

## Influence of Environment and Measurement Conditions on Blood Pressure During Self-Measurement Blood Pressure

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### ABSTRACT

**Background:** Effective blood pressure (BP) monitoring outside medical office requires that each patient have validated sphygmomanometer. Due to their relatively high expense, these sphygmomanometers remain little or not accessible in our working context. When self-monitoring of blood pressure (SMBP) is prescribed in the office, most patients go to private pharmacies where BP measurements are influenced by environment and measurement conditions.

**Aim:** To determine influence of environment and measurement conditions on BP during SMBP in healthy sedentary people in order to describe reality of practice of this method in our working context.

**Method:** Prospective experimental transversal study including 174 volunteers (47 women), aged 18 to 25 years. Systolic BP (SBP), diastolic BP (DBP), and heart rate (HR) were measured by home SMBP according to international guidelines and by private "pharmacies SMBP". Information on environment and conditions of BP measurement was collected on form by each subject. Means and standard deviations of SBP, DBP, and HR were calculated and compared from the measurements obtained.

**Results :** The mean age of study population was 21.1±2 years (Table 1). Only 9.7% of pharmacy measurements were taken in quiet environment (Figure 1). In study population, SBP, DBP, and HR measured by home SMBP were significantly ( $p=0.00$ ) higher than those measured by "pharmacies SMBP" (Table 2). However, no significant difference ( $p>0.5$ ) was found between measurements obtained by home SMBP and those obtained by " pharmacies SMBP " in quiet environment (Table 3). All of the equipment used in pharmacies were validated electronic sphygmomanometers (Figure 2).

**Conclusion:** The environment significantly influenced measurements performed in pharmacies. Compared to home SMBP, "private pharmacies SMBP" in our working context does not follow international guidelines and is therefore influenced by environment and measurement conditions.

**Keywords:** blood pressure, blood pressure measurement environment and conditions, blood pressure self-measurement.

## INTRODUCTION

Blood pressure (BP) is impulse of blood on each unit area of arterial wall.<sup>1</sup> This propulsive force induced by heart to perfuse body tissues at an average value of 100 mmHg. As cardiac ejection is intermittent, BP oscillates between systolic maximum of 120 mmHg and diastolic minimum of 80 mmHg.<sup>1</sup> A persistent increase in these values, greater than or equal to 140 and/or 90 mmHg at medical office, is hypertension.<sup>2,3</sup> Hypertension, major cardiovascular risk factor, has established itself as public health problem in our developing countries.<sup>4</sup> In 2017, its prevalence was 24.8% in sub-Saharan Africa.<sup>5</sup> In Côte d'Ivoire, it was estimated at 20.4%.<sup>6</sup> Hypertension remains major contributor to morbidity and mortality worldwide.<sup>5</sup> Its management requires regular BP monitoring in and out of medical office<sup>2,3</sup>. Among methods of ambulatory BP monitoring, self-measurement of blood pressure (SMBP) is becoming increasingly significant in diagnostic evaluation and therapeutic management of hypertension<sup>7</sup>. It's defined as conscious and voluntary measurement of BP by a subject<sup>8</sup> outside the medical office, in his familiar environment.<sup>9</sup> SMBP provides many blood pressure values outside medical office to better estimate cardiovascular risk<sup>7</sup>. To be more effective, this method requires that each subject has reliable, validated and suitable sphygmomanometer.<sup>9</sup> However, in our working context, due to their relatively high cost, validated electronic sphygmomanometers remain little or not accessible considering the indigence of most patients<sup>10</sup>. This obliges them to go to private pharmacies when home SMBP is required. But according to the recommendations<sup>2,3,9</sup>, home SMBP should be performed at home, by the subject himself, in a quiet environment, sitting with his feet flat, back and arms supported, after five minutes of rest, with validated sphygmomanometer and humeral cuff. In practice, these recommendations are not or only marginally followed in private pharmacies, some of which propose BP measurements in a noisy environment, sometimes in standing posture. Therefore, the

aim of this work is to determine influence of environment and measurement conditions on resting BP values of healthy sedentary subjects during SMBP in order to describe reality of this method in our work context.

## MATERIAL AND METHODS

### Ethical approbation

This study was approved by the ethics committee of the Yopougon Hospital and University Center (Abidjan-Côte d'Ivoire) and followed the guidelines of Helsinki Declaration. The problematics, purpose, objectives and protocol of the study were explained to the subjects. Written informed consent was obtained from all study participating. The barrier precautions for Covid-19 were respected.

### Study population

The target population consisted of student volunteers from the Félix Houphouët-Boigny University (FHB) in Abidjan (Côte d'Ivoire), who were recruited orally in amphitheatres after receiving information on purpose and methodology of study. Subject inclusion for study was based on age between 18 and 25 years, black African origin, Ricci and Gagnon score of less than 35 (inactive and not very active subjects) and body mass index (BMI) of less than 30 kilograms per square meter. Subjects with any of following criteria were not included in study: hypertension, diabetes, smoking, obesity, regular alcohol consumption, cardiovascular or bronchopulmonary symptoms or pathology, hemoglobinopathy, recent (less than 1 week) or active infection, cardiovascular drug therapy, clinical anemia. Inclusion and non-inclusion criteria were determined by using survey questionnaire organized into interrogation section and recording of anthropometric parameters. Among 330 voluntary subjects, 294, including 80 women, were enrolled.

### Study protocol

This was prospective experimental study conducted in physiology and functional

explorations laboratory, FHBU and in private pharmacies in Abidjan. The study was conducted between February 2022 and October 2022. The protocol was organized in two steps. A first steps where subjects were received according to predetermined program, by groups of twenty-five, in physiology laboratory, previous education on the self-measurement of blood pressure (SMBP) principle and methodology and of SMBP procedure. This latter consisted of two phases: home SMBP, according to international guidelines<sup>2,3</sup> and "pharmacies SMBP".

Seven OMRON (m3, Japan) electronic sphygmomanometer were used. The day subjects received electronic sphygmomanometer, they were reminded SMBP methodology. For both subjects, it was recommended to measure BP on the non-dominant arm, in quiet environment, in seated position after five-minute rest, with the cuff positioned at the semi-flexed arm, itself placed on table at heart level. Measurement should be done in morning on an empty stomach and in evening before bedtime, three times in a row, one to two minutes apart. Measurements were performed on three consecutive days<sup>2,3</sup>.

Subjects visited private pharmacies for BP measurement in traditional pharmacy environment and working conditions. Participants went to private pharmacy of their choice in Abidjan for three days in a row. They were asked to perform three BP measurements, one or two minutes interval.

For both phases, the results of the BP and heart rate (HR) measurements were recorded on protocol datasheet given to each subject. On this protocol datasheet and for measurement in private pharmacies, subject should fill in information on measurement environment: noisy or quiet, availability or not of room or box designated for measurement of BP; conditions of measurement: measurement by himself or by pharmacy staff, respect or not of minimum of five minutes of rest, standing or sitting posture, back and arms supported or not (if measurement in sitting posture),

mark of instrument used. To minimize methodological bias, the sequence of home SMBP and was randomized for each subject. At end of protocol, 120 subjects (33 women) whose were performed in the standing posture were excluded from study.

### Statistical Analysis

In each subject, means and standard deviations of systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were calculated from different measurements obtained in overall population, according to gender and site of measurement. Statistical analysis was performed by IBM SPSS Statistics 20 software. Comparisons of means of anthropometric parameters as well as those of SBP, DBP, and HR between men and women were conducted using the independent samples t test. Comparisons of means of SBP, DBP, and HR by measurement site were obtained using paired-samples t test. Analyses were conducted for an acceptable type 1 error set at 0.05.

## RESULTS

A total of 174 subjects (147 males and 47 females) comprised study population and its characteristics are reported in Table 1. The mean age of men was  $21.3 \pm 2.1$  years, significantly higher than that of women, which was  $20.6 \pm 1.7$  years. Table 2 compares means of SBP, DBP, and HR by measurement site in overall population and by gender. SBP, DBP, and HR measured by "pharmacies SMBP" were significantly higher than those measured in home SMBP. Table 3 compares means of SBP, DBP, and HR during home SMBP versus "pharmacies SMBP" in subject group where "pharmacies SMBP" was performed in a quiet environment. These means were statistically identical. Figure 1 and Figure 2 show data on environment and conditions of BP measurement in pharmacies, respectively. Ninety percent of pharmacies conducted measurements in a noisy environment. In all pharmacies visited, BP measurement was performed by staff present.

**Table 1: Age and anthropometric characteristics of study population.**

Characteristics	All (n=174)	Women (n= 47)	Men (n= 127 )	p
Age (years)	21,1 ± 2	20,6 ± 1,7	21,3 ± 2,1	0,01
Weight (Kg)	61,8 ± 9,7	59,9 ± 12,6	62,5 ± 8,2	0,04
Size (m)	1,7 ± 0,1	1,6 ± 0,1	1,7 ± 0,1	0,00
BMI (kg/m <sup>2</sup> )	21,5 ± 3,7	22,6 ± 5	21,1 ± 2,9	0,00

n = population size; kg/m<sup>2</sup> = kilogram per square meter; m = meter; BMI = body mass index; p = significance of test.

**Table 2 : Comparative means of blood pressure and heart rate during home versus “pharmacies” self-measurement blood pressure.**

POPULATION	Characteristics	SELF-MONITORING OF BLOOD PRESSURE		
		Home	Pharmacies	p
ALL (n= 174)	SBP (mmHg)	105,8 ± 4,7	109,5 ± 10,2	0,00
	DBP (mmHg)	65,8 ± 4,5	72,4 ± 2,9	
	HR (bpm)	67,3 ± 5,2	80,1 ± 10,9	
WOMEN (n= 47)	SBP (mmHg)	103,8 ± 4,8	110,4 ± 10,6	
	DBP (mmHg)	65,3 ± 5,3	72,4 ± 3,1	
	HR (bpm)	69,3 ± 6,8	82,2 ± 12,6	
MEN (n= 127)	SBP (mmHg)	106,6 ± 4,4	109,2 ± 10,1	
	DBP (mmHg)	66 ± 4,1	72,4 ± 2,9	
	HR (bpm)	66,6 ± 4,2	79,4 ± 10,1	

n = population size; SBP = systolic blood pressure; DBP = diastolic blood pressure, HR = heart rate; LmmHg = millimeter of mercury; p = significance of test.

**Table 3: Comparative means of blood pressure and heart rate during home (H-SMBP) versus “pharmacies” (P-SMBP) blood pressure self-measurement in quiet measurement environment-.**

QUIET MEASUREMENT ENVIRONMENT (n=17)			
	PARAMETRES	MOYENNES	p
H-SMBP Vs P-SMBP	SBP (mmHg)	108 ± 13	0,39
		109 ± 13	
	DBP (mmHg)	73 ± 6	0,05
		74 ± 6	
	HR (bpm)	79 ± 10	0,44
		80 ± 10	

n = population size; SBP = systolic blood pressure; DBP = diastolic blood pressure, HR = heart rate; mmHg = millimeter of mercury; p = significance of test.6

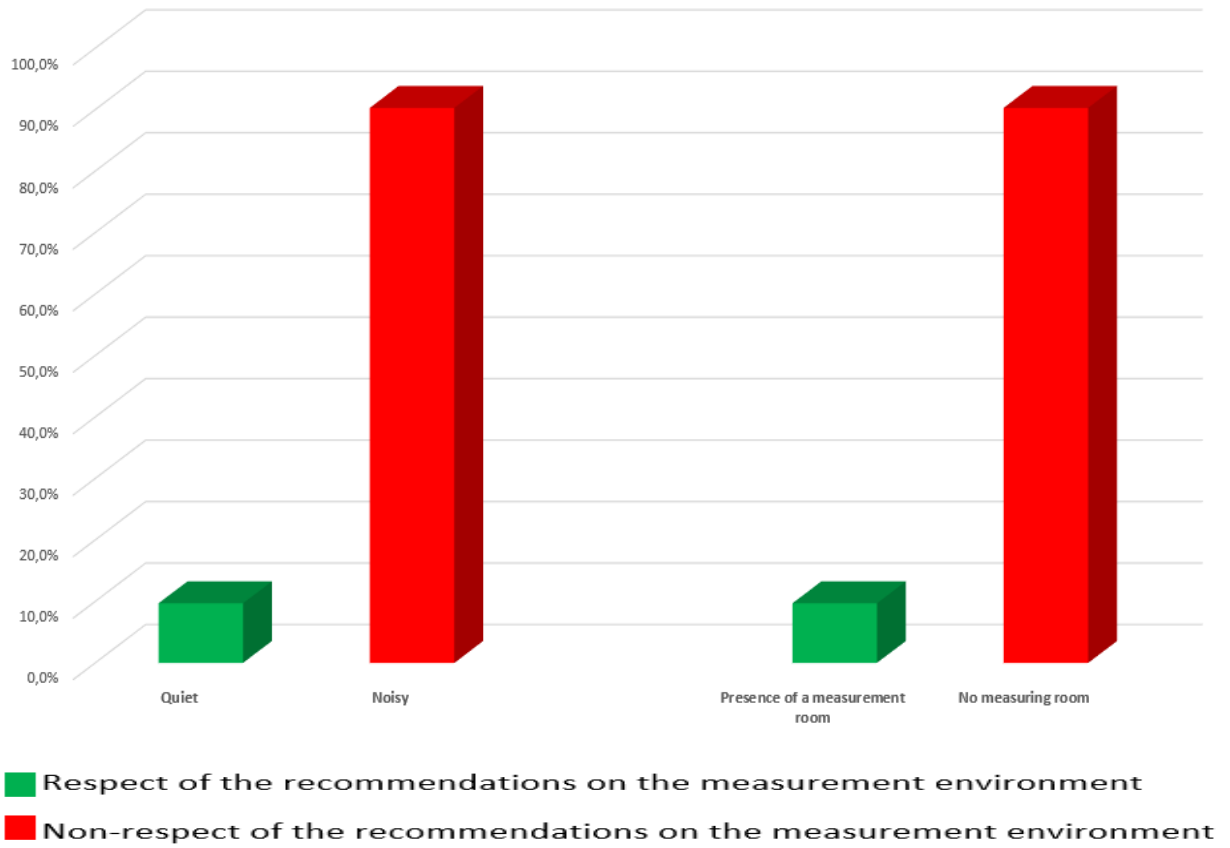


Figure 1: Blood pressure measurement environment in pharmacies.

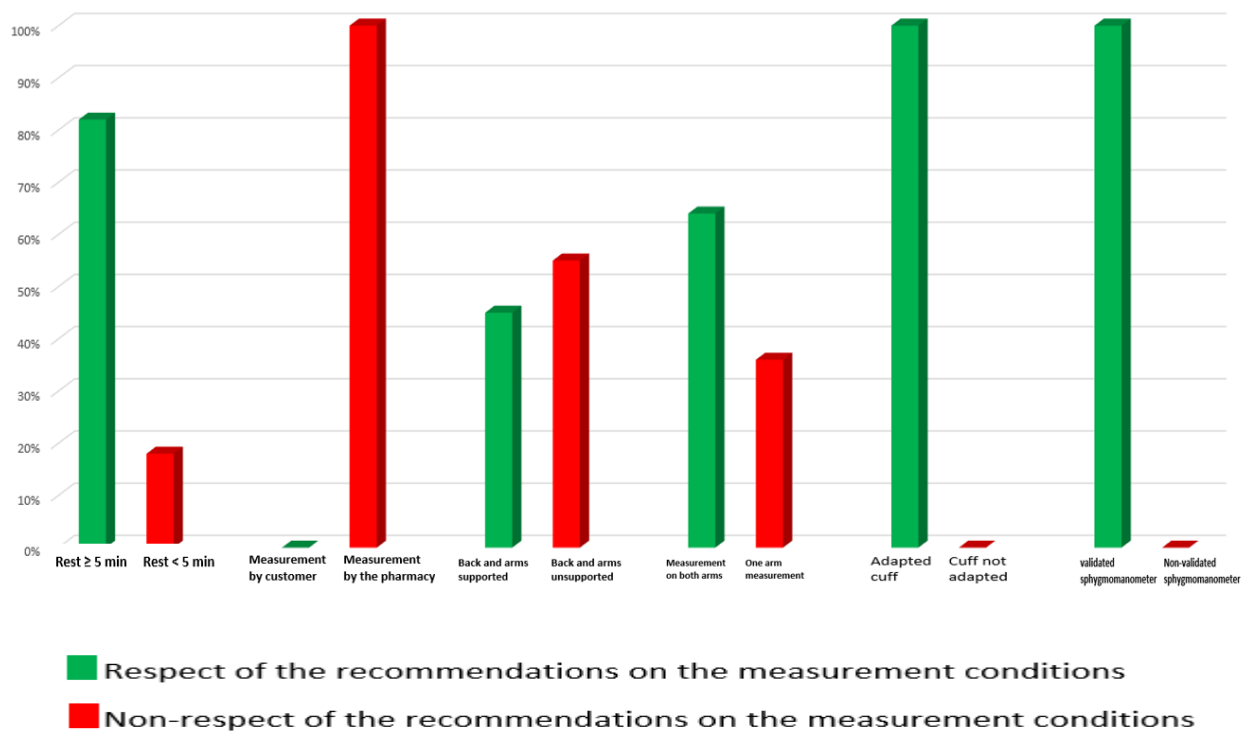


Figure 2: Conditions of measuring of blood pressure in pharmacies

## DISCUSSION

The aim of this work was to determine influence of environment and measurement conditions on resting blood pressure (BP) values of healthy sedentary people during self-measurement of blood pressure (SMBP) in order to describe reality of this method in our work context. Systolic (SBP) and diastolic (DBP) BP and heart rate (HR) measured by “pharmacies SMBP” were significantly higher than those obtained by home SMBP.

Recommended since 2005, ambulatory BP measurements have been confirmed by European recommendations in 2007<sup>11</sup>. Home SMBP is routinely included in all international recommendations for management of adult hypertension<sup>12,13</sup>. Home SMBP blood pressure values better define basal blood pressure level than the conventional method, are more correlated with target organ damage, and better predict cardiovascular morbi-mortality<sup>11</sup>. Documentation on practice of home SMBP in Africa is almost non-existent. In our population, its practice was estimated at 36.3%<sup>14</sup>. In present study, differences observed between “pharmacies SMBP” and home SMBP blood pressure values could be attributed to non-adherence to the recommendations<sup>2,3,9</sup> in private pharmacies compared with home measurements. Indeed, in our work context, the pharmacy is place where the pharmacist stores and sells drugs. It is a relatively noisy trading environment because of many customers. Most do not have exclusively customer’s rooms for SMBP. In addition, the measurement is not done by the customer himself but by staff present (figure 2). It is therefore not “true SMBP” because it does not hide, among other things, the white coat effect. The noisy measurement environment was main factor that affected the blood pressure values in pharmacies and explained difference observed (Table 3). In all the pharmacies visited, cuff size of blood pressure monitor used was adapted to the subject’s arms. This could be explained as study population was composed of subjects who were neither obese or underweight. Actually, size of cuff

is crucial for an accurate BP measurement. A lower cuff than necessary overestimates BP and a higher cuff underestimates it<sup>9</sup>.

Management of hypertensive subject is strongly dependent on analysis of blood pressure values, reliable and accurate measurement of the BP thus appears fundamental<sup>15</sup>. While in developed countries initiatives have been made to remove barrier that affordability of blood pressure monitors may represent for practice of home SMBP<sup>16</sup>, in Côte d’Ivoire, blood pressure monitors are not covered by universal health insurance. In such context, when home SMBP is prescribed, patients who do not have electronic sphygmomanometer at home go to private pharmacies. In Abidjan, the latter offer PA measurement at costs ranging from 200 to 500 XOF (between 0.4 and 1 dollar US). Home SMBP is preferential method for long-term follow-up of treated hypertensive patients. It’s accepted by patients for long-term use and improves compliance and thus control of hypertension<sup>9</sup>. Considering many benefits of home SMBP<sup>2,3,9</sup>, if it’s to be realized outside home, it should be sufficiently supervised by previous education of subject on environment and conditions of measurement, including recording BP by patient himself with validated electronic sphygmomanometer, in room reserved for this purpose in pharmacy. Therefore, in order to reduce obstacle of financial accessibility to electronic sphygmomanometer validated in our context, health authorities should, firstly, through universal health coverage, grant a subsidy to make them more accessible and, secondly, create SMBP rooms or stations in public health establishments throughout the country.

## CONCLUSION

This study confirms influence of environment and measurement conditions on resting blood pressure. It also shows reality of home self-monitoring of blood pressure in our work context. Compared with home self-measurement blood pressure, self-measurement blood pressure performed in pharmacies by most of subjects in our

work context does not follow international guidelines and is therefore influenced by environment and measurement conditions.

**Conflict of interest:** None

**Source of funding :** Self

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