

# Evaluation of Validity and Reliability of Rapid Upper Limb Assessment (RULA) Method in Research Experiment: A Systematic Review

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## Abstract

This research paper presents an evaluation of the validity and reliability of Rapid Upper Limb Assessment (RULA) method used in research, examination and experiment. A systematic review process is adopted in this evaluation approach. A range of scientific journals in which the RULA method is adopted in their respective research fields are selected for the systematic review and evaluation of the RULA method's validity and reliability. The RULA method is used in the research area for the assessment of ergonomic risk levels using a defined evaluation scoring method with regard to different body postures adopted whilst working or performing certain tasks. It is important to systematically evaluate and examine the RULA method of assessment in the field of ergonomic study to ascertain its validity and reliability performance. In many research areas, ensuring validity and reliability are critical parameters with regards to the research methodology used, the test criteria, the hypotheses development, the assessment tools used and also the data collected and evaluated. Thus, in the research area where RULA method is adopted, it is primarily crucial to ensure that validity and reliability are upheld and achieved. Discussion of the test of validity and reliability is also pursued in this research paper to encompass the holistic evaluation of the RULA method. Finally, the final judgement is made by proving the hypothesis whether RULA method is valid and reliable for use for research and evaluation. The scoring of risk levels will be determined and concluded.

## Keywords

Rapid Upper Limb Assessment, Validity, Reliability, Posture, Evaluation Scoring Method, Ergonomic Risks Levels, Research Experiment

## 1. Introduction

Researchers often need test evaluation or assessment tools to be used and adopted in their respective research areas to quantify their data and make analyses from there onward. Hence, many researchers, especially in the field of ergonomics, will resort to evaluative scoring test tools or measurement methods available in the field of study to adopt their research methodology approach. One of the commonly available research tools used for the evaluative score assessment in various ergonomic or posture evaluations and experiments is the Rapid Upper Limb Assessment (RULA). RULA has been adopted by many researchers and scientists in their research experiments to assess and examine ergonomic issues, namely body posture evaluations, with regard to risk levels. Thus, it is of paramount importance for this research evaluative scoring tool, namely RULA, to be valid and reliable in its evaluation and assessment performance for a variety of research experiments. RULA is a quick, fast evaluative scoring tool that can be used to assess the different risk levels of the parts of the body, such as the arm, lower back, hand, wrist, and neck when performing tasks. RULA can be used to determine whether there are ergonomic risks for the various body postures adopted to perform the task. Due to the high usage and adaptation of the use of RULA in many research and experiments, this paper aims to evaluate the validity and reliability of the RULA method through comprehensive study and systematic reviews of research journals that have adopted the RULA methods in their respective research experiments. The research data gathered can only be valid and reliable if only the research instrument or research tool used is also valid and reliable, *vis a vis*, the RULA method assessment adaptation.

## 2. Research Objectives and Rationale

Two main research objectives are formulated and developed to ensure that the research works progress in alignment with the appropriate line of achievements to ensure targeted consistency and relevancy.

The overall research objectives are:

- 1) To perform a systematic review, literature study and content analysis of published journals to determine the validity and reliability of RULA method of body postural assessments.
- 2) To identify any benefits or lapses or limitations of the RULA method of assessments in the evaluations of body postures in research experiments.

The rationale of this research is to determine the validity and reliability of the RULA method of assessment for body postures so that researchers can adopt it more confidently with little margin of errors or no tolerance of errors for their respective research areas. This research paper is also determined to identify any lapses or shortfalls or limitations of the RULA method of assessment so that recommendations can be made to improve further its usage for any scientific research experiments in the future. Hindsight, the benefits of using RULA method of assessment is also another rationale of this research paper so that scientists or

researchers can adopt the assessment method of RULA with high confidence without any doubts of the tool in any scientific experiments or measurements.

### 3. Definitions of RULA, Validity and Reliability

Rapid Upper Limb Assessment (RULA) is designed to allow analysis of biomechanical or postural stresses on a worker's upper limbs. RULA is a method to detect the risk of developing Muscular Skeletal Disorder (MSD). RULA method allows an assessment based on the various joints and joint angles when carrying out tasks requiring the upper part of the body. The Rapid Upper Limb Assessment (RULA) method was first developed Dr. Lynn McAtamney and Professor E. Nigel Corlett, ergonomists from the University of Nottingham in England. RULA is a postural targeting method for estimating the risks of work-related upper limb disorders. A RULA assessment gives a quick and systematic assessment of the postural risks to a worker. The analysis can be conducted before and after an intervention to demonstrate that the intervention has worked to lower the risk of injury. RULA has now been frequently adopted assessment and evaluation tool used for many researchers in their respective research fields, especially in the area of ergonomics and human body posture risks. Thus, it is paramount important that this RULA evaluation tool is used effectively and efficiently. Prior, to ensure its effectiveness and efficiency, RULA as an assessment tool must be first be valid and reliable. The validity and reliability of the RULA assessment method must be determined.

The connotation of validity and reliability of research tools must be understood prior to any engagement and usage of them. Validity means “the quality of being based on truth or reason, or of being able to be accepted.” [1] Whereas, the meaning of reliability is “the quality of being able to be trusted or believed because of working or behaving well.” [1] In another perspective of research, the meaning of reliability refers to whether or not you get the same answer by using an instrument to measure something more than once. In simple terms, research reliability is the degree to which a research method produces stable and consistent results. [2] Meaning of validity in research, according to Yeshaswi G., refers to the accuracy and significance of the data. [3] When research is valid, it means that the methodology and measurement technique are valid and capable of gathering results that align with the research objective. There are different types of validity according to Yeshaswi G., namely construct validity, content validity, face validity, and criterion validity. Construct validity ensures that the method used to measure something aligns with what it is trying to measure.

Content validity examines whether a test adequately represents all aspects of the topic of measures. Face validity evaluates how appropriate the content of a test appears at first glance. It shares similarities with content validity, but is a more informal and subjective evaluation. Criterion validity, also known as criterion-related validity, assesses how well a test measures the specific outcome it was intended to measure. Yeshaswi G., gives a different perspective on reliability in re-

search, sharing his definition of reliability in research as that collecting data is consistent and dependable, like having a steady hand that produces the same results for a given task. In a research context, reliability ensures that the results would be consistent each time if the same study were repeated using the same reliable method. It's similar to having different researchers independently conduct the same experiment and obtain outcomes that match perfectly. By knowing the meaning of both terms of validity and reliability, this research will explore and examine various researchers' methods of using RULA as part of their research evaluations and thus review whether these research works conform and envelope to the validity and reliability terms and meanings.

#### **4. Research Methodology**

The research method adopted in this research work is by comprehensive systematic reviews of the scientific journals with regard to the use of the RULA assessment tools. A systematic review is adopted to ensure that experiments that utilize the use of RULA method of assessment can be fairly evaluated in a systematic manner without jeopardizing the nuances of the importance of the reliability and validity of RULA method. These research journals should have shown some evidences of consistency of results with regard to the use of the RULA method of assessment so that it could prove that the RULA method is reliable since it is able to provide consistent results. At the same time, the data results generated from using the RULA Method assessment in all these research works is able to present and demonstrate the evidences of validity of the research results, namely content validity.

Thus, this systematic review is intended to uncover evidence of reliability and validity of using the RULA assessment method for the various research works performed by various researchers. The systematic reviews done here are also to establish the significance and accuracy of the data resulted from these research works by these different researchers so that the validity of the RULA method can be justified and supported. The comparison of the extensive range of data collected, derived from the use of the RULA method in different research settings by various researchers, further illustrates the method's reliability. If the comparisons made do not signify any major differences across the various research settings that utilized the RULA method, this would indicate that the RULA method is a highly effective tool. The reliability of this assessment and evaluation tool is thus demonstrated to be consistent, yielding a high level of confidence.

The research strategy of this systematic review is to ensure that the criteria of the definitions of reliability and validity are included in the content analysis of these journals, namely showing consistency of results-obtained from the RULA method used in all the experiments in these journals and the data results illustrated the achievements of the objectives intended of all these research journals respectively. Other criteria under the ambit of the definition of validity and reliability are excluded for these systematic reviews to be more focus-driven and qual-

ity orientated in pursuit of this systematic review of scientific journals using the RULA method adaptation. Further research can be made later using other criteria for all inclusion purposes. Due to the limited time and resources, only two criteria are being adopted in the research methodology of this systematic review process. Another exclusion of this systematic review process is the comparative approach to distinguish the difference between the nuances of validity and reliability so that this research article is able to adopt simplicity in its approach.

## 5. Findings and Data Analysis

The data collated from the systematic review from all the 10 related scientific articles are examined and evaluated comprehensively and thoroughly. The 10-related scientific articles are sourced from the related topic of the usage of RULA Method of assessment as a test tool used in their various research experiments. One of the scientific articles systematically reviewed is entitled “Ergonomic risk assessment of working postures of nurses working in a medical faculty hospital with REBA and RULA methods”, written and authored by Ozkan Ayvaz, Bedia Ayhan Ozyildirim, Halim Issever, Gozde Oztan, Muhmmmed Atak and Sevda Ozel from the Department of Public Health, Istanbul University Faculty of Medicine, Istanbul, Türkiye [4]. The aim of the study is to reach objective results about the ergonomic risks of nurses’ working postures not only by using questionnaires, but also by using Rapid Entire Body Assessment (REBA) and Rapid Upper Limb Assessment (RULA) methods, which are risk assessment methods used in engineering fields. The study is a cross-sectional study. A total of 383 nurses were evaluated using a survey. Of these, 91.4% were women and 6.5% were men. The average age was 38.20 years for females and 31.5 years for males; the average weight was 65.50 kg for females and 81.50 kg for males; the average height was 162.7 cm for females and 176.80 cm for males; and the average body mass index (BMI) was 24.80 for females and 26 for males. The hospital was divided into eight workstations, where the REBA and RULA scores of the three nurses working at each workstation were calculated, and the average REBA and RULA scores for each workstation were determined. The percentage of those who experience musculoskeletal pain in the last one year at each workstation and the mean REBA-RULA scores were as follows; ward (92%; 6.92 - 5.69), operating station (98%; 10 - 7), emergency department (100%; 6.08 - 5.33), outpatient clinic (75%; 5.5 - 5.16), intensive care (94%; 6.21 - 5.57), administrative affairs (94%; 5 - 5), laboratory (95%; 5.80 - 5.2), and interventional procedure (92%; 6.4 - 5.4). In these stations, the highest scores were seen in the operating room. In the questionnaire, 92.46% of the nurses reported experiencing complaints in at least one area of the musculoskeletal system over the past year. The hospital’s weighted mean scores were REBA 6.86 and RULA 5.71. When the REBA and RULA measurements were evaluated, it was found that the risk levels in the departments where the nurses worked were generally at medium risk. The REBA and RULA scores indicate that ergonomic changes and adjustments should be implemented. To make this determination, the risks associ-

ated with working postures should be assessed using quantitative methods.

One of the limitations of the research is that no logistic regression comparisons were made. As a result, literature on this subject was examined and it was understood that the musculoskeletal complaints of the nurses were seen at levels that can be characterized as high, that is, above the medium value in both the survey results and the REBA and RULA score results. It is seen that this study and the literature reviewed have similar results. The subjectivity of the data in surveys can affect the reliability of the results. Therefore, it is recommended that posture risks be measured at regular intervals not only by survey method but also by systematic observation methods in order to be cheap and objective. Although NIOSH, OWAS, etc. measurement methods are among the systematic observation methods, REBA and RULA methods have recently been preferred in the field of health due to their suitability. Overall, it was found that the limitations do not affect any of the validity and reliability of the data results. Furthermore, it was found that the research article suggested the RULA method as part of the preferred method of measurements and thus validating the fact that it is a reliable tool of measurement as compared to other methods of measurements.

The second article under systematic review is entitled, “Comparing the Effectiveness of Three Ergonomic Risk Assessment Methods—RULA, LUBA and NERPA—to Predict the Upper Extremity Musculoskeletal Disorders”, written by team of researchers namely Yazdanirad S., Khoshakhlagh A.H., Habibi E., Zare A., Zeinodini M., Dehghani F. from the Department of Occupational Health Engineering, School of Health, Tehran University of Medical Sciences [5]. The study covers the objective to compare the three different ergonomic risk assessment methods—rapid upper limb assessment (RULA), loading on the upper body assessment (LUBA) and new ergonomic posture assessment (NERPA) method to predict extremity musculoskeletal disorders. The research was conducted on 210 workers from three different industries including pharmaceutical, automotive, and assembly in Isfahan province. A Nordic questionnaire was used to determine the level of musculoskeletal disorders. Then, selected postures were evaluated with RULA, LUBA and NERPA methods. Finally, data were analyzed with the Kolmogorov-Smirnov test to check the normality distribution of data, Spearman’s correlation test to investigate the correlation between the assessed levels with musculoskeletal disorders, and the Wilcoxon test to identify significant differences between the values with SPSS version 16. The final results demonstrated that the Wilcoxon test revealed a significant difference between the values related to NERPA and RULA ( $P < 0.0001$ ), whereas no significant relation between LUBA and RULA was shown by the test ( $P = 0.914$ ). The correlation coefficients between the level of musculoskeletal disorders and the RULA and LUBA levels were 0.74, 0.73, and 0.69, respectively. The conclusion made from this research demonstrated that there are indications of low-risk level in NERPA, medium-risk level in LUBA and high-risk level in RULA in which RULA method signifies a better evaluation method of assessment. The results showed that RULA was the best

method for assessing musculoskeletal disorders among the three methods. Hence, this research strongly implies that the RULA method is not only valid and reliable as an evaluation method, but it also demonstrates superiority compared to the other two methods, LUBA and NERPA.

The third scientific article in the systematic review process is an article written by A.H. Wibowo and A. Mawadani, entitled, “The Analysis of Employees’ Work Posture by using Rapid Entire Body Assessment (REBA) and Rapid Upper Limb Assessment (RULA).” [6] The study aimed to analyze the work postures of employees by using REBA and RULA methods. In this study, the angles of the employee's body were calculated, and the results showed that for body part B, the angle of back movement is 77° of flexion, the neck is at 18° of extension, and the leg is at 39°, while the leg is not uniformly supported. For another body part, the upper arm forms an angle of 65° of flexion, the forearm is at 13° of flexion, the wrist is at 0° of flexion, and the wrist is in the intermediate range of rotation. Based on the results of RULA, a grand score is 7, categorized as Action Level 4. Meanwhile, based on the results of REBA, the grand score obtained is 11, and also categories as Action level 4. Based on the calculation of work posture using RULA and REBA methods, it revealed that the operator’s work posture has a high-level and dangerous risk. Therefore, the operator needs to immediately improve his work posture. In addition, due to the lifting position that was started with no squatting position, it caused waist injures, since it becomes lift’s pedestal.

The research study showed that the data collected and the results obtained using both the REBA and RULA methods are consistent with each other and supportive. The research also justified that the study is in accordance with previous research which states that the RULA and REBA methods can show maximum results in assessing good work positions, and the study agrees with previous research which states that the RULA and REBA methods are methods that can provide comprehensive results in determining a good work position in order to know whether repairs need to be done immediately or not. In addition, this research complements previous research that only uses the RULA method, so that the results obtained will be renewable information. Hence, in the overall evaluation of the RULA validity and reliability, it is of no doubt that this third systematic review, proves the significance of concrete evidence that the RULA method is fully justified for its reliability of usage and also validity in the data results obtained as shown in this third data systematic evaluation of the third journal. Unlike the previous systematic review of the second article where comparison is made between different methods of assessment, namely NERPA, RULA and LUBA, the third systematic review goes deeper into comparing with previous research and the outcome of the research justified that the results obtained can be accepted and are valid with utmost reliability when using RULA method of assessment on work posture.

The fourth scientific article under scrutiny of systematic review is entitled, “Ergonomic Analysis of Working Postures at a Construction Site using RULA and

REBA Method,” authored by Md. Golam Kibria, from the Department of Industrial Engineering and Management, Khulna University of Engineering & Technology, Khulna, Bangladesh [7]. The study analyzed the working postures of construction workers and assessed the level of risk of injury in their work. Four categories of working postures were collected from elementary works as a form of still pictures from the construction site. Two assessment tools RULA (Rapid Upper Limb Assessment) & REBA (Rapid Entire Body Assessment) were used to assess the working postures of construction workers. Results showed that beam and column casting and masonry workers were at high risk of injury due to the absence of maintaining proper working postures during the work. This study suggested construction workers maintain proper postures during works for avoiding any occupational injuries.

The research study does not unveil any limitations to the use of both methods of RULA and REBA. The data are analysed without any indications of any significant weaknesses of the tool measurements used and adopted. Indeed, the research hypothesis proven supported other research works done on similar settings in the construction site environment. No distortion of any data of results demonstrated in this research work. The visibility of the poor postures adopted from the observations done for the various construction works are inline and align to the measurement of the RULA method and its final results. This showed that there is definite validity and reliability of the RULA method adopted in this research. The author also stated that the RULA and REBA methods are commonly used assessment tools for evaluating working postures. Additionally, the author mentioned that both RULA and REBA are popular ergonomic tools that require no equipment and easily identify the risk levels of predictable and unpredictable postures. He also referenced other research that adopted the RULA and REBA method for working postures evaluations of risk level. Hence, from the author’s writings, opinions and perspectives, it suggested and indicated that RULA method is one of the reliable and valid method as a tool for assessment and evaluations of working postures risk levels.

The fifth scientific article under systematic review is entitled, “A Comparative Assessment of Ergonomic Risk Factors in University Personnel Using RULA and REBA Aiming to Study the Cause and Effect Relationship,” written by Chowdhury N. from Louisiana State University and Agricultural and Mechanical College [8]. The research aims to conduct an ergonomic assessment of working postures and the design of computer workstations of the employees in Louisiana State University. The purpose of the study is threefold namely, 1) to determine the major ergonomic issues in university employees while working on computer workstations, 2) to compare the two ergonomic assessment tools (RULA and REBA) to see how similarly or differently they assess the risks present in the same working condition and 3) to develop a model that correlates between working condition, work posture and computer workstation design with their effects on musculoskeletal system. This research was constituted of a comprehensive survey (5 minutes) and a

quantitative risk assessment session (20 minutes) conducted over 72 participants and their workstations in the university workplace. Along with the pre-assessment questionnaire; the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) and two ergonomic assessment tools REBA (Rapid Entire Body Assessment) and RULA (Rapid Upper Limb Assessment) were used to quantify the ergonomic risk factors. To evaluate the computer work stations “OSHA Computer Workstations eTool—Evaluation Checklist” was used.

The greatest number of participants (75.71%) reported suffering from upper and lower back pain. Following this were discomfort in the shoulder and upper arm (45.71%), and then in the forearm and wrist (42.85%). The average RULA score (5) was higher than that of REBA (4), indicating that RULA is a more consistent assessment tool for evaluating upper limb activities, such as working at a computer workstation. In 85.48% of cases, the RULA score was the same as or higher than the REBA score, which suggests that the strenuous work of office employees causes more disorders in the upper limbs than in the lower limbs. Proportional odds ordinal regression model was used to identify the most significant factors contributing towards the WMSD symptoms which are, 1) inappropriate positioning of computer monitor and exposure to prolonged awkward posture of the 2) trunk or torso, 3) shoulder-upper arm, 4) forearm-elbows and 5) wrist and hand. Three equations were developed for predicting the probabilities of a user having slightly, moderately or very uncomfortable pain when the postural and design factors are given.

The study had evidently demonstrated that RULA performance is much better in terms of consistency as compared to REBA. The study unveiled the unique differences between both assessment tools of RULA and REBA. It turns out that RULA provided better results and more detailed information to support the hypothesis. Thus, by having this research conducted, it was proven that RULA provides better reliability in terms of consistency of data and results. It also demonstrates the validity of the assessment tool, as RULA provides data that are similar to those obtained from REBA, reinforcing the conclusion about the validity of the data from both assessment tools.

The sixth and seventh scientific articles being systematic reviewed next is entitled, “A deep learning-based RULA method for working posture assessment,” written by Li Li and Xu Xu [9]; and “Ergonomic Risk Assessment Using RULA in Relation to Mobile Gaming,” written by Sharma P. and Gaur G. [10]. Both these scientific research articles indicated that the RULA method used as an assessment tool for postures evaluations is valid and reliable. Li cited that RULA is one of the most popular observational methods in industrial practice due to its simplicity and effectiveness. However, RULA, as other observational methods, suffers from two major weaknesses. First, experience raters are needed for the evaluation, which can be less cost-effective. Second, the final score is subject to inconsistency brought by the subjectivity of the raters. To tackle these limitations, some studies adopted wearable sensors, such as inertial measurement unit and electromyogra-

phy sensors, to facilitate real-time data collection. The recent development in computer vision provides a great opportunity to address these weaknesses. For example, a single RGB-D camera (e.g. Microsoft Kinect) can be used to estimate human 3-D pose. Whereas as for Dr. Pooja Sharma's view on the use of the RULA method signifies the validity of RULA method as one of the effective screening tools to assess the risk factors the person is exposed to in the light of the posture assumed (by the neck, upper limb and trunk) and the use of muscles and other external loads or forces experienced by the body. She proved in her research that neck MSDs (Musculoskeletal Disorders) were significantly correlated with the RULA Action Level and Grand Score for both the right and left sides. Upper back score too, were significantly correlated with the RULA Action level and Grand Score for both the right and left sides. Further, RULA Score A of left side was correlated with the wrist MSDs, and RULA Score C of left side was correlated with the shoulder MSDs. The above opinions from these research authors are evident to conclude that their research proves the validity and reliability of the RULA method of assessment.

The eight scientific article under the systematic review process is written by I Wayan Gede Suarjana, Moh Fikri Pomalingo and Fety Fathimah entitled, "Evaluation of work posture using Rapid Upper Limb Assessment (RULA) methods: a case study." [11] This study aims to evaluate the work posture of bean-roasting process workers. The RULA method is used for eight workers. The results obtained were work posture with a low category of 25%, risk with a medium category of 38%, and risk with a high category of 50%. The conclusion of this study, namely the evaluation of work postures that have been carried out in this small industry with the RULA tool, is that a significant proportion of workers are in unsafe and insecure positions, as found by the author. This is due to the fact that small and medium enterprises are lack of ergonomic knowledge and awareness. The study emphasis that the RULA method was developed to detect work postures at risk and make improvements as soon as possible. In the study too, there is no discussion on the limitations of the RULA method and this has shown the validity and reliability of the RULA method with data being obtained with easy and comfort manner. The study has also shown evidence that RULA method can be used as a tool to ensure timely intervention of any ergonomic risks and proper mitigation recommendations can be made based on the results of RULA score. Thus, the validity and reliability of the RULA method cannot be denied, as the data obtained in this experiment indicate a critical need for early ergonomic interventions.

The ninth scientific article for systematic review of RULA method validity and reliability is entitled, "Rapid Upper Limb Assessment (RULA): Validity and Reliability Evidences in Identifying Workplace Ergonomics among Bank Employee's Using Computers," written by Kumar A. and Kamath S. [12]. The objective of the study is to examine the validity and reliability of RULA among the bank employee's using computers. A total of 301 participants were recruited in this study, in which 170 participants were males, and the other 131 were females. Concurrent

validity of RULA with the criterion measure REBA is found to be good as measured by spearman's rank correlation test,  $P = 0.91$  ( $P < 0.001$ ). Intra and inter-rater reliability of RULA is found to be excellent with ICC = 0.92 (0.90 - 0.94) and 0.91 (0.89 - 0.93) respectively. In conclusion, validity and reliability of RULA have been established among the bank employees' using computers and there exists good validity and excellent reliability among them.

The last scientific article is written by Rosman Bin Abdul Halek, Arun Dev, Kew Hong Chew and Mohammed Abdul Hannan entitled, "Ergonomic Risks on Driver's Posture Interface." [13] This research presents a study and analysis on the existence of ergonomic risks to drivers while sitting in the vehicle seat for prolonged periods in static posture during driving of a vehicle. The main aim of this research is to understand and prove the hypothesis on the existence of ergonomic risks of drivers in the sitting static posture in the vehicle. The vehicle in the study is a car. Test subjects are samples, for the field experiments at the three percentiles namely the 5th, 50th and 90th percentile range of drivers in Singapore. The demographic parameters for the test subjects identified for the purpose of this research encompass the gender, age range and competency level. The dependent variable use for this research is "driver posture" whilst the independent variable used is the "ergonomic risks". The research is important to understand the existence of ergonomic risks for awkward sitting postures in order for ergonomists and especially car manufacturers to take into consideration of ergonomic safety factors in designing car seats in this modern era and advanced technology age. The research adopts the RULA method in performing the assessment and evaluation of the static sitting postures of these drivers. The good aspect of the research is that it adopts the inter-rater method of assessment where more than one assessor is needed to perform the RULA method of evaluation of the risk levels. Thus, by having a different person observing and conducting the RULA assessment, this provide a strong justification that the RULA method as a tool of assessment is valid and reliable since the results obtained is true and consistence amongst the assessors. In addition, the research also performed expert interviews to ensure that the RULA method data scores and results aligned with the views and opinions given by these experts in the field of ergonomic risks study.

## 6. Conclusion & Recommendations

In conclusion, the RULA method is proven by these systematic reviews of scientific journals to be a valid and reliable tool for the assessment of risk levels for ergonomic body posture evaluations. The systematic reviews performed in this research article unveiled a concrete and consistent outcome of identifying that the RULA method is valid and reliable. The systematic reviews of these scientific journals demonstrated that the RULA method is evident to be valid and reliable by having to compare the results obtained using other methods such as REBA and it turned out to be similar and consistent in comparison. In addition, some of these research journals also compare the data obtained by RULA method to be the same

as previous research experiments in different settings. Intra- and inter-rater methods are also used by these researchers to ensure the validity and reliability of the RULA method adopted, which has been significantly proven to be true. The data gathered from RULA methods used is able to be justified in terms of consistency of data, hence proving the reliability of results and data collated due to rapid and unchanged consistency throughout. With regards to content validity, it holds true for these 10 scientific research journals because the research data gathered from the RULA method is able to align and achieve the objectives of each of these research works. This research of systematic reviews of the RULA method's validity and reliability is very important for researchers in the field of ergonomic and work posture evaluations since the validity and reliability of RULA method will affect the final outcome and results of their research works. Based on the two criteria set in the research methodology of this systematic review, it is safely concluded that the two criteria had been met without any ambiguity, namely achieving consistency of results from the RULA method adopted in all these research experiments to show reliability and also achievement of the objectives in alignment of the data results of the RULA method to show validity.

One benefit of this research work is to give a level of confidence for researchers embarking on the ergonomic assessments using RULA method that the method used is valid and reliable, and thus, the data and results obtained can be used without any doubts. Other benefits include correcting any improper or awkward postures after the outcome of the RULA method assessment so that proper education and coaching can be done to correct this misalignment of postures. The limitation of the RULA method is that it is a tool used to observe human beings with regard to posture, thus resulting in subjectivity and ambiguity at times. However, this challenge can be overcome with other added computer simulation measurements of the postural angles or the use of EMG for better enhancement of these observations and postural calculations for accurate measurements, thus eliminating the bias and subjectivity portion with added objective and quantitative concrete data. It is recommended that future researchers who will be adopting the RULA method ensure validity and reliability in many ways justifications apart from having to understand that this research of systematic reviews gives them some level of confidence to adopt the RULA method for their experiments.

### **Conflicts of Interest**

The authors declare no conflicts of interest regarding the publication of this paper.

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