

Comparison of blood pressure measurement with two digital sphygmomanometers

ABSTRACT

Aims: identify the correlation between systolic and diastolic blood pressure measurement with digital arm and wrist baumanometers in young adults aged 18 to 40 at the Public University of Celaya, Guanajuato, Mexico.

Study design: Observational, analytical, quantitative, correlational, diagnostics

Place of Study: Public University of Celaya, Guanajuato, Mexico.

Methodology: We included 397 participants of an age range between 18 and 40 years; which 287 were women and 110 were men; with an average weight of 65.28 ± 15.08 , and of stature 1.63 ± 0.09 . Two types of digital, wrist and arm baumanometers were used to measure the systolic and diastolic blood pressure to observe the effectiveness of the values recorded during the measurement.

Results: The correlation between the 3 measurements of the systolic blood pressure was repeated in the first and third measurements ($r = 0.46$) and varied in the second ($r = 0.39$), in all three the value recorded by the highest arm baumanometer was found. In the 3 measurements of the diastolic blood pressure the correlation varied ($r = 0.54$, $r = 0.50$, $r = 0.59$); registering the highest value in the measurement with the arm baumanometer.

Conclusion: The correlation between the measurements with the baumanometers was not perfect, however it was good, it was considered that the measurement of blood pressure with the wrist baumanometer should be done with the wrist at the level of the heart; as well as movements of arm, hand or fingers will alter the result.

Keywords: Blood pressure, Digital and arm baumanometers. Adults

1. INTRODUCTION

14 Blood pressure is the force exerted by the blood against the walls of the vessels (arteries) when being pumped by the heart, it takes into account
15 the arterial resistance to the blood flow, the diameter of the arterial light and the blood volume of ejection also called cardiac output [1].

16
17 The instrument for measuring blood pressure is the sphygmomanometer, also known as the baumanometer, which records the values in
18 millimeters of mercury (mmHg) by two figures. The larger figure represents systolic blood pressure (SBP); that is, the maximum pressure that is
19 reached in the contraction phase of the myocardium and the lower figure represents the diastolic blood pressure (DBP) that occurs when the
20 myocardium relaxes.

21
22 According to the World Health Organization (WHO) [2], blood pressure is classified into five categories according to the values recorded by the
23 baumanometer, where arterial hypertension (AH) is organized at different levels:

24
25 **Table 1. Categorization of blood pressure figures**

26

Category	Systolic (mmHg)	Diastolic (mmHg)
Ideal blood pressure	< 120	< 80
High normal blood pressure	120-139	80-89
Mild hypertension	140-159	90-99
Moderate hypertension	160-179	100-109
Severe hypertension	≥ 180	≥ 110

27 Reference: World Health Organization [2]

28
29 In people aged 25 years and older, hypertension was diagnosed in 40% of the world during 2008; the number of people affected increased in the
30 year 1980 to 600 million and in 2008 there were already 1,000 million cases [3]. Worldwide, during 2010, hypertension was diagnosed in 40% of
31 adults; in 2012, 31.5% of people with Mexican nationality over 20 years old had already been diagnosed. It is estimated that ≈450,000 new cases
32 are diagnosed annually in Mexico [4].

33
34 There are several factors that directly influence the figures obtained in the measurement of blood pressure, within them we can highlight non-
35 modifiable factors such as age, genetic factors, gender and some modifiable socioeconomic factors such as excess weight, obesity, sedentary
36 lifestyle, ingestion of alcohol, tobacco and diet.

37
38 People who suffer from hypertension have signs and symptoms that are nonspecific, which is why it is considered a difficult disease to detect,
39 according to the WHO, most people with hypertension do not show any symptoms. Occasionally, hypertension causes symptoms such as
40 headache, shortness of breath, dizziness, chest pain, heart palpitations and nosebleeds, but not always [1].

41
42 The detection of hypertension is carried out by measuring blood pressure using the baumanometer following the recommendations of NOM-030-
43 SSA2-2009, which indicates that the systolic and diastolic blood pressure value recorded will correspond to the average of at least two
44 measurements made with a minimum interval of two minutes [6]; taking into account that the person must be in a sitting position, relaxed and with

45 the arm or wrist in which they will measure on some object and it is recommended to do it during the first hour of the morning, using the
46 baumanometer. This study is non-invasive because the pressure exerted on the artery to interrupt the flow through it is external, and the value
47 generated by the pressure inside the artery is equal to the pressure exerted to occlude it.
48

49 The first time this method was used was in 1827, the doctor Karl von Basch made measurements of blood pressure using a column of water, but a
50 year later, the physiologist Jean Léonard replaced the water with mercury, in 1860, the doctor Étienne Jules Marey improved the sphygmograph
51 and created the first sphygmomanometer. The version designed by William A. Baum in 1915 is the version that is currently used [5].
52

53 Today there are different types of sphygmomanometers which have a very similar functionality have a bracelet that is placed on the arm or wrist, at
54 the bottom have a camera that is inflated with a manual knob or automatically inflate generates a pressure over the artery and prevents blood
55 circulation, when the pressure is higher measures the SBP and when reaching the maximum level it is gradually deflated by the relief valve and
56 there is a small turbulent and noisy blood flow that thanks to the Stethoscope is auscultated and is what is known as Korotkoff sounds.
57

58 Baumanometers are classified according to the way they are used, manual and digital sphygmomanometers; The first class in turn are divided into
59 2 types: the mercury baumanometer consisting of a cell with mercury anchored to a tube that has a scale ranging from 0 to 300 mmHg [5], this is
60 considered the most accurate since It should not be calibrated before use, but it is currently forbidden to use because mercury is a heavy metal
61 and is neurotoxic and considered an environmental pollutant [7].
62

63 The other manual type is the aneroid or analog sphygmomanometer that instead of a mercury cuvette uses a needle that is pushed by inner
64 springs, the needle is inside a sphere graduated in mmHg [5], this unlike the previous one is needed calibrate every 6 months apart that in order to
65 use it requires a stethoscope to be able to listen to the patient's Korotkoff sounds.
66

67 The digital sphygmomanometers also called oscillometric are divided according to the location of the body where the tension is measured ergo in
68 the arm or wrist, unlike manual digital ones are very easy to use because they do not depend on a stethoscope besides the fact that anyone with
69 no previous experience can use them, this is why it has become so popular today; in both types the operation is the same; the bracelet swells and
70 deflates automatically and shows the results obtained on its screen [5].
71

72 The difference between them is the location of where the blood pressure is taken, in case of using the arm, the cuff should be placed at the level of
73 the heart in the same way as the manual blood pressure meter, on the other hand the wrist is placed on a centimeters of the hand.
74

75 Although they differ only in location, there are currently many questions regarding the effectiveness and accuracy of the measurement of the wrist
76 baumanometer, since several publications mention that the blood pressure measurements taken on the wrist are usually greater and less precise
77 than those taken in the upper arm. This is because the arteries of the wrist are narrower than and not as deep under the skin as those in the upper
78 arm [8].
79

80 However, it is considered that the reliability of the measurement of blood pressure with wrist devices, which has not been previously evaluated in
81 real life circumstances in the general population, depends on the correct position of the wrist device at heart level according to the American Heart
82 Association [9].
83

84 This is a method widely used in the home of people who need a continuous check because of its easy use and that in some cases people have a
85 very large arm mainly in obese patients or it can be painful in older adults.
86

87 Considering all of the above, just as the health of people with hypertension depends on constant monitoring of the measurement of their blood
88 pressure, a comparison of the effectiveness of both types of digital baumanometers should be considered, since they are currently the most used.
89

90 The objective was to identify the correlation between the measurement of systolic and diastolic blood pressure with digital arm and wrist
91 baumanometers in adults from 17 to 51 years of age from the public University of Celaya, Guanajuato, Mexico.
92

93 **2. METHODOLOGY**

94 **2.1 Study design**

95 An observational, analytical, quantitative, correlational, and diagnostic study was designed.

96 **2.2 Place and Universe of the study**

97 The universe was undergraduate students related to health in a public university in Celaya, Guanajuato, Mexico, with a population of 1910
98 students.

99 Simple random sampling was carried out until the sample size was completed.

100 **2.3 Selection of participants**

101 **2.3.1 Inclusion criteria**

102 Men or women 17 years of age or older who voluntarily accepted to participate in the study, signed the informed consent and were registered
103 students in the institution.

104 **2.3.2 Exclusion criteria**

105 Those students who did not accept to participate.

106 **2.4 Variables**

107 **2.4.1 Sociodemographic**

108 Age, discrete quantitative variable; number of years completed from the date of birth; its scale of measurement is in years and it is summarized
109 with frequencies and percentages.

110 Gender, dichotomous categorical variable; they are the phenotypic characteristics that differentiate men from women; its measurement scale is
111 male or female and is summarized with frequencies and percentages.

112 Marital status, nominal categorical variable; it is the state of the physical persons determined by their relations of couple, coming from the
113 marriage, that establishes certain duties and rights; his scale of measurement is single, married, divorced, widowed, separated, free union; it is
114 summarized with frequencies and percentages.

115 Weight, continuous quantitative variable; is the body mass expressed in kilograms; it is measured on an altimeter, Medidata® digital, without shoes
116 with as little clothes as possible; Its measurement scale is in kilograms and is summarized with mean and standard deviation.

117 Height, continuous quantitative variable; is the measurement from the feet to the parietal region of the scalp, expressed in meters; it is measured in
118 scale with altimeter, Medidata® digital, without shoes, in erect position and facing forward; Its measurement scale is in meters and it is
119 summarized with mean and standard deviation (s).

120 BMI, continuous quantitative variable; is the body mass expressed in kg / m^2 ; its measurement scale is in Kg / m^2 ; and it is summarized with media
121 and s.

122 **2.4.1 Independent**

123 Measurement of systolic blood pressure; is the hydrostatic force of the blood on the arterial walls that results from the contraction of the heart, it is
124 measured with a humeral digital baumanometer with an adult bracelet, it is measured three times with an interval of two minutes and the average
125 systolic blood pressure is obtained; its measurement scale is in mm Hg; it is summarized with media and s.

126 Measurement of dyastolic blood pressure; it is the hydrostatic force of the blood on the arterial walls that results from the relaxation of the heart, it
127 is measured with a humeral digital baumanometer with an adult bracelet, it is measured three times with an interval of two minutes and the
128 average of the diastolic blood pressure is obtained; its measurement scale is in mm Hg; it is summarized with media and s.

129 **2.4.3 Dependent**

130 Measurement of systolic blood pressure; is the hydrostatic force of the blood on the arterial walls that results from the contraction of the heart, it is
131 measured with a Rossmax LC 150 digital wrist baumanometer with an adult bracelet, it is measured three times with an interval of two minutes and
132 the average of systolic blood pressure; its measurement scale is in mm Hg; it is summarized with media and s.

133 Measurement of dyastolic blood pressure; it is the hydrostatic force of the blood on the arterial walls that results from the relaxation of the heart, it
134 is measured with a digital wrist baumanometer with an adult bracelet, it is measured three times with an interval of two minutes and the average
135 blood pressure is obtained diastolic; its measurement scale is in mm Hg; it is summarized with media and s.

136 **2.5 Procedures**

137 After the approval of the protocol by the Bioethics Committee, authorization was requested to the University directors to contact the students. They
138 were informed of the study objectives and their potential benefits and risks; the questions they had to ask were answered; they were asked to sign
139 the informed consent. Those who agreed to participate answered the general questionnaire about sociodemographic data and proceeded to the
140 measurement of blood pressure. To start the procedure, the participant was kept at rest for 10 minutes seated; the participant's wrist was placed
141 and the extremity at the level of the heart and remained in that position during the measurements, after the rest period, the wrist baumanometer
142 bracelet Rossmax LC 150 was placed on the non-dominant wrist and the measurement was made; after the initial reading, the bracelet was
143 removed and after two minutes, the second measurement was made; the bracelet was removed again for two minutes and replaced for the third
144 measurement.

145 At the end of the third measurement with the wrist baumanometer the participant was kept at rest for 10 minutes and the first blood pressure
146 measurement was performed with the digital arm baumanometer; it was removed, 2 minutes were waited and the second measurement was made
147 and again 2 minutes later the third measurement was made.

148 **2.6 Sample size**

149 Assuming there is a Pearson's r of 0.5 between the measurements of the two baumanometers, the minimum sample size is 37 subjects with 95%
150 precision and 90% power (Epidat 4.1, 2014, Xunta de Galicia, Spain; Pan American Health Organization (PAHO-WHO), CES University,
151 Colombia).

152 **2.7 Statistical analysis**

153 For the sociodemographic variables, descriptive statistics were used. To identify the correlation and possible linear relationship, Pearson's r , linear
154 regression equation, t test, P value, and 95% confidence intervals are used. Also, we calculated ANOVA between each two measures. It was
155 calculated the differences between blood pressure with wrist and arm baumanometers, and then, the mean of these differences and t -paired test,
156 and P -value. To demonstrate the statistical significance of the results, the value of P was set at .05. The statistical analysis was performed in
157 STATA 13.0 © (Stata Corp., Colege Station, TX, USA).

158 **RESULTS AND DISCUSSION**

159 A higher rate of women was found, indicating a frequency of 287 of the participants, their residence was more frequent in the urban area with a
160 frequency of 313 than was expected due to the place where the participants were recruited; more than 90% of the participants shared the single
161 marital status, however there are, although in minimal amounts, people in each category (Table 2).

162 In another study conducted in Greece where the sample used was 81 having a higher frequency for females with 43 participants (54%). The study
163 covers a correlation between two types of digital strain gauges for the arm and arm [10].

164 **Table 2. Characteristics categorical sociodemographic variables in the sample**

Variable		f	%
Gender	Man	110	27.71
	Woman	287	72.29
Residence	Urban	313	78.84
	Suburban	57	14.36
	Rural	27	6.80
Civil status	Single	377	94.96
	Married	14	3.53
	Separate	1	0.25
	Divorced	1	0.25
	Free union	4	1.01

165
166 The average age was 21.41 years which was expected to be students of higher level (Table 3), compared to the study in Greece [10] and Italy [9]
167 where the average age was $56.7 \pm 11, 8$ years and 49.3 ± 15.4 respectively; another variable also involved in the investigation was the average
168 weight and height was $65.28 \text{ kg} \pm 15.08$ and $1.63 \text{ m} \pm 0.09$ respectively, this indicates that the weight in this sample was not very high although
169 there were participants up to 171 kg, these values differ of the means of the investigation of the study in Greece [10] where a value of or $168.1 \pm$
170 9.6 cm and $79.2 \pm 18 \text{ kg}$ of height and weight respectively was recorded. The average BMI corresponds to the adequate mean in the sample
171 although there was a BMI of up to $55 \text{ kg} / \text{m}^2$ (Table 3); On the other hand, in the study in Greece [10], it reached a value of $27.8 \pm 5 \text{ kg} / \text{m}^2$; the
172 highest value can be observed in the study of Greece due to the higher value in weight.

173
174 **Table 3. Quantitative sociodemographic characteristics of the sample**
175

Variable	Range	Mean \pm SD.
Age (years)	17 - 51	21.41 ± 3.08
Weight (kg)	38.7 - 171.2	65.28 ± 15.08
High (m)	1.17 - 1.98	1.63 ± 0.09
Body mass index (kg/m^2)	16.1 - 55.37	24.41 ± 4.40

177 Comparing the systolic and diastolic blood pressure measurements with the wrist and arm baumanometers, by sociodemographic variables, we
 178 found that the SBP measurements, significant differences between the baumanometers for both genders ($P < .05$); for residents in urban, suburban
 179 and rural areas ($P < .05$) and between age groups ($P < .05$) (Table 4). Regarding DBP measurements, no significant differences ($P > .05$) were
 180 found between measures with wrist and arm baumanometer (Table 4).

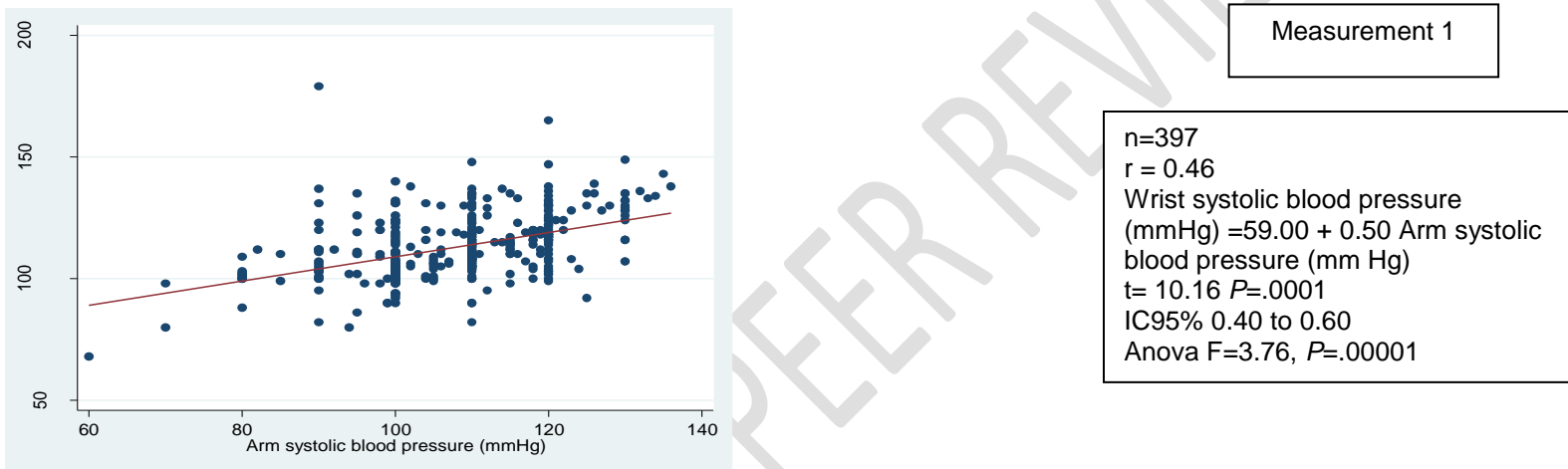
181 **Table 4. Mean of differences from systolic and diastolic blood pressure with wrist and arm baumanometers by sociodemographic**
 182 **characteristics of the sample**

Systolic blood pressure (mm Hg)						
Variable	Wrist Mean \pm S	Arm Mean \pm S	Mean_d \pm S_d	t-paired test	Degree of freedom	P-Value
Gender						
Male (n=110)	119.49 \pm 10.00	112.34 \pm 11.02	7.15 \pm 12.58	5.96	109	.00001
Female (n=287)	109.90 \pm 12.14	105.83 \pm 14.13	4.07 \pm 16.18	4.26	286	.00001
Residence						
Urban (n=313)	112.32 \pm 11.71	107.65 \pm 14.03	4.67 \pm 15.45	5.35	312	.00001
Suburban (n=57)	111.80 \pm 14.89	105.71 \pm 12.55	6.09 \pm 16.86	2.73	56	.0085
Rural (n=27)	117.00 \pm 13.29	111.57 \pm 10.58	5.43 \pm 9.56	2.95	26	.007
Age (years)						
17-35 (n=393)	112.47 \pm 12.35	107.62 \pm 13.71	4.85 \pm 15.36	6.26	392	.00001
36-51 (n=4)	121.90 \pm 9.69	109.82 \pm 2.43	12.08 \pm 7.70	3.14	3	.05
Diastolic blood pressure (mm Hg)						
Gender						
Male (n=110)	75.56 \pm 7.77	74.18 \pm 7.91	1.39 \pm 7.53	1.94	109	.06
Female (n=287)	70.35 \pm 8.25	70.01 \pm 8.09	0.34 \pm 7.39	0.78	286	.44
Residence						
Urban (n=313)	71.96 \pm 8.28	71.31 \pm 7.98	0.65 \pm 7.05	1.63	312	.10
Suburban (n=57)	69.50 \pm 8.01	69.76 \pm 9.18	-0.25 \pm 8.68	-0.22	56	.83
Rural (n=27)	74.68 \pm 10.13	72.44 \pm 9.12	2.24 \pm 8.81	1.32	26	.20
Age (years)						
17 - 35 (n=393)	71.76 \pm 8.46	71.15 \pm 8.28	0.60 \pm 7.46	1.59	392	.12
36 - 51 (n=4)	75.42 \pm 4.57	72.25 \pm 2.63	3.17 \pm 2.63	2.41	3	.10

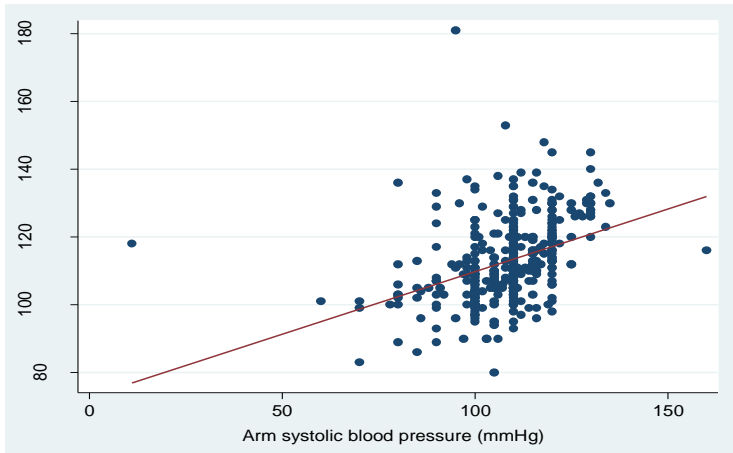
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Meand ± Sd Mean of differences ± Standard deviation

184 Figure 1 show the three measures of systolic blood pressure with the digital arm and wrist baumanometer with scattered point graphs and showing
185 the correlation results and the linear regression equation and ANOVA. Having a sample of 397 the correlation between the measurement of the
186 systolic blood pressure with the digital arm and wrist baumanometer varied in the second measurement carried out having a value of 0.39 unlike
187 that obtained in the first and third measurements where the correlation it was 0.46; taking into account that the measurement of the SBP had
188 different values in the three measurements and differed according to the type of baumanometer used, highlighting that the value measured by the
189 wrist baumanometer was smaller having the largest difference in the first measurement (Figure 1).



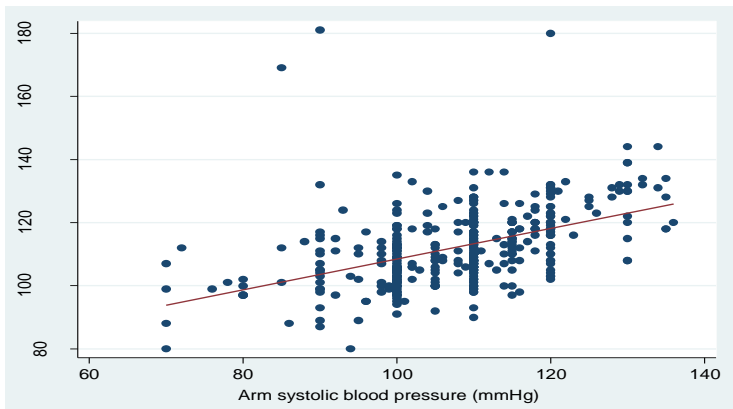
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Measurement 2

n=397
 r = 0.39
 Wrist systolic blood pressure (mmHg) = 72.87 + 0.37 Arm systolic blood pressure (mm Hg)
 t= 8.47 P=.0001
 IC95% 0.28 to 0.45
 Anova F=3.73, P=.00001

191



Measurement 3

n=397
 r = 0.46
 Wrist systolic blood pressure (mmHg) = 59.86 + 0.48 Arm systolic blood pressure (mm Hg)
 t= 10.50 P=.0001
 IC95% 0.39 to 0.57
 Anova F=4.16, P= .00001

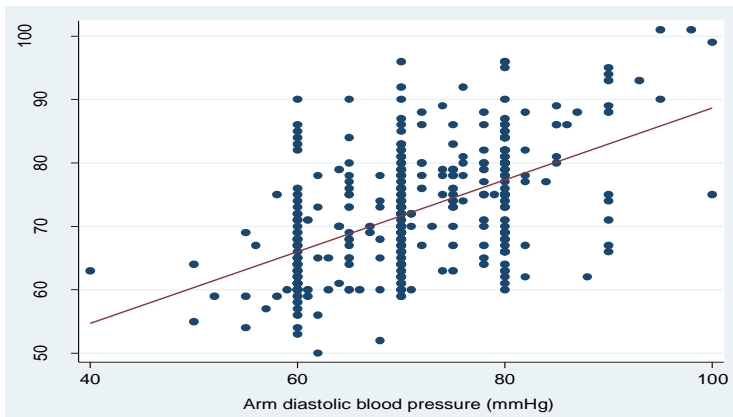
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193 **Figure 1. Correlation and linear regression among blood pressure systolic in arm and wrist**

194 In the study conducted in Greece, an average of the SBP measured in the arm of 132.4 ± 13.0 mmHg was recorded, being greater than the values
 195 measured in the wrist 127.2 ± 11.7 mmHg; being able to observe the measurement between both had a difference of ≥ 10 mm Hg [10]. These
 196 values are like those obtained in the research in Celaya, emphasizing that the values recorded by the wrist baumanometer are greater.

197 In contrast to the values obtained, the results of a study about the poor reliability of the self-measurement of wrist blood pressure in the home by
198 Casiglia et al., in Italy; in which they used a sample of 721 unselected subjects using wrist balancers (UB-542) and arm (UA-767 Plus) they found a
199 discrepancy between the measurement in two different places because in the office, the systolic blood pressure was 2.5 % lower in the wrist than
200 in the arm ($P = 0.002$), while in the home, the systolic and diastolic blood pressures were higher in the wrist than in the arm + 5.6% and + 5.4%,
201 respectively; $P < 0.0001$ for both [9].

202 Repeating the sample of 397 the correlation between the three measurements of the DBP varied, the highest obtained was in the third
203 measurement; it is noteworthy that the measurement of the DBP by the digital wrist baumanometer is greater than that measured by the arm
204 baumanometer and graphs of scattered points, correlation, linear regression equation and ANOVA are shown for the three diastolic blood pressure
205 measurements [Figure 2]. There are a good correlation and lineal relationship in the three measures for DBP, but there are differences in
206 measures of DBP with wrist compared with arm baumanometer,



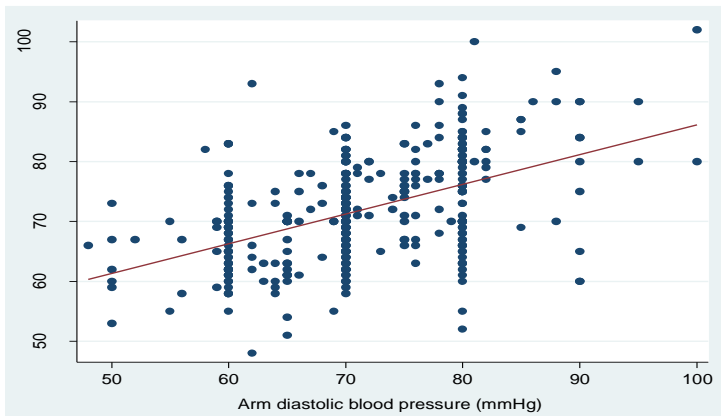
Measurement 1

n=397
r = 0.54
Wrist diastolic blood pressure
(mmHg) = 32.03 + 0.56 Arm diastolic
blood pressure (mm Hg)
t= 12.78 $P= .0001$
IC95% 0.48 to 0.65
Anova F=5.55, $P= .00001$

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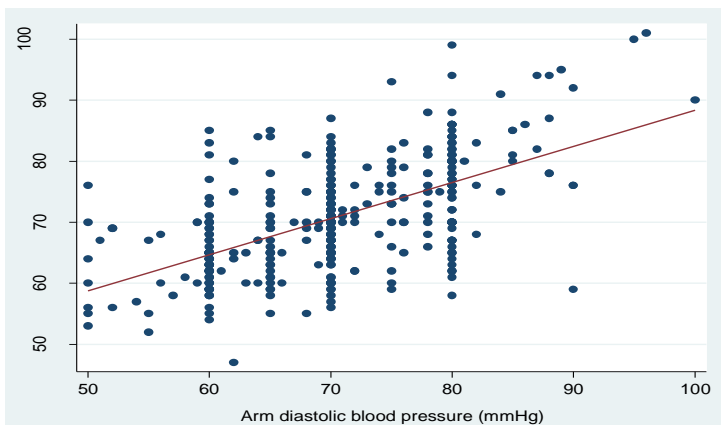
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Measurement 2

n=397
 r = 0.50
 Wrist diastolic blood pressure (mmHg)
 = 36.48 + 0.49 Arm diastolic blood
 pressure (mm Hg)
 t= 11.61 P=.0001
 IC95% 0.41 to 0.58
 Anova F=5.44, P= .00001

210



Measurement 3

n=397
 r = 0.59
 Wrist diastolic blood pressure
 (mmHg) = 29.10 + 0.59 Arm diastolic
 blood pressure (mm Hg)
 t= 14.48 P=.0001
 IC95% 0.51 to 0.67
 Anova F=5.95, P= .00001

211 **Figure 2. Correlation and lineal regression among blood pressure diastolic in arm and wrist**

212 Stergiou et al, reported in Greece, the average of the PAD measured in the arm of 79.7 ± 9.1 mmHg being higher compared to the values
 213 measured in the wrist 77.5 ± 9.7 mmHg, being the measurement in the arm the highest value [10] These values are similar to those obtained by
 214 Casiglia et al., study in Italy [9], where systolic and diastolic blood pressures were greater in the wrist than in the arm (+ 5.6% and + 5.4%,
 215 respectively; $P < 0.0001$ for both); Casiglia et al., did not obtain significant differences (-0.7% for diastolic) [9].

216 According to the three measurements of the systolic blood pressure with the digital wrist and arm baumanometer, the mean difference was
 217 obtained for each measurement; the difference between the values obtained in each measurement with each type of baumanometer was positive,
 218 and a P value (0.00001) indicative of the mean difference is not equal to 0, demonstrating that the values obtained with the wrist baumanometer
 219 were greater (Table 5).

220 According to the three measurements of the diastolic blood pressure, the first one coincides with the positive value in the difference of the
 221 measurements with both types of baumanometer having a value of $P=.02$, different from 0, indicating that the value obtained in the measurement
 222 with the baumanometer of wrist was greater; in comparison to the second and third measurements in which the P -value were .16 and .73,
 223 indicates that there is not difference between mean of differences in both measures the two types of baumanometers (Table 5).

224 **Table 5. Mean differences between systolic and diastolic blood pressure measurements with wrist and arm baumanometer**

Measures	Range	$\bar{x}_d \pm S$	t	df	P-value
Systolic 1	-33 a 89	4.60 ± 12.79	7.17	396	0.00001
Systolic 2	-44 a 107	4.64 ± 13.57	6.81	396	0.00001
Systolic 3	-22 a 91	4.28 ± 12.29	6.94	396	0.00001
Diastolic 1	-26 a 30	1.05 ± 8.73	2.40	396	0.02
Diastolic 2	-30 a 31	0.61 ± 8.69	1.40	396	0.16
Diastolic 3	-31 a 26	0.14 ± 8.05	0.35	396	0.73

225 S= standard deviation, \bar{x}_d = mean of difference, df= degrees of freedom

226 With respect to the results obtained from blood pressure measurements with digital wrist and arm baumanometers, a similarity was found in the
 227 values of systolic blood pressure in the study conducted in Greece, where in both studies the values recorded by the digital wrist baumanometer
 228 were greater than those recorded by the arm baumanometer; these results differ with the study conducted by Edoardo Casiglia et al., in Italy,
 229 where lower values were found using the wrist baumanometer.

230 The results coincided with the first measurement of the diastolic blood pressure since the values recorded by the digital wrist baumanometer were
 231 higher than those recorded by the arm baumanometer, however for the second and third measurements the values recorded by both types of
 232 baumanometer They were almost similar but not exactly the same. Conversely, studies conducted in Greece and Italy recorded lower values of
 233 diastolic blood pressure with the digital wrist baumanometer.

234 This reflects the dissimilarity that exists in the measurement of blood pressure using the digital wrist and arm baumanometers, where the values
235 can vary upwards or downwards.

236 The research had strengths as they were the response of the participants to agree to be part of the investigation, none was rejected since all met
237 the requirements and measurements.

238 Among the weaknesses is the fact that, although it was supervised, that the wrist with the baumanometer placed at the height of the participant's
239 heart and that they did not move their fingers or their hand, a measurement bias could be possible.

240

241 **CONCLUSION**

242 The correlation between the measurement with the digital wrist and arm baumanometers was not perfect, however it was good ($r = 0.50$), it was
243 considered that the BP measurement with the wrist baumanometer should be done with the wrist at the level of the heart; placing it below or
244 above, as well as movements of arm, hand or fingers will alter the result.

245

246

247 **COMPETING INTERESTS**

248

249 Authors have declared that no competing interests exist.

250

251

252 **CONSENT**

253

254 All participants signed the consent form.

255

256 **ETHICAL APPROVAL**

257

258 Reviewed and approved by the research and bioethics committees of the division of health sciences and engineering of the Celaya-Salvatierra
259 campus of the University of Guanajuato, with the registry **CIDCSIC-0911204**.

260

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