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Ergonomic Risk Assessments (ERA) on Cycling Posture using Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) Method among Cyclists

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Abstract: This research utilised an Ergonomic Risk Assessments (ERA) analysis of cyclists' body posture in order to determine the limb hazards associated with cyclists who are at risk for musculoskeletal illnesses (MSD). This is because riding a bike requires unusual body postures such as bending, sitting, and standing. To lower the risk of MSD, researchers conducted ergonomic assessments directly in the activity area using the RULA and REBA methodologies. This study was done in the state of Kelantan, and the survey respondents included multiple male bikers (N=95). This study examined three distinct types of bicycles: road bikes, mountain bikes, and folding bikes. The age range of respondents for road bikes (N=31) ranged from 22 to 36 years (29.55±3.45). Meanwhile, mountain bikes (N=33) were between 23 to 35 years old (28.94±3.05), and folding bikes (N=31) were between 25 to 32 years old (28.81±1.85). The results showed that for road cyclists, the body postures assessed by RULA were at Action Levels 2 (54.84%) and 3 (45.16%), while REBA all passed Action Levels 3 (100%). For mountain cyclist's results, the average was at Action Levels 2 (RULA:75.76%, REBA:15.15%) and 3 (RULA:24.24%, REBA:84.85%). Results for folding cyclists the body posture assessed by RULA at Action Levels 1 (61.29%), 2 (29.03%), and 3 (9.68%). Meanwhile, REBA was evaluated at Action Levels 2 (45.16%) and 3 (54.84%). In conclusion, combination of risks leads to high increase of ERAs among cyclists.

Keywords: RULA, REBA, Cyclists, Musculoskeletal Disorders

1. Introduction

Cycling is a popular and cost-effective mode of human travel, as well as a relatively inexpensive and convenient mode of transport. Additionally, it has a number of health benefits, including enhanced well-being, a decreased chance of colon cancer, and a decreased risk of cardiovascular death [1]. Physical risk factors such as uncomfortable posture, vibration, energy repetition, and length were found

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associated with high levels of musculoskeletal disorders (MSDs) in the neck, shoulders, and arms, according to Normal and Wells [2]. One of the most severe consequences is Musculoskeletal Disorders (MSDs) from musculoskeletal strain associated with improper work. Feeling discomfort in either one or more parts of the body is a symptom of Musculoskeletal Disorder (MSDs) [3]. Musculoskeletal Disorders (MSDs) can begin suddenly or develop over time; for example, bikers frequently experience neck, chest, thigh, back, and leg pain. When cycling, the human body has a different posture than when standing, sitting, or lying down. Cyclists' anthropometry demonstrates that their stance is constrained by the geometry of their bike [4]. Chronic musculoskeletal problems tend to worsen over time and essentially result in lifelong disability [5]. Ergonomic risk factors (ERFs) such as repetitive movements, hard exercise, and uncomfortable postures have been linked to musculoskeletal disorders such as Cumulative Trauma Disorders (CTDs) [6]. It is critical for cyclists to maintain proper posture in order to avoid long-term health issues.

Cyclists have a variety of goals, and many of them are related to excessive joint activity, particularly in the lower body. Overall, 25.8 % of cyclists reported knee pain, 27.6 % of amateur cyclists reported knee pain, and 15.9 % of professional cyclists reported knee pain. The majority of cyclists reported pain as mild (61.6 %) or moderate (28.7 %); anterior knee pain accounted for 58.1 % of knee pain [7]. According to some epidemiological studies, cyclists who ride for extended periods experience knee pain or injuries at a rate of 14.8% to 33% and 61% of cyclists had not suffered an injury in the previous year, but 29% experienced knee pain, indicating that their knee pain may have been due to long-distance cycling experience [8]. According to research, low back pain (LBP) is a common complaint among mountain cyclists with chronic low back pain (LBP) have lower cross-sectional areas with a prevalence of 24% to 41% [9]. In addition, studies of triathletes have shown a high lifelong prevalence of neck pain 48.3% due to several sports such as cycling, swimming, and running [10]. The purpose of this study was to determine the risk assessment level for cyclists using Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA).

2. Materials and Methods

2.1 Sample Size and Selected Bikes

From October to December 2021, 95 cyclists aged 22 to 36 were evaluated for their risk assessment level of ERAs in various designated activity zones in the state of Kelantan on Peninsular Malaysia's east coast. Kota Bharu is a Malaysian city with a population of approximately 352538 people and a land area of 403 square kilometres; the average age of Kota Bharu residents is 21.6 years, compared to 21.4 in Kelantan and 27.6 in Malaysia [11]. Three bikes were chosen for this study: a road bike, a mountain cycle, and a folding bike, with a target ride length of 16 to 29 inches and 16', 20', 26/27.5', and 29' wheels, as seen in Figure 1. The study examined how cyclists' body posture mobility influences their ERAs.

(a)

(b)

(c)

Figure 1: (a) Road Bike, (b) Mountain Bike, (c) Folding Bike

2.2 Rapid Upper Limb Assessment (RULA)

McAtamney and Corlettin developed the Rapid Upper Limb Assessment (RULA) tool in 1993 to evaluate the effectiveness of the postural targeting method for assessing the risks of work-related upper limb problems [12]. Scores are entered in Part A (arm and wrist analysis) and Part B (leg and foot analysis) for each body area depending on the evaluations (neck, trunk, and leg analysis). After collecting and scoring data for each region, the risk factor variables are aggregated using the worksheet's tables to provide a score representing the Musculoskeletal Disorder Risk in Table 1.

Table 1: Rapid Upper Limb Assessment (RULA) decision table

Analysis Score	WMSDs risk level	Action Required
1-2	Ignorable	No action required
3-4	Low risk	Change may be needed
5-6	Medium risk	Further investigation, change soon
7+	Very high risk	Immediate change to be implemented

Note: - WMSDs = Work Musculoskeletal Disorders

As illustrated in Table 1, a score of 1-2 indicates that the user is at low risk and does not require remediation. Scores of 3-4 and 5-6 indicate that the user is at low or moderate risk, respectively, and that additional research is necessary to determine if any modifications are necessary. If the score exceeds 6, the user is in extreme risk and must make the necessary adjustments immediately to correct the inappropriate posture.

2.3 Rapid Entire Body Assessment (REBA)

The Rapid Entire Body Assessment (REBA) is a postural risk assessment technique for evaluating the risk of work-related entire body disorders by conducting a rapid and systematic assessment of employees' postural risks. The REBA is a postural targeting technique used to assess the risk of work-related whole-body illnesses. The Rapid Entire Body Assessment (REBA) is used to analyse workers' postures. Hignett and McAtamney developed the REBA in 2000 to calculate the risk index for work-related musculoskeletal diseases (WRMSDs) [12]. Score A is the sum of Table A and Load/Force scores. Score B is the sum of the Table B and Coupling scores for each hand. Score A represents the row in table C, while Score B represents the column. Table C contains the same row and column as this row and column, so Score C is obtained from there. For further considerations, there is a scoring scale as well as adjustment remarks for each location. The load or force, as well as the coupling factors, were then scored. The level of risk can be determined in Table 2's REBA decision table.

Table 2: Rapid Entire Body Assessment (REBA) decision table

Analysis Score	WMSDs risk level	Action Required
1	Ignorable risk	No action required
2-3	Low risk	Change may be needed
4-7	Medium risk	Further investigation, change soon
8-10	High risk	Investigation and implement change
11+	Very high risk	Immediate change to be implemented

Note: - WMSDs = Work Musculoskeletal Disorders

A score ranging from 1 to 10 indicates that the user is at a bit of risk and necessary no action. Consider the following scenarios: the score is 2-3 or 4-7. In that instance, it consecutively perceives the person as low or medium risk. It suggests further research to see whether any risk estimate should be altered. Any score more than 8 indicates that the user is extremely vulnerable and that necessary adjustments should be made immediately.

2.4 Data Collection

Direct observation of ERAs' body postures was used to collect data for exposure risk assessment levels. The data gathering process was focused on their physical activity performance, which included postures, repetitive movements, sitting, and standing. The advantage of this observation method is that it is more suitable for the field of application than other methods that have been widely used and applied in numerous instances in similar studies [13]. Pictures were taken for each participant while cycling for further evaluation process regarding the exposure risk assessment level on body posture of ERAs. Only one side of the body is inspected; specifically, the side that has been wounded the most; however, if both sides are extremely dissimilar, both are evaluated [14]. The technique for collecting data with the RULA and REBA tools can be summarised in five steps. To begin, it is necessary to observe the participant's activity or movement in order to develop an ergonomic body evaluation, which includes the participant's movement and environment. Additionally, if possible, capture the data using a snapshot or a video camera. Second, interviews and measurements were conducted with cyclists utilising a goniometer measurement equipment. Following that, it is necessary to score each item of risk scores, compute the score, and mark the numbers at the crossing points of each step of the circled number using the RULA and REBA tools. Then, based on the risk scores, it must determine the overall final scores. Finally, for the final step, the total final scores will indicate whether the body posture is acceptable for a negligible risk level, may require change for a medium risk level, will require change soon for a medium risk level, will require investigative work for a high risk level, or will require implementation to change for a very high risk level.

2.5 Data Analysis

The Statistical Package for the Social Sciences (SPSS) software was used to analyse the data received from RULA and REBA. The descriptive statistics for the RULA and REBA findings include counts, percentages, the mean, and standard deviation. To determine if the scores represented the difference between two observation variables for the same subject, the Wilcoxon Signed Rank Test was performed. As the nonparametric equivalent of the paired t-test, the signed-rank test can be used in place of the t-test when the population data do not follow a normal distribution. The Wilcoxon sign test used RULA and REBA as dependent variables.

3. Results and Discussion

3.1 Demographic Data for Road Bikes

The ergonomic risk assessment (ERA) results for cyclists using road bikes, mountain bikes and folding bikes were collected around the state of Kelantan. Ninety-five (95) cyclists have been collected in the form of Kelantan. Cyclists aged between 22 and 36 at different selected activities areas around the state of Kelantan. Thirty-one (31) road bikes cyclists have been collected in the form of Kelantan. There were 45.20 percent of them aged between 26 to 30 years old. 12 (38.70%) of cyclists were aged over than 31 years old while 5 (16.10%) of them were aged less than 25 years old, and the total mean for age among respondents was 29.55 years (SD=3.45 years) involved throughout the research. A total of 33 cyclists have been collected in Kelantan, focusing on mountain bike cyclists. The research participants were between 23 and 35, with 18 (54.50%) aged between 26 to 30 years old. 9 (27.30%) of cyclists were aged over than 31 years old while 6 (18.20%) of them were aged less than 25 years old and total mean for age among respondents with the mean age of 28.94 (SD=3.05 years). Riders riding foldable bikes gathered a total of 31 cyclists aged 25 to 32, with 74.20 percent of them being between the ages of 26 and 30. 7 (22.60%) of cyclists were over the age of 31, while only 1 (3.20%) were under the age of 25, and the overall mean age of respondents was 28.81 years (SD=1.85 years). They were all interviewed to elicit more information regarding their riding activities, which are summarised in Table 3.

Table 3: Demographic Data (N=95)

Characteristic	Road Bike			Mountain Bike			Folding Bike		
	N (%)	Mean	SD	N (%)	Mean	SD	N (%)	Mean	SD
Age									
≤25	5 (16.1)			6 (18.2)			1 (3.2)		
26-30	14 (45.2)	29.6	3.5	18 (54.5)	28.9	3.1	23 (74.2)	28.8	1.9
≥31	12 (38.7)			9 (27.3)			7 (22.6)		
Total	31 (100)			33 (100)			31 (100)		

Notes: - % = Percentage, SD = Standard Deviation

3.2 Rapid Upper Limb Assessment Final Score, Risk Level and Action Level

Research has been done to analysis the postures to get the scores were presented in Table 4. First, the upper arm, lower arm, and wrist postures have been marked for Part A. Most of the road bikes cyclists experienced scores for upper arm, lower arm, and wrist postures with the mean 3.0 (SD=0.0), 1.35 (SD=0.49), 2.48 (SD=0.51), and 1.39 (SD=0.50). Meanwhile, for a Part, B: neck, trunk, and leg postures have been analyses by how far they deviate from the neutral position, with the mean 1.65 (SD=0.80), 3.00 (SD=0.0) and 2.00 (SD=0.00). Once the values from parts A and B have been calculated, the final scores mean 6.45 (SD=0.51), being the average final score. Next, for mountain bikes cyclists part A: upper arm, lower arm, and wrist postures scores were presented cyclists experienced scores for upper arm, lower arm, and wrist postures with the mean 2.76 (SD=0.44), 2.70 (SD=0.47), 2.12 (SD=0.78), and 1.21 (SD=0.42). Then, for part B: neck, trunk, and leg postures scores, with the mean 1.36 (SD=0.60), 2.76 (SD=0.44), and 2.00 (SD=0.00). The final scores were provided as a mean of 6.09 (SD=0.63). Close observations are made by analysis of bikers' upper limb body postures while riding folding bikes. Part A: upper arm, lower arm, and wrist postures are studied, with mean values of 3.0 (SD=0.0), 1.71 (SD=0.46), 1.65 (SD=0.88), and 1.52 (SD=0.51) for upper arm, lower arm, and wrist postures, respectively. However, for component B: neck, trunk, and leg postures, the mean is 1.77 (SD=0.62), 2.16 (SD=0.37), and 2.00 (SD=0.00, respectively. After marking the results from sections A and B, the final scores are provided, with the mean 4.58 (SD=0.92) representing the average final score for a participant.

Table 4: Analysis Score for Part A, Part B and RULA Final Score (N=95)

Positions	Road Bike		Mountain Bike		Folding Bike	
	Mean	SD	Mean	SD	Mean	SD
Part A						
Upper Arm Score	3.0	0.0	2.8	0.4	3.0	0.0
Lower Arm Score	1.4	0.5	2.7	0.5	1.7	0.5
Wrist Score	2.5	0.5	2.2	0.8	1.7	0.9
Wrist Twist Score	1.4	0.5	1.2	0.4	1.5	0.5
Part B						
Neck Score	1.7	0.8	1.4	0.6	1.8	0.6
Trunk Score	3.0	0.0	2.8	0.4	2.2	0.4
Leg Score	2.0	0.0	2.0	0.0	2.0	0.0
Rapid Upper Limb Assessment (RULA) Score	6.5	0.5	6.1	0.6	4.6	0.9

Note: - SD = Standard Deviation

RULA final score, level of risk, and action for the research are presented in Table 5. Based on the results, there are two levels of risks classified for road bikes cyclists under a medium level (54.84%) of risks that the cyclists needed further investigation and required a planned approach change soon. The other, which indicated a high degree of risks (45.16%), necessitated studying and implementing change as rapidly as possible in order to lower ergonomic risk assessments, with a final score of 6 to 7. Next,

the risk level for mountain bikes cyclists involved during cycling was a medium level 25 (75.76%) of risks that needed further investigation and required a change soon. Next, a high level 8 (24.24%) of risks is necessary to investigate and implement change action to control the ergonomic risk assessments, with a final score in the range of 5 to 7. The results for folding bikes cyclists show there are three levels of risks that were classified as low level (61.29%) of risks and had further investigation or change may be needed in the future. 2 exposure risks are classified under medium level (29.03%) of risks showed the cyclists required further research and need a planned approach change soon. The other risk group is the high level (9.68%) of risks necessary to investigate and take corrective action as quickly as possible.

Table 5: RULA Final Score, Risk Level and Action Level (N=95)

RULA Level	0	1	2	3
RULA Score	1-2	3-4	5-6	7
Risk Level	Negligible	Low	Medium	High
Reqd. Action	Acceptable posture	Further investigation and change may be needed	Further investigation and change soon	Investigation and implement change
Number of Road Bike Cyclists (%)	--	--	17 (54.8)	14 (45.2)
Number of Mountain Bike Cyclists (%)	--	--	25 (75.8)	8 (24.2)
Number of Folding Bike Cyclists (%)	--	19 (61.3)	9 (29.0)	3 (9.7)

Notes: - RULA = Rapid Upper Limb Assessment, % = Percentage

The upper arm, wrist, trunk, and leg all received high grades in this study among road bike cyclists. Additionally, the majority of selected respondents reported many ergonomic issues related to static posture and highly repetitive motions associated with cycling, such as bending to reduce the angle. The high-risk level for the upper limb body was connected with static posture, repetitive actions, and posture in a slouched position with their trunks turned to a lesser degree. The upper extremities and low back muscle groups are much more exhausted, which may be reflected in the bicycle's poor balance [15]. The results also showed that none of the cyclists is at negligible risk level and low-risk level.

Mountain bike cyclists scored highly in the upper arm, lower arm, wrist, trunk, and leg. These presented are at a high or medium risk and should be explored and addressed immediately, whereas 24.24 percent of bikers were at a high risk. It was emphasised that mountain biking is a demanding sport, and bikers must adjust their posture if they wish to avoid developing MSDs. The upper extremities account for over two-thirds of acute injuries, while the lower extremities account for a comparable proportion of overuse injuries. Acute and overuse injuries are possible depending on the type of MTB and the technical difficulties of the terrain. Appropriate bike fit and protective equipment, such as a helmet, can decrease the chances of some of these injuries [9]. It is recommended to take corrective action as soon as possible to overcome these problems. The table also showed that none of the cyclists is at negligible and low-risk levels.

The results showed that the majority 19 (61.29%) of the folding bike cyclists are at a low-risk level and need to investigate and change may be required, whereas nine cyclists (29.03%) and three cyclists (9.68%) have reached medium and high-risk levels. This finding indicates that RULA final scores in the range of 4 to 5 are considered to be medium to high. It was emphasised that if cyclists maintained their current stance, they would avoid MSDs associated with such a score value. However, it is recommended that they take remedial action to improve their comfort level by riding in a different position. Additionally, none of the bikers were found to be at a negligible risk threshold.

3.3 Rapid Entire Body Assessment Final Score, Risk Level and Action Level

According to the result presented in Table 6, all body posture scores for positions involved Part A, Part B, and REBA final scores. First observations for road bikes cyclists are made at the neck, trunk, and legs, with the mean 1.29 (SD=0.46), 3.00 (SD=0.0), and 4.00 (SD=0.0). Meanwhile, the upper arm, lower arm, and wrist postures have been analysed to get the scores, with the mean 3.00 (SD=0.00), 1.35 (SD=0.49), and 1.48 (SD=0.51). Once the values from parts A and B have been marked, the final scores were analysed, with the mean 9.03 (SD=0.75) being the average of final score. Next, for mountain bikes cyclists part A: neck, trunk, and legs, with the mean 1.06 (SD=0.24), 2.76 (SD=0.44), and 4.0 (SD=0.0). Then, the upper arm, lower arm, and wrist postures have been analysed the scores, with the mean 2.76 (SD=0.44), 1.70 (SD=0.47), and 1.36 (SD=0.49). The final scores were presented, and the mean 8.64 (SD=0.74) was the participant's average final score. Close observations are made on limbs and body postures of folding bikes cyclists most frequently used, and the focused to extreme joint angles, duration, and forces. The scores on neck, trunk, and legs, with the mean 1.26 (SD=0.45), 2.16 (SD=0.37), and 4.0 (SD=0.0). However, the upper arm, lower arm, and wrist postures have been analysed scores, with the mean 3.00 (SD=0.00), 1.71 (SD=0.46), and 1.26 (SD=0.45). Then, the REBA final scores have been analysed and presented with the mean 7.97 (SD=1.11) being the average final score of a participant.

Table 6: Analysis Score for Part A, Part B and REBA Final Score (N=95)

Positions	Road Bike		Mountain Bike		Folding Bike	
	Mean	SD	Mean	SD	Mean	SD
Part A						
Neck Score	1.3	0.5	1.1	0.2	1.3	0.5
Trunk Score	3.0	0.0	2.8	0.4	2.2	0.4
Leg Score	4.0	0.0	4.0	0.0	4.0	0.0
Part B						
Upper Arm Score	3.0	0.0	2.8	0.4	3.0	0.0
Lower Arm Score	1.4	0.5	1.7	0.5	1.7	0.5
Wrist Score	1.5	0.5	1.4	0.5	1.3	0.5
Rapid Entire Body Assessment (RULA) Score	9.0	0.8	8.6	0.7	8.0	1.1

Note: - SD = Standard Deviation

Table 7 summarises and presents the REBA final score, risk level, and action results. According to the findings, there were no degrees of risks for road bike cyclists that were negligible, low, medium, or extremely high. The risk level is high (100 percent) for all riders involved, with a final score of between 8 and 10. This demonstrated final score among road bike bikers necessitates further investigation and modification of ergonomic risk evaluations in order to minimise risk. Following that, the risk level for mountain bike cyclists is discussed. 2 risk levels were classified for mountain bikes cyclists under a medium level 5 (15.15%) of risks that need further investigation and required a change soon. The other danger was organized under a high level 28 (84.85%) of risks that needed to be investigated and implemented, with final scores in the range of 7 to 9. In contrast, the high risk needs to investigate and implement change to reduce the ergonomic risk assessments that may affect the body. The results for cyclists riding foldable bikes indicate that there are two exposure levels that warrant additional analysis and immediate modification as a medium risk level 14. (45.16 percent). Another danger level is high, with 17 (54.84 percent) of risks requiring prompt action affecting the body postures under investigation, with a final score of 7 to 10. The high-risk group must conduct research and adopt changes to minimise ergonomic risk assessments that may contribute to problematic body posture. One of the causes of cyclists has been recognised as static posture and repetitive actions.

Table 7: REBA Final Score, Risk Level and Action Level (N=95)

REBA Level	0	1	2	3	4

REBA Score Risk Level	1 Negligible	2-3 Low	4-7 Medium	8-10 High	11-15 Very high
Reqd. Action	Negligible risk	Change may be needed	Further investigate and change soon	Investigate and implement change	Implement change
Number of Road Bike Cyclists (%)	--	--	--	31 (100)	--
Number of Mountain Bike Cyclists (%)	--	--	5 (15.2)	28 (84.8)	--
Number of Folding Bike Cyclists (%)	--	--	14 (45.2)	17 (54.8)	--

Notes: - REBA = Rapid Entire Body Assessment, % = Percentage

Upper arm, trunk, and leg are widespread of most scores among cyclists in this study. Around 9 (29.03%), 14 (45.16%), and 8 (25.81%) of the road bikes cyclists were in postures at high-risk levels. If the cyclists continued to cycle in the same pose, they would soon suffer from the MSDs related to neck, shoulder, and back pain. From the past review, there is higher muscle fatigue evident in the back muscles of the LBP group when compared to their cohorts [16]. It is recommended to take corrective action as quickly as possible. Some of the cyclists were bending their trunks to a lower degree, which was unacceptable and needed change.

The results showed that around 28 (84.85%) of the mountain bikes cyclists were at high-risk levels. It was found that the leg, trunk, and upper arm have a high average score. The riders needed to take immediate corrective action to avoid MSDs associated with leg, shoulder, neck, and back pain. Road racers and mountain bikers had a higher rate of knee pain than the general population, most likely because their knees were more susceptible to overuse. Bicycle fitting, coaching, using clipless pedals, warming up, average years of riding experience, average weekly mileage travelled, resistance training, strength training, and average weekly rest days were all found to be unrelated [7]. Mountain bike bikers need to be trained in appropriate posture and cycling posture to lower the risk of musculoskeletal diseases and improve overall health.

Bicycles that collapse Around 17 (54.84 percent) of bikers were classified as high-risk. It was discovered that if cyclists maintained their current position, they would soon develop MSDs linked to neck, shoulder, leg, and back pain. It was suggested that corrective action be taken immediately. The leg received a greater score than the others. It is recommended to take corrective action by altering the saddle design to alleviate numbness in the low back. One explanation for the absence of correlation between bicycle configuration and knee pain is the force distribution among the various lower limb muscles [17]. Responses changes in the ankle, knee and hip angles with the large number of muscles crossing the three main joints in the lower limb allow for numerous combinations of activations and muscle forces. The results also showed that none of the cyclists is negligible, low, and very high-risk. The study was done on cyclists in postures with their activities.

3.4 Dependent Final Score between RULA and REBA

A Wilcoxon matched-pairs signed-rank test was conducted to explore differences in final scores between RULA and REBA for road, mountain, and folding bikes. An alpha level of 0.05 was utilised. Descriptive statistics were presented in Table 8 for road bikes, mountain bikes and folding bikes. A statistically test revealed that RULA scores were significantly lower after the intervention (Mdn = 6.00, n = 31) compared to REBA (Mdn = 9.00, n = 31), z = -5.02, $p < 0.05$. That analysis indicated a significant difference in the final score for RULA and REBA against the road bike cyclists, z = -5.02, $p < 0.05$. A Wilcoxon Signed-Ranks Test indicated that the median REBA scores (Mdn = 9.00, n = 33) were

statistically significantly higher than the median RULA scores (*Mdn* = 6.00, *n* = 33), *z* = -5.17, *p* < 0.05 for mountain bike. The output indicated that REBA scores were statistically significantly higher than RULA scores, *z* = -5.17, *p* < 0.05. The finding of this study indicated a significant association with final scores between RULA and REBA methods ($p<0.05$). Others figure skating scores were compared to final scores of RULA and REBA for folding bike cyclists. On average, otters performed lowest RULA (*Mdn* = 4.00, *n* = 31) than REBA (*Mdn* = 8.00, *n* = 31) for folding bike. A Wilcoxon signed-rank test indicated that this difference was statistically significant, *T* = 496, *z* = -5.06, *p* < 0.05. The results showed statistically significant differences between RULA and REBA ($p<0.05$).

Table 8: Descriptive Statistics RULA and REBA (N=95)

Types of Bicycles	Rapid Upper Limb Assessment (RULA)		Rapid Entire Body Assessment (REBA)	
	Mean	SD	Mean	SD
Road Bike	6.5	0.5	9.0	0.8
Mountain Bike	6.1	0.6	8.6	0.7
Folding bike	4.6	0.9	8.0	1.1

Note: - SD = Standard Deviation

4. Conclusion

In conclusion, by assessing ergonomic risk assessments on body posture among cyclists, the changes of body postures can be evaluated without waiting for changes in the prevalence of MSDs to become evident. From the SPSS analysis results of the Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA), there are statistically significant differences were found between both methods ($p<0.05$). Most cyclists have high exposure levels of ERAs involving the upper arm, trunk, and leg. Meanwhile, all-road bike cyclists showed medium and high-risk levels regarding the body postures. They described a variety of ergonomic issues, including static posture, highly repetitive motion, and posture with their trunks bending and lowering the angle. Road cyclists must conduct additional research and make modifications to their cycling performance in order to reduce ERAs. Apart from that, mountain bike bikers' final ratings indicate a medium to high danger level. It was emphasised that mountain biking is a demanding sport, and bikers must adjust their posture if they wish to avoid developing MSDs. However, the data indicate that folding bike cyclists face three distinct levels of risk: low, medium, and high. The folding bike bikers require additional examination, or perhaps a change will be required in the future. However, for high-risk situations, investigate and take corrective action immediately. According to cycling literature, the handlebars of a dropped handlebars bike should be at or below the cyclist's seat height, depending on the cyclist's unique characteristics, such as height and flexibility [18]. This position enables simple access to the brakes and superior steering. Effective preventative body postures and proper cycling positions are indicated to mitigate cyclists' ergonomic risk evaluations.

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