Kendedes Cultural Park, Malang Regency. This research is the object of the gojek driver. The time of the research was carried out from 15 June 2022-15 August 2022.

2.3 Population and research sample

The population of this research is the gojek driver at the Singosari Kendedes Cultural Park, Malang Regency. The research sample consisted of 30 respondents with the following inclusions:

1. Transport types of vehicles supra-125, vario-125 and vixion New.
2. Rider's height ≥ 150 cm.
3. Respondents are in normal condition so that risk assessment can be determined from the results of the Nordic body map, RULA and REBA correctly.

2.4 Data source

Sources of data in this study, including primary data and secondary data. Primary data created by researchers by measuring the driver's work posture and distributing Nordic body map questionnaires. The main secondary data is related to research journals that have the topic of the dangers of musculoskeletal disorders in inappropriate work postures. While supporting secondary data related to books, and relevant data analysis techniques in the field of ergonomics.

2.5 Variable operations

Operationalization of variables as a presentation of information to reach conclusions from research. Variable operationalization is in the following Table 1.

2.6 Data analysis method

This study uses data analysis techniques to obtain research results with the following stages:

1. Nordic body maps assessment analysis [16]
2. RULA score with equation [4-18]:

$$Group_A = \text{upper arm} + \text{forearm} + \text{wrist} + \text{muscle score} + \text{burden} \quad (1)$$

$$Group_B = \text{neck} + \text{spine} + \text{legs} + \text{muscle score} + \text{burden} \quad (2)$$

$$Grand\ RULA = \sum Group \quad (3)$$

3. Penilaian REBA dengan persamaan [6, 7]:

$$Group_A = \text{neck} + \text{spine} + \text{legs} + \text{burden score} \quad (4)$$

$$Group_B = \text{upper arm} + \text{forearm} + \text{wrist} + \text{score clutch} \quad (5)$$

$$Grand\ REBA = \sum Grup + skor\ aktivitas \quad (6)$$

Determination of the value of Nordic body maps, RULA scores and REBA scores and the Asia Pacific reference body mass index [19], declared normal BMI interval 18.5-24.9 and declared overweight interval 23.0-24.9 will be modified according to assessing BMI<22.9 is declared not obese and BMI>23.0 is declared obese in respondents to the occupational risk assessment.

Table 1. Variable operations

Variable	Definition	Dimension	Measurement	Measuring tools	Scale
Musculoskeletal disorders	System for measuring complaints of body pain [17]	27 complaint points on the body [13]	Filling by respondent	Nordic Body Maps	Interval
Work posture	Body movement during work activities [5]	Group A: upper arm, forearm and wrist Group B: neck, spine and legs	observation and Corel DRAW software	RULA sheet	Interval
		Group A: back, neck and legs Group B: upper arm, forearm and wrist	observation and Corel DRAW software	REBA sheet	Interval
Worker risk	The impact of work activities	Work activity risk level	Nordic body map data processing, RULA and RULA	Nordic body map, RULA dan RULA	interval

Source: Data processing, 2022

Table 2. Musculoskeletal disorders assessment recapitulation with Nordic body maps

Codes	Nordic Body Map	No Sick		Sick		Ranking Sick
		n	%	n	%	
0	Upper neck	9	30.0	21	70.0	2
1	Lower neck	4	13.3	26	86.7	1
2	Shoulder left	12	40.0	18	60.0	7
3	Shoulders right	9	30.0	21	70.0	2
4	Left upper arm	14	46.7	16	53.3	10
5	Back	11	36.7	19	63.3	5
6	Upper right arm	27	90.0	3	10.0	24
7	Waist	28	93.3	2	6.7	27
8	Hips	28	93.3	2	6.7	27
9	Butt	10	33.3	20	66.7	4
10	Left elbow	25	83.3	5	16.7	18
11	Right elbow	25	83.3	5	16.7	18
12	Left arm down	24	80.0	6	20.0	16
13	Right arm down	24	80.0	6	20.0	16
14	Left wrist	23	76.7	7	23.3	13
15	Right wrist	13	43.3	17	56.7	9
16	Left hand	26	86.7	4	13.3	20
17	Right hand	12	40.0	18	60.0	7
18	Left thigh	23	76.7	7	23.3	13
19	Right thigh	19	63.3	11	36.7	12
20	Left knee	27	90.0	3	10.0	24
21	Right knee	23	76.7	7	23.3	13
22	Left calf	26	86.7	4	13.3	20
23	Right calf	27	90.0	3	10.0	24
24	Left ankle	11	36.7	19	63.3	5
25	Right ankle	17	56.7	13	43.3	11
26	Left Foot	26	86.7	4	13.3	20
27	Right Foot	26	86.7	4	13.3	20

3. RESULT AND DISCUSSION

3.1 Nordic body maps rating

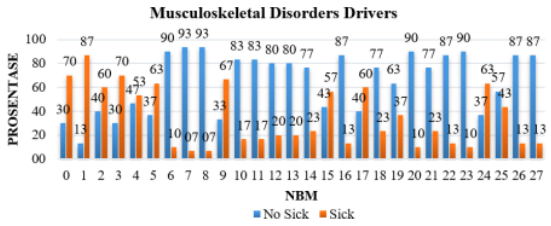


Figure 1. Musculoskeletal disorders drivers

Table 2 and Figure 1, based on the determination of the value of Nordic body maps, it was stated that the highest ranking was at the lower neck body point with a pain rate of 86.7% in rank 1; upper neck and right shoulder with a pain rate of 70.0% in rank 2; butt with a pain rate of 66.7% in rank 4; back and left ankle with a pain rate of 63.3%. Of the 7 points of the body is the dominant point of occurrence of musculoskeletal disorders in online motorcycle taxi drivers. This strengthens the findings made by Bakri et al. [20] stating the role of the back and neck to be the dominant factor in the occurrence of musculoskeletal disorders with a back value of 72.97%; forearm on the pain level of 62.16%; buttocks on the pain level of 54.05%. This is a reference that activities at work do require caution. Especially when it comes to the role of the back and a static work position with a duration of up to 8 until 12 hours per day. The value of Nordic body maps is what has a real level in proving the distribution of musculoskeletal disorders. The distribution of musculoskeletal disorders is influenced by a history of working with less supportive postures and the dimensions of the motorcycle used. Therefore, observations of a period of up to 2 months state that the highest ranking body point needs recommendations for improvement of work methods in the near future.

3.2 RULA score

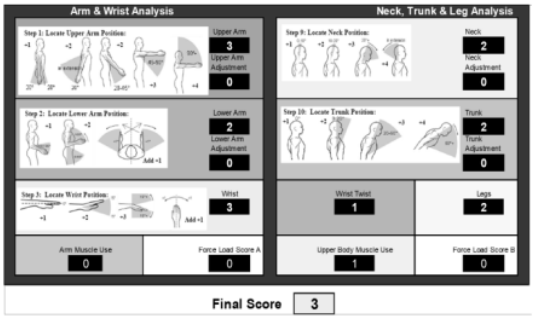


Figure 2. RULA score respondent 1 Lynn Mcatamney and E. Nigel Corlett sheet
Source: Data Processing RULA, 2022

Figure 2, the RULA assessment for the 1st respondent, shows a RULA score of 3. The meaning of the score 3 indicates that the action is included in the action level 2 category, which requires further inspection activities and requires changes in work posture for online motorcycle taxi drivers on the third respondent. 1. The recapitulation of the

results of the measurement of the RULA value for the 2nd to 30th respondents is as follows.

Table 3, states that the role of the RULA score has an impact in determining severity information during driving. There were respondents 18, 19, 21, 22, 23, 24, 25, 27, 28, 29 and 30 experiencing This condition is dangerous so inspection and changes are needed immediately. The RULA score is from what they experienced with the RULA score of 7.

Table 3. Score RULA

Respondent to-	Score RULA	Information
1	3	Further inspection is needed and changes are also needed
1	5	Inspections and changes need to be made immediately
3	1	Further inspection is needed and changes are also needed
4	1	Further inspection is needed and changes are also needed
5	1	Further inspection is needed and changes are also needed
6	4	Further inspection is needed and changes are also needed
7	1	Inspections and changes need to be made immediately
8	1	Inspections and changes need to be made immediately
9	1	Inspections and changes need to be made immediately
10	6	Inspections and changes need to be made immediately
11	1	Inspections and changes need to be made immediately
12	6	Inspections and changes need to be made immediately
13	5	Inspections and changes need to be made immediately
14	5	Inspections and changes need to be made immediately
15	1	Inspections and changes need to be made immediately
16	1	Inspections and changes need to be made immediately
17	6	Inspections and changes need to be made immediately
18	1	This condition is dangerous so inspection and changes are needed immediately (at that moment).
19	1	This condition is dangerous so inspection and changes are needed immediately (at that moment).
20	6	Inspections and changes need to be made immediately
21	1	This condition is dangerous so inspection and changes are needed immediately (at that moment).
22	1	This condition is dangerous so inspection and changes are needed immediately (at that moment).
23	1	This condition is dangerous so inspection and changes are needed immediately (at that moment).
24	1	This condition is dangerous so inspection and changes are needed immediately (at that moment).
25	1	This condition is dangerous so inspection and changes are needed immediately (at that moment).
26	6	Inspections and changes need to be made immediately
27	1	This condition is dangerous so inspection and changes are needed immediately (at that moment).
28	1	This condition is dangerous so inspection and changes are needed immediately (at that moment).
29	7	This condition is dangerous so inspection and changes are needed immediately (at that moment).
30	7	This condition is dangerous so inspection and changes are needed immediately (at that moment).

Table 4. Action Level RULA

Score	Number of respondents	%	Rank
1-2	0	0.0%	4
3-4	5	16.7%	3
5-6	14	46.7%	1
6+	11	36.7%	2
Sum	30	100.0%	

Table 5. Existing RULA Working Posture Sample of Each Motorcycle

Type of Motorcycle	Sample Existing Posture to- Documentation and Angles	RULA score
Supra 125	 Characteristics of the 25th Respondent: Height: ±154 cm Category: small (≤ 155 cm) Weight: ± 57 kg Category of Weight: fat (BMI 24,0)	This condition is dangerous so inspection and changes are needed immediately (at that moment) with score 7

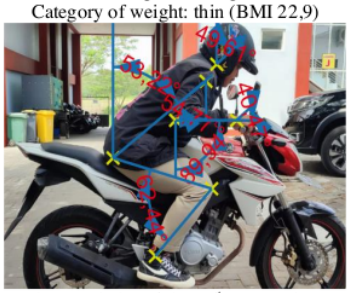
Vario	 Characteristics of the 21st Respondent: Height: ±159 cm Category: medium (155 ≥ x ≤ 166 cm) Weight: ± 58 kg Category of weight: thin (BMI 22,9)	This condition is dangerous so inspection and changes are needed immediately (at tha 1 moment) with score 7
V-ixion	 Characteristics of the 30th Respondent: Height: ±168 cm Category: tall (≥166 cm) Weight: ± 74 kg Category of weight: fat (BMI 26,2)	This condition is dangerous so inspection and changes are needed immediately (at that moment) with score 7

Table 4, based on the RULA action level, the dominant action level is the first rank, namely Inspections and changes need to be carried out immediately with a total of 14 respondents with a percentage of 46.7%. the first rank, namely this condition is dangerous, then inspection and changes are needed immediately (at the same time) a total of 11 respondents with a percentage of 36.7%. There are conditions where the role of examination and changes in work posture dominates. This is due to the impact of the static posture of each online motorcycle taxi driver. It is indeed a major factor, if the static position includes the point of the upper neck, lower neck, back and hips. This means that the accuracy of the Nordic body maps corresponds to what online motorcycle taxi drivers complain about.

Table 5, states that the existing condition of RULA with 3 types of motor vehicles that show the characteristics of the respondents, body weight, height category, and the appearance of the posture angle during driving of each vehicle used. The three types of motorized vehicles are a reference in determining the REBA score which will be an action level assessment.

3.3 REBA score

Figure 3, The REBA assessment for the 30th respondent, shows a REBA score of 8. The meaning of the score 8 indicates that the action is included in the Risk level 8 category, which requires immediate action to improve work posture on the 30th respondent. The recapitulation of the REBA value measurement results for the 1st to 30th respondents is as follows.

Table 6, shows the REBA action level of the total 30 rider respondents. It is stated that the action that will be used as a solution to improve driving posture is at the High level with a score of > 7.

Table 7, based on the REBA risk level, the dominant action level is the first rank, namely necessary, where the role of the need for improving work posture does have a medium level of importance of 19 people with a percentage of 63.3% and the second rank is necessary soon, where the role of the need for improvement in work posture must be immediate carried out has a high level of importance of 11 people with a percentage of 36.7%. There are conditions where the role of examination and changes in work posture dominates. This is due to the impact of the static posture of each online motorcycle taxi driver. It is indeed a major factor, if the static position includes the point of the upper neck, lower neck, back and hips. This means that the accuracy of the nordic body maps corresponds to what online motorcycle taxi drivers complain about.

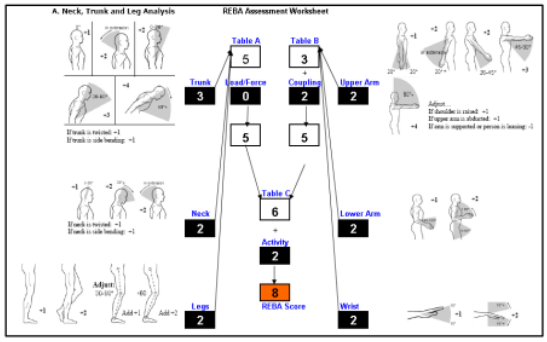


Figure 3. REBA score respondent 30 Higneet, S and Lynn McAtamney sheet

Table 6. Level action REBA

Responden ke-	Score REBA	Risk Level	Action
1	7	Medium	Necessary
2	10	High	Necessary Soon
3	10	High	Necessary Soon
4	8	High	Necessary Soon
5	6	Medium	Necessary
6	6	Medium	Necessary
7	7	Medium	Necessary
8	9	High	Necessary Soon
9	9	High	Necessary Soon
10	10	High	Necessary Soon
11	7	Medium	Necessary
12	7	Medium	Necessary
13	5	Medium	Necessary
14	5	Medium	Necessary
15	5	Medium	Necessary
16	6	Medium	Necessary
17	4	Medium	Necessary
18	4	Medium	Necessary
19	5	Medium	Necessary
20	4	Medium	Necessary
21	8	High	Necessary Soon
22	8	High	Necessary Soon
23	8	High	Necessary Soon
24	6	Medium	Necessary
25	9	High	Necessary Soon
26	8	High	Necessary Soon
27	7	Medium	Necessary
28	7	Medium	Necessary
29	7	Medium	Necessary
30	8	High	Necessary Soon

Table 7. Action level REBA

Risk Level	Number of respondents	%
Negligible	0	0.0%
Low	0	0.0%
Medium	19	63.3%
High	11	36.7%
Very High	0	0.0%
Jumlah	30	100.0%

Table 8, shows that the findings of the REBA method show the need for improvement in work posture as the main factor with a score of > 7, namely 8 and 9, with the category necessary soon. This finding is associated with the risk level, which is an action that must be taken according to the risk level. Neligable and low risk levels do not require corrective work posture, because this risk level means that it does not have any impact on the driver's working posture. However, none of the online motorcycle taxi drivers are at the negligible and low risk level. There are medium and high risk levels with a total of 30 respondents. The standard of posture measurement is that online motorcycle taxi drivers who are at this level pay special attention to the work posture during driving. Mitigation that is carried out in the near future and requires follow-up, namely changing the working method. The changed working method relates to the angle of working posture during driving. The body parts that are highlighted are neck, trunk, leg, upper arm, forearm, and wrist.

Table 8. Existing REBA working posture sample of each motorcycle

Type of Motorcycle	Sample Existing Posture to-Documentation and Angles	REBA score
Supra 125	 Characteristics of the 25th Respondent: Height: ±154 cm Category: small (≤ 155 cm) Weight: ± 57 kg Category of Weight: fat (BMI 24,0)	Score: 9 Category necessary soon

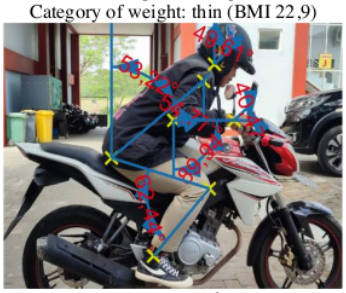
Vario	 Characteristics of the 21st Respondent: Height: ±159 cm Category: medium (155 ≥ x ≤ 166 cm) Weight: ± 58 kg Category of weight: thin (BMI 22,9)	Score: 8 Category necessary soon
V-ixion	 Characteristics of the 30th Respondent: Height: ±168 cm Category: tall (≥166 cm) Weight: ± 74 kg Category of weight: fat (BMI 26,2)	Score: 8 Category necessary soon

Table 9. Recommendations of RULA and REBA posture improvement

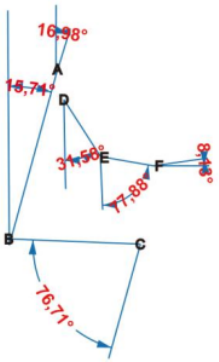
Recommendation of RULA and REBA posture angles	Description of outcome musculoskeletal disorders
	A (Neck) = neck angle interval at an angle of 0 - 20° with unstressed conditions B (Trunk) = interval 0-20° with the back condition supported by a seat height that matches body posture, the position of the buttocks when sitting right leaning between the front seat and the front seat C (leg) = the interval is at least the knee position is facing forward for the supra-125 and vario-125 types, while the v-xion slightly opens on the right and left sides D (upper arm) = the upper arm interval is 20-45° with the arm position not tense when driving and doing movements every 15-20 minutes to reduce muscle tension E (forearm) = 50-100° intervals with the forearm position not tense to reduce contractions with the bag arm and perform the movement every 15-20 minutes F (wrist) = angle of 15° up or down by reviewing the handlebars that have grips to provide a safe driving effect and reduce slippage when doing additional driving gas pulls

Table 9 states that recommendations for posture improvement are developing better than before. The recommendations expressed in the riding posture angle model include the neck, trunk, leg, upper arm, forearm and wrist areas. The six parts of the body are the dominating tipping points of the RULA and REBA assessments. Thus, it is a highlight in the implementation of the angle of riding posture.

3.4 Future development

The RULA and REBA studies that have been conducted on 30 respondents from online motorcycle taxis with 3 samples of motorcycles, show that complaints from online motorcycle taxi drivers are included in the examination and changes need to be made to the RULA method immediately. While complaints from online motorcycle taxi drivers are dominant, it is necessary to improve posture for the REBA method. Improved posture integration of RULA and REBA can have an impact on suppressing the occurrence of musculoskeletal disorders.

The strategic step is in accordance with the results of the Nordic body maps measurement, namely reducing the level of pain in the Nordic body maps assessment. The level of pain that is reduced by the percentage includes the lower neck, upper neck, right shoulder, butt, back and left ankle points. Reducing the level of pain in these points of the body can use an intensive pre-test and post-test. Pre-test can be done to respondents from online motorcycle taxi drivers in the last 6

months, the last 3 months, the last 1 month and the last 1 week. Future observations have the aim of assessing differences in musculoskeletal disorders complaints during the observation period. The achievement is that with the observation period there is a decrease in musculoskeletal disorders or an increase in musculoskeletal disorders.

Body position while driving is associated with the type of motorcycle used, dominantly not in accordance with the integration study of RULA and REBA. There is a yellow action level which indicates that further inspection is needed and changes are also needed. The purpose of the follow-up examination is to provide advice on how to use the correct driving position with changes in posture according to the angle of the RULA and REBA integration study. Arunachalam et al. provide a statement that to suppress musculoskeletal disorders requires replacement of work facilities [21, 22]. Of course, changing the facility requires an in-depth ergonomics study to reduce the risk of both RULA and REBA. Back to the principle that was developed, namely, by reducing the risk of musculoskeletal disorders, it is used as strategic efforts. This means, leading to the findings Kee [7], the prevalence of which emphasizes the use of body posture loads and work related musculoskeletal disorders. From the 2 previous findings, it can support the findings that have been exposed in this article, namely the burden of body posture by identifying height, body weight and determining body mass index. This indicator will later be used as the basis for designing the best facilities, which are related to the dimensions of online motorcycle taxi seats. For now, the findings of this study are the achievement of improving RULA and REBA postures as recommendations for a more suitable posture angle for online motorcycle taxi drivers.

4. CONCLUSION

The conclusions of the research are (1) determining the value of Nordic body maps, it is stated that the highest ranking is at the lower neck body point with a pain rate of 86.7% in rank 1; upper neck and right shoulder with a pain rate of 70.0% in rank 2; butt with a pain rate of 66.7% in rank 4; back and left ankle with a pain rate of 63.3%. Of the 7 points of the body are the dominant points of occurrence of musculoskeletal disorders in online motorcycle taxi drivers. This is a reference that activities at work do require caution. Especially when it comes to the role of the back and a static work position with a duration of up to 8 hours per day. (2) Improving the working posture of the integration of RULA and REBA, namely for neck conditions at 0-20^{o} angle intervals with conditions that are not tense; back interval 0 - 20^{o} with the seat height according to body posture and the position of the buttocks when sitting right leaning between the front seat and the front seat; the condition of the legs adjusts to the knee position facing forward for the supra-125 and vario-125 types, while the v-xion opens slightly on the right and left sides; the interval between the upper and lower arms is 20-45^{o} with the arm position not tensed while driving and performing movements every 15-20 minutes to reduce muscle tension; wrist with an angle of 15^{o} up or down by paying attention to the grips on the gas pull handlebar. The implication of this research is that there is no improvement in the condition of seat height, seat width and handlebar dimension conditions on each motorcycle sample motor used as the research sample. Thus, the contribution given is the implementation of RULA - REBA integration in motorcyclists and the improvement of motorcycle dimensions to include posture fit to the motorcycle used with the Body Mass Index approach and improvement of the dimensions of the seat and handlebar of the motorcycle used as a research sample. The contribution of this study is to lead to risks when riding from the aspect of motorcycles and riders' posture.

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