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Portable Wireless Handheld Ultrasound Linear Series UProbe-L5 and Hitachi Aloka F37 Ultrasound Reliability Test

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Abstract
The utilization of portable ultrasound technology in medical imaging has experienced significant growth due to its inherent mobility and user-friendly nature. Nevertheless, to enhance trust in this portable equipment, the evidence about its reliability must be acknowledged and disclosed. Assessing the reliability of the Handheld Ultrasound UProbe-L5 and the Hitachi Aloka F37 machine in assessing muscle thickness is a complex task with significant implications for both clinical practice and research. In line with the issue, this study aims to assess the reliability of the portable wireless handheld ultrasound Sonostar Linear Series UProbe-L5 with the Hitachi Aloka F37 ultrasonography machine for muscle thickness measurements. Twenty male university athletes, aged between 19 and 20 years (mean age 19.52 ± 0.29), participated in this study. The reliability of the Handheld Ultrasound UProbe-L5 and Hitachi Aloka F37 scans were evaluated. A test-retest reliability study design was employed to quantify the muscle thickness of the biceps brachii muscle. Three measurements were taken using both devices. The participants were required to refrain from participating in any type of resistance exercise for a period of forty-eight hours before the assessment. The participants are supine, with their arms and legs stretched out and relaxed. The measurement points were positioned at a distance of 60% between the lateral epicondyle of the humerus and the acromial process of the scapula. The muscle thickness was assessed in the short-axis view by measuring the maximum vertical distance between the superficial and deep fascia layers. The data were analyzed using Reliability Analysis to assess the consistency of a measure from these two devices, and the reliability and internal consistency of biceps brachii

muscle thickness were analyzed using Cronbach's alpha coefficient. Hence, the results indicate that the scale used to measure muscle thickness has a good level of reliability and internal consistency, as demonstrated by a Cronbach's alpha coefficient of 0.999. The findings suggest no substantial change in the construct being assessed over the two instances in the portable wireless handheld ultrasound devices, specifically the Linear Series UProbe-L5 and Hitachi Aloka F37 ultrasound machines. This study implies that the students, researcher, or medical imaging practitioner can adhere to this study outcome in administrating and utilizing the practical application of the portable or remote ultrasonography assessment. In conclusion, the UProbe-L5 handheld ultrasound apparatus presents a convenient and reliable approach for assessing muscle thickness. Future research is warranted to expand these findings with a larger sample size and ascertain the full scope of the possible application of the Handheld Ultrasound UProbe-L5 instrument in more extensive clinical practice settings.
Keywords: Uprobe-L5, Portable Ultrasound, Wireless Ultrasound, Handheld Ultrasound, Ultrasonography, Reliability

Introduction

Medical imaging plays a vital role in contemporary healthcare by furnishing physicians with crucial visual data for diagnosis and treatment strategizing. Besides that, these medical imaging applications also become more demanding in education environments and research areas of interest. In the past few years, there has been a rise in the utilization of portable ultrasound devices as a viable substitute for conventional ultrasound machines. These devices offer enhanced portability and accessibility, making them a promising option for medical professionals (Chen et al., 2023; Jin et al., 2022). Nevertheless, there are still questions about the precision and reliability of these devices compared to their more extensive and costly equivalents.

The emergence of portable wireless handheld ultrasound equipment has demonstrated significant potential in medical imaging. These gadgets can enhance healthcare in regions with low resources and extend the reach of medical applications to geographically isolated areas (Chen et al., 2023; Miao et al., 2021). The impetus for the advancement of portable ultrasound devices has been motivated by the demand for imaging instruments that are more readily available and convenient, particularly within rural communities (Haji-Hassan et al., 2021). The smaller size of portable ultrasound machines has facilitated the ability of medical practitioners to conduct diagnostic procedures in non-traditional settings, such as patients' residences or accident sites (Hu et al., 2022). Healthcare technology's portability facilitates healthcare practitioners' ability to deliver prompt and precise diagnoses in diverse environments, encompassing distant and emergency scenarios. As previously stated, technological advancement has led to the introduction of several models of portable, wireless, and handheld ultrasound devices. These devices have undergone extensive testing to assess their reliability, performance, and accuracy. However, one of the studies conducted shows that when evaluating four prevalent portable ultrasound devices, it was observed that none possessed all the needed attributes (Le et al., 2022). Every single device has specific features and varies according to the model. This finding highlights the need for additional investigation and advancement in this area.

Besides using ultrasound devices in an actual medical setting and practices, incorporating portable wireless ultrasound imaging into undergraduate anatomy instruction has positively affected students' comprehension and acquisition of anatomical knowledge (Edwards et al., 2023). As mentioned above, the observation stresses the pedagogical value of portable ultrasound instruments in medical education, emphasizing the imperative nature of their integration within the established curriculum. Furthermore, it is expected that the growth of the latest technologies, such as wireless handheld ultrasound devices and gadgets integrating artificial intelligence, will enhance undergraduate medical education (Kameda et al., 2022; Sauza-Sosa et al., 2022). The previous assertion indicates that using portable ultrasound devices is advantageous in educational settings.

Besides that, numerous studies have assessed the diagnostic precision of portable ultrasound equipment. A previous study observed that non-expert practitioners utilizing standard portable ultrasound instruments could obtain a sensitivity and specificity of approximately 85% in detecting rheumatic heart disease (Eggleston et al., 2022; Francis et al., 2021). These studies provide evidence of the potential efficacy of handheld ultrasound devices in enhancing diagnostic capacities across several medical disciplines.

One of the primary benefits associated with the utilization of portable ultrasound machines lies in their capacity to effectively and reliably detect muscle thickness. A study compared the efficacy and reliability of a portable ultrasound machine with a standard ultrasound machine for measuring muscle thickness in a sample of healthy people (Alfuraih et al., 2023; Chen et al., 2023). The study's findings indicated that using the portable ultrasound machine was practicable and reproducible for such measures. As mentioned earlier, the observation illustrates the dependability and precision of the portable ultrasound device in delivering constant and precise measurements.

Another noteworthy characteristic of the handheld portable ultrasound equipment is its ability to assess muscle thickness across different muscle groups. One of the studies conducted has brought attention to the constraints associated with traditional ultrasound devices for evaluating muscle thickness in specific anatomical regions (Wang et al., 2022). These limits arise from the bulky ultrasound probe and the substantial pressure applied by the probe during examination. On the other hand, the handheld portable ultrasound machine's compact and portable design offers enhanced flexibility and manoeuvrability, facilitating measurements across various muscle groups. This technological advancement enhances the precision and accuracy of muscle thickness measures, guaranteeing dependable and uniform outcomes.

Despite the growth of research papers and official statements emphasizing the favourable characteristics of portable ultrasound devices, there is a need to evaluate and substantiate the dependability of these particular portable machines in connection to traditional ultrasound machines and their correlation or consistency. Therefore, in line with the issue, the objective of this study is to evaluate the reliability of the portable wireless handheld ultrasound device, Sonostar Linear Series UProbe-L5, compared to the Hitachi Aloka F37 ultrasonography machine precisely to measure muscle thickness.

Materials and methods

Study participants.

The study involved the participation of twenty male university athletes, whose ages ranged from 19 to 20 years. The mean age of the participants was 19.52 ± 0.29. These individuals volunteered to take part in a laboratory-controlled study. The individuals were devoid of any musculoskeletal injury, not under the influence of any prescribed medication, and not currently utilizing performance-enhancing substances. The study participants were duly informed about the study methods and subsequently granted their informed permission in writing. The researchers gained ethical approval from the Research Ethics Committee of Sultan Idris Education University (Ref. No. : 2023-049-01)

Study organization.
The current study utilizes a test-retest reliability research design. The bicep brachii muscle of the subject's dominant hand was scanned using two separate ultrasound machines, as shown in Figure 2 and Figure 3, the Linear Series UProbe-L5 (Cornwall, UK)and the Hitachi Aloka F37 (Tokyo, Japan). In order to mitigate the potential confounding effects of acute increases or changes in muscle thickness resulting from resistance training, the participants needed to abstain from engaging in any form of resistance training for forty-eight hours prior to the assessment. It is widely believed that within this timeframe, any acute effects on muscle thickness would have subsided and returned to baseline levels (Van Every et al., 2022). The measurement sites were identified and marked using a marker pen to prepare for the assessment. Specifically, the measurement points were located at a distance of 60% between the lateral epicondyle of the humerus and the acromial process of the scapula. It is worth noting that these exact measurement marks were consistently utilized for all assessments (Kikuchi & Nakazato, 2017). Later, the participants lie supine with their limbs extended and relaxed (Li et al., 2020). The muscle thickness was measured in the short-axis view at the maximal vertical distance from the superficial to deep fascia layers (Baek et al., 2023). The assessment commences using the portable handheld Linear Series UProbe-L5 for the initial three muscle thickness measurements, followed by three additional measurements utilizing the Hitachi Aloka F37 ultrasound machine. The flow of the data collection process is presented in Figure 1.

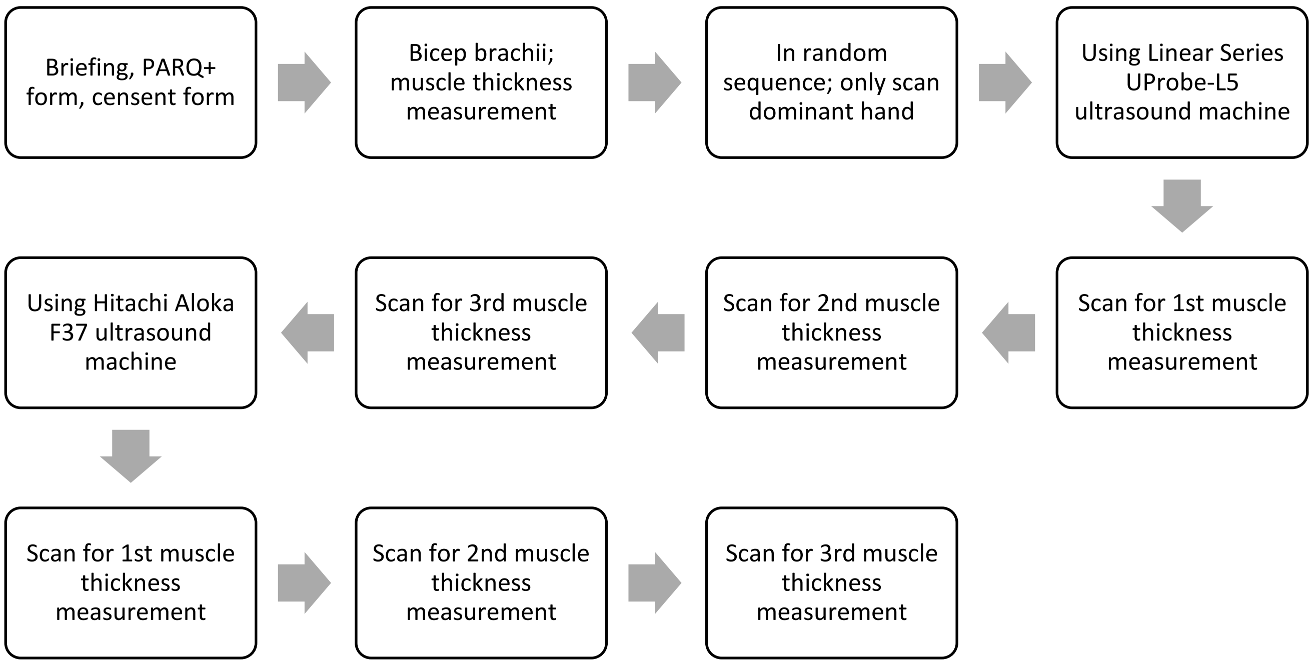

Figure 1: Data collection process

Figure 2: Linear Series UProbe-L5 ultrasound machine (Cornwall, UK)

Figure 3: Hitachi Aloka F37 ultrasound machine (Tokyo, Japan)

Statistical analysis.
Descriptive statistics were employed to analyze the demographic data of the participants. A normality test was conducted to assess the normal distribution of the data. Subsequently, the reliability of the 6-item muscle thickness was evaluated using Cronbach's alpha coefficient, which measures internal consistency. The findings mentioned above were presented and evaluated, leading to the formulation of conclusions grounded on the obtained information, making a valuable contribution to the field of research.

Results
The descriptive statistics analysis derived the demographic data's mean and standard deviation (SD). All statistical analyses were run on version 26 of the Statistical Package for Social Science (SPSS) software (IBM, USA).

Table 1:
Descriptive Statistic of Demographic Data

	N	Minimum	Maximum	Mean	Std. Deviation
Age (years)		18.99	19.96	19.52	0.29
Weight (kg)	20	46.00	111.00	67.76	16.63
Height (cm)		158.00	178.00	169.35	4.64

The participants' demographic data has been analyzed, and the resulting descriptive statistics are presented in Table 1. The study included 20 participants, whose average age was 19.52 ±

0.29 years. The age range of the participants varied from a minimum of 18.99 years to a maximum of 19.96 years. In addition, their body weight's mean and standard deviation (SD) is 67.76 ± 16.63 kg, with a minimum weight of 46 kg and a maximum of 111 kg. The average height, represented by the mean ± standard deviation, is 169.35 ± 4.64 cm. The range of heights observed in the sample ranges from a minimum of 158 cm to a maximum of 178 cm.

Table 2:
Normality Test Data

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Handheld 1	.121	20	.200*	.969	20	.741
Handheld 2	.125	20	.200*	.962	20	.582
Handheld 3	.139	20	.200*	.962	20	.591
Aloka 1	.130	20	.200*	.971	20	.779
Aloka 2	.114	20	.200*	.963	20	.609
Aloka 3	.152	20	.200*	.962	20	.593

The findings of the normality tests, specifically the Kolmogorov-Smirnov and Shapiro-Wilk tests, are presented in Table 2. The table includes information such as the test statistic, degrees of freedom, and p-value associated with each test. Given that the study utilized a sample size of less than 50 observations ($N = 20 < 50$), the interpretation of the Shapiro-Wilk test results is justified. The Shapiro-Wilk test of normality was employed to assess the normal distribution of the muscle thickness measurement. The findings suggest the data has a normal distribution ($p = > 0.05$).

Table 3:
Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.999	0.999	6

The reliability and internal consistency of the 6-item muscle thickness scale were assessed using Cronbach's alpha coefficient. Consequently, the findings suggest that the scale assessing muscle thickness exhibits favourable reliability and internal consistency levels, as evidenced by a high Cronbach's alpha coefficient of 0.999.

Discussion

The findings of this investigation indicate that the Handheld Ultrasound UProbe-L5 device exhibits validity and reliability as a viable substitute for conventional ultrasound equipment in the context of medical imaging, specifically on muscle thickness measurement. The device exhibited a notable level of precision and reliability, yielding outcomes on par with the Hitachi Aloka F37 regarding the quality of the images produced and the device's capacity to facilitate accurate measurement of muscle thickness. The findings mentioned above align with other research that has examined the validity and reliability of portable ultrasound devices.

The assessment of muscle thickness is of significant importance in evaluating muscle size, architecture, well-being and functionality. The utilization of conventional ultrasound equipment for this objective has been prevalent. However, its size is typically bulky and demands operators with specialized training (Alfuraih et al., 2023). Recent technological improvements have facilitated the emergence of handheld ultrasound instruments, exemplified by the UProbe-L5 machine, which provides a portable and user-friendly option for measuring muscle thickness.

The UProbe-L5 machine is an example of a portable ultrasound instrument developed explicitly to measure muscle thickness. The portable nature, user-friendly interface, and capability to provide real-time imaging are among the notable characteristics that distinguish it from conventional ultrasound devices (Nakanishi et al., 2023; Zhang et al., 2023). This feature renders it a valuable instrument for healthcare practitioners across many settings, including clinics, sports medical facilities, instructional contexts, and research environments.

Comparing the reliability of the Handheld Ultrasound UProbe-L5 and the Hitachi Aloka F37 machine in muscle thickness measuring is multifaceted and carries significant consequences for clinical practice and research. This study assesses the viability and replicability of a portable ultrasound device compared to a conventional ultrasound machine for evaluating muscle thickness in individuals without underlying health conditions. The findings of this research offer significant contributions to the understanding of the reliability of portable ultrasound equipment in the context of measuring muscle thickness.

The result of this study is also supported by the previous study conducted, which was reliable when investigating the portable ultrasound machine with traditional ultrasound machines in comparing muscle thickness (Alfuraih et al., 2023). Furthermore, a study was conducted to examine the agreement and reliability of a handheld and portable ultrasound system in measuring the muscle architecture of the human lower limb, providing insights into the possible reliability of handheld ultrasound devices for evaluating muscle features (Ritsche et al., 2022). Moreover, the significance of muscle ultrasound in diagnosing neuromuscular illnesses and evaluating muscle thickness was underscored, with particular emphasis on the potential dependability of ultrasound in determining muscle well-being (Pillen & van Alfen, 2011).

The compactness and ease of use of handheld ultrasound devices provide them an appealing choice for healthcare practitioners, especially in situations with limited resources where more bulk in size and expensive equipment may be lacking. The findings of this investigation, in conjunction with other scholarly inquiries, indicate that the UProbe-L5 instrument serves as a compact and user-friendly ultrasound equipment developed explicitly for measuring muscle thickness. The portability and user-friendly interface of the solution contribute to its convenience. As addressed in a previous study, the lack of empirical evidence supporting concerns over handheld ultrasound devices can now subside, as this study suggests that these devices can serve as a valuable tool in medical imaging, particularly for evaluating muscle thickness.

Conclusion

In conclusion, the findings of this study provide evidence supporting the reliability of the Handheld Ultrasound UProbe-L5 equipment for muscle thickness measurement purposes, indicating its comparability to the Hitachi Aloka F37 ultrasonography machine. The findings indicate that the Handheld Ultrasound UProbe-L5 device can be a viable substitute for conventional ultrasound machines, especially in scenarios where portability, ease of use and accessibility are priorities. Nevertheless, further study is warranted to expand these findings with a larger sample size and ascertain the full scope of the possible application of the Handheld Ultrasound UProbe-L5 instrument in more extensive clinical practice settings. Overall, the findings of this study indicate that the novel Handheld Ultrasound UProbe-L5 device has promise as a medical imaging tool, specifically in muscle thickness measurement, potentially leading to enhancements in medical services, educational purposes and research settings.

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Conflict of interest
No conflicts of interest are relevant to this paper for the author(s).

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