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EFFECTIVINESS OF SMARTWATCH ALARM DETECTOR AND PMR-ISOMETRIC EXERCISE AS HYPERTENSION TREATMENT

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ABSTRACT
Hypertension is the leading cause of death in the 21st century when systolic and diastolic blood pressure increases. Prevention of complications due to hypertension can be done by monitoring blood pressure. Smartwatch innovations are helpful in the health sector for monitoring blood pressure, which can be used as an initial screening for people. In addition to monitoring blood pressure, nonpharmacological therapy is one of the management of hypertension. A combination of progressive muscle relaxation and isometric exercise in hypertensive patients can help lower blood pressure by relaxing muscles. Objective: This research aims to determine the effectiveness of smartwatches in generating hypertension alarms and the effectiveness of pmr-isometric as therapy in lowering blood pressure. This research used a quick experiment with one group pre-post test design. The respondents were recruited by purposive sampling method for 16 hypertensive people. The inclusion criteria in this study are respondents aged 35-65 years, have good hemodynamic status to be able to do therapeutic exercises, can speak Indonesian, and do not have vision and hearing problems. Exclusion criteria were respondents who had advanced complications of hypertension, such as heart disease, stroke, paralysis, and immobilization. The intervention was given once for 20 minutes using a YouTube video connected to smartwatch and a demonstration followed by the respondent. The pre-test value was measured from the respondent's blood pressure 5 minutes before the intervention, while the post-test value was taken after 5 minutes. Data were analyzed by paired sample t-test. The results showed that the smartwatch alarm detector could detect blood pressure, and there was an effect of applying a combination of progressive muscle relaxation and isometric exercise on the blood pressure values of hypertensive patients with a p-value of 0.002 ($p < 0.05$). Smartwatch has proven effective as an early screening for hypertension and a combination of progressive muscle relaxation and isometric exercise, which effectively lower blood pressure in people with hypertension.

Keywords: hypertension; isometric exercise; progressive muscle relaxation; smartwatch

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INTRODUCTION

Hypertension is a condition of increasing systolic and diastolic blood pressure where systolic blood pressure exceeds 140 mmHg and diastolic blood pressure of 90 mmHg (Wahyuni, 2020). Signs and symptoms of hypertension generally begin with dizziness, headaches, and a feeling of heaviness around the nape, leading to weakness (Listiana & Faradisi, 2021). Hypertension that is not handled correctly will result in various risks of complications such as stroke, heart failure, coronary artery disease, and kidney failure (Andri et al., 2018). Hypertension is the leading cause of death worldwide (Naldi et al., 2022). The World Health Organization (WHO) in 2019 stated that 1.3 billion people in the world suffer from

hypertension and is expected to continue to increase to 1.5 billion by 2025 (Riskesdas, 2018). The Basic Health Research Report explains that hypertension ranks first as a non-communicable disease with a proportion of 34.11% (Suharmanto, 2022). The prevalence of hypertension cases according to the first quarter of the 2021 Health Handbook states that the number of people with hypertension in Central Java in 2021 was 626,762 people (Dinkes Jateng, 2021).

The increasing number of people with hypertension has an impact on the risk of complications, so an effort to control blood pressure must be made (Andri et al., 2018). The government program through Intergrated Development Post Non-Communicable Diseases provides services in the form of blood pressure measurement as an initial screening for hypertension patients. However, the accuracy and time efficiency in performing blood pressure measurements could be more optimal (Adi et al., 2021). Technological developments in the health sector are increasingly sophisticated, one of which is wearable devices that can attract attention and become an alternative in the health sector. A smartwatch is a computerized watch with the function of a personal digital assistant and a timekeeper (Lorinsa, 2020). Smartwatches have made monitoring basic health parameters such as blood pressure easier to detect people with hypertension early (Dirjayanto et al., 2022). Monitoring blood pressure regularly can help reduce the risk of complications in people with hypertension (Fakhriyah et al., 2022).

Complications of hypertension occur due to an uncontrolled increase in blood pressure, which causes stroke, coronary artery disease, heart failure, and kidney failure (Yunita, 2022). Therefore, management efforts are needed to prevent complications. Management of hypertension includes pharmacological and nonpharmacological therapies (PERHI, 2019). Nonpharmacological therapy includes physical exercise (Rihiantoro & Widodo, 2018). One of the exercises or physical activities that can be given is progressive muscle relaxation and isometric exercise. Progressive muscle relaxation (PMR) is a therapy that helps release tension and restore balance to the mind and body which can affect blood pressure stability (Yuniati & Sari, 2022). PMR exercise is a nonpharmacological therapy nurses give to hypertensive patients (Gunawan, 2022). *Isometric exercise* is a therapy physiotherapists often give by performing static movements (Gunawan, 2021). This therapy uses a handgrip dynamometer, which involves muscle contraction without changing muscle length (Zainuddin & Labdullah, 2020). Giving hypertensive patients a combination of progressive muscle relaxation and isometric exercise can help reduce blood pressure by relaxing the muscles and increasing the body's control of the neurocardiac system, which affects sympathetic nerves (Naldi et al., 2022).

Based on the above background, the prevalence of hypertension is increasing every year and requires appropriate monitoring and management to prevent complications. This study aimed to determine the effectiveness of smartwatch detection alarms as an early screening of hypertension and the effect of progressive muscle relaxation therapy and isometric exercise programs in the management of people with hypertension.

METHOD

This research method uses a quasi-experiment with a one-group pre-post test design where this study aims to test the effectiveness of using an alarm detector on a smartwatch as hypertension screening without a control group. The sampling technique used purposive sampling. The population in this study were hypertensive patients in Semarang, with a total of 20 people. The sample selection used the Slovin formula and obtained 16 people. Samples

were selected based on the inclusion and exclusion criteria in the study. The inclusion criteria in this study are respondents aged 35-65 years, have good hemodynamic status to be able to do therapeutic exercises, can speak Indonesian, and do not have vision and hearing problems because they have to watch and demonstrate the exercises, the respondent must be able to move his limbs. Exclusion criteria were respondents who had advanced complications of hypertension, such as heart disease, stroke, paralysis, and immobilization. This research was conducted in March 2023 with interventions in progressive muscle relaxation and isometric exercises. The instruments in this study were smartwatch alarm detectors to measure blood pressure and observation sheets. The intervention was given once for 20 minutes using a YouTube video and a demonstration followed by the respondent. The pre-test value was measured from the respondent's blood pressure 5 minutes before the intervention, while the post-test value was taken after 5 minutes. Blood pressure was analyzed by calculating the Mean Arterial Pressure (MAP) before and after the intervention.

The results of the respondent's MAP measurements before and after the intervention were processed by statistical analysis. Univariate data analysis is presented in the frequency and percentage distribution tables. Meanwhile, bivariate analysis was carried out using the Shapiro-Wilk test for normality because the number of respondents was <50, and the data was usually distributed > 0.05. Thus, the bivariate analysis uses the paired sample t-test because it is to compare data in the paired groups. The smartwatch used in this study is the Samsung Galaxy Watch 4, where several features have been developed. Smartwatch use begins with pairing the smartwatch and a Samsung cellphone.

Figure 1. Pairing Smartwatch with Samsung phone

After pairing with the cellphone, the user must download the Samsung Health Monitor application from the cellphone and synchronize data via Google Fit.

Figure 2. Samsung Health Monitor Display

Figure 2 shows the display of the Samsung health monitor recording health data synchronized with Google Fit. Furthermore, to be able to measure blood pressure, the smartwatch is calibrated three times by setting it through a program on a mobile phone and calibrated via a digital sphygmomanometer, while the test is carried out three times and compares the measurement results with a digital sphygmomanometer.

Figure 3. Smartwatch calibration test

The development of this smartwatch is an alarm detection application as an early screening for hypertension and a link feature that is connected to YouTube which contains videos of progressive muscle relaxation therapy exercises and isometric exercise programs that can be viewed both on the smartwatch screen and from the cellphone. After the calibration test is carried out, the user can directly measure blood pressure. If the user is at risk of hypertension, an alarm notification will appear where the user can immediately perform therapeutic exercises via a link in the application that is directly connected to YouTube.

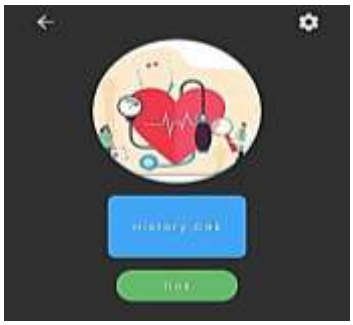

Figure 4. Application of hypertension alarm

RESULTS

Table 1.
Characteristics of Respondents (n=16)

Characteristic	f	%
Gender		
Man	5	31.3
Woman	11	68.8
Age		
35 – 45	7	43.8
46 – 55	2	12.5
56 – 65	7	43.8
Education		
Out-of-school	1	6.3
Elementary school	2	12.5
Middle school	2	12.5
High school	9	56.3
College	2	12.5
Work		
Housewives	7	43.8
Private employee	7	43.8
Teacher	1	6.3
Laborer	1	6.3

This study was conducted in the Cabean subdistrict, the working area of Karangayu Semarang Health Center in March 2023. The number of respondents was 16, according to the inclusion and exclusion criteria.Table 1 shows that most of the respondents were female (68.8%), the respondents aged 35-45 years were (43.8%) while the respondents aged 56-65 years were (43.8%). More than half of the respondents had a high school education (56.3%) and most of the respondents worked as housewives (43.8%) and as private workers (43.8%).

Figure 5.Blood Pressure Measurement

Figure 6.Notification Alarm Detector

Figure 5 shows how the blood pressure measurement begins by attaching the smartwatch to the wrist. Next, the application system will give commands to take blood pressure measurements within ± 30 seconds. Furthermore, the smartwatch will display information related to blood pressure measurement results and information containing health messages. If the respondent has hypertension, a notification alarm will appear to provide information and a video link to the progressive muscle relaxation and isometric exercise program (Figure 6).

Figure 7. Alarm Detection Application on Smartwatch

Figure 8.Video Display on a Smartwatch

Figure 7 is a view of the alarm application on the smartwatch. The app contains a history of periodic blood pressure measurements and a link to YouTube. Figure 8 shows a video playback of progressive muscle relaxation and isometric exercises that can be used as a therapeutic guide when blood pressure is high.

Tabel 2.
Analysis of the Effect of Progressive Muscle Relaxation and Isometric Exercise Program on the Mean Arterial Pressure (MAP) Value of Hypertensive Patients (n = 16)

Mean Arterial Pressure (MAP)	Mean	SD	SD *Error*	*P value*
Pre-test MAP values	103,2	6,66	1,66	0,002*
Post-test MAP values	98,7	4,66	1,16	

**Paired t-test < 0.05*

Table 2 shows a significant difference between the pre and post-intervention MAP values of the combination of progressive muscle relaxation and isometric exercise with p-value <0.05 (0.002), where the mean before intervention is 103.2 and the mean value after intervention is 98.7. This shows that progressive muscle relaxation and isometric exercise can reduce blood pressure in people with hypertension.

DISCUSSION

A smartwatch is a wearable device with various features supporting health, such as heart rate, oxygen saturation, and blood pressure (Widyarini, 2022). According to Sari & Yuliharto (2020), the existence of smartwatches has an impact on the emergence of "healthology," where a person becomes motivated to use devices that are integrated with the fields of informatics, health, and technology into something innovative. The main feature of this tool is to detect blood pressure, which is equipped with an alarm sensor to determine the increase in blood pressure in people with hypertension. Surbakti et al. (2021) state that the device can record data through essential sensors such as the accelerometer, light sensor, vibration, and gyroscope. One of the sensors on a smart device is 9-axis motion tracking, a combination of several sensors that makes this sensor able to capture the movement of human limbs in 3 dimensions accurately. So, it is widely used in wearable devices such as smartwatches and fitness trackers (Siradj, 2016). The onboard sensors found in this smartwatch utilize pulse waves to measure heart rate and blood pressure.

The data recorded by the sensor can then be tracked through the Android-based health platform Google Fit (Reza & Suryana, 2022). A *smartwatch* is an innovation that integrates health with technology that assists health workers in monitoring vital signs without physical contact and early screening to reduce the risk of worsening conditions (Surbakti et al., 2021). The advantage of the alarm detector smartwatch, besides the detection sensor, is that a feature can be connected to a YouTube video containing progressive and isometric muscle relaxation training guidelines. This is in line with (2021), which explains that the advantages of a smartwatch are its relatively cheap price, a device that can be carried and used anywhere, as well as the ability to be able to send data and results with a relatively high degree of accuracy via the Internet.

The results using paired sample t-tests showed an effect of a combination of progressive muscle relaxation and isometric exercise on the blood pressure of hypertensive patients with a p-value = 0.002 (<0.05). This is in line with research which states that PMR can reduce blood pressure in hypertensive patients with a p-value of 0.000 (< 0.05) (Rahmawati et al., 2018). Progressive muscle relaxation exercises performed properly, calmly, and correctly for 15 minutes can reduce the secretion of CTH (corticotrophin-releasing-hormone) and ACT (adrenocorticotrophic-hormone) in the hypothalamus (Ermayani et al., 2020). This condition will produce relaxation in the body to inhibit the increase in sympathetic nerves so that the number of hormones that cause dysregulation can be reduced (Zainaro, 2021).

Apart from the physiological aspect, PMR is effective in reducing stress and improving sleep quality in people with hypertension, with a p-value of 0.009 (< 0.05) (Setyaningrum et al., 2018). Anxiety and stress can provoke the production of norepinephrine and epinephrine hormones. PMR exercise can reduce epinephrine and norepinephrine levels to help reduce stress, blood stress, and insomnia (Ermayani et al., 2020). PMR exercise can reduce epinephrine and norepinephrine levels to help reduce stress, blood pressure, and insomnia. (Sutamiyanti, Suniyadewi, & Devhy, 2020). Research by Rosdiana Cahyati (2019) found that progressive muscle relaxation can increase parasympathetic nerve activity, lowering blood

pressure, heart rate, respiratory frequency, and pupil dilation. This was also supported by Deno et al. (2022), who showed that there was a decrease in systolic and diastolic blood pressure after PMR intervention with a p-value of 0.000 (<0.05).

Another study showed a significant reduction in the average difference in blood pressure values in hypertensive patients after an isometric handgrip exercise intervention with a p-value of 0.001 (<0.05) (Graciano & Sartika, 2022). Isometric exercises can activate mechanical responses directly due to increased muscle tension (Rahmawati et al., 2018). Isometric exercise physiologically triggers the mechanism of shear stress by ischemic stimulus, which impacts increasing blood flow in the distal blood vessels. Furthermore, this mechanism can induce the release of potential vasodilators, namely NO-endothelium, resulting in peripheral resistance (Susiladewi et al., 2017). When muscle tension occurs, the central nervous system will increase sympathetic nerve outflow and decrease parasympathetic outflow, increasing blood pressure response (Zainuddin & Labdullah, 2020). This increase in response is caused by a reflex that increases perfusion pressure to the active muscle, where blood flow will be hampered by continuous muscle contraction. Lack of muscle mass involvement during isometric exercise can result in a higher reduction in blood pressure (Yanti et al., 2021).

Research conducted by Wiles et al. (2018) states that the provision of Isometric Exercise Training (IET) benefits the mechanical response and autonomic modulation of the heart and the sensitivity of the baroreceptor reflex. However, Farah et al. (2017) state that giving isometric exercise 30 minutes/week can reduce blood pressure, which is easy. In line with research by Widiyawati et al. (2022), which shows a decrease in blood pressure after isometric exercise with a p-value of 0.000 (<0.05), after the intervention was given, the body became more relaxed, and dizziness complaints were reduced. Smartwatches can potentially contribute to health monitoring (Siradj, 2016). Follow-up evaluation of the use of smartwatches is helpful to optimize the function of smartwatches, which in this study were still using ordinary developer systems that need to be upgraded, smartwatches that must be connected to the Internet. It is recommended that the distance between the use of smartphones and smartwatches is pretty close. This study has not analyzed the range of influence of combination therapy on reducing respondents' systolic and diastolic blood pressure. A combination of progressive muscle relaxation and isometric exercise can help to lower blood pressure. Regular monitoring provides an alternative therapy that can accompany medication use (Yuniati & Sari, 2022).

CONCLUSION

The conclusion of this study shows that smartwatches are proven effective in screening hypertension patients. A smartwatch has the advantage of being a wearable device that is practically used for measuring blood pressure at any time. In addition, this smartwatch innovation is equipped with an alarm feature that can provide notifications that the user is at risk for hypertension and a link containing videos of therapeutic exercises that can be done immediately. Based on the study's results using 16 respondents, it was found that progressive muscle relaxation programs and isometric exercises effectively reduce blood pressure in hypertensive patients with a p-value of 0.002 (<0.05). In hypertensive patients, progressive muscle relaxation interventions and isometric exercises can help lower blood pressure by relaxing muscles and increasing the body's control of the neurocardiac system, which affects the sympathetic nerves to lower blood pressure. The smartwatch can be used as one of the innovations in the health sector as a device that can help make it easier for people with hypertension to monitor blood pressure regularly. We recommend upgrading system

development on the alarm application to record and present data quickly and accurately. It can be used for further research on the duration of endurance of smartwatch use as an early screening in the long term. The combination of progressive muscle relaxation and isometric exercise programs is recommended for people with hypertension to do regularly and periodically so that blood pressure is maintained and can reduce anxiety and provide a sense of relaxation. We also hope that there is further monitoring of the frequency of progressive muscle relaxation and isometric exercise combination on the reduction of systolic and diastolic blood pressure and the psychological aspects of chronic hypertensive patients. Limitations: This study did not use a comparison group, so differences in MAP values in the intervention group could not be compared; besides, this study still uses a free development system, so there is still a delay in the alarm in displaying information.

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