Comparison of Blood Pressure Measurements Between Aneroid and Digital Sphygmomanometers in Hypertensive Older Adults

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Abstract. Blood pressure measurement errors may lead to serious clinical consequences, including misclassification of hypertension due to false-positive or false-negative results. Accurate measurement is therefore essential for effective hypertension management, particularly in older adults. This study aimed to compare blood pressure measurements obtained using aneroid and digital sphygmomanometers in hypertensive older adults. A paired comparative study was conducted among 70 hypertensive older adults aged ≥ 60 years in the working area of Dinoyo Health Center, Malang City, Indonesia. Participants were selected using accidental sampling. Blood pressure was measured using both aneroid and digital sphygmomanometers following standardized procedures. The paired blood pressure measurements obtained using the aneroid and digital sphygmomanometers were compared using the Wilcoxon signed-rank test because the data were not normally distributed. The results showed no statistically significant differences in systolic and diastolic blood pressure measurements between the two devices ($p > 0.05$). The findings indicate comparable measurement outcomes between the two devices. In conclusion, aneroid and digital sphygmomanometers demonstrated similar performance in measuring blood pressure among hypertensive older adults. However, further studies using more rigorous designs are recommended to confirm the interchangeability of these devices in clinical practice.

Keywords: Aneroid Sphygmomanometer, Blood Pressure Measurement, Digital Sphygmomanometer, Hypertensive Elderly, Measurement Accuracy.

1 Introduction

Hypertension remains one of the leading global public health challenges, affecting approximately 1.28 billion adults worldwide, particularly among older populations [1]. The prevalence of hypertension continues to increase with age, making older adults a high-risk group for cardiovascular morbidity and mortality [2]. In Indonesia, the burden of hypertension has also risen significantly, with national surveys reporting a prevalence exceeding 30% among adults [3]. This condition highlights the urgent need for accurate diagnosis and effective management strategies, especially in primary healthcare settings.

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Accurate blood pressure measurement plays a crucial role in the diagnosis, classification, and management of hypertension [4]. Measurement errors can lead to serious clinical consequences, including false-positive diagnoses that may result in unnecessary treatment, as well as false-negative results that may delay appropriate intervention [5]. Even small deviations of 3–5 mmHg in blood pressure readings can significantly alter clinical decisions and affect patient outcomes [6]. Therefore, ensuring the reliability of measurement devices is essential in clinical practice.

Various types of sphygmomanometers are currently used in healthcare settings, particularly aneroid and digital devices [7]. Mercury sphygmomanometers, previously considered the gold standard, are no longer widely used due to environmental and safety concerns [8]. As a result, aneroid and digital sphygmomanometers have become the most commonly used alternatives. Aneroid devices are generally considered reliable when properly calibrated but require trained personnel and manual auscultation [9]. In contrast, digital sphygmomanometers offer ease of use and practicality; however, their accuracy may be influenced by factors such as movement, device sensitivity, and calibration issues [10].

Previous studies comparing aneroid and digital sphygmomanometers have produced inconsistent findings. While several studies have reported significant differences in blood pressure measurements between the two devices, others have demonstrated comparable performance, leaving uncertainty regarding their clinical interchangeability [11][12]. Moreover, most available evidence has been derived from the general adult population or individuals with normal blood pressure, whereas studies involving hypertensive older adults remain scarce, particularly in primary healthcare settings where both devices are routinely used for hypertension management. Given that age-related vascular changes, including increased arterial stiffness and reduced arterial compliance, may influence blood pressure measurements obtained using different measurement techniques [13], further investigation in hypertensive older adults within real-world primary care settings is warranted.

Given the widespread use of both aneroid and digital sphygmomanometers in primary healthcare settings, particularly in community health centers, it is important to evaluate whether these devices provide comparable measurement results in clinical practice. Therefore, this study aimed to compare blood pressure measurements obtained using aneroid and digital sphygmomanometers among hypertensive older adults in the working area of Dinoyo Health Center, Malang City.

2 Methods

This study employed a paired comparative study design in which blood pressure was measured using both aneroid and digital sphygmomanometers in the same hypertensive older adults under standardized conditions. The study was conducted in the working area of Dinoyo Health Center, Malang City, Indonesia. A total of 70 hypertensive older adults aged ≥60 years were included. Participants were recruited using an accidental sampling technique based on their availability during the data collection period. Eligible participants were individuals with a documented diagnosis of hypertension based on medical records at Dinoyo Health Center or a previous diagnosis made by a physician or other qualified healthcare professional. Participants were also required to be able to communicate effectively and undergo blood pressure measurement procedures. Individuals with acute medical conditions, severe cognitive impairment, arrhythmias, or physical limitations that could interfere with blood pressure measurement were excluded from the study.

Blood pressure measurements were performed using both an aneroid and a digital sphygmomanometer for each participant. All measurements were obtained during the same session under standardized conditions by the same trained examiner. A resting interval of 1–2 minutes was allowed between consecutive measurements to minimize the potential influence of repeated cuff inflation on blood pressure readings. This paired measurement approach enabled direct comparison of the two devices while minimizing inter-individual variability. The aneroid sphygmomanometer utilized the auscultatory method with the assistance of a stethoscope to detect Korotkoff sounds, whereas the digital sphygmomanometer employed an oscillometric method to automatically display systolic and diastolic blood pressure values. Prior to data collection, the aneroid sphygmomanometer was calibrated to ensure measurement accuracy. The digital sphygmomanometer used in this study was a clinically validated device that met recognized blood pressure measurement standards.

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Prior to measurement, participants were instructed to rest for at least 5 minutes and to avoid caffeine intake, smoking, and physical activity for at least 30 minutes. Measurements were carried out in a seated position with the arm supported at heart level, and an appropriate cuff size was selected based on the participant’s arm circumference. Blood pressure was measured using both devices on the same participant under similar environmental conditions, and both systolic and diastolic values were recorded for analysis.

Data was analyzed using statistical software. Descriptive statistics were used to summarize participant characteristics and blood pressure measurements. The normality of the data distribution was assessed prior to inferential analysis. As the data were not normally distributed, the Wilcoxon signed-rank test was used to compare measurements between the two devices. A p-value of <0.05 was considered statistically significant.

This study was approved by the Health Research Ethics Committee of the Faculty of Health Sciences, Universitas Brawijaya, with ethical clearance number No. 5124/UN10.F17.10.4/TU/2023. Written informed consent was obtained from all participants prior to data collection, and confidentiality as well as anonymity were strictly maintained throughout the study.

3 Results

A total of 70 hypertensive older adults participated in this study. The majority of participants were female (70%) and aged 60–64 years (45.7%). Most participants were housewives (45.7%) and had a primary school education (45.7%). The duration of hypertension was predominantly 1–5 years (55.7%), and most participants had no comorbid conditions (80%). All participants were non-smokers. A summary of participant characteristics is presented in Table 1.

Table 1. Characteristics of Participants (n = 70)

Variable	n	%
Female	49	70
Male	21	30
Age 60–64 years	32	45.7
Hypertension duration 1–5 years	39	55.7
No comorbidity	56	80
Non-smoker	70	100

The mean of the most recent systolic blood pressure recorded in medical records was 142.6 ± 14.97 mmHg, while the mean diastolic blood pressure was 80.2 ± 10.27 mmHg. Blood pressure measurements using aneroid and digital sphygmomanometers showed relatively similar values. The mean systolic blood pressure measured using the aneroid device was 148.29 ± 12.11 mmHg, while the digital device showed a mean of 149.89 ± 12.07 mmHg. For diastolic blood pressure, the mean values were 82.37 ± 6.98 mmHg for the aneroid device and 82.14 ± 6.94 mmHg for the digital device. Detailed descriptive statistics are shown in Table 2.

Table 2. Descriptive Statistics of Blood Pressure Measurements

Variable	Mean ± SD	Median	Min–Max
Systolic (Aneroid)	148.29 ± 12.11	150	122–172
Systolic (Digital)	149.89 ± 12.07	147	121–178
Diastolic (Aneroid)	82.37 ± 6.98	80	70–97
Diastolic (Digital)	82.14 ± 6.94	82	61–97

Normality testing indicated that most variables were not normally distributed ($p < 0.05$), therefore non-parametric analysis was applied. The The comparison of paired blood pressure measurements between the aneroid and digital sphygmomanometers using the Wilcoxon signed-rank test showed no statistically significant differences in either systolic ($p = 0.335$) or diastolic ($p = 0.757$) blood pressure measurements. The comparison results are presented in Table 3.

Table 3. Comparison of Blood Pressure Measurements (Wilcoxon signed-rank test)

Variable	Mean Rank (Aneroid–Digital)	p-value
Systolic	67.21 – 73.79	0.335
Diastolic	69.45 – 71.55	0.757

Overall, these findings suggest that blood pressure measurements obtained using the aneroid and digital sphygmomanometers did not differ significantly among hypertensive older adults under the conditions of this study.

4 Discussion

This study aimed to compare blood pressure measurements obtained using aneroid and digital sphygmomanometers among hypertensive older adults. The findings showed that there were no statistically significant differences in both systolic and diastolic blood pressure measurements between the two devices. This indicates that both measurement methods produced comparable results in this population. The similarity in measurement outcomes between aneroid and digital devices observed in this study is consistent with several previous studies reporting comparable performance between the two types of sphygmomanometers [11][12]. This finding suggests that, under standardized measurement conditions, digital devices may produce measurements comparable to manual methods under standardized conditions. The minimal differences observed in mean systolic and diastolic values further support the notion that both devices yield similar measurement patterns.

Accurate blood pressure measurement is essential for appropriate diagnosis and management of hypertension. Even small inaccuracies may lead to misclassification, potentially resulting in under-treatment or over-treatment [5][6]. In this study, although slight differences in blood pressure measurements were observed between the aneroid and digital sphygmomanometers, these differences were not statistically significant. More importantly, the magnitude of these differences was small and is unlikely to influence clinical decision-making regarding hypertension assessment and management in older adults under the conditions of this study. Nevertheless, these findings should be interpreted with caution, as the absence of statistically significant differences does not necessarily indicate measurement agreement or interchangeability between the two devices. Further studies using agreement analyses, such as Bland–Altman analysis and intraclass correlation coefficients, are recommended to confirm their clinical interchangeability.

From a practical perspective, digital sphygmomanometers offer several advantages, including ease of use, reduced observer bias, and suitability for use in primary healthcare settings and home monitoring [10]. These features are particularly beneficial for older adults, who may require frequent monitoring and may have limitations in accessing healthcare facilities. On the other hand, aneroid sphygmomanometers rely on operator skill and require regular calibration to maintain accuracy [5]. Therefore, the comparable results observed in this study may also reflect proper measurement procedures and controlled conditions during data collection.
Despite these findings, several factors may influence blood pressure measurement outcomes, especially in older adults. Age-related physiological changes, such as arterial stiffness and reduced vascular compliance, can affect measurement accuracy and variability [13]. In addition, factors such as body position, cuff size, emotional state, and environmental conditions may also contribute to measurement variability [4]. These factors should be considered when interpreting blood pressure readings in clinical practice.
This study has several limitations. First, the use of a pre-experimental design without a gold standard comparison, such as a mercury sphygmomanometer, limits the ability to determine the true accuracy of the devices. Second, the sample was selected using an accidental sampling technique, which may limit the generalizability of the findings. Third, measurements were conducted within a single setting, which may not fully represent broader clinical conditions. Therefore, future studies using more rigorous designs, larger sample sizes, and agreement analysis methods such as Bland–Altman are recommended to further evaluate the interchangeability of aneroid and digital sphygmomanometers. Additionally, including a reference standard would provide stronger evidence regarding measurement accuracy.

5 Conclusion

This study found no statistically significant differences in systolic and diastolic blood pressure measurements between aneroid and digital sphygmomanometers among hypertensive older adults. These findings indicate that both devices provide comparable measurement results under standardized conditions. From a practical perspective, digital sphygmomanometers may serve as a convenient alternative for blood pressure monitoring, particularly in primary healthcare settings and for home use, due to their ease of operation and reduced observer dependency. However, careful measurement procedures and regular device maintenance remain essential to ensure reliable results. Further studies using more rigorous designs and agreement analysis are recommended to confirm the interchangeability of these devices in broader clinical settings.

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