Covenant Journal of Engineering Technology (CJET) Vol.4 No.2, December, 2020
ISSN: p. 2682-5317 e. 2682-5325

An Open Access Journal Available Online

Reliability of a Health and Safety Complaint Ergonomic Assessment Tool Developed for Improved Work Posture Assessment on the Shop Floor

Mgbemena, Chika Edith

Department of Industrial & Production Engineering, Nnamdi Azikiwe University, Awka, Nigeria.
ce.mgbemena@unizik.edu.ng

Received: 18.03.2020 Accepted: 01.10.2020 Published: 31.12.2020

Abstract- Strategies for minimising the rate of occurrence of awkward postures during manual handling operations have been recommended. Awkward postures, if adopted for prolonged periods, can result in Musculoskeletal Disorders (MSDs). Hence, manual operations need to be assessed to identify if awkward postures exist. A real-time automatic Health and Safety (H&S) compliance posture assessment tool based on 3D sensing technology has been developed to assess operators undertaking manual handling tasks. This paper presents the validation of the developed tool using a reference tool. The analysis results indicate little notable angular discrepancies in the data measured by the developed tool and the reference tool. Comparing the data measured with the two tools, it is evident that there is remarkable consistency. The tool could be useful in workplaces to assess new workstations' safety and correct workers' methods in real-time.
Keywords: Microsoft Kinect; Musculoskeletal Disorders; Awkward Postures; Ergonomics; Manual Handling

1. INTRODUCTION

Strategies for minimising awkward postures' rates during manual handling operations have been recommended and include improved workstation design, modified tool design, proper reach distances, adjustable seated and standing workstations [1]–[8]. Researchers have recommended posture assessment as a remedial measure to minimise MSD threat because effective posture assessment is important in ensuring postural comfort [9]–[11]. Existing assessment is normally carried out by observing several operations and carrying out analysis afterward. Although some improvements can be identified for the operations, this lagging assessment cannot alert operators and prevent them from adopting awkward postures in time. The real-time automatic health and safety assessment tool developed by [12] that can prompt the workers to adjust their work postures continuously is of great significance in workplaces .

There are two methods by which human work postures are analysed on the shop floor – the observational technique and the instrument-based technique. The observational technique uses visual perception to evaluate the rate at which the body moves away from the neutral position. These include the Ovako Working Posture Analysis System, Rapid Upper Limb Assessment, RULA, the Quick Exposure Check, the Rapid Entire Body Assessment, REBA [13]–[18]. The tools are time-consuming and labour-intensive [19].

The instrument-based technique records work postures using instruments [20]. These tools often require offline data collection for posture assessment and include the force plate, photography. Direct body measurements using the goniometers, inclinometers, and 3D analysis using markers. Electromagnetic tracking system, 4D Computer tomography (4D CT) [13], [21]–[24]. Active and passive video-based systems such as the NDI and the Vicon Motion capture systems can pose great problems because they are complex and bulky [25]. The Electromagnetic tracking system, which is less bulky, is less accurate because of the magnetic field interferences caused by metallic objects on the shop floor. The Inertial systems, such as the Xsens, also have their accuracy greatly affected by metals [26]. Photographs and videos often produce an inaccurate measurement of joint angles resulting from distortions caused by camera placement issues [13].

This study is aimed at testing the developed real-time, automatic, health and safety compliance ergonomic posture assessment tool, which is based on 3D sensing and tracking technology for reliability and validity under repeatable and reproducible conditions

2. MATERIALS AND METHODS

A 12-inch, 360 degrees goniometer was used in this study to measure the exact back flexion, elbow flexion, and shoulder flexion angles of the participants.

2.1. Experimentations

Testing the developed tool, an experiment was conducted to evaluate the closeness of agreement in the tool's measured data and compare the captured data with data from the reference tool (Goniometer). For all the tests, the participants were asked to perform tasks while facing the Kinect at a 2m-distance and 90° horizontal field of view from the sensor, which is placed on a tripod 1.2m above the floor [27], as depicted in Figures 1a and 2a. The back and arm postures were measured at a specified time using the developed tool, as the participants performed the assigned tasks. The Goniometer was also used to record the same angles of the participant at that posture. The measured angles include the back-flexion angle, the shoulder flexion angle, and the elbow flexion angle.

2.2. Data Processing and Statistical Analysis.

Two tests were conducted to assess the precision of measurements obtained from the developed tool compared to the goniometer measurements. These are the repeatability and reproducibility tests.

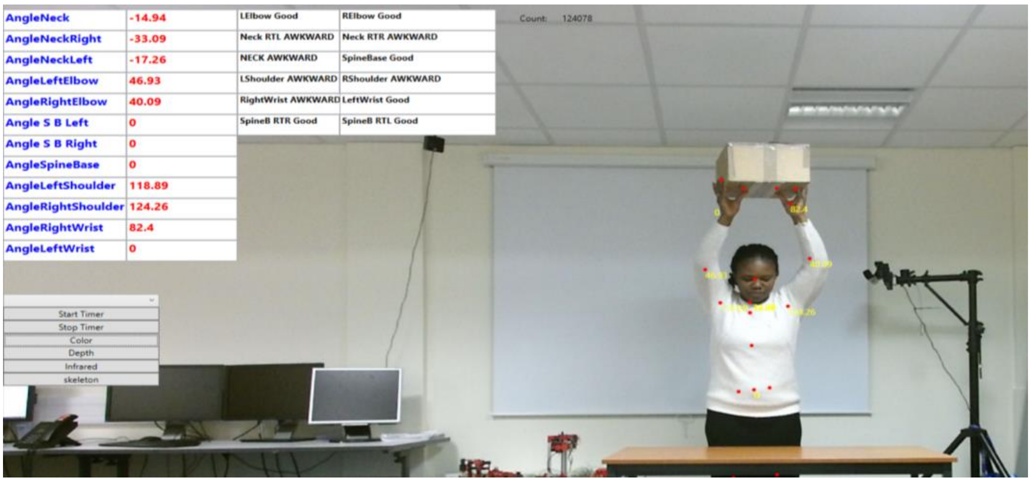
2.2.1. Repeatability Tests

While a sole participant repeatedly performed a lifting-above-head-height task, the elbow and shoulder angles were measured using the developed tool and the Goniometer. The purpose of the test was to evaluate the consistency and conformity in the data measured by the two independent tools and, consequently, the tool's reliability, when a participant's postures are assessed while wearing the same clothing to perform the same task with the same load severally at the same workstation. The experimental setup for this study is depicted in Figure 1a. The participant, shown in Figure 1b, was asked to lift a load of 0.5kg from a work table to above head height, while the elbow and shoulder flexion angles are captured at 5 seconds from the start of the lift depicted in Figure 1c. The Goniometer is then used to measure these angles simultaneously as the participant maintains the same posture. This procedure is repeated 30 times. For each capture, the Goniometer is used to measure the participant's elbow and shoulder flexion angles.

The developed tool's measurement results were compared with those of the goniometer measurement to assess the level of agreement and consistency, which helps to inform the precision of measurements obtained from the developed tool. The difference in angular measurements is statistically analysed using the mean, standard deviation, and the inter-item correlation between the two tool's measured data. The intraclass correlation coefficient (ICC) was used to evaluate the tool's test-retest reliability in SPSS version 24.0. The significance level was set at $p < 0.05$ and the results obtained was evaluated from 0 to 0.5 = no/poor agreement/reliability, 0.5 to 0.75 = moderate agreement/reliability, 0.75 to 0.9 = good agreement/reliability and >0.9 = excellent agreement/reliability [28]. ICC was selected because of its suitability in assessing the consistency of quantitative measurements made by different devices measuring the same quantity.

a. Experimental Setup for the repeatability test

b. Participant during the repeatability test



c. Screenshot of the participant as captured by Kinect during repeatability test

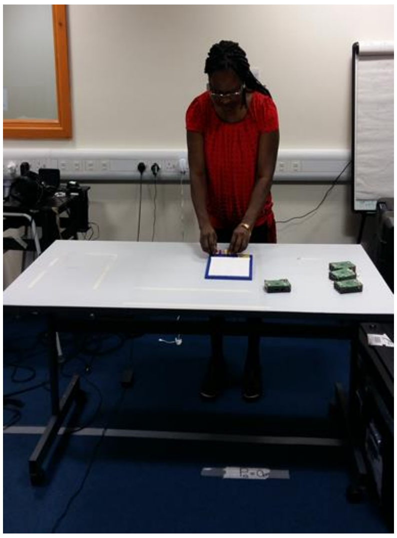
Figure 1. Participant during the repeatability test

2.2.2. Reproducibility Tests

The purpose of the reproducibility test conducted in this study was to evaluate the consistency and conformity in the data measured by the two independent tools. During the test, postures of different participants were assessed while wearing different clothings to perform different tasks involving different loads in different workplace locations. Sixteen different volunteers participated in the study. Some of the tasks undertaken are presented in Figure 2 and include lifting, hammering, sitting to handle, assembly tasks, and carrying the load. Figures 2a and 2b depict the experimental Setup for the assembly of electrical components and the participant performing the task, respectively. Sixteen participants were asked to perform specified tasks as their back flexion, elbow, and shoulder flexion angles were captured after 5 seconds with the developed tool and Goniometer. Figure 2c shows one of the participants who performed the sitting to pick a task, as his left elbow posture was measured with the Goniometer. Figures 2d and 2e presents the screenshots of two participants as tracked and measured by the developed tool.

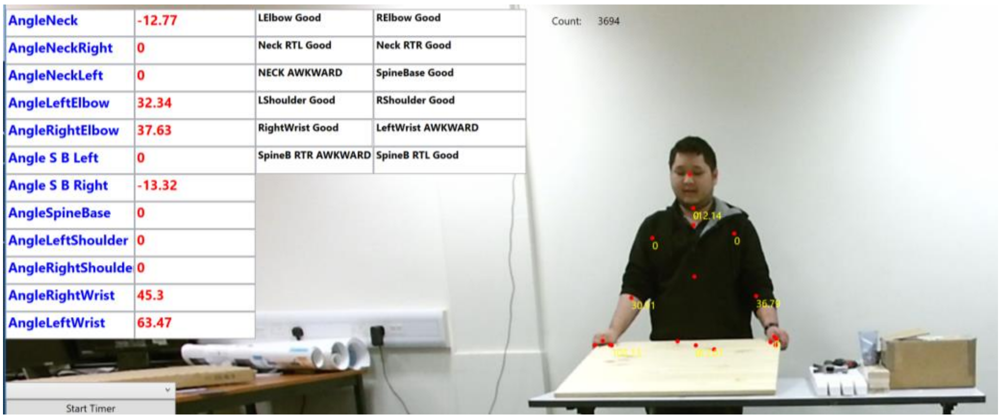
Angular discrepancies in the two tool's measured data are statistically analysed using the measured data's mean and standard deviation. The Kendall's coefficient of concordance (w) was used to evaluate the level of agreement in the data measured by the two independent tools because of its suitability and versatility in handling data measured by different raters without any regard to the nature of the data's probability distribution. The significance level was set at $p < 0.05$, and the results obtained were evaluated from 0 = no agreement to 1 = perfect agreement.

a. Experimental Setup for the reproducibility test

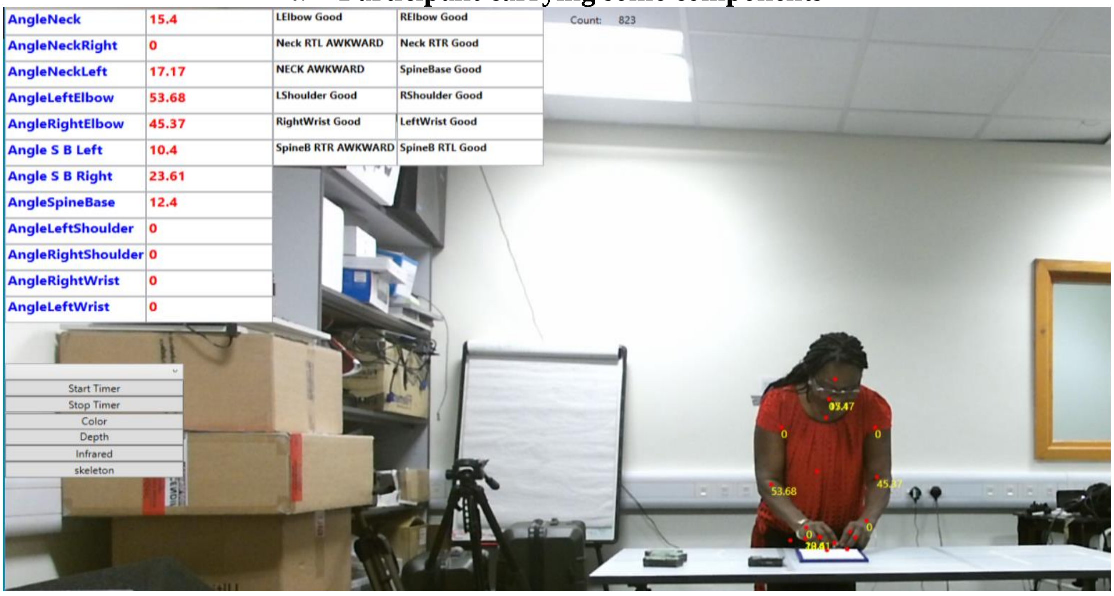


b. Participant during the reproducibility test

c. Measuring the Left elbow of a participant with the Goniometer



d. **Participant carrying some components**



e. **Participant handling electrical components**

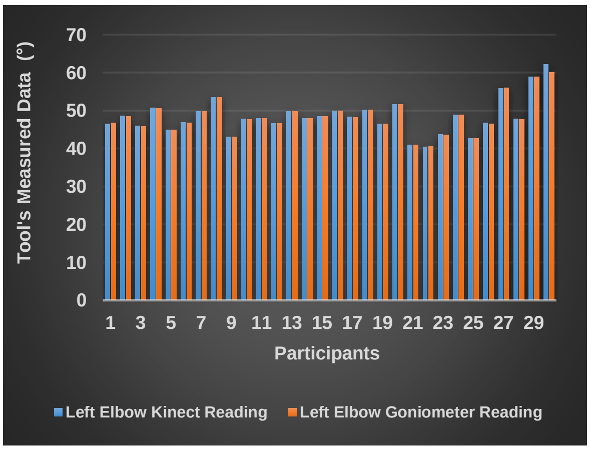
Figure 2 Screenshots of participants during reproducibility testing.

3. RESULTS AND DISCUSSION

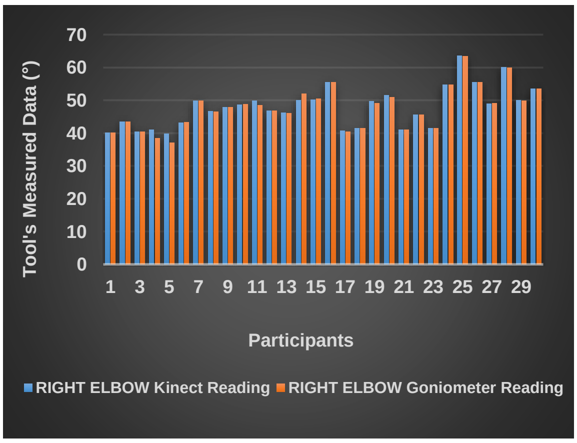
Results of Testing for Tool's Reliability

The result of the repeated arm posture assessment of a sole participant, captured 30 different times with the developed tool and the Goniometer during a lifting task, is presented in Figure 3. Figure 3 shows, at a glance, the angular discrepancies in the data measured with the developed tool and the reference tool

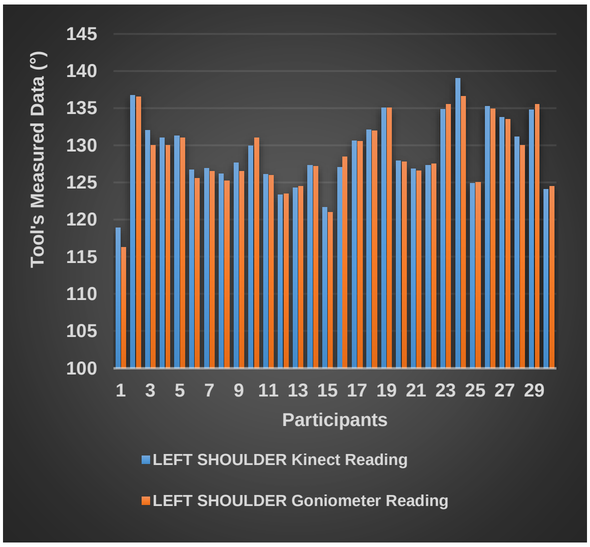
.



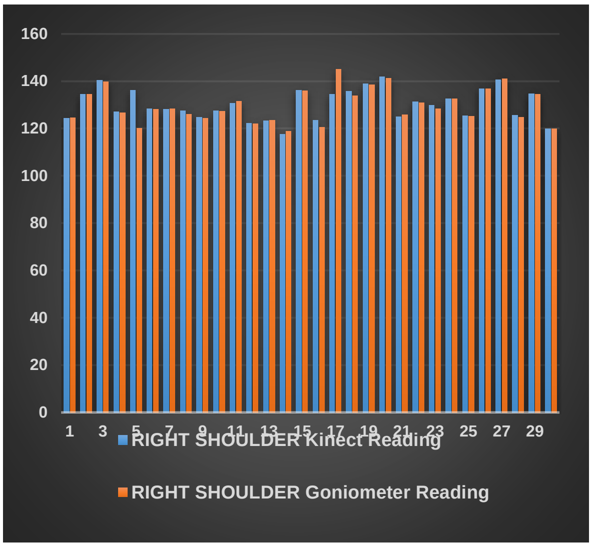
a. **Developed tool vs. Goniometer measurement for left elbow flexion**



b. **Developed tool vs. Goniometer measurement for right elbow flexion**



c. **Developed tool vs. Goniometer measurement for left shoulder flexion**



d. **Developed tool vs. Goniometer measurement for right shoulder flexion**

Figure 3: Developed tool vs. Goniometer is measured arm posture data of a sole participant under repeatability conditions

Generally, there was excellent agreement between the measurements made by the developed tool and the Goniometer when four different arm postures were analysed in SPSS, as summarised in Table 1.

Table 1: Result of statistical analysis of the data measured under repeatable conditions.

Posture	Mean (°) & S.D. for new tool's reading	Mean (°) & S.D. for Goniometer reading	Difference in Mean (°) & Difference in S.D.	inter-item correlation	Average Measures for ICC
Left Elbow Flexion	48.45 & 4.72	48.34 & 4.51	0.11 & 0.21	0.997	0.998
Right Elbow Flexion	47.92 & 6.13	47.71 & 6.39	0.21 & 0.26	0.992	0.996
Left Shoulder Flexion	129.16 & 4.76	128.81 & 4.86	0.35 & 0.1	0.982	0.990
Right Shoulder Flexion	130.14 & 6.5	129.67 & 7.15	0.47 & 0.65	0.863	0.925

**ICC = Intraclass correlation coefficient, S.D. = Standard Deviation.
** & Separates the Mean from the Standard Deviation

For left elbow flexion, an average angle of 48.45° and 48.34° with the standard deviation of 4.72 and 4.51 was measured for the 30 participants using the developed tool and the Goniometer, respectively. The apparent similarity in the average angular measurements and standard deviation indicates no notable difference in the distribution of the data measured by the developed tool and the Goniometer. The difference in measurements of 0.11° is low, indicating that discrepancies in angular measurement between the two tools are small, with a standard deviation of 0.21 indicating possible consistency in measurement. An inter-item correlation of 0.997 was obtained, showing an excellent correlation between the developed tool's measured data and the Goniometer measured data. The reliability test yielded an average ICC measure of 0.998, which indicates excellent inter-rater reliability. For right

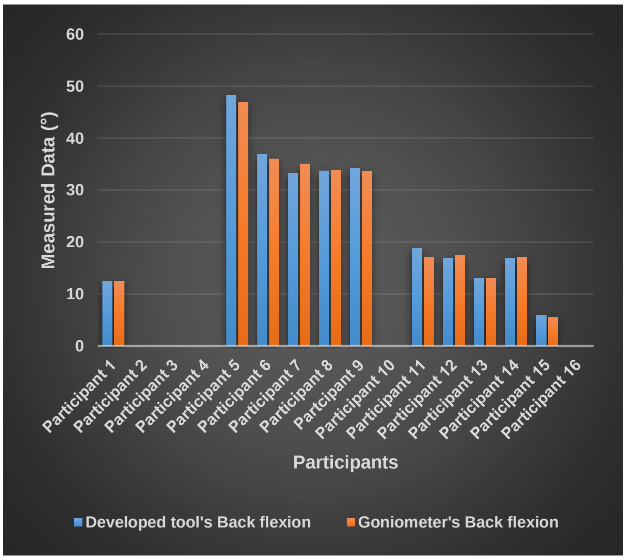
elbow flexion, an average angle of 47.92°and 47.71° with the standard deviation of 6.13 and 6.39, was measured for the 30 participants using the developed tool and the Goniometer, respectively. The difference in the measurements was 0.21°, with a standard deviation of 0.26. Again, the obvious similarity in the average angular measurements and standard deviation indicates no notable difference in the distribution of the data measured by the developed tool and the Goniometer. The measurements' difference is low, indicating that discrepancies in angular measurement between the two tools are small. An inter-item correlation of 0.992 was obtained, showing an excellent correlation between the developed tool's measured data and the Goniometer measured data. The reliability test yielded an average ICC measure of 0.996, which indicates excellent inter-rater reliability.

For left shoulder flexion, an average angle of 129.16°and 128.81° with the standard deviation of 4.76 and 4.86 was measured for the 30 participants using the developed tool Goniometer. The difference in the measurements was 0.35°, with a standard deviation of 0.1. The obvious similarity is that the average angular measurements and standard deviation indicate no notable difference in the distribution of the data measured by the developed tool and the Goniometer. The measurements' difference is low, indicating that discrepancies in angular measurement between the two tools are small. An inter-item correlation of 0.982 was obtained, indicating an excellent correlation between the developed tool's measured data and the Goniometer measured data. The reliability test yielded an average ICC measure of 0.990, which indicates excellent inter-rater reliability.

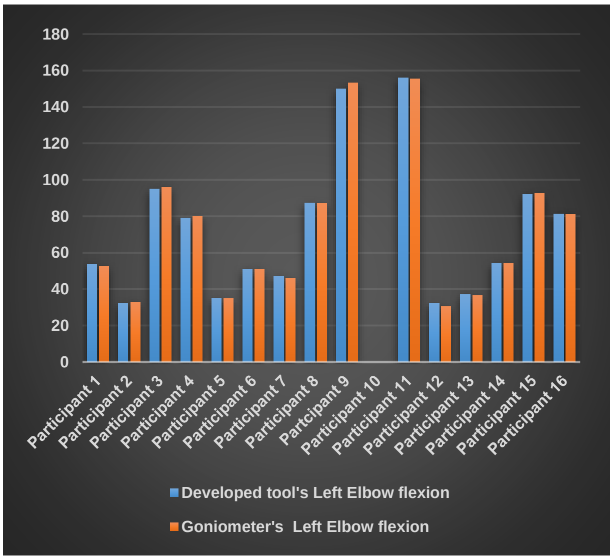
For right shoulder flexion, an average angle of 130.14°and 129.67° with the standard deviation of 6.5 and 7.15 was measured for the 30 participants using the developed tool and the Goniometer, respectively. The difference in the measurements was 0.47°, with a standard deviation of 0.65. The obvious similarity is that the average angular measurements and standard deviation indicate no notable difference in the distribution of the data measured by the developed tool and the Goniometer. The measurements' difference is low, indicating that discrepancies in angular measurement between the two tools are small. An inter-item correlation of 0.863 was obtained, indicating a good correlation between the developed tool's measured data and the Goniometer measured data. The reliability test yielded an average ICC measurement of 0.925, which indicates excellent inter-rater reliability.

Similarly, when tested under reproducible conditions, the results obtained from the 16 volunteers that participated in the study are presented in Figure 4 and Table 2.

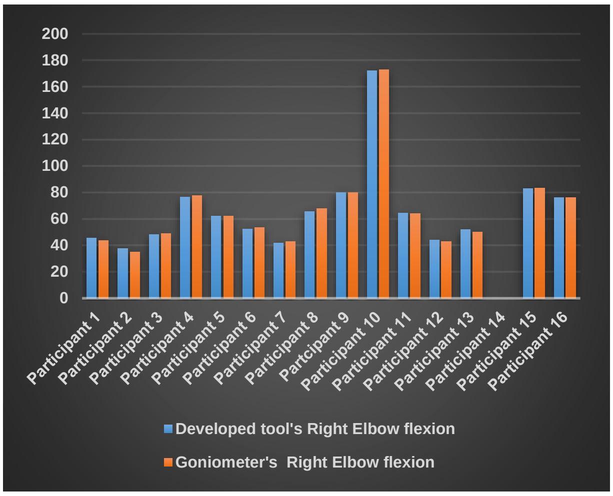
For back flexion, an average angle of 16.88°and 16.74°, with the standard deviation of 15.94 and 15.81, was measured for the 16 participants using the developed tool and the Goniometer, respectively. The obvious similarity is that the average angular measurements and standard deviation indicate no notable difference in the distribution of the data measured by the developed tool and the Goniometer when tested under reproducibility conditions. The difference in the measurements of 0.15° means and 0.13 S.D. is low, indicating that the two tools' angular measurement is small and consistent. Kendall's coefficient of concordance (w) of 0.989 ($p = 0.013$) was obtained, showing an excellent level of agreement between the developed tool's measured data and the Goniometer measured data.



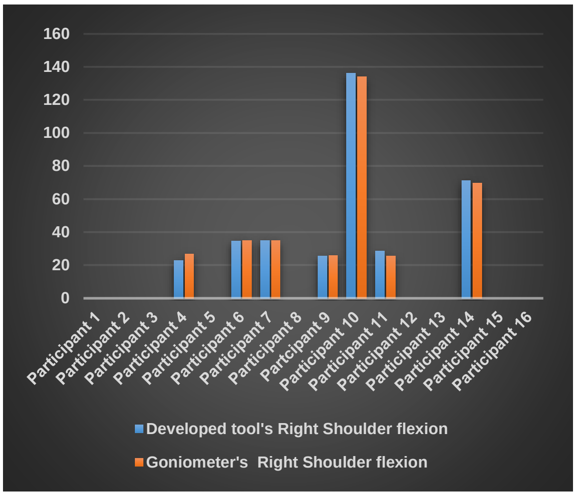
a. Back flexion



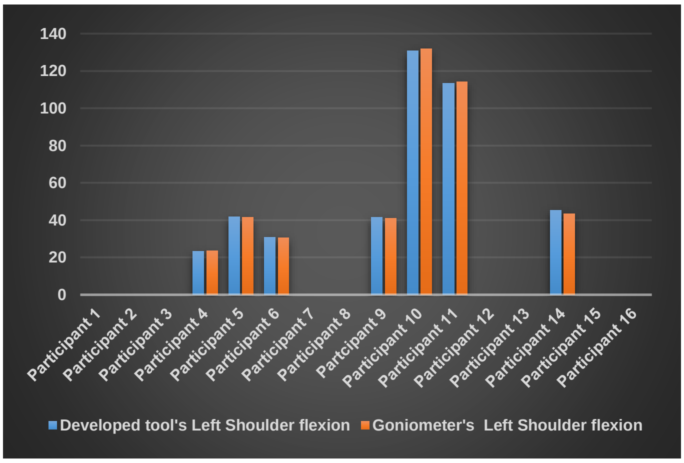
b. Left elbow flexion



c. Right elbow flexion



d. Right shoulder flexion



e. Left shoulder flexion

Figure 4: Developed tool vs. Goniometer's measured posture data of different participants under reproducibility conditions.

Table 2: Results of statistical analysis of the data measured under reproducibility conditions

Posture	Mean (°) & S.D. for new tool's measurement	Mean (°) & S.D. for Goniometer measurement	Difference Mean (°) & Difference in S.D.	Kendall's Coefficient of Concordance (w)	P-value
Back Flexion	16.88 & 15.94	16.74 & 15.81	0.15 & 0.13	0.989	0.013
Left Elbow Flexion	67.75 & 42.27	67.71 & 42.84	0.04 & 0.57	0.999	0.012
Right Elbow Flexion	62.57 & 35.73	62.52 & 36.15	0.06 & 0.42	1	0.012
Left Shoulder Flexion	26.70 & 41.34	26.64 & 41.55	0.06 & 0.21	1	0.012
Right Shoulder Flexion	22.13 & 36.70	22.00 & 36.12	0.13 & 0.57	0.993	0.013

** & Separates the Mean from the Standard Deviation

The left elbow flexion, an average angle of 67.75 °and 67.71 °, with the standard deviation of 42.27 and 42.84, was measured for the 16 participants using the developed tool Goniometer, respectively. Despite the large spread in the measured data as indicated by the large quantity of S.D., there is an obvious similarity in the average angular measurements and standard deviation, indicating no notable difference in the distribution of the data measured by the developed tool and the Goniometer, when tested under reproducibility conditions. The difference in the measurements of

0.04° mean and -0.57 S.D. is low, indicating that the angular measurement between the two tools is small and consistent. Kendall's coefficient of concordance of 0.999 (p = 0.012) was obtained, showing an excellent level of agreement between the developed tool's measured data and the Goniometer measured data.

For right elbow flexion, an average angle of 62.57° and 62.52°, with the standard deviation of 35.73 and 36.15, was measured for the 16 participants using the developed tool and the Goniometer, respectively. Despite the large spread in the measured data as indicated by the large quantity of S.D., there is an obvious similarity in the average angular measurements and standard deviation, indicating no notable difference in the distribution of the data measured by the developed tool and the Goniometer, when tested under reproducibility conditions. The difference in the measurements of 0.06° mean and -0.42 S.D. is low, indicating that the angular measurement between the two tools is small and consistent. Kendall's coefficient of concordance of 1 (p = 0.012) was obtained, showing an excellent level of agreement between the developed tool's measured data and the Goniometer measured data.

Also, for left shoulder flexion, an average angle of 26.70° and 26.64°, with the standard deviation of 41.34 and 41.55, was measured for the 16 participants using the developed tool and the Goniometer, respectively. Despite the large spread in the measured data as indicated by the large quantity of S.D., there is an obvious similarity in the average angular measurements and standard deviation, indicating no notable difference in the distribution of the data measured by the developed tool and the Goniometer, when tested under reproducibility conditions. The difference in the measurements of 0.06° mean and -0.21 S.D. is low, indicating that the angular measurement between the two tools is small and consistent. Kendall's coefficient of concordance of 1 (p = 0.012) was obtained, showing an excellent level of agreement between the developed tool's measured data and the Goniometer measured data.

For right shoulder flexion, an average angle of 22.13° and 22.00°, with the standard deviation of 36.70 and 36.12, was measured for the 16 participants using the developed tool and the Goniometer, respectively. Despite the large spread in the measured data as indicated by the large quantity of S.D., there is an obvious similarity in the average angular measurements and standard deviation, indicating no notable difference in the distribution of the data measured by the developed tool and the Goniometer, when tested under reproducibility conditions. The difference in the measurements of 0.13° means and 0.57 S.D. is low, indicating that the two tools' angular measurement is small and consistent. Kendall's coefficient of concordance of 0.993 (p = 0.013) was obtained, showing an excellent level of agreement between the developed tool's measured data and the Goniometer measured data.

Finally, the analysis results indicate little notable angular discrepancies in the data measured by the developed tool and the reference tool. Comparing the data measured with the two tools, it is obvious that there is a great consistency. This is further validated by the intraclass correlation coefficient and Kendall's coefficient of concordance values, which suggest excellent levels of agreement and consistency in the data measured by the two tools. Hence, the developed tool proved to be reliable and consistent in its measurement.

4. CONCLUSION

Several posture assessment tools have been developed, but these often require an assessment to be carried out by observing several operations and carrying out analysis afterward. A real-time automatic health and safety posture assessment tool developed by [12], [27] was tested in this study. The new tool is an automatic, portable, cost-effective tool that detects and assesses work postures with real-time feedback to the workers and their employers. It consists of a Microsoft Kinect 3D motion sensor and a developed software application for retrieving posture data from the 3D motion sensor. The tool's statistical test under repeatability and reproducibility conditions, presented in this study, suggests satisfactory agreement and consistency levels in the data measured by the developed tool. Hence, the developed tool proved to be reliable and consistent in its measurement. The tool's benefit is its usefulness in the automatic real-time detection and assessment of work postures, promoting a reduction in the rate of occurrence of awkward postures and, consequently, the risk of MSDs among workers in the workplace.

ACKNOWLEDGMENT

The author would like to acknowledge the Petroleum Technology Development Fund, PTDF Nigeria, for sponsoring her Ph.D. from which this paper is derived.

CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

REFERENCES

[1] HSE, "ART tool: Posture," 2015. .

[2] OSHA-Heavy Lifting, "Ergonomics eTool: Solutions for Electrical Contractors - Materials Handling: Heavy Lifting." .

[3] OSHA Technical Manual, "OSHA Technical Manual (OTM) | Section VII: Chapter 1 - Back Disorders and Injuries | Occupational Safety and Health Administration." .

[4] OSHA - Hazard Index, "Ergonomics eTool: Solutions for Electrical Contractors - Supplemental Information: Hazard Index." .

[5] U. Steinberg, "New tools in Germany: development and appliance of the first two KIM ('"lifting, holding and carrying"' and ' 'pulling and pushing'') and practical use of these methods," *Work*, vol. 41, pp. 3990–3996, 2012.

[6] WSH (Workplace Safety and Health) Council, "Workplace Safety and Health Guidelines Improving Ergonomics in the Workplace," Workplace Safety and Health Council in collaboration with the Ministry of Manpower., 2014.

[7] C. E. Mgbemena, A. Tiwari, Y. Xu, V. Prabhu, and W. Hutabarat, "Ergonomic evaluation on the manufacturing shop floor: A review of hardware and software technologies," *CIRP J. Manuf. Sci. Technol.*, vol. 30, pp. 68–78, Aug. 2020.

[8] C. E. Mgbemena *et al.*, "Gesture Detection Towards Real-Time Ergonomic Analysis for Intelligent Automation Assistance," in *Advances in Ergonomics of Manufacturing: Managing the Enterprise of the Future*, C. Schlick and S. Trzcieliński, Eds. Switzerland: Springer International Publishing, 2016, pp. 217–228.

[9] A. Naddeo, N. Cappetti, and C. D'Oria, "Proposal of a new quantitative method for postural comfort evaluation," *Int. J. Ind. Ergon.*, vol. 48, pp. 25–35, 2015.

[10] W. Chu, S. Han, X. Luo, and Z. Zhu, "Monocular Vision–Based Framework for Biomechanical Analysis or Ergonomic Posture Assessment in Modular Construction," *J. Comput. Civ. Eng.*, vol. 34, no. 4, p. 04020018, Jul. 2020.

[11] F. Scotto di Luzio, C. Lauretti, F. Cordella, F. Draicchio, and L. Zollo, "Visual vs vibrotactile feedback for posture assessment during upper-limb robot-aided rehabilitation," *Appl. Ergon.*, vol. 82, p. 102950, Jan. 2020.

[12] C. E. Mgbemena, J. Oyekan, W. Hutabarat, Y. Xu, and A. Tiwari, "Design and implementation of ergonomic risk assessment feedback system for improved work posture assessment," *Theor. Issues Ergon. Sci.*, vol. 19, no. 4, pp. 431–455, Oct. 2018.

[13] J. A. Diego-Mas and J. Alcaide-Marzal, "Using Kinect^{TM} sensor in observational methods for assessing postures at work," *Appl. Ergon.*, vol. 45, no. 4, pp. 976–985, 2014.

[14] J. Sanjog, T. Patel, A. Chowdhury, and S. Karmakar, "Musculoskeletal ailments in Indian injection-molded plastic furniture manufacturing shop-floor: Mediating role of work shift duration," *Int. J. Ind. Ergon.*, vol. 48, pp. 89–98, 2015.

[15] A. D. Pinder, "Benchmarking of the Manual Handling assessment Charts (MAC)," 2002.

[16] L. McAtamney and E. Nigel Corlett, "RULA: a survey method for the investigation of work-related upper limb disorders.," *Appl. Ergon.*, vol. 24, no. 2, pp. 91–9, Apr. 1993.

[17] H.-S. Park, J. Kim, H.-L. Roh, and S. Namkoong, "Analysis of the risk factors of musculoskeletal disease among dentists induced by work posture.," *J. Phys. Ther. Sci.*, vol. 27, no. 12, pp. 3651–4, Dec. 2015.

[18] P. Mukhopadhyay, D. Jhodkar, and P. Kumar, "Ergonomic risk factors in bicycle repairing units at Jabalpur.," *Work*, vol. 51, no. 2, pp. 245–54, Jun. 2015.

[19] C. Wiktorin, M. Mortimer, L. Ekenvall, A. Kilbom, and E. W. Hjelm, "HARBO, a simple computer-aided observation method for recording work postures.," *Scand. J. Work. Environ. Health*, vol. 21, no. 6, pp. 440–9, Dec. 1995.

[20] D. Kee and W. Karwowski, "A Comparison of Three Observational Techniques for Assessing Postural Loads in Industry," *Int. J. Occup. Saf. Ergon.*, vol. 13, no. 1, pp. 3–14, Jan. 2007.

[21] R. a Clark *et al.*, "Validity of the Microsoft Kinect for assessment of postural control.," *Gait Posture*, vol. 36, no. 3, pp. 372–7, Jul. 2012.

[22] J. L. P. do Rosário, "Biomechanical assessment of human posture: A literature review," *J. Bodyw. Mov. Ther.*, vol. 18, no. 3, pp. 368–373, 2014.

[23] I. Åkesson, I. Balogh, and G.-Å. Hansson,

"Physical workload in neck, shoulders and wrists/hands in dental hygienists during a work-day.," *Appl. Ergon.*, vol. 43, no. 4, pp. 803–11, Jul. 2012.

[24] A. B. Cunha *et al.*, "Assessing the Validity and Reliability of a New Video Goniometer App for Measuring Joint Angles in Adults and Children," *Arch. Phys. Med. Rehabil.*, vol. 101, no. 2, pp. 275–282, Feb. 2020.

[25] C. D. McKinnon, M. W. Sonne, and P. J. Keir, "Assessment of Joint Angle and Reach Envelope Demands Using a Video-Based Physical Demands Description Tool," *Hum. Factors J. Hum. Factors Ergon. Soc.*, p. 001872082095134, Sep. 2020.

[26] T. Dutta, "Evaluation of the Kinect™ sensor for 3-D kinematic measurement in the workplace.," *Appl. Ergon.*, vol. 43, no. 4, pp. 645–9, Jul. 2012.

[27] C. E. Mgbemena, J. Oyekan, W. Hutabarat, S. Fletcher, Y. XU, and A. Tiwari, "Optimum Kinect Setup for Real-Time Ergonomic Risk Assessment on the Shop Floor," in *Contemporary Ergonomics and Human Factors 2017*, 2017th ed., J. Charles, Rebecca & Wilkinson, Ed. London, UK: Chartered Institute of Ergonomics and Human Factors, 2017, pp. 265–272.

[28] T. K. Koo and M. Y. Li, "A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research.," *J. Chiropr. Med.*, vol. 15, no. 2, pp. 155–63, Jun. 2016.