



Analysis of Employee's Blood Pressure Before and After Working at Height at PT. Chandra Asri Petrochemical Site Office Serang

Amos Gris Setyadi¹, Sapti Heru Widiyarti²

¹Faculty of Nursing, Indonesian Adventist University

²Lecturer at the Faculty of Nursing, Indonesian Adventist University

ARTICLE INFO

Article history:

Received May 15, 2023
Revised May 20, 2023
Accepted May 30, 2023

Keywords:

Blood pressure;
Employee;
Hypoxia;
Working at height.

ABSTRACT

Blood pressure measurement before doing high-altitude work is very important. At high altitude will cause hypoxia due to the reduced partial pressure of oxygen and the body will respond with the acclimatization process. With the acclimatization process, there will be an increase in hemoglobin levels to adapt to low-oxygen conditions. Elevated hemoglobin levels can lead to increased blood pressure or hypertension. Therefore, this study aims to analyze the blood pressure of employees before and after doing work at height. The population in this study is all employees who do work at height. Purposive samples were taken with a total of 39 people doing work at an altitude of >1.8 meters. The method of collecting data in this study is by measuring blood pressure twice, namely before and after doing work at height. This Research Design is Pre-Experiment Design with One Group Pretest Post-Test. Before conducting the analysis, the instrument is first tested to determine the level of validity and reliability. Then the data is transformed and tested for normality so that it can be known whether the data is normally distributed after which the paired t SPSS test is carried out. The results of the study showed a significant difference between blood pressure before and after doing work at altitude with the significance value of systolic blood pressure is 0.000 where ($p < 0.05$) and diastolic blood pressure is 0.001 where ($p < 0.05$) is receiving H_a . From these results it is known that there is an effect of working at height with blood pressure. The results of this study recommend for future studies to add other factors that can affect increased blood pressure when working at height.

This is an open access article under the [CC BY-NC](https://creativecommons.org/licenses/by-nc/4.0/) license.



Corresponding Author:

Amos Gris Setyadi
Department of Faculty of Nursing,
Indonesian Adventist University,
Jl. Kolonel Masturi No.288, Cihanjuang Rahayu, Parongpong, Kabupaten Bandung Barat, Jawa Barat 40559.
Email: Amossetyadi@gmail.com

1. Introduction

According to the World Health Organization (2021), blood pressure is the force exerted by blood circulation against the walls of the body's arteries, the main blood vessels in the body. Blood pressure is written as two numbers. The first number (systolic) represents the pressure in the blood vessels when the heart contracts or beats. The second number (diastolic) represents the pressure in the blood vessels when the heart is resting between beats.

Table 1.
Blood pressure categories

Blood pressure category	Sistolik	Diastolik
Normal	<120	<80
Increase	120-129	<80
Stage 1 hypertension	130-139	80-89
Stage 2 hypertension	140 and above	90 and above
Crisis hypertension	>180	>120

Working at height is an activity or work activity carried out by the workforce at the workplace on the surface of the land or water where there is a difference in height and has the potential to fall, which causes the workforce or other people who are in the workplace to be injured, die, or cause property damage (RI Minister of Manpower No. 9 of 2016). According to Musadir (2019), changing body position from a low altitude to a higher area causes physiological changes in the body, especially in the processes of oxygenation and brain metabolism. One of them is a change in cerebral blood flow (CBF) to the brain, and the end result of this can increase blood pressure. CBF is the flow of blood supply to the brain. Waani (2014) said that being at a height will cause hypoxia due to reduced oxygen partial pressure, and the body will respond with an acclimatization process. With the acclimatization process, there will be an increase in hemoglobin levels to adapt to low oxygen conditions. Increased hemoglobin levels can cause increased blood pressure or hypertension (Natalia Selfia Nena, 2020). So based on the description above, the researcher wants to conduct research with the aim of analyzing blood pressure before and after employees work at heights.

2. Method

The research design is a pre-experiment design with one group pretest and one group post-test. Design is used to be able to find out the changes that occurred before and after treatment or intervention (Suparyanto 2018). The sample in this study was taken based on a purposive sampling technique. This research was conducted at PT. Chandra Asri Petrochemical, which is located in Serang, Banten province. The sample is all employees who work at heights of as many as 39 adult males aged 25 to 45 years who have worked for 2 to 10 years and who work at heights of > 1.8 meters to 5 meters and for 1-3 hours. This research was declared ethically feasible by KEPK-FIK UNAI with SK number 271/KEPK-FIK.UNAI/EC/II/23. Data collection was carried out by measuring the respondent's blood pressure after signing the informed consent. Respondents' participation in this study was voluntary, and there was no coercion in agreeing to be a respondent. Blood pressure measurements were carried out twice, namely before and after the respondent worked at height using a blood pressure measuring device, namely the OMRON Automatic Blood Pressure Monitor model HEM-7156, which has been calibrated. Processing and analysis of the data in this study were carried out using the Paired T-Test statistic. By using the Statistical Package for the Social Sciences (SPSS) computer program. The difference test with the t-test is used to analyze the average difference in blood pressure measurement results between before and after for all respondents who work at height. And to find out whether the difference in measurement results for each individual is significant or not, the mean test with the t-test is used.

3. Analysis And Results

Table 2.

No	Average results of blood pressure measurements before and after doing work at height			
	Before doing work		After doing work	
	Sistolik	Diastolik	Sistolik	Diastolik
1	110	70	124	86
2	125	66	130	76
3	120	80	130	74
4	110	71	113	73
5	130	83	140	90

No	Before doing work		After doing work	
	Sistolik	Diastolik	Sistolik	Diastolik
6	130	86	136	80
7	128	69	124	71
8	131	90	135	80
9	124	69	117	62
10	130	66	131	80
11	130	90	140	95
12	130	68	117	69
13	135	90	120	71
14	120	66	128	74
15	120	85	132	90
16	119	85	125	80
17	116	69	120	73
18	111	70	123	78
19	118	75	130	80
20	105	76	120	85
21	120	78	130	84
22	110	85	117	80
23	112	80	120	75
24	110	75	135	80
25	105	80	118	75
26	130	90	145	92
27	125	80	130	90
28	122	75	120	80
29	115	66	110	75
30	110	70	112	78
31	119	60	131	85
32	110	70	141	90
33	119	67	126	77
34	122	73	131	89
35	118	70	123	76
36	125	70	140	87
37	115	70	120	82
38	115	58	115	68
39	120	78	123	80
Jumlah	4664	2919	4922	3110
Mean	119.59	74.85	126.21	79.74

A worker's blood pressure before doing work at height

Based on table 2, it means that the average blood pressure of workers before doing work at altitude is 119.59 mmHg, and the average diastolic blood pressure before working at altitude is 74.85 mmHg. It was found that the average value of blood pressure, both systolic and diastolic, is normal, and blood pressure numbers less than 120/80 mmHg, systolic blood pressure less than 120, and diastolic blood pressure less than 80 are normal (AHA, 2020).

The difference in blood pressure between workers before and after doing work at height

Based on table 2, the results of measuring the blood pressure of respondents who work at heights show that the average systolic blood pressure before working at heights is 119.59 mmHg and after working at heights is 126.21 mmHg, with a difference between before and after working at heights of 6.62 mmHg, or an increase of 5.53% from before doing work at height. Meanwhile, the average diastolic blood pressure before working at altitude was 74.85 mmHg and after working at altitude was 79.74 mmHg. The difference between before and after working at heights is 4.89 mmHg, or an increase of 6.53% from before working at heights.

Blood pressure normality test

Normality of blood pressure data with the Kolmogorov-Smirnov test can be seen in the following table below.

Table 3.
Blood pressure normality test one-sample kolmogorov-smirnov test

		Systolic Before Work	Diastolic Before Work	Systolic After Work	Diastolic After Work
N		39	39	39	39
Normal Parameters ^{a,b}	Mean	119.59	74.85	126.21	79.74
	Std. Deviation	7.946	8.518	8.781	7.340
Most Extreme Differences	Absolute	.110	.177	.119	.153
	Positive	.095	.177	.119	.153
	Negative	-.110	-.098	-.103	-.078
Test Statistic		.110	.177	.119	.153
Asymp. Sig. (2-tailed)		.200 ^{c,d}	.003 ^c	.176 ^c	.022 ^c

- Test distribution is Normal.
- Calculated from data.
- Lilliefors Significance Correction.
- This is a lower bound of the true significance.

From the results mentioned above, the normality of systolic pressure data with the Kolmogorov-Smirnov test (Asymp. sig.) The systolic pressure before work is 0.200 and the Asymp value is sig., and the systolic pressure after work is 0.176, while the diastolic pressure is Asymp. sig. The diastolic pressure before work is 0.003, and the asymptotic value is sig. Diastolic pressure after work is 0.022. These results indicate that the data is normally distributed.

Statistical Test of Systolic Blood Pressure

The results of the statistical test of systolic blood pressure in respondents who work at height with the Paired T-Test can be seen in the following table below.

Table 4.
Statistical test of systolic blood pressure paired samples test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
Pair					Lower	Upper			
1	Systolic before work - Systolic after work	-6.615	8.762	1.403	-9.456	-3.775	-4.715	38	.000

From the statistical test results of systolic blood pressure at high jobs, it is known that the sig. of 0.000 or less than 0.05 ($p < 0.05$), then H_a is accepted. These results indicate a significant difference between systolic blood pressure before and after working at height.

Diastolic blood pressure statistical test

The results of the statistical test of systolic blood pressure on exposure to heat stress with the Paired T-Test can be seen in the following table below.

Table 5
Diastolic blood pressure statistical testpaired samples test

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	Diastolic before work - Diastolic after work	-4.897	8.804	1.410	-7.751	-2.043	-3.474	38	.001

From the results of statistical tests on diastolic blood pressure at high jobs, it is known that if the sig. is 0.001 or less than 0.05 ($p < 0.05$), then H_a is accepted. These results indicate that there is a significant difference between blood pressure before and after working at height.

From the results of measuring the blood pressure of respondents who work at heights, the average systolic blood pressure before working at heights is 119.59 mmHg, and after working at heights is 126.21 mmHg, with a difference before and after working at heights of 6.62 mmHg or experienced an increase of 5.53% from before doing work at height. Meanwhile, the average diastolic blood pressure before working at altitude was 74.85 mmHg, and after working at altitude was 79.74 mmHg. The difference before and after working at heights is 4.89 mmHg, or an increase of 6.53% from before working at heights.

Based on the results of statistical tests, it is known that there is a significant and real correlation, where the systolic blood pressure at a high job is known that the sig. of 0.000 or less than 0.05 ($p < 0.05$) and diastolic blood pressure at high work, it is known that the sig. of 0.001 or less than 0.05 ($p < 0.05$) The results of this study (significant if the p-value < 0.05). This study's results align with Verma's research (2017), which is similar to previous studies with relevant topics, where an increase or decrease in altitude will correlate in the same direction as an increase or decrease in blood pressure.

As in several studies reported by Parati (2015), changes in blood pressure values due to differences in a person's height in an area can be understood because several complex mechanisms underlie these changes, the most important of which is a reduction in barometric pressure which in turn will cause a reduction in blood pressure. Oxygen partial pressure affects the process of inspiration, and depletion of tissue O_2 gas occurs, which will then cause hypobaric hypoxia. As the body's response to hypobaric hypoxia, the body will carry out a series of adaptive physiological responses known as acclimatization, either in a moment or up to a certain period after experiencing exposure to these conditions (Torlasco, 2019).

Meanwhile, Parati (2015) revealed that acute hypoxia would activate sympathetic nervous system stimulation through peripheral chemoreceptor stimulation, which is the main cause of increased cardiac output, heart rate, and peripheral vasoconstriction, as well as systemic vascular resistance will increase arterial blood pressure. , followed by a significant decrease in tissue O_2 saturation (SpO_2) and a sustained increase in sympathetic activity. This sympathetic nerve activation will occur immediately after being in the highlands, can last for several days in the highlands, and will gradually return to normal values (Verma, 2017). This is also done as an adaptation of the body's response to maintain homeostasis (Parati, 2015)

Increased sympathetic tone may act as a natural response by subjects who have not previously adapted to resist the effects of hypoxia. Hypoxia directly affects vascular tone from systemic vascular resistance, increasing ventilation and sympathetic activity through stimulation of peripheral chemoreceptors. Interactions occur between systemic arteriolar vasodilatation and chemoreceptor-mediated responses in the systemic circulation. Thus it will cause baroreceptor-mediated sympathetic excitation. This adaptation to autonomic nervous activity increases blood pressure during the continuation of hypoxia (Liu Y, 2014). In other studies, it was also found that significantly the parameters of hematological markers such as hemoglobin and hematocrit would increase in those at high altitudes compared to those at low altitude/sea level, Hb ($p < 0.001$) and Hct ($p < 0.001$), so this supports the

previously known understanding that hemoglobin and hematocrit increase as a result of acclimatization to the body's response to the need for tissue oxygenation (Singh K, 2014).

Although the results of this study show compatibility with several previous studies, the results also show some differences from other studies. Other research results do not show a correlation or a non-unidirectional correlation between changes in a person's height in a certain area and changes in blood pressure. A cohort study by Keyes et al. (2017), conducted on 672 Himalayan climbers, showed that at an altitude of 2,860-4,300 masl, there was no significant change in blood pressure values for both normotensive climbers and hypertensive climbers. Blood pressure values are also known not to experience significant changes in those who climb in areas with medium altitude.

Research conducted on a group of male adolescents in China also showed that overall, with changes in altitude, changes in blood pressure occurred only in systolic blood pressure, not in diastolic blood pressure (Liu Y, 2014), and in a study of a population living in the highlands of Nepal, also found that a strong and significant correlation only occurred for changes in systolic blood pressure about an increase in altitude. In contrast, no significant correlation was found for changes in diastolic blood pressure, even though the correlation was linear/unidirectional (Aryal N, 2019). While at a plateau, systemic blood pressure will experience changes due to several physiological responses, in which the pattern of these changes can occur through three different phases.

Although the results of this study show compatibility with several previous studies, the results also show some differences from other studies. Other research results do not show a correlation or a non-unidirectional correlation between changes in a person's height in a certain area and changes in blood pressure. A cohort study by Keyes et al. (2017), conducted on 672 Himalayan climbers, showed that at an altitude of 2,860-4,300 masl, there was no significant change in blood pressure values for both normotensive climbers and hypertensive climbers. Blood pressure values are also known not to experience significant changes in those who climb in areas with medium altitude.

Research conducted on a group of male adolescents in China also showed that overall, with changes in altitude, changes in blood pressure occurred only in systolic blood pressure, not in diastolic blood pressure (Liu Y, 2014), and in a study of a population living in the highlands of Nepal, also found that a strong and significant correlation only occurred for changes in systolic blood pressure about an increase in altitude. In contrast, no significant correlation was found for changes in diastolic blood pressure, even though the correlation was linear/unidirectional (Aryal N, 2019). While at a plateau, systemic blood pressure will experience changes due to several physiological responses, in which the pattern of these changes can occur through three different phases.

Although the results of this study show compatibility with several previous studies, the results also show some differences from other studies. Other research results do not show a correlation or a non-unidirectional correlation between changes in a person's height in a certain area and changes in blood pressure. A cohort study by Keyes et al. (2017), conducted on 672 Himalayan climbers, showed that at an altitude of 2,860-4,300 masl, there was no significant change in blood pressure values for both normotensive climbers and hypertensive climbers. Blood pressure values are also known not to experience significant changes in those who climb in areas with medium altitude.

Research conducted on a group of male adolescents in China also showed that overall, with changes in altitude, changes in blood pressure occurred only in systolic blood pressure, not in diastolic blood pressure (Liu Y, 2014), and in a study of a population living in the highlands of Nepal, also found that a strong and significant correlation only occurred for changes in systolic blood pressure about an increase in altitude. In contrast, no significant correlation was found for changes in diastolic blood pressure, even though the correlation was linear/unidirectional (Aryal N, 2019). While at a plateau, systemic blood pressure will experience changes due to several physiological responses, in which the pattern of these changes can occur through three different phases.

4. Conclusion

Based on the results and discussion, it can be concluded that every physical activity affects blood pressure; physical activity is all body movements, and doing work at heights is also physical activity in

work done at heights. From the research and observations conducted by researchers on 39 respondents who did work at height, it was found that the average blood pressure of workers before doing work at height at PT Chandra Asri Petrochemical, both systolic and diastolic, was normal, namely systolic blood pressure 119.59 mmHg and diastolic 79.85 or less than 120/80 mm Hg. The average blood pressure of workers after doing work at height at PT. For both systolic and diastolic, Chandra Asri Petrochemical increased, namely 126.21 mmHg for systolic and 79.74 mmHg diastolic or more than 120 mmHg for systolic and less than 80 mmHg for diastolic. There is a significant difference between blood pressure before and after working at height at PT. Chandra Asri Petrochemical's significance value of systolic blood pressure is 0.000 ($p < 0.05$). Moreover, the significance value of diastolic blood pressure is 0.001 where ($p < 0.05$), which means accepting H_a . From these results, it is known that there is a significant effect between working at altitude and blood pressure.

References

- Aprilia, A. (2021, Desember 14). *Artikel Kesehatan*. Retrieved from Dinas kesehatan Kabupaten Ogan Komering Ulu: <https://dinkes.okukab.go.id/waspadai-hipertensi-kendalikan-tekanan-darah>
- Aryal N, W. M. (2019). Blood pressure and hypertension in people living at high altitude in Nepal. *Hypertens Res*, 42.
- Banten, D. P. (2020, Maret). *Syarat K3 Lingkungan Kerja. Syarat K3 Lingkungan Kerja*. Banten.
- Center, C. D. (2023, March 17). *Know Your Risk For Blood Pressure*. Retrieved from https://www.cdc.gov/bloodpressure/risk_factors.htm
- Djie, A. (2020, Maret 22). *Sederet Faktor yang Mempengaruhi Tekanan Darah Anda*. Retrieved from SehatQ: <https://www.sehatq.com/artikel/kenali-dan-atur-faktor-yang-mempengaruhi-tekanan-darah>
- Janssen. (2022). Evidence synthesis Timing of physical activity within the 24-hour day and its influence on health: a systematic review. *Research, Policy Vol 42, no 4*, 135.
- Juwita, N. M. (2019). Pengaruh Ketinggian Terhadap Stroke. *Jurnal Kedokteran Nanggroe Medika*, 31.
- Kemkes. (2018). *Mengenal Jenis Aktivitas Fisik*. Retrieved from <https://promkes.kemkes.go.id/content/?p=8807>
- Ketenagakerjaan, B. P. (2020, March 30). *Syarat K3 dalam lingkungan kerja*. Retrieved from Disnakertrans Propinsi Banten: <https://disnakertrans.bantenprov.go.id/Berita/topic/265>
- Keyes LE, S. T. (2017). Blood pressure and altitude: An observational cohort study of hypertensive and nonhypertensive Himalayan trekkers in Nepal. *High Alt Med Biol*, 1-11.
- Liu Y, C. J. (2014). Correlation between blood pressure changes and AMS, sleep quality and exercise upon high-altitude exposure in young chinese men. *Military Med Research*, 1-9.
- Munthe, D. Y. (2020). Hubungan Penggunaan Alat Pelindung Diri Dengan Keselakaan Kerja Pada Penderes Karet di PTPN III Kebun Giting 2020.
- Musadir, N. (2019). Pengaruh Ketinggian Terhadap Stroke. *J. Ked. N. Med VOL. 2 NO. 1 Maret 2019*, 30-34.
- Nugraheni, A. (2019). Pengaruh Senam Hipertensi Terhadap Perubahan Tekanan Darah Pada Penderita Hipertensi di kelompok Prolanis Wilayah Kerja Puskesmas Sukorejo.
- Parati G, O. J. (2015). Aging, High Altitude, and Blood Pressure: A Complex Relationship. *High Alt Med Biol*, 97-109.
- Pemberdayaan, K. K. (2018, June 23). *Mengenal Jenis aktivitas fisik*. Retrieved from <https://promkes.kemkes.go.id/content/?p=8807>
- Pusparini. (2021). Faktor yang Mempengaruhi Kinerja Pegawai (Satuan Kajian Literatur Manajemen Sumber Daya Manusia). *Ilmu Manajemen Terapan Volume 2, Issue 4*.
- Ramadani, A. (2018). Perbedaan Kadar Hemoglobin Sebelum dan Sesudah Aktivitas Fisik Pada Latihan Zumba.
- Rizki Rahmawati, S. A. (2019). Faktor-faktor yang Berhubungan Dengan Kelelahan Kerja Pada Perawat di RSUD Bangkinang tahun 2019.
- Saffira, I. A. (2021). Hubungan Pola Makan Dengan Kejadian Obesitas Pada Anak Balita di Wilayah Kerja Puskesmas Kunti Sampung Ponorogo. *Artikel Ilmiah Mahasiswa Universitas Muhammadiyah Ponorogo*, 14.
- Seliyanto, M. H. (2019). Hubungan Karakteristik Pekerja Dengan Perilaku Tidak Aman Tenaga Kerja di PT. Aneka Adhilogam Karya Ceper Klaten.
- Siga, N. S. (2020). Studi Literatur : Hubungan Kadar Hemoglobin Dengan Tekanan Darah Pada Pasien Penderita Hipertensi.
- Singh K, G. R. (2014). Long term stay at low altitude (1,200 m) promotes better hypoxia adaptation and performance. *Indian J Physiol Pharmacol*, 376-380.
- Supriyono. (2019). Analisis faktor-faktor yang berhubungan tekanan darah sistolik pada peserta pelatihan manajemen puskesmas.

- Susanti, M. R. (2021). Hubungan Asupan Natrium dan Kalium Dengan Tekanan Darah Pada Lansia di Kelurahan Pajang. 14.
- Torlasco C, B. G. (2019). Effects of acute exposure to moderate altitude on blood pressure and sleep breathing patterns. *Int J Cardiol.*, 1-24.
- Verma N, P. A. (2017). Effect of Altitude on Blood Pressure. *Hypertens.* 171-172.
- Waani, A. (2014). Kadar Hemoglobin Pada Orang Dewasa yang Tinggal di Dataran Tinggi Dengan Ketinggian yang Berbeda. *e-Biomedik*, 471.
- Wahyuni, S. (2020). Hubungan Perilaku Dengan Kecelakaan Kerja Pekerja Bengkel Las Di Jalan Mahkamah Medan Kota. 10-28.
- WHO. (2022, Oktober). *Physical Activity*. Retrieved from <https://www.who.int/news-room/fact-sheets/detail/physical-activity>
- Wicaksono, S. (2015). Hubungan Usia Dan Jenis Kelamin Lansia Dengan Peningkatan Tekanan Darah (Hipertensi) Di Dusun 1 Desa Kembangseri Kecamatan Talang Empat Bengkulu Tengah. 5.