

Identification of Injury Risk on Guitar Players Using NBM (Nordic Body Map), QEC (Quick Exposure Check), RULA (Rapid Upper Limb Assessment), and REBA (Rapid Entire Body Assessment) Methods

Sulistiono¹, Bambang Suhardi^{2*}, Susy Susmartini³

^{1,2,3}(Department of Industrial Engineering, Universitas Sebelas Maret, Indonesia)

ABSTRACT : Guitar player or guitarist is an activity that is related to the movement of the hands and fingers to play notes and chords on a guitar instrument. If done for a long time, there is a risk of injury to a guitar player's posture, and then it will interfere with his guitar performance and playing. Therefore, it is necessary to identify using several methods including NBM (Nordic Body Map), from 25 respondents there are 3 respondents who experience moderate risk when sitting and 12 respondents when standing. QEC (Quick Exposure Check), having an average exposure level of 46% and 44% means that further research is needed. RULA (Rapid Upper Limb Assessment) has a Grand Score when standing and sitting with a score of 7 so, what needs to be done is to immediately investigate the problem and implement changes related to the body posture of the guitar player or the guitar design used. and REBA (Rapid Entire Body Assessment), the last score (Grand Score) is 11, while in the sitting position the last score (Grand Score) is 9 indicating that the activity is very dangerous and needs to immediately implement changes related to the body posture of the guitar player or the guitar design used. And the results of the identification will be used as a reference basis in improving good posture in playing the guitar and become the main basis for making design changes to design an ergonomic guitar.

Keywords - Injury Risk, NBM (Nordic Body Map), QEC (Quick Exposure Check), RULA (Rapid Upper Limb Assessment), REBA (Rapid Entire Body Assessment)

1. Introduction

The problem of the risk of injury to guitar players is often faced by arts workers in a performance, practice or leisure time. Based on research [1] shows that musicians, especially guitar players are at risk of experiencing work disruption caused by the length of playing the guitar with various activities such as fast movements, repetitive movements, and work pressure with the condition of standing and sitting postures so that they experience Performing Art Injuries, namely a risk of injury that often occurs to musicians when playing musical instruments such as guitar, piano, drums and other musical instruments. From the risk of injury to musicians, musculoskeletal injuries such as overuse injuries, cumulative trauma disorders, muscle-tendon pain syndromes, playing-related musculoskeletal disorders and strains. And guitar instrumentation became the second after the use of computers in terms of population exposure to risk factors for musculoskeletal injury problems [2].

It is not uncommon for instrumental musicians, especially guitar players, due to incorrect posture, non-ergonomic techniques, excessive strength, repetitive movements, stress, and insufficient rest, can contribute to chronic injuries that can cause severe pain, flawed, and even ended his career as a guitarist. Body posture is

also influenced by the size of the guitars used, and how to position the guitar when it is played, will certainly affect the risk of injury. The following demographics and injury risk problems from some stringed instruments such as electric guitars, acoustics, bass and banjo[3].

TABLE 1. Demographics for the Overall Guitar Category [3]

Demographics*	Acoustic Guitar (n = 213)	Electric Guitar (n = 185)	Electric Bass (n = 108)	Banjo (n = 14)	Total Guitar (n = 520)
Age, yrs	37.12 (11.62)	31.11 (11.21)	33.14 (10.58)	48.14 (9.67)	33.04 (13.05)
Gender, % male	78	97	91	78	88
Height, in	69.9 (3.7)	70.4 (3.6)	70.4 (3.2)	68.5 (2.9)	69.8 (3.4)
Weight, lbs	183.4 (37.1)	178.7(36.4)	184.8 (40.3)	206 (68.8)	188.2 (45.7)
Marital, % married	51	38	45	71	51
Yrs of music college instruction	1.7 (2.3)	4.1 (2.9)	1.8 (2.6)	0.3 (0.8)	1.2 (2.2)
Practice per day, hrs					
Earning <input type="checkbox"/> 50% of income from music	2.2 (1.6)	2.6 (1.7)	2.1 (1.4)	1.6 (1.1)	2.1 (1.4)
performance, %	19	21	13	7	18
Classical guitarist in group, %	9	0.5	3.7	—	6
Smoker, %	13	21	18	14	16.5
Physical exercise, hrs/wk	3.3 (3.4)	4.4 (5.5)	3.7 (5.2)	3.8 (4.2)	3.8 (4.6)

2. Method

In identifying the risk of injury, it takes respondents consisting of beginner or professional guitar players to map body postures that experience pain complaints when playing the guitar in a sitting and standing position, using conventional electric guitars[4]. The following are the methods used in identifying the risk of injury to guitar players including: NBM (*Nordic Body Map*) distributing Nordic Body Map questionnaires consisting of guitar playing length, guitar weight, age and duration of playing guitar [5], QEC (*Quick Exposure Check*) distributing questionnaires aimed at observers and guitar players / workers. The questionnaire on the observer is more focused on body posture when playing the guitar, while the guitar player questionnaire focuses more on the perceived burden when playing the guitar such as the burden that must be lifted and the duration when playing the guitar [6], RULA (*Rapid Upper Limb Assessment*) data processing obtained by observation directly and see a guitar player playing sitting and standing), and REBA (*Rapid Entire Body Assessment*) Observation of work postures to assess risk factors for overall body disturbance [7].

3. Results and Discussion

3.1. NBM (*Nordic Body Map*)

Based on data collected through filling out questionnaires against 25 respondents, then scoring of individuals with a Likert scale has been set. The scale is in the form of information contained in the questionnaire that is Not Sick (do not feel complaints at all) with a score of 1, Rather Sick (feel a little complaint or pain) with a score of 2, Sick (feeling complaints of pain in certain parts) with a score of 3 and Very Sick (feel pain complaints with a high scale) with a score of 4.

TABLE 2. Percentage of Questionnaire When Seated and Standing Postion

No	Type of complaint	Percentage of Questionnaire When Seated								Percentage of Questionnaire When Standing							
		NS		RS		S		VS		NS		RS		S		VS	
		A	%	A	%	A	%	A	%	A	%	A	%	A	%	A	%
0	Stiff pain in the upper neck	0	0%	25	100%	0	0%	0	0%	0	0%	21	84%	4	16%	0	0%
1	Stiff pain in the lower neck	7	28%	18	72%	0	0%	0	0%	0	0%	21	84%	4	16%	0	0%
2	Pain in the left shoulder	0	0%	18	72%	3	12%	0	0%	0	0%	5	20%	20	80%	0	0%
3	Pain in the right shoulder	1	4%	22	88%	2	8%	0	0%	1	4%	21	84%	3	12%	0	0%
4	Left upper arm pain	12	48%	13	52%	0	0%	0	0%	9	36%	15	60%	1	4%	0	0%
5	Back pain	24	96%	1	4%	0	0%	0	0%	0	0%	22	88%	3	12%	0	0%
6	Right upper arm pain	20	80%	5	20%	0	0%	0	0%	20	80%	4	16%	1	4%	0	0%
7	Low back pain	4	16%	21	84%	0	0%	0	0%	0	0%	18	72%	7	28%	0	0%
8	Pain in the buttocks	9	36%	16	64%	0	0%	0	0%	25	100%	0	0%	0	0%	0	0%
9	Pain in the buttocks	25	100%	0	0%	0	0%	0	0%	25	100%	0	0%	0	0%	0	0%
10	Pain in the left elbow	20	80%	5	20%	0	0%	0	0%	13	52%	12	48%	0	0%	0	0%
11	Pain in the right elbow	25	100%	0	0%	0	0%	0	0%	2	8%	18	72%	5	20%	0	0%
12	Left forearm pain	0	0%	18	72%	7	28%	0	0%	0	0%	20	80%	5	20%	0	0%
13	Right forearm pain	0	0%	19	76%	6	24%	0	0%	0	0%	12	48%	13	52%	0	0%
14	Pain in the left wrist	0	0%	1	4%	24	96%	0	0%	0	0%	2	8%	23	92%	0	0%
15	Pain in the right wrist	0	0%	22	88%	3	12%	0	0%	0	0%	16	64%	9	36%	0	0%
16	Pain in the left hand	0	0%	7	28%	18	72%	0	0%	0	0%	4	16%	21	84%	0	0%
17	Pain in the right hand	0	0%	24	96%	1	4%	0	0%	0	0%	24	96%	1	4%	0	0%
18	Pain in the left thigh	25	100%	0	0%	0	0%	0	0%	25	100%	0	0%	0	0%	0	0%
19	Pain in the right thigh	4	16%	21	84%	0	0%	0	0%	22	88%	3	12%	0	0%	0	0%
20	Pain in the left knee	25	100%	0	0%	0	0%	0	0%	24	96%	1	4%	0	0%	0	0%
21	Pain in the right knee	24	96%	1	4%	0	0%	0	0%	23	92%	2	8%	0	0%	0	0%
22	Pain in the left calf	23	92%	2	8%	0	0%	0	0%	19	76%	6	24%	0	0%	0	0%
23	Pain in the right calf	2	8%	23	92%	0	0%	0	0%	1	4%	24	96%	0	0%	0	0%
24	Pain in the left ankle	25	100%	0	0%	0	0%	0	0%	24	96%	1	4%	0	0%	0	0%
25	Pain in the right ankle	20	80%	5	20%	0	0%	0	0%	11	44%	14	56%	0	0%	0	0%
26	Pain in the left leg	24	96%	1	4%	0	0%	0	0%	25	100%	0	0%	0	0%	0	0%
27	Pain in the right leg	25	100%	0	0%	0	0%	0	0%	16	64%	9	36%	0	0%	0	0%

Results of the percentage of respondents while playing the guitar with a sitting position for the most number for the category of mild pain there is a complaint of stiff pain in the upper neck with 25 respondents all feel the same complaint. Whereas for the pain category there are complaints on pain in the left wrist with 24 respondents felt the complaint, and the percentage of respondents when playing the guitar in a standing position for the highest number for the category of mild pain was found in complaints of pain in the right hand and pain in the right calf with 24 respondents all feeling the same complaint. Whereas for the pain category there are complaints on pain in the left wrist with 23 respondents felt the complaint.

3.2. QEC (Quick Exposure Check)

Based on the recapitulation of the answers to the questionnaire in each playing position, then the exposure score values obtained on body parts such as back, shoulders / upper arms, wrists and neck take into account the interaction of posture with force / load, movement with force / load, duration with force / load, posture with duration and movement with duration. The following is the recapitulation of the exposure score for sitting and standing position when playing the guitar.

TABLE 3. Recapitulation *Exposure Score*

Observed Posture	Sitting Position		Standing Position	
	Kicek	Ryan	Kicek	Ryan
Back (Statis)	14	14	14	14
Back (Move)	18	18	18	14
Shoulder/Arm	18	18	18	16
Wrist	18	14	18	14
Neck	8	8	8	8
Total Exposure	76	72	76	66

This questionnaire was carried out with two game sessions namely when playing the guitar in a sitting and standing position. The following is a recapitulation of the answers to the observer questionnaire and guitar player for each guitar playing position.

TABLE 4. Recapitulation *Exposure Level*

Position	Player Name	Exposure Level	Average Exposure Level of Postion	Action
Duduk	Kicek	47%	46%	Need Further Research
	Ryan	44%		Need Further Research
Berdiri	Kicek	47%	44%	Need Further Research
	Ryan	41%		Need Further Research

Based on the results of the calculation of the exposure level in the table above, overall the guitar player when playing in a sitting and standing position has an average exposure level of 46% and 44%. This shows that further research needs to be done and changes need to be made if there is a risk of injury to body postures such as back, shoulders / arms, wrists that have the highest exposure score, so the proposed improvement will focus more on the comfort of playing on the part of the posture.

3.3. RULA (Rapid Upper Limb Assessment)

Based on the analyzed worksheet *Rapid Upper Limb Assessment*. The following is the guitar player's posture when seated and standing while playing the guitar, shown in the Fig.1 and Fig.2 below:

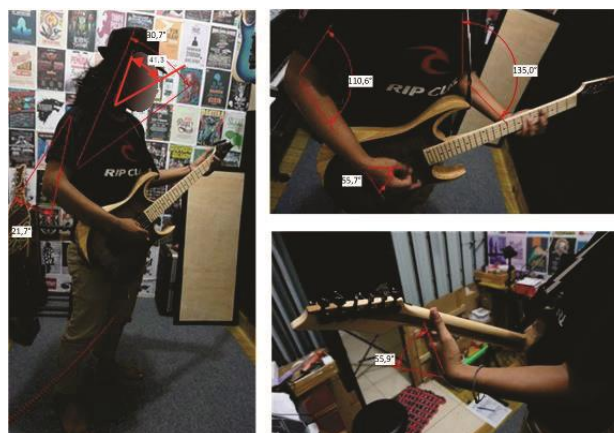


Figure 1. Playing the guitar on position Standing

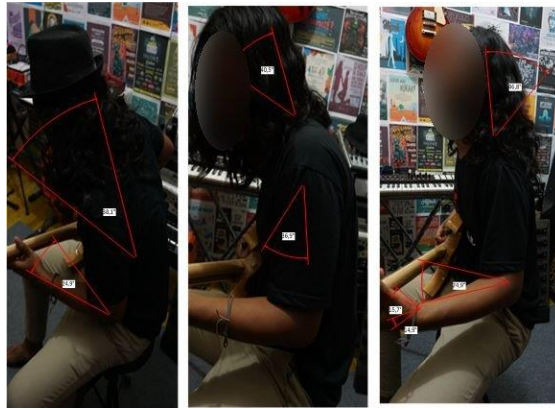


Figure 2. Playing the guitar on position Sitting

Based on the final score (Grand Score) when standing position is obtained a score of + 7, the thing that needs to be done is to immediately investigate the problem and implement changes related to the guitar player's body posture or the guitar design used, so as to reduce the burden of the guitar player when standing up, while the final score (Grand Score) when sitting position is +7, the thing that needs to be done is to immediately investigate the problem and implement changes related to the guitar player's posture or the guitar design used, so as to reduce the burden on the guitar player when sitting .

3.4. REBA (*Rapid Entire Body Assessment*)

Based on the analyzed worksheet rapid entire body assessment. The following is the guitar player's posture when seated and standing while playing the guitar, shown in the Fig.3 and Fig.4 :



Figure 3. Playing the guitar on position Standing

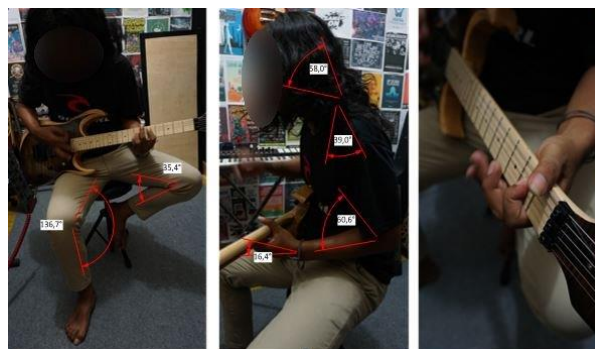


Figure 4. Playing the guitar on position Sitting

Based on the table above that the final REBA score value when standing position is obtained the score value in table C and the score activity with a value of +1, then the final value (Grand Score) obtained which is 11 indicates that the activity is very dangerous and needs to implement changes immediately related to the guitar player's body posture or the design of the guitar used, so as to reduce the risk of injury and the burden of the guitar player when standing up, While the final REBA score when seated gets the score in table C and the score activity with a +1, then obtained the final value (Grand Score) obtained which is 9 indicates that the activity

needs to immediately implement changes related to the guitar player's body posture or the design of the guitar used, so as to reduce the risk of injury and burden from the guitar player when sitting.

3.5. Mapping Results of Work That Have Risk of Injury

The following are the results of the mapping between work postures and body postures that are at risk of injury from several previous identification methods, and then will be presented in more detail.

TABLE 5. Mapping Work Posture with Body Posture in Standing Position





No	Overview of Work Position Posture	Posture That Experienced Complaints of Pain	Score Results				
			NBM	QEC	RULA	REBA	
1	Guitar Picking Process The Right Perspective	Upper neck	54	8	3	2	
		Neck down	54	8	3	2	
		Right shoulder	52	14	-	-	
		Right Elbow	53	-	-	-	
		Right Upper Arm	-	-	3	3	
		Right Forearm	63	18	3	1	
		Right Hand Wrist	59	18	3	2	
		Right hand	51	-	1	1	
		Legs	-	-	1	4	
		Overall Score Results					
		Score NBM > 50 = Medium Risk					
		Result Score Each Posture					
	Score QEC > 50 = Need Change						
	Score RULA > 7 = Need Change						
Score REBA > 11 = High Risk							
2	Guitar Picking Process Rear View Perspective	Left Shoulder	70	14	-	-	
		Back	53	18	3	3	
		Waist	57	-	-	-	
		Left Forearm	55	18	3	1	
		Left Hand Wrist	73	18	3	2	
		Left hand	71	-	1	1	
		Legs	-	-	1	4	
		Overall Score Results					
		Score NBM > 50 = Medium Risk					
		Result Score Each Posture					
Score QEC > 50 = Need Change							
Score RULA > 7 = Need Change							
Score REBA > 11 = High Risk							

TABLE 6. Mapping Work Posture with Body Posture in Sitting Position

No	Seated Work Posture Overview	Posture That Experienced Complaints of Pain	Score Results				
			NBM	QEC	RULA	REBA	
1	Guitar Picking Process Frontal Perspective 	Upper arm	-	-	2	2	
		Right Forearm	-	-	2	1	
		Right Hand Wrist	51		3	1	
		Right hand	-	-	1	1	
		Legs	-	-	1	4	
		Overall Score Results					
		Score NBM > 50 = Medium Risk					
		Result Score Each Posture					
		Score QEC > 50 = Need Change					
		Score RULA > 7 = Need Change					
		Score REBA > 9 = High Risk					
2	Guitar Picking Process Rear View Perspective 	Neck	-	8	3	2	
		Left Shoulder	51	-	-	-	
		Back	-	18	-	3	
		Left Forearm	55	-	2	1	
		Left Hand Wrist	71	-	3	1	
		Left hand	65	-	1	1	
		Legs	-	-	1	4	
		Overall Score Results					
		Score NBM > 50 = Medium Risk					
		Result Score Each Posture					
		Score QEC > 50 = Need Change					
Score RULA > 7 = Need Change							
Score REBA > 9 = High Risk							

4. Conclusion

It can be concluded that the relationship between work posture and body shape when playing the guitar in a sitting and standing position has a risk of injury that needs to be changed, therefore researchers will focus more on changing aspects of design on the anatomy of the electric guitar by implementing several ergonomic concepts, and then these results will be a reference and consideration in designing an ergonomic guitar design that suits the needs of consumers. Because, if changes are made by changing the work posture or how to play the guitar it will be difficult for the guitar player, because everyone has the habits and how to play the guitar itself, because basically playing the guitar is universal.

Therefore, the best choice in overcoming the risk of injury is to have to change the design of the guitar, because changing the design will automatically change the pattern of work postures and body posture will also follow the reflexes of the guitar design. So many luhier guitars now develop ideal ergonomic guitars, not only for custom or individual needs but also ergonomic designs that can be used for everyone and are widely accepted by the market.

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Corresponding Author: Bambang Suhardi, Department of Industrial Engineering, Universitas Sebelas Maret, Indonesia.

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