Differences in Blood Pressure Using Mercury and Digital Sphygmomanometer in Stand and Supine Positions

Nova Lusiana[1], Estri Kusumawati[1]
[1]*Faculty of Psychology and Health, UIN Sunan Ampel Surabaya, Indonesia*
novalusiana@uinsby.ac.id

Keywords Blood Pressure, Sphygmomanometer Mercury and Digital, Standing and Supine Position.

Abstract One billion people in the world suffered hypertension in 2011 (WHO), and the prevalence will continue to increase. It predicted in 2025, as many as 29% of adults are getting a high blood pressure. Efforts made in controlling hypertension include increasing prevention and controlling community-based hypertension with "self-awareness" through regular blood measurements. Blood pressure can be checked using both manually and electric sphygmomanometer blood pressure. This study aims to know the differences in blood pressure measurement results between sistol and diastole, in a standing and supine position using manual and digital sphygmomanometer. This research is a laboratory observational study with the cross-sectional approach. The study population was students of the Biology Department, State Islamic University of Sunan Ampel Surabaya. The study was conducted at the integration laboratory in March 2018. The study found that the measurement of systolic and diastolic blood pressure in a standing position was higher than in supine position, there was a difference of 5-6 mmHg. Furthermore, blood pressure measurement using manual sphygmomanometer is higher than using digital sphygmomanometer, there is a difference of 5-8 mmHg in the measurement of systolic blood pressure, and 6-10 mmHg for diastolic blood pressure

1 INTRODUCTION

Blood pressure is the pressure that blood produces on the blood vessels. This pressure is influenced by blood volume and elasticity of blood vessels which causes an increase or decrease in blood pressure (setiawan and Sari, 2010). Systolic blood pressure is the highest pressure when the heart contracts to pump blood. Whereas when blood pressure decreases or relaxation is called diastolic pressure. Blood pressure is written as cystolic pressure per diastolic pressure (E R Kowalski, 2010). Adult blood pressure tends to increase with age. In addition, gender is also influential, where male blood pressure is greater than women. Stress and medication also contribute to an increase or decrease in blood pressure, for example excessive stress will increase blood pressure (Kunikullaya, 1999).

Blood pressure varies greatly depending on circumstances, will increase when physical, emotional, and stress activities will then decrease during sleep and relaxation (Lionel Ginsberg, 2007). Elderly people, blood pressure when sitting is very different from when he stood. Therefore, the measurement of blood pressure needs to be done in a standing position and also in certain circumstances (Dr Anna Palmer and Profesor Bryan Williams, 2007). Gender, clinically there is no significant difference in blood pressure in men or women. Women generally have lower blood pressure than men of the same age, this tends to be due to hormonal variations. Anxiety, fear, pain, and emotional stress result in sympathetic stimulation, which increases blood frequency, cardiac output, and peripheral vascular resistance. Many medications that directly or indirectly affect blood pressure, such as diuretics and vasodilokators. Another group that affects blood pressure is narcotic analgesics, which can lower blood pressure. After menopause, women generally have higher blood pressure than before (Audrey Berman, 2010).

The ability of the heart to pump will decrease as it does in the elderly. This can be caused by several factors, namely the elasticity of the blood vessels, the wall of the aorta closes, the heart valve thickens and stiffness until the heart is difficult to pump. The

ability of the heart to pump will decrease by 1% every year starting from the age of 20 years and over. Changes in position also affect blood pressure as in changes in position from deep sleep which causes a decrease of about 65 mmHg which can result in sudden dizziness due to decreased effectiveness of perifer vessels for oxygenation. Blood pressure can be high due to increased resistance from poriferous vessels (Nugroho, 2008).

The pressure measurement itself can generally be divided into 2 ways (method), namely the direct method and the indirect method. In the direct method, usually using an arterial catheter that will be inserted into a vein (brachtialis ateri). This method is a method with a very high level of accuracy so that it can be used as a basis for blood pressure measurement. However, the use of this method is very dangerous and can cause health problems such as inflammatory pain due to catheter stabbing, blood clots can occur because the catheter is bent, which can cause thromboplebitis (Marhaendra et al., 2016). Indirect methods are often used in blood pressure measurement because this method is very safe, inexpensive and easy to check, for those who want to know the pressure in their blood, using the help of a sphygmomanometer and a stethoscope. Blood pressure in this method can be measured in two ways, namely 1) Palpation, measurements that only measure the systolic pressure only 2) Auscultation, measurements that can measure systolic pressure and diastolic pressure with the help of a stethoscope.

Sphygmomanometer has two types, namely digital sphygmomanometer and manual sphygmomanometer. Digital Sphygmomanometer is a practical blood pressure measuring device because its use does not require a stethoscope. The use of this digital sphygmomanometer only turns on the device without cuffs by itself being able to pump and can know directly the amount of blood pressure that can be seen on the monitor (Eriska et al., 2016). Sphygmomanometer does not need to require an expert person to measure blood pressure because this tool is very easy to use and practical in its use but the accuracy of this tool is still debated (Afoakwah A N and Owusu WB, 2011). The manual sphygmomanometer is a mercury sphygmomanometer consisting of an inflated Inflatable Cuff, a measuring unit (Mercury Manometer) and a tube to connect the two, and a pump equipped with a valve (Suheriyono et al., n.d.).

Knowing blood pressure is an important thing. This is because blood pressure checks can indicate indications of a disease, such as hypertension. Regular blood pressure measurements can prevent the potential for hypertension by taking action afterwards, such as controlling food consumed or limiting heavy activities. Complicated hypertension (5.3%) is the number 5 cause of death at all ages. Hypertension that does not get good treatment causes stroke complications (51%) and coronary heart disease (45%) which is the highest cause of death. According to WHO in 2011 one billion people in the world suffer from hypertension. The prevalence of hypertension will continue to increase and it is predicted that by 2025 29% of adults worldwide will develop hypertension. Efforts made in controlling hypertension include increasing prevention and controlling community-based hypertension with self-awareness through routine blood measurements (Kementerian Kesehatan, 2017). Generally blood pressure can be checked using a sphygmomanometer both manual and digital (Marhaendra et al., 2016).

This blood pressure measurement uses 2 tools, namely a digital sphygmomanometer and a manual sphygmomanometer. This measurement is thought to be more accurate by using a manual sphygmomanometer than a digital sphygmomanometer, because digital sphygmomanometer often causes errors in usage, for example because the battery starts to run out so that the device work is not perfect. Repetition occurs several times as needed because each repetition of the results is different so repetition is done. The difference in blood pressure in the manual sphygmomanometer and digital sphygmomanometer may be around 2-5mmHg (Canzanello et al., 2001). Measurements using digital and manual sphygmomanometer have different results. Measurement using a digital sphygmomanometer is higher than using a manual sphygmomanometer. This is because many experts say that digital sphygmomanometers have low accuracy because there are several factors such as the condition of the battery, the length of use of the device, and the quality of the equipment (Prasetyo, 2017). This study aims to determine differences in the results of systolic and diastolic blood pressure measurements in adolescents in standing and supine positions using mercury and digital sphygmomanometer

2 METHOD

This research is laboratory observational study with a cross sectional approach where the research subjects were only measured at the time of the study. The study population were students of Biology Department, State Islamic University of Sunan Ampel Surabaya.the sample was a total sampling of

69 students who participated in animal physiology courses voluntarily and had signed an informed consent.

The study was conducted at the integration laboratory of State Islamic University Sunan Ampel Surabaya in March 2018. Examination of systolic blood pressure and diastole was performed using mercury sphygmomanometer and stethoscope and digital sphygmomanometer. The hypothesis in this study is that there are differences in systolic and diastolic blood pressure in the standing and supine position and there is a difference in blood pressure between systole and diastole using mercury and digital sphygmomanometer. The research data were analyzed to find out the differences using the free sample T 2 test through the SPSS program.

3 RESULT AND DISCUSSION

Research subjects were 69 students aged 18-23 years, 12 students male and 57 female students, obtained by measuring systole and diastolic blood pressure using mercury and digital sphygmomanometer as follows

Differences in Systolic Blood Pressure Using Mercury and Digital Sphygmomanometer in Stand and Supine Positions

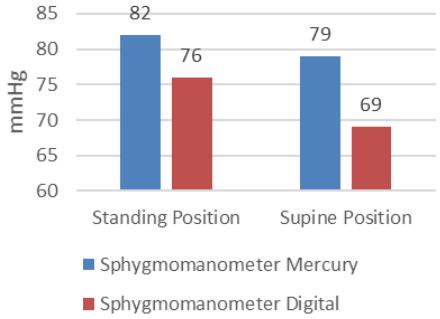

Figure 1. Systole Mean Bar Chart

The average measurement of Systolic blood pressure in the standing position is 116 mmHg and the mean measurement of the systole in the supine position is 110 mmHg. Based on the free sample T test obtained P value 0.001 5 0.05, then there is a difference in systolic blood pressure in the standing and supine position

In Figure 1 it can be seen that there is an average difference of 8 mmHg of systole measurement in standing and supine position using mercury sphygmomanometer and there is a difference of 5 mmHg as a result of systolic blood pressure measurement in a standing and supine position using a digital sphygmomanometer. Based on the T test, it was found that P 0.007 can be said to have different measurements of systole in a standing position using mercury and digital sphygmomanometer. In the supine position P 0.227 is obtained or it can be said that there is no difference in the measurement of systolic blood pressure in the supine position using mercury and digital sphygmomanometer.

Differences in Diastol Blood Pressure Using Mercury and Digital Spygmomanometer on Standing and Supine Positions

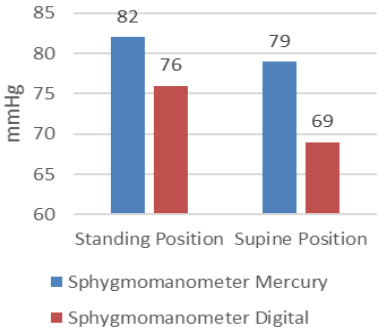

Figure 2. Diastol Mean Bar Chart

The average measurement of diastolic blood pressure in the standing position is 79 mmHg and the average measurement of diastole in the supine position is 74 mmHg. Based on the T Test, P value is $0.004 \leq 0.05$, so there is a difference in diastolic blood pressure in the standing and supine position

In Figure 2 it can be seen that there is an average difference of 3 mmHg of diastolic measurement in standing and supine positions using mercury sphygmomanometer and there is a difference of 7 mmHg as a result of diastolic blood pressure measurement in the standing and supine position using a digital sphygmomanometer. Based on the T test, it was found that P 0.005 and 0.001 can be said to have different measurements of systole in the standing and supine position using mercury and digital sphygmomanometer.

Systole measurement results in a standing position higher than in the supine position, there is a difference of 5-8 mmHg systolic measurement in the supine position and standing, it is known if the result is compared to blood pressure when standing is higher than blood pressure sitting position because of standing blood pressure we are affected by the muscles that are contracting and the force of gravity (E R Kowalski, 2010). The standing and supine position or sitting shows a difference in the value of systolic blood pressure in the sitting position and standing position where changes occur, namely, an increase in systolic blood pressure from a sitting position to a standing position. When compared, the

results of systolic and diastolic blood pressure in the body position lie lower than the standing body position. These results are in accordance with Amiruddin's statement (Amiruddin et al., 2015) which states that the heavier the activities performed, the greater the pulse produced and can affect blood pressure to be high. That is, when standing, will require greater energy than lying down. This is because supine position considered a body position in a resting state. In addition, the possibility of the influence of gravity will facilitate blood flow when standing. So, the greater the blood pressure and the more pulse it produces.

Blood pressure when standing position is higher than when supine, this is because in the supine position lies the upper and lower extremities parallel to the heart, so that the speed of blood flow is normal. But if standing up, the upper extremity and the head are higher than the heart, so to meet the needs in the intended place (brain) a large pump pressure is needed so that cardiac output increases blood pressure (Soewolo et al., 2005).

Everyone's blood pressure will vary depending on the performance of the heart and the physical condition of the person (A C Guyton and J E Hall, 2007). Blood pressure in the arteries in adults in a lying position at rest is approximately 120/70 mmHg. Because blood pressure is the result of cardiac output and peripheral resistance, blood pressure is affected by conditions that affect each and every part of the stroke. Therefore the magnitude of the contents of the stroke is determined by the contraction of the volume of blood that returns to the heart and myocardium (A C Guyton and J E Hall, 2007). This is in accordance with the theory that is, where in people do not do physical activity, the heart muscle will work harder in each contraction resulting in greater pressure on the artery wall so that peripheral pressure will increase causing blood pressure to be higher (Yarows and Qian, 2001).

If the body is in a standing position, the intravascular pressure becomes equal to the pressure produced by heart contraction plus additional pressure equal to the weight of the blood column from the heart to the measurement point. Increased hydrostatic pressure that occurs on the feet when a person stands will push out the vein wall causing distention. The result is collecting blood in the veins. Some of the blood coming from the capillary will enter the dilated veins rather than return to the heart. At the same time, the pressure on the capillary will increase due to the gravitational force causing an increase in fluid filtration from the capillaries to the interstitial space. The accumulation of blood in the vein and increased capillary filtration, will reduce the volume of effective blood sirculation. Venous return is decreased so there is a temporary decrease in the end diastolic volume. Finally reducing cardiac output and decreasing blood pressure (Manembu et al., 2015).

In the supine position, the center of gravity is in the anterior part of the ischia and about 25% of the body weight is transmitted down through the lower extremity so that the limbs are relaxed (Manembu et al., 2015). This will reduce stroke volume, and ultimately reduce cardiac output and decrease blood pressure. Measurement of blood pressure in a standing and supine position using a mercury and digital measuring device produces a different size of blood pressure, in systole there is a difference of 5 -8 mmHg and in diastole there is a difference of 3-7 mmHg. The difference between the results of manual and digital blood pressure gauges is very different. Mercury or digital blood pressure checks have their own advantages and disadvantages. But according to Mg Myers research suggests that digital sphygmomanometer (automatic) has the same level of accuracy or accuracy as manual sphygmomanometer and can replace manual sphygmomanometer in measurement (A'Court et al., 2011). From the measurement of blood pressure that has been done, the results of measurements by mercury sphygmomanometer and digital sphygmomanometer showed a difference in results although not significant enough in systolic measurements in the supine position. However, the results shown by modern tools are recognized for their higher accuracy than manual tools. Because the mercury sphygmomanometer only relies on the audio visual observation of examiners such as the determination of systolic pressure and diastolic pressure. While modern tools have been designed in such a way with special functions with a low error rate.

The use of sphygmomanometer with mercury is the most accurate type of sphygmomanometer compared to digital sphygmomanometer. Although digital sphygmomanometer is easier to use, but the level of accuracy is lower (Martuti, 2009). This blood pressure measurement uses 2 tools, namely a digital sphygmomanometer and a manual sphygmomanometer. This measurement is thought to be more accurate by using a manual sphygmomanometer than a digital sphygmomanometer, because digital sphygmomanometer is often an error in usage, for example because the battery starts to run out so that the tool work is not perfect. Repetition occurs several

times as needed because each repetition of the results is different so repetition is done.

The difference in blood pressure in the manual sphygmomanometer and digital sphygmomanometer may be around 2-5mmHg (Canzanello et al., 2001). Blood pressure when standing affects the results of the blood pressure because standing makes the heart rate increase when a person stands up, because the blood returning to the heart will be less. This condition may cause a sudden increase in heart rate when a person moves from a sitting position or lies to a standing position. As many as 300-500 ml in the standing position, blood in the vessels "capacitance" veins of the lower limbs and the contents of the buds decreased to 40% (setiawan and Sari, 2010).

Skills in measuring blood pressure are important clinical skills controlled by a nurse. The procedure for making measurements can trigger a bad error if all procedures are not performed properly. A nurse must be trained and have broad up-to-date insights on measuring blood pressure both using conventional mercury and sphygmomanometer aneroid and electronic blood pressure monitors. Because it can also be a potential for errors in blood pressure measurement (Rushton and Smith, 2016).

4 CONCLUSIONS

The study found that measurement of systolic and diastolic blood pressure in a standing position was higher than in supine position, there was a difference of 5-6 mmHg. Furthermore, blood pressure measurement using manual sphygmomanometer is higher than using digital sphygmomanometer, there is a difference of 5-8 mmHg in the measurement of systolic blood pressure, and 6-10 mmHg for diastolic blood pressure.

REFERENCES

A C Guyton, J E Hall, 2007. Buku Ajar Fisiologi Kedokteran, 11th ed. EGC Penerbit Buku Kedokteran, Jakarta.

A'Court, C., Stevens, R., Sanders, S., Ward, A., McManus, R., Heneghan, C., 2011. Type and accuracy of sphygmomanometers in primary care: a cross-sectional observational study. Br. J. Gen. Pract. J. R. Coll. Gen. Pract. 61, e598-603. https://doi.org/10.3399/bjgp11X593884

Afoakwah A N, Owusu WB, 2011. The Relationship Between Dietary Intake, Body Composition and Blood Pressure in Male Adult Miners in Ghana. Asian J. Clin. Nutr. 3, 1–13. https://doi.org/10.3923/ajcn.2011.1.13

Amiruddin, M.A., Danes, V.R., Lintong, F., 2015. Analisa Hasil Pengukuran Tekanan Darah Antara Posisi Duduk Dan Posisi Berdiri Pada Mahasiswa Semester Vii (Tujuh) Ta. 2014/2015 Fakultas Kedokteran Universitas Sam Ratulangi. J. E-Biomedik 3.

Audrey Berman, 2010. Buku Ajar Keperawatan Klinis, 5th ed. EGC Penerbit Buku Kedokteran.

Canzanello, V.J., Jensen, P.L., Schwartz, G.L., 2001. Are aneroid sphygmomanometers accurate in hospital and clinic settings? Arch. Intern. Med. 161, 729–731.

Dr Anna Palmer, Profesor Bryan Williams, 2007. Simple Guide Tekanan Darah Tinggi. Penerbit Erlangga, Jakarta.

E R Kowalski, 2010. Terapi Hipertensi : Program 8 Minggu Menurunkan Tekanan Darah Tinggi dan Mengurangi Resiko Serangan Jantung dan Stroke Secara Alami. Qanita, Bandung.

Eriska, Y., Adrianto, A., Basyar, E., 2016. Kesesuaian Tipe Tensimeter Pegas Dan Tensimeter Digital Terhadap Pengukuran Tekanan Darah Pada Usia Dewasa. J. Kedokt. Diponegoro 5, 1923–1929.

Kementerian Kesehatan, 2017. Sebagian Besar Penderita Hipertensi tidak Menyadarinya.

Kunikullaya, 1999. The Effect of Gender on Heart Rate Variability and Uric Acid Levels among Subjects with Different Blood Pressure Profiles [WWW Document]. URL http://www.heartindia.net/article.asp?issn=2321-449x;year=2014;volume=2;issue=4;spage=93;epage=98;aulast=Kunikullaya (accessed 9.17.18).

Lionel Ginsberg, 2007. Lecture Notes Neurologi, Kedelapan. ed. Penerbit Erlangga.

Manembu, M., Rumampuk, J., Danes, V.R., 2015. Pengaruh Posisi Duduk Dan Berdiri Terhadap Tekanan Darah Sistolik Dan Diastolik Pada Pegawai Negeri Sipilkabupaten Minahasa Utara. J. E-Biomedik 3.

Marhaendra, Y.A., Basyar, E., Adrianto, A., 2016. Pengaruh Letak Tensimeter Terhadap Hasil Pengukuran Tekanan Darah. J. Kedokt. Diponegoro 5, 1930–1936.

Martuti, 2009. Hipertensi Merawat dan Menyembuhkan Penyakit Tekanan Darah Tinggi. Kreasi Kencana, Bantul Indonesia.

Rushton, M., Smith, J., 2016. How to measure blood pressure manually. Nurs. Stand. 30, 36–39. https://doi.org/10.7748/ns.30.21.36.s43

setiawan, R., Sari, F., 2010. Fisiologi Kardiovaskular. EGC, Jakarta.

Soewolo, Soedjono Basuki, Yudani T, 2005. Fisiologi Manusia. Universitas Negeri Malang, Malang Indonesia.

Suheriyono, G.A., Pudji, A., Makruf, M.R., n.d. Kalibrator Tensimeter Dilengkapai Dengan Pengukuran Suhu dan Kelembaban 12.

Yarows, S.A., Qian, K., 2001. Accuracy of aneroid sphygmomanometers in clinical usage: University of Michigan experience. Blood Press. Monit. 6, 101–106.