

Preliminary study of blood pressure and arterial stiffness monitoring using the niva device (non-invasive vascular analyzer)

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ABSTRACT

Introduction: Measuring vascular parameters using the NIVA (Non-Invasive Vascular Analyzer) is an important step in assessing the health of blood vessels in the community, especially in groups at risk of hypertension. **Objective:** This study aims to describe the results of baseline blood pressure and vascular parameter examinations in respondents before further intervention. **Methods:** Respondents underwent an initial screening process including informed consent, anamnesis, and baseline blood pressure measurement. **Results:** The graph shows a balanced gender distribution and a dominance of the 31-40 and 41-50 age groups, which are age groups at high risk of experiencing increased arterial stiffness. The hand and foot blood pressure graphs show variations in systolic and diastolic values in the mild to moderate hypertension range, indicating that the hemodynamic condition of the respondents is stable and safe for NIVA examination. NIVA measurements were performed by attaching a cuff to the upper arm and left ankle to obtain parameters such as baPWV, ABI, MAP, PP, and Vascular Age. Blood pressure variations in the baseline graph support accurate reading of vascular parameters, especially because there was no indication of peripheral stenosis based on the comparison of hand and foot blood pressure. The data recording and validation process was performed by comparing the measurement results to the baseline, which was consistent with the initial graph. **Conclusion:** The examination results indicate that the respondents' initial condition met the requirements for non-invasive vascular evaluation and provided a representative picture of blood vessel health status prior to clinical intervention.

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INTRODUCTION

Cardiovascular disease remains a major cause of morbidity and mortality worldwide with hypertension being the largest risk factor contributing directly to stroke, heart failure and other vascular disorders (Goorani et al., 2024). According to the WHO report in 2018, around 17.9 million deaths per year are related to cardiovascular disease and this number continues to increase as the global population ages. (Muharram et al., 2024) In Indonesia, the prevalence of hypertension reached 34.11% based on the 2018 Basic Health Research, indicating that this problem is a serious public health challenge and requires innovation in therapeutic approaches that are more effective, safe, and easily accepted by patients (Manto & Islamiaty, 2020).

Hypertension can be classified into primary and secondary hypertension. Approximately 90% of cases are primary hypertension, which has no specific cause but is influenced by genetic factors, stress, lifestyle, and diet. (Pratamawati et al., 2022) Meanwhile, secondary hypertension can be triggered by certain medical conditions such as kidney disorders, endocrine disorders, insulin resistance, and the use of certain medications (Carey et al., 2021). Regardless of the cause, uncontrolled high blood pressure will affect arterial elasticity and cause vascular stiffness, which can be evaluated through parameters such as Pulse Wave Velocity (PWV). High PWV values are an indicator of vascular risk and a strong predictor of future cardiovascular events (Kim, 2023).

As healthcare technology advances, non-invasive examination methods are becoming increasingly used in clinical practice. One such device is the NIVA (Non-Invasive Vascular Analyzer) from PT Selaras Citra Nusantara Perkasa Tbk, a PPG sensor-based device with oscillometric pressure that can measure various vascular parameters quickly and comfortably. This device allows for examination of arterial elasticity through brachial-ankle Pulse Wave Velocity (baPWV) measurements, while also providing an estimate of blood vessel age, thus facilitating early identification of vascular risk (Romero-Ante et al., 2024).

Vascular health screening in the community is an important step because many individuals with hypertension are unaware of their condition and do not receive a comprehensive evaluation of their blood vessel health. (Dhungana et al., 2022) By directly assessing blood pressure and vascular parameters in a population, the data obtained can depict the actual conditions of the community, including age profiles, gender, and blood pressure variations, as shown in the initial graph. This is useful for observing patterns and distribution of risk within a population.

Therefore, this preliminary study was conducted to describe the baseline blood pressure and vascular health of respondents through measurements using the NIVA device. This evaluation aims to provide an initial overview of hemodynamic status and blood vessel elasticity before intervention or further studies are conducted. This baseline data is expected to provide an important basis for efforts to improve early detection of cardiovascular risk.

RESEARCH METHOD

All research activities were carried out after obtaining ethical approval from the authorized Health Research Ethics Committee, to ensure that the blood pressure and vascular parameter measurement procedures using the NIVA (Non-Invasive Vascular Analyzer) met ethical standards for human research. Prior to the examination, each respondent was given a complete explanation of the purpose, benefits, procedures, and potential discomfort during the measurement process. After understanding this information, respondents were asked to sign an informed consent form as a form of voluntary agreement to participate. This process ensured that all stages of the research were conducted ethically, transparently, and respectfully with respect for the rights and privacy of respondents.

Tool

The tools used in this study include a standard digital tensiometer for blood pressure measurement, a NIVA (Non-Invasive Vascular Analyzer) tool from PT Selaras Citra Nusantara Perkasa Tbk for evaluating arterial stiffness (baPWV, ABI, MAP, PP, and Vascular Age), a stopwatch, stationery, and a data recording form.

Material

Materials used in vascular measurement activities include an informed consent form, a brief history sheet, and a test recording form. In addition, batteries or power sources for digital sphygmomanometers and NIVA devices are used, alcohol wipes for sterilizing the skin area before sensor attachment (if necessary), as well as stationery and data recapitulation sheets. All of these materials support the blood pressure assessment process and the measurement of vascular parameters (baPWV, ABI, MAP, PP, and Vascular Age).

Research Procedures

- a. Screening and Baseline Data Collection, respondents were collected, then an initial screening was carried out in the form of filling out informed consent, a brief anamnesis regarding history of hypertension, medication used, and a general condition examination.(Endrias et al., 2024). Next, respondents were asked to rest for at least 5 minutes before taking an initial blood pressure measurement using a digital tensiometer as baseline data.(Tobe et al., 2021).
- b. Blood Pressure Measurement, blood pressure was measured on the left arm in a relaxed sitting position. The blood pressure cuff was correctly applied, and the measurement was taken twice, and the average value was recorded as the baseline blood pressure.(Y. Li et al., 2020)This measurement ensures the respondent's hemodynamic condition before proceeding to the measurement of NIVA vascular parameters.(Hocking et al., 2023).
- c. Preparation for Arterial Stiffness Measurement with NIVA, after blood pressure is recorded, the respondent is instructed to lie on their back in the NIVA examination area. The NIVA cuff is then placed on the left upper arm and left ankle. The technician ensures the sensor, cuff, and the respondent's body are in a calm position to ensure accurate readings.(Çobanoğlu, 2024).
- d. Measurement of Vascular Parameters with NIVA, the NIVA device was activated to automatically measure vascular parameters including baPWV, ABI, MAP, PP, and Vascular Age. Respondents were asked to remain relaxed and motionless during the procedure. The measurement results were then displayed on the device and recorded on a study form.(Liu et al., 2025).
- e. Data Recording and Validation, all blood pressure measurements and NIVA parameters were summarized and double-checked to ensure there were no recording errors. Respondents received brief education about their measurement results, and the activity concluded with a closing and data documentation.(de Ossorno Garcia et al., 2021).

RESULTS AND DISCUSSIONS

Screening and Baseline Data Collection

The screening stage is very important to ensure that respondents who take part in the NIVA examination are the right population to be evaluated.(Matthews et al., 2021)Based on the graph in Figure 1, it can be seen that the gender composition is quite balanced between men (51.04%) and women (48.96%). This balance is advantageous because it can minimize bias in physiological responses between genders to blood pressure and arterial stiffness. Therefore, the baseline data obtained from screening can be considered representative of the population.publicin general(Lan et al., 2019).

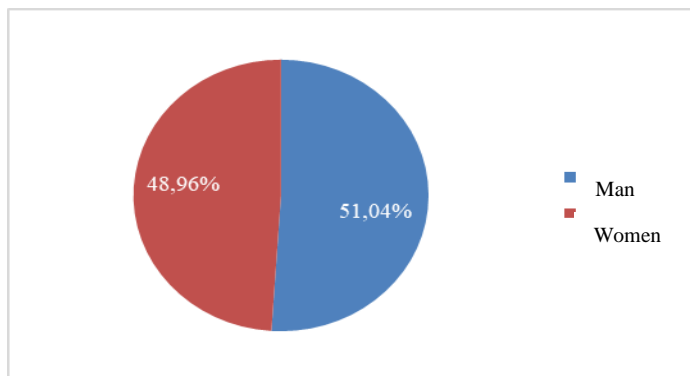


Figure 1. Gender data graph

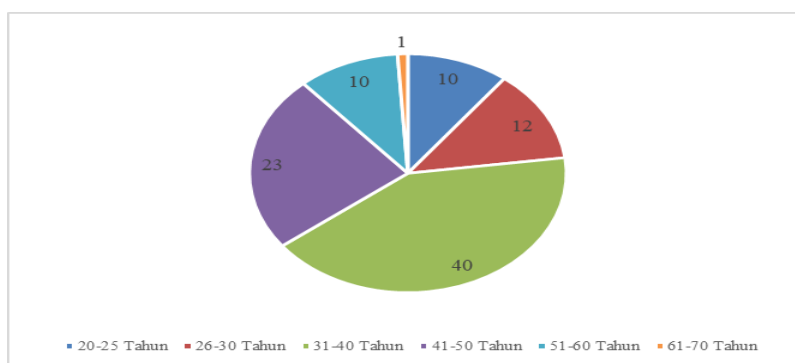


Figure 2. Graph of respondent age data

The age data for respondents depicted in Figure 2 shows a predominance of 40 respondents aged 31-40 years, followed by 23 respondents aged 41-50 years. These two groups represent age ranges with a tendency towards increased blood pressure and the onset of arterial stiffness. With the largest proportion of respondents coming from an age group prone to hypertension, screening provides a strong basis for ensuring that NIVA participants are truly within the relevant vascular risk range for analysis. (Marcus et al., 2025).

Baseline blood pressure measurements displayed on hand and foot blood pressure graphs show variations in systolic and diastolic values between respondents. (Q. Li et al., 2021) These values are still within the mild to moderate hypertension category. This baseline condition is important because it ensures that the respondents are not in a critical condition and are safe for further examination using the NIVA device. Furthermore, variations in blood pressure values help map the initial state of arterial elasticity, which will be further evaluated. (Herzog et al., 2025).

Overall, the screening and baseline stages showed that respondents had characteristics consistent with the hypertension population. The first graph data provides strong support that the population examined has met the conditions necessary to obtain valid and representative NIVA results. (Boateng et al., 2021).

Blood Pressure Measurement

Weekly blood pressure measurements are performed to consistently monitor changes in systolic and diastolic values. (Weinfeld et al., 2021).

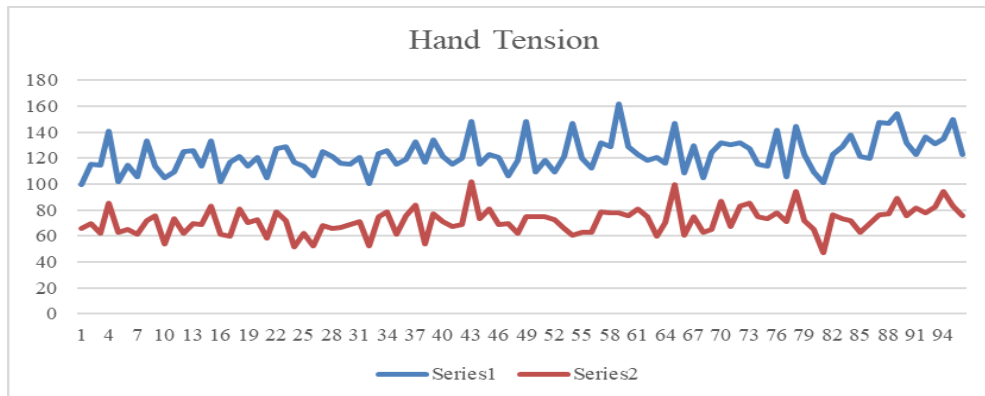


Figure 3. Hand blood pressure data graph

The graph in Figure 3 of the hand blood pressure data provides an overview of the blood pressure condition before the intervention. Systolic values were seen for most respondents between 120-140 mmHg and diastolic values between 80-90 mmHg. These figures reflect mild to moderate hypertension, which is common in Indonesia (Iswatun et al., 2021). Consistency of this value is very important at the baseline blood pressure measurement stage because it provides an initial hemodynamic picture before the respondent undergoes the NIVA examination.

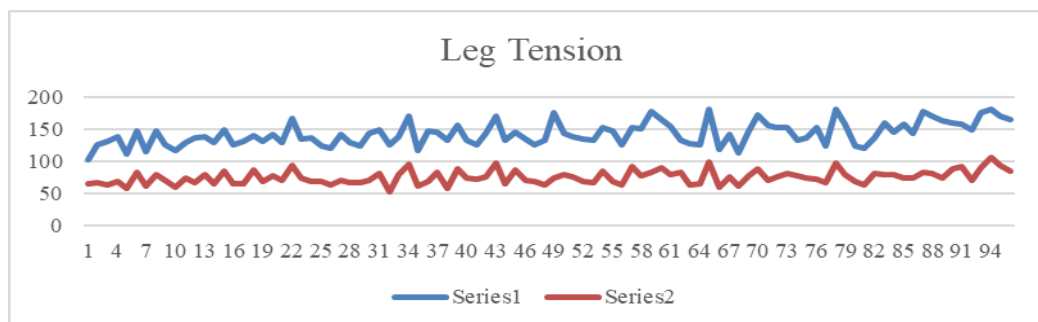


Figure 4. Foot pressure data graph

The leg blood pressure displayed in Figure 4 shows that the systolic value in the legs appears higher than in the arms. This is a normal physiological phenomenon, as pressure in the lower extremities tends to be slightly higher due to peripheral resistance in the leg blood vessels (Criqui, 2012). This strengthens the validity of the baseline data and shows no indication of severe peripheral arterial insufficiency so that ABI measurements with NIVA can be performed without any obstacles.

Measuring blood pressure twice and averaging the results is in accordance with the principles of proper blood pressure monitoring. With graphs showing relatively stable values, this process helps improve baseline accuracy. A stable baseline blood pressure is also crucial as an internal control before proceeding to the vascular parameter measurement stage (Asmar et al., 2024). Thus, graphs 3 and 4 provide evidence that the respondents' blood pressure levels were within a safe range while remaining relevant for measuring arterial stiffness. This ensures that all blood pressure values recorded during the procedure constitute a valid baseline for NIVA interpretation.

Preparation for Arterial Stiffness Measurement with NIVA

The preparation phase for NIVA measurement requires the respondent to be in a stable state. Hand and foot blood pressure graphs that do not show extreme fluctuations support the

respondent's hemodynamic stability and are sufficiently calm and safe to be placed in a supine position prior to NIVA cuff application. This position is essential for obtaining consistent PPG and oscillometric sensor readings.(Matthewman et al., 2024).

The difference in arm and leg blood pressure seen on the graph is particularly relevant during the NIVA preparation phase. Because the device calculates ABI and baPWV based on these two points, the initial data showing higher leg pressure than arm blood pressure confirmed that there was no indication of arterial stenosis. This made cuff placement on the left ankle an appropriate and safe procedure for all participants.(Sheppard et al., 2020).

The age distribution in the graph also supports the preparation for NIVA measurements. The 41-50 age group is the age group where arterial elasticity begins to decline. This means that respondents in this age group likely have more meaningful baPWV values for analysis.(Yuan et al., 2025). Thus, the respondent's preparation before entering the measurement process has a strong physiological basis.

Overall, the baseline graphs indicate that the respondents had vascular conditions that allowed the field technician to optimally apply the cuff and sensor. This preparation phase is key to ensuring accurate and trouble-free NIVA readings.

Measurement of Vascular Parameters with NIVA

At this stage, the NIVA device measures several important parameters, such as baPWV, ABI, MAP, PP, and Vascular Age. Hand and foot blood pressure graphs play a crucial role in interpreting these parameters. Variations in systolic pressure seen on the graph directly influence MAP and PP calculations, which then form part of the interpretation of the respondent's vascular condition.(Wang et al., 2022)The stability of these values indicates that NIVA readings can be performed without the risk of extreme blood pressure variability.

Table 1. Classification of NIVA measurement respondents based on age group

Age Group (Years)	Total Respondents	Gender		Normal ABI	Average baPWV (m/s)	Vascular Age		
		(L)	(P)			(Younger)	(In accordance)	(Older)
20-25	10	5	5	10	9,771	6	4	0
26-30	12	7	5	12	10,155	5	3	4
31-40	40	1	2	40	10,744	14	10	16
41-50	23	9	1	23	11,455	7	4	12
		1	1					
51-60	10	4	6	10	12,015	6	2	2
61-70	1	1	0	1	13,190	1	0	0
Total	96	4	4			39	23	34
		8	8					

The primary analysis of Table 1 shows that the 31-40 age group had the largest number of respondents, reaching 40 out of a total of 96 people, with an overall balanced gender distribution. Although the majority of respondents were in their productive years, a progressive increase in arterial stiffness was observed, with the mean baPWV value increasing from 9,771 m/s in the 20-25 age group to 12,015 m/s in the 51-60 age group. This increase was reflected in the Vascular Age results, where respondents with an 'Older' Vascular Age dominated the 41-50 age group (12 respondents), indicating the presence of premature vascular aging in almost half of this middle-aged subgroup.(Criqui, 2012).

Higher leg pressure values support a normal ABI calculation. If the chart shows lower leg pressure than arm pressure, this would indicate peripheral blood flow restriction.(Criqui, 2012)However, the initial graph shows a physiological pattern, so the ABI results produced by NIVA can be considered valid and do not need to be analyzed as pathological values.

Baseline blood pressure plays an important role in measuring baPWV. A higher systolic pressure typically results in an increased baPWV value because the pulse wave travels faster in stiffer vessels.(Fan et al., 2020). By reading the baseline graph which shows quite wide variations between respondents, it can be predicted that the baPWV value obtained by NIVA will vary according to each individual's vascular condition.

This measurement stage is strongly supported by graphical data that accurately depicts the respondents' initial conditions. This allows all NIVA results to be analyzed based on the participants' actual conditions. Publicwithout any bias due to abnormal or unstable blood pressure values.

Data Recording and Validation

In the final stage, the data recording process requires a clear baseline to ensure proper validation of the test results. Graphs 3-4 illustrate that the hand and foot blood pressure values follow a reasonable and consistent pattern. This makes it easier for researchers to verify the NIVA results match the respondents' baseline conditions.

The age distribution on the graph also helps in the data validation process, especially for the Vascular Age parameter. Respondents aged 41-50 years will typically have a Vascular Age range that is easily compared to their biological age.(Ahmed et al., 2024)Having clear age data on the chart makes the validation process more structured and accurate.

Furthermore, stable baseline data on the hand and foot blood pressure charts ensures that each value recorded by the NIVA device is not affected by external factors such as stress, physical activity prior to the examination, or unstable hemodynamic conditions. This makes recording and rechecking data easier and more reliable.

This way, the data generated by the examination can be properly recorded and validated. The final result is comprehensive data that reflects the community's vascular health status.

CONCLUSION

Based on the initial examination results, the baseline graph showing the distribution of gender, age, and blood pressure values in the hands and feet showed that the respondents were in a suitable condition for vascular evaluation using the NIVA tool. The majority of respondents were in the 41-50 year age group with blood pressure classified as mild to moderate hypertension, so their hemodynamic condition was stable and safe for further examination. The gender balance and blood pressure variations that remained within physiological limits strengthened the validity of the screening and baseline measurements ensured that the data obtained reflected the vascular health condition of the population.publicrepresentatively.

The results show that all measurement stages, from baseline to recording NIVA results, were supported by strong and consistent initial data. Hand and foot blood pressure graphs helped validate ABL, MAP, PP, Vascular Age, and baPWV measurements, all of which are highly dependent on baseline blood pressure. Thus, the entire measurement process produced accurate and reliable vascular data. All of these results were performed according to the methodology and were able to reflect the respondents' actual vascular condition before any intervention or further research was conducted.

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