A comparative study of digital versus manual measurement of blood pressure in healthy subjects.

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3. Abstract

Background: Digital (automated) and mercury column sphygmo manometer provide comparable systolic blood pressure, but there is significant difference in

measurement of diastolic blood pressure. Measurement of diastolic blood pressure in digital (automated) device should need attention in interpretation.

Methodology: It is cross sectional study done on paramedical students.

Systolic pressure and diastolic blood pressure is measured by digital (automated) and

mercury column sphygmomanometer.

Results: In our study there are 250 subjects, Mean systolic blood pressure (SBP) is 108±10.38 mmHg and mean diastolic blood pressure (DBP) is 70.92±07.40 mmHg by mercury column sphygmomanometer. Mean systolic blood pressure is 109.90±24.09mmHg and mean diastolic blood pressure is 69.86±9.70 mmHg by digital sphygmomanometer.

Conclusion: This study highlights key differences between manual and digital blood pressure measurement methods. Systolic blood pressure (SBP) readings did

not show significant variation by the two methods. Diastolic blood pressure (DBP) readings recorded by digital sphygmomanometers were significantly different from those obtained by using manual sphygmomanometers. Study by Anita Shrivasta et.al shows similar result. Higher standard deviations in digital readings suggest greater variability, which may impact the accuracy of clinical diagnosis.

4. Keywords: Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Digital (automated) device, Mercury column sphygmomanometer.

Introduction

Blood pressure measurement is one of the vital parameter in diagnosis and maintaining day to day clinical assessment of patients in wards of hospitals.[1] Mercury column sphygmomanometer is used more than 100 years. It is gold standard method for measurement of blood pressure, but now digital sphygmomanometer is replacing it almost in every clinic and wards.[2] The Minamata Convention on Mercury is a global treaty adopted in 2013 and entering into force in 2017, aims to protect human health and the environment from mercury emissions and releases by regulating the entire life cycle of mercury, including its supply, trade, use, emissions, releases, storage, and waste management.[3] By 2021, European commission band sale of device containing mercury.[4] In India, it is banned in 2020 by treaty signed in minamata convention.[5] Accuracy of device in measurement of blood pressure is questionable. We wanted to check the accuracy of digital device with comparison of standard mercury column sphygmomanometer. So, we compare readings of digital vs mercury column sphygmomanometer and determine any variation in its recordings.

Hypertension has since long been known as the silent killer, in the modern world of increasing non-communicable disease. Accurate reading of blood pressure not only is an important parameter as vital recording but also crucial for diagnosing hypertension (6). Very limited studies are available concerning accuracy and reliability of digital (automated) Blood pressure sphygmomanometer.

Methods

A cross-sectional study was clone in 250 healthy paramedical students. Informed consent was taken and procedure is explained before measurement of blood pressure. Blood pressure is recorded on dominant hand with help of mercury column and digital sphygmomanometer. Three reading were recorded by both mercury column and digital sphygmomanometer in sitting position with interval of

1 minute. Mean and standard deviation of Systolic blood pressure (SBP) and Diastolic blood pressure (DBP) were compared between mercury and digital sphygmomanometer for any variations.

Data was analysed using IBM SPSS 23. P value of <0.5 was considered significant.

Inclusion criteria: Subject within the age group 18 to 25 years with no history of any disease.

Exclusion criteria: Subject with a history of hypertension, cardiac diseases, endocrine disorder, obesity, and renal diseases are excluded from the study.

Results

In our study, there are 83 males and 167 females. Mean systolic blood pressure is (SBP) 108.68±10.38 mm Hg and Mean diastolic blood pressure (DBP) is 70.92±7.40 mmHg by mercury column sphygmomanometer respectively. Mean systolic blood pressure (SBP) is 109.90±24.09 mm Hg and mean diastolic blood pressure (DBP) is 69.86±9.20 mm Hg by digital sphygmoman

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recorded among two devices was not statistically significant. Table 1 presents a comparison of blood pressure measurements using manual and digital methods.

For systolic blood pressure (SBP), the manual method recorded a mean of 108.68 ± 10.38 mmHg, while the digital method showed a slightly higher mean of 109.90 ± 24.09 mmHg, indicating greater variability in the digital readings. For diastolic blood pressure (DBP), the manual method had a mean of 70.92 ± 7.40 mmHg as compared to 69.86 ± 9.20 mmHg for the digital method. The standard deviations associated with the digital method suggest high- variation in its recordings whereas the manual method provided more stable and reliable values for both SBP and DBP. Table 2 presents a paired sample test comparing systolic blood pressure (SBP) and diastolic blood pressure (DBP) measurements, obtained using manual and digital methods, along with a reliability assessment using Cronbach's Alpha. For systolic blood pressure (SBP), the mean difference between manual and digital readings was -1.22 mmHg with a standard deviation of 23.15 and a standard error of 1.46. The p-value of 0.40 indicates that the difference is not statistically significant.

In contrast, for diastolic blood pressure (DBP), the mean difference was 1.06 mmHg, with a standard deviation of 8.26 and a standard error of 0.52. The p-value of 0.04 indicates a statistically significant difference ($p < 0.05$) between manual and digital diastolic blood pressure (DBP) measurements. The significance of the p-value suggests inconsistency between the two methods for diastolic blood pressure (DBP) readings.

However, the Cronbach's Alpha value of 0.603 reflects moderate reliability, suggesting variability between the two methods and indicating that the internal consistency is not very strong. Overall, the moderate Cronbach's Alpha value of 0.603 indicates that the reliability of the measurements is acceptable but not optimal. While the systolic blood pressure (SBP) readings do not differ

significantly between manual and digital methods, the diastolic blood pressure (DBP) values show a significant difference, highlighting the need for caution when interpreting measurements obtained using digital devices. This variability underscores the importance of standardizing digital methods to improve reliability, especially in clinical and research settings.

Discussion

In our study, we choose healthy volunteers with almost similar age. So that no confounding factors influence result. The findings of this study indicate that while both manual and digital sphygmomanometers provide comparable systolic blood pressure (SBP) readings, but there is a significant difference in diastolic blood pressure (DBP) values, with digital devices showing greater variability. Study done by Asha Shekhar et.al shows that diastolic blood pressure (DBP) reading between aneroid and digital shows significant difference (7). This study finding is similar to our study. This highlights the need for caution when relying on digital BP measurements, particularly in clinical settings where precise readings are crucial for diagnosing and managing hypertension.

The observed variability in digital BP measurements could be attributed to several factors, including device calibration, cuff positioning, and individual subject variability. Digital sphygmomanometers rely on oscillometric methods, which may be influenced by arm movement, pulse pressure variability, and device algorithm differences. Oscillometric apparatus translate arterial pressure in oscillometric wave and with system build algorithm display reading (8). In contrast, the mercury

column sphygmomanometer, when used correctly, provides more stable readings

due to its direct auscultatory method. The study's moderate Cronbach's Alpha value (0.603) suggests that while digital devices are fairly reliable, they are not optimal in terms of consistency when compared to manual methods. Given the increasing use of digital sphygmomanometers in hea

lthcare settings, efforts

should be made to improve their standardization and calibration to minimize variability.

Additionally, the significant difference in diastolic blood pressure (DBP) values raises concerns about the accuracy of digital sphygmomanometers in diagnosing conditions like isolated diastolic hypertension. If digital devices underestimate or overestimate diastolic blood pressure (DBP), it could lead to misdiagnosis and inappropriate treatment decisions. Future research should focus on larger sample sizes, inclusion of hypertensive subjects, and evaluating different brands of digital sphygmomanometers to determine if variability is device-specific. Moreover, studies incorporating ambulatory blood pressure monitoring (ABPM) could provide a more comprehensive assessment of blood pressure(BP) measurement accuracy over time.

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Table1: Mean Blood Pressure Measurements Using Manual & Digital Methods

Blood pressure		Mean	N	Std.Deviation	Std. Error Mean
Manual	Average SBP	108.68	250	10.38	0.66
	Average DBP	70.92	250	7.40	0.47

Digital	Average SBP	109.90	250	24.09	1.52
	Average DBP	69.86	250	9.20	0.58

Avg. SBP (Systolic Blood Pressure)

Avg. DBP (Diastolic Blood Pressure)

Figure 1: Comparison of Systolic Blood Pressure (SBP) And Diastolic Blood Pressure (DBP) Measurement Using Manual And Digital Devices
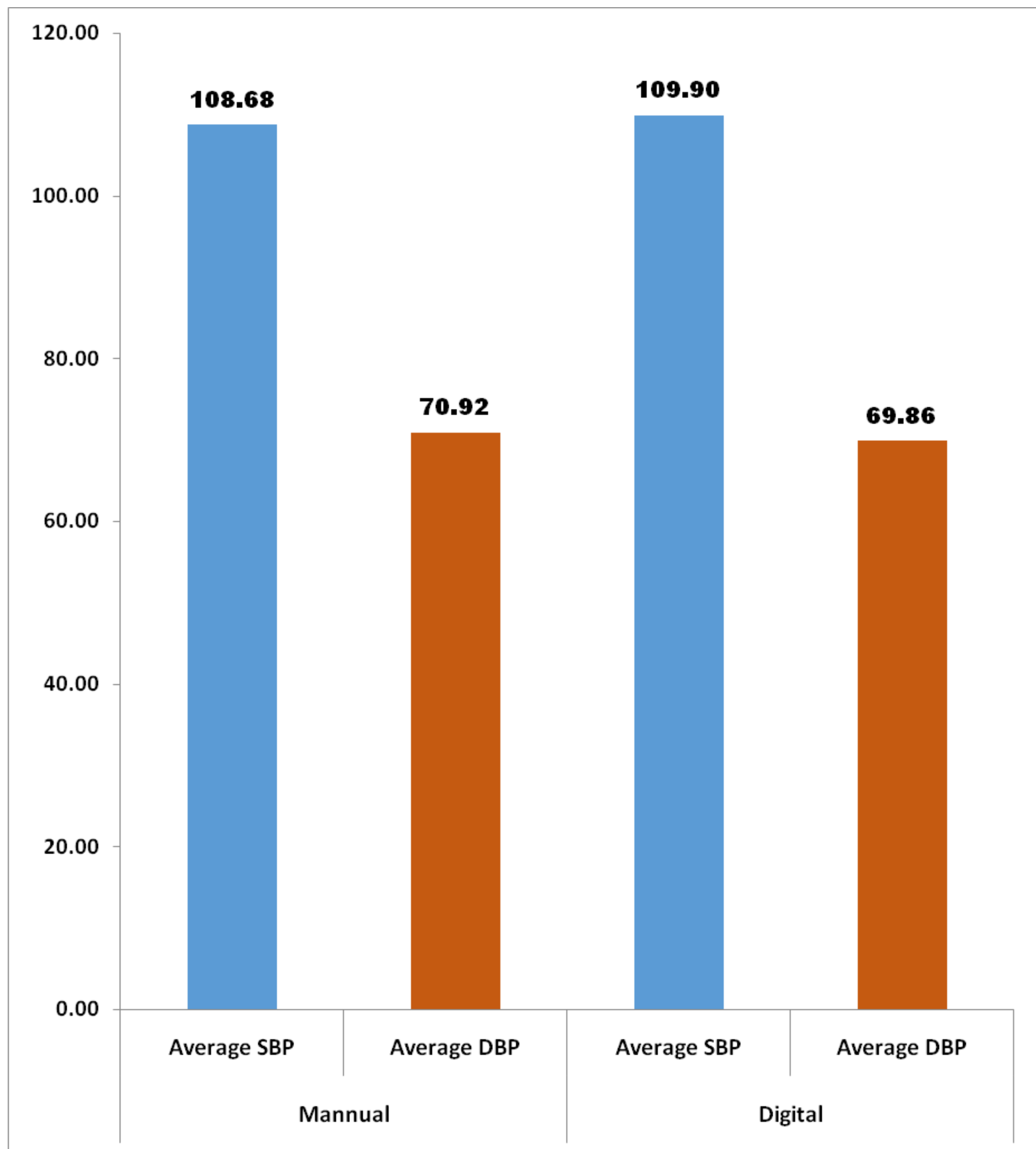
Table 2: Paired Comparison of Manual and Digital Blood Pressure Measurements with Reliability Analysis

Paired Samples Test						Reliability statistics
		Paired Differences				Cronbach's Alpha
		Mean	Std. Deviation	Std. Error Mean	p Value	
Pair 1	AVG Manual SBP - AVG Digital SBP	-1.22	23.15	1.46	0.40	0.603
Pair 2	AVG Manual DBP - AVG Digital DBP	1.06	8.26	0.52	0.04*	