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Original Research Paper

The effect of slow deep breathing exercise on IL-6 and IL-10 levels in hypertensive elderly: a pre-experimental study

Abdillah Choirul Chisholi*[1], Setiawati Setiawati[2], Susiana Candrawati[3]
[1]Master of Biomedical Sciences, Faculty of Medicine, Universitas Jenderal Soedirman, Banyumas, Indonesia
[2]Department of Pharmacology, Faculty of Medicine, Universitas Jenderal Soedirman, Banyumas, Indonesia
[3]Department of Physiology, Faculty of Medicine, Universitas Jenderal Soedirman, Banyumas, Indonesia
abdillahchoirul94@gmail.com

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Abstract
Hypertension is a major risk factor for cardiovascular disease and is often associated with chronic inflammatory processes. Pro-inflammatory cytokines such as Interleukin-6 (IL-6) play a role in the pathogenesis of hypertension, whereas anti-inflammatory cytokines such as Interleukin-10 (IL-10) can inhibit inflammatory effects. Slow Deep Breathing Exercise (SDBE) has been linked to improved autonomic nervous system regulation and potential anti-inflammatory effects. This study used a one-group pretest-posttest design involving 35 pre-elderly and elderly participants with hypertension. Subjects underwent SDBE intervention for six weeks, three sessions per week, with each session lasting 10–15 minutes. IL-6 and IL-10 levels were measured using the ELISA method, and blood pressure was measured before and after the intervention. Data analysis was performed using the Wilcoxon Signed Rank Test. There was a significant increase in IL-10 levels after the intervention ($p = 0.000$), but IL-6 levels showed no significant change ($p = 0.108$). Systolic and diastolic blood pressure significantly decreased from 158.54±13.86 mmHg to 149.69±13.90 mmHg ($p = 0.005$) and from 88.80±15.08 mmHg to 84.66±8.99 mmHg ($p = 0.005$), respectively. In older adults with hypertension, slow deep breathing exercise can lower blood pressure and raise IL-10 levels, an anti-inflammatory cytokine, while IL-6 levels did not significantly change. This intervention can be used as a non-pharmacological therapy to help manage hypertension.

Keywords: hypertension; IL-6; IL-10; inflammation; slow deep breathing exercise

1. Introduction

Hypertension is a critical global health challenge, often termed the "silent killer" due to its asymptomatic nature until vital organ damage occurs, such as in the heart, brain, and kidneys (Magnani, 2023). Globally, the prevalence of hypertension has reached 22%, while in Indonesia, the rate continues to rise, currently affecting 34.1% of the population (Lu et al., 2020; Kurnianto et al., 2020). This phenomenon is particularly pronounced among the elderly, where the aging process significantly exacerbates the risk of vascular disorders (Balitbangkes RI, 2018).

The pathogenesis of hypertension involves complex mechanisms, with low-grade chronic inflammation, immune response, and oxidative stress playing central roles in triggering endothelial dysfunction (Guzik & Touyz, 2017). Elevated pro-inflammatory cytokines, specifically Interleukin-6 (IL-6), contribute to the increase of reactive oxygen species (ROS) and the activation of the renin-angiotensin-aldosterone system (RAAS), which promotes vascular hypertrophy (Zhang et al., 2023). Conversely, anti-inflammatory cytokines such as Interleukin-10 (IL-10) act as protective agents by suppressing excessive inflammation and improving nitric oxide (NO) bioavailability, thereby maintaining vascular elasticity (Fauzan et al., 2020).

Although pharmacological therapies are widely available, adherence among elderly patients is often low due to costs and medication side effects. Consequently, lifestyle interventions through physical

exercise have become a crucial alternative. One practical and effective exercise model is Slow Deep Breathing Exercise (SDBE). SDBE operates through biochemical mechanisms, including the elevation of endorphin levels and the reduction of sympathetic nervous system activity, which ultimately lowers blood pressure (Herawati et al., 2023).

Several empirical studies indicate that regular breathing exercises significantly improve cardiovascular function and quality of life (Vasuki, 2017; Sangprasert et al., 2019). However, the molecular mechanisms of SDBE in modulating the balance of pro- and anti-inflammatory cytokines, particularly IL-10 in the elderly population, require further exploration (De Miguel et al., 2014). This study aims to bridge this gap by evaluating the effects of SDBE on IL-6 and IL-10 levels among hypertensive patients in an elderly community, supporting the development of more holistic non-pharmacological therapeutic strategies.

2. Research Methods

This study is a quantitative research with a pre-experimental approach using a one-group pretest-posttest design. The aim of the study was to evaluate the effect of slow deep breathing exercise (SDBE) on interleukin-6 (IL-6), interleukin-10 (IL-10), and blood pressure in elderly individuals with hypertension. A total of 35 participants were selected through total sampling from the population of elderly hypertensive patients at the Waras Winangun Elderly Health Post in East Purwokerto. The inclusion criteria included elderly individuals diagnosed with hypertension, able to communicate effectively, and willing to participate in the intervention and data collection procedures. Participants with cognitive impairments, those currently undergoing other breathing therapies, or with specific medical conditions such as tension pneumothorax were excluded. Subjects who missed more than three exercise sessions or were absent during the post-intervention data collection were considered drop-outs.

The intervention consisted of slow deep breathing exercises (SDBE) performed three times a week for six weeks, with each session lasting 10–15 minutes. The breathing technique included inhaling for five seconds, holding the breath for three seconds, and exhaling slowly over eight seconds. IL-6 and IL-10 levels were measured using the Enzyme-Linked Immunosorbent Assay (ELISA) method from serum blood samples collected before and after the intervention. In addition, blood pressure was measured using a standard aneroid sphygmomanometer.

Data analysis was performed using the Shapiro-Wilk test to assess data normality. Since the data were not normally distributed, the Wilcoxon Signed Rank Test was used to analyze the differences between pre- and post-intervention. To control for potential confounding variables such as age, gender, smoking habits, and antihypertensive medication use, ANCOVA was applied. All statistical analyses were conducted using SPSS version 23, with a significance level set at $p < 0.05$.

3. Results and Discussion

3.1.Results

This study involved 35 subjects from the Waras Winangun Elderly Health Post in East Purwokerto who underwent a slow deep breathing exercise (SDBE) intervention for six weeks (18 sessions). Based on the analysis, there was a reduction in both systolic and diastolic blood pressure, along with a significant increase in IL-10 levels, although changes in IL-6 levels were not statistically significant.

Table 1. Comparison of IL-6, IL-10, and Blood Pressure Before and After Intervention

Variable	Result		
	Before (Mean ± SD)	After (Mean ± SD)	p-value
IL-6 (pg/mL)	1.395 ± 0.273	0.828 ± 0.456	0.108

Variable	Result		
	Before (Mean ± SD)	After (Mean ± SD)	p-value
IL-10 (pg/mL)	3.430 ± 1.497	18.140 ± 6.013	0.000*
Systolic Blood Pressure (mmHg)	158.54 ± 14.42	149.69 ± 13.07	0.005*
Diastolic Blood Pressure (mmHg)	88.80 ± 8.23	84.66 ± 8.11	0.005*

Note: *$p < 0.05$ indicates statistically significant results. The Wilcoxon Signed-Rank Test was used because the data were not normally distributed.*

Specifically, IL-6 levels decreased from a mean of 1.395 ng/L to 0.828 ng/L (p = 0.108), while IL-10 levels significantly increased from a mean of 3.430 pg/mL to 18.140 pg/mL (p = 0.000). Systolic blood pressure decreased from 158.54 mmHg to 149.69 mmHg, and diastolic blood pressure decreased from 88.80 mmHg to 84.66 mmHg (p = 0.005 for both).

These findings indicate that SDBE intervention has a significant effect on increasing IL-10 levels and reducing blood pressure, and therefore may be considered a non-pharmacological intervention for hypertension management in elderly individuals.

3.2. Discussion

3.2.1. Participant Characteristics and Hypertension Risk

The majority of subjects in this study were in the 60–69 years age group (62.9%), which represents the cohort with the highest prevalence of hypertension (Azwaldi et al., 2023). This finding aligns with global studies indicating an increased vascular risk across the 35–85 years age range due to the biological aging process and diminished therapeutic adherence (Cheng et al., 2022; Leszczak et al., 2024). Lifestyle factors, such as low physical activity and unhealthy dietary patterns, were found to increase the risk of hypertension by up to 5.52-fold in the elderly (Dida et al., 2023). The predominance of female respondents (77.1%) further highlights the role of post-menopausal estrogen decline in reducing vascular elasticity (Rahmadhani, 2021; Tadic et al., 2022). Although most subjects were non-smokers, a history of smoking remains a critical risk factor as nicotine triggers systemic vasoconstriction (Jareebi, 2024).

3.2.2. Physiological Mechanisms of Blood Pressure Reduction

The reduction in blood pressure through SDBE is facilitated by several neurophysiological mechanisms. These findings are consistent with the study by Thome et al. (2018), which states that SDBE works by reducing sympathetic nervous system activity and enhancing the relaxation response. Deep and slow breathing triggers a decrease in heart rate and respiratory rate, which systemically lowers blood pressure. Furthermore, this exercise increases baroreflex sensitivity, strengthening the body's homeostatic capacity to regulate blood pressure more effectively (Thome et al., 2018).

The efficacy of SDBE as a non-pharmacological intervention is also supported by Krisnadeva & Hidayah (2023) and a literature review by Herawati et al. (2023). In an analysis of 20 studies, it was found that 16 of them showed significant reductions in SBP ranging from 4 to 54.22 mmHg and DBP ranging from 3 to 17 mmHg (Herawati et al., 2023). Specifically, Widarti et al. (2024) explained that the stimulation of the parasympathetic nervous system through deep breathing plays a central role in regulating heart rate and reducing muscle tension and stress, which are primary risk factors for hypertension. Beyond neurological aspects, this method improves blood circulation and oxygenation, cumulatively supporting the reduction of arterial blood pressure (Widarti et al., 2024).

3.2.3. Interleukin-6 (IL-6) Dynamics Post-SDBE Intervention

Statistical analysis in this study indicates that the six-week Slow Deep Breathing Exercise (SDBE) intervention did not yield a significant effect on reducing IL-6 levels in the research subjects. The change in cytokine levels did not reach statistical significance, showing a mean increase of (+)0.159 pg/mL (p=0.108). This finding aligns with the study by Herawati et al. (2023), which reported that inflammatory biomarkers such as IL-6, IL-1ra, galectin-3, and CRP showed no significant changes during the SDBE training period.

Biomolecularly, IL-6 is a pleiotropic cytokine that plays a central role in the acute phase of inflammation and the pathophysiology of various chronic diseases, including hypertension. Its production is triggered by various cell types such as macrophages, endothelial cells, and adipocytes in response to the activation of inflammatory signaling pathways like NF-κB and STAT3. In pre-elderly and elderly populations, IL-6 expression tends to increase persistently due to the phenomenon of inflamm-aging, a chronic, low-grade systemic inflammatory condition that occurs with advancing age in the absence of acute infection. This condition is triggered by the activation of M1 macrophages, an increase in senescent immune cells, and the dysregulation of the Toll-Like Receptor (TLR) pathways (Rea et al., 2018; Singh, 2017).

The aging process is also closely linked to increased oxidative stress through the accumulation of reactive oxygen species (ROS). Under normal physiological conditions, ROS serves as a second messenger in the regulation of gene transcription via the MAPK and NF-κB pathways. However, in the elderly, this regulatory disruption causes ROS to excessively activate inflammatory signal transduction pathways such as IKK/NF-κB and p38 MAPK, directly stimulating IL-6 gene expression in various cell types, including endothelial cells and macrophages.

In addition to oxidative stress factors, the autonomic nervous system imbalance prevalent in the elderly also influences the stability of IL-6 levels. Sympathetic nervous system dominance triggers the release of norepinephrine and epinephrine, which activate β-adrenergic receptors through the cAMP–PKA–CREB pathway, thereby increasing IL-6 secretion (Wang et al., 2016). Conversely, the decline in parasympathetic activity inhibits the release of acetylcholine, which is crucial for the cholinergic anti-inflammatory pathway (ChAP). This pathway normally functions to inhibit NF-κB activation and IL-6 production through the binding of acetylcholine to the α7-nAChR receptors on macrophages. Disruptions in this mechanism lead to a loss of effective bodily control over IL-6 expression.

The presence of comorbidities such as diabetes mellitus, obesity, and cardiovascular disease in the research subjects is suspected to further reinforce the chronic inflammatory state through the activation of the NLRP3 inflammasome and JNK pathways. As emphasized by Crowley (2014), oxidative stress and inflammation are two intracellular processes that mutually reinforce each other in a pathological feedback loop. Therefore, the biomolecular complexity accompanying the aging process encompassing sympathetic dominance, oxidative stress, immune dysregulation, and comorbidities explains why a six-week SDBE intervention may not be potent enough to significantly suppress IL-6 levels in an elderly population with a complex inflammatory background.

3.2.4. Interleukin-10 (IL-10) Modulation and Activation of the Cholinergic Anti-Inflammatory Pathway

The results of this study demonstrate a highly significant increase in IL-10 levels following the slow deep breathing exercise (SDBE) intervention, with a mean increase of (+)7.059 pg/mL (p=0.000). This finding indicates that SDBE effectively enhances the anti-inflammatory response in pre-elderly and elderly populations with hypertension. As a primary anti-inflammatory cytokine, IL-10 plays a crucial role in suppressing the inflammatory cascade. Therefore, the elevation of its levels serves as a

protective mechanism for the body in mitigating the chronic inflammation that commonly accompanies hypertensive conditions.

This positive modulation of the immune system carries significant clinical implications for hypertensive patients. Chronic inflammation is a major pathophysiological pillar contributing to cardiovascular complications, including atherosclerosis. Consequently, the increase in IL-10 through SDBE not only supports mechanical blood pressure regulation but also provides protection against risks of inflammation-mediated vascular complications.

The mechanism of immunomodulation via SDBE is explained through its influence on the autonomic nervous system (ANS), specifically by strengthening parasympathetic tone. Physiologically, the inhalation phase increases sympathetic activity, whereas a deep and slow exhalation phase triggers the vagus nerve to enhance parasympathetic activity (Wehrwein, Orer, & Barman, 2016). This increased parasympathetic activity contributes to improved heart rate variability (HRV), representing a superior autonomic balance that benefits the cardiovascular health profile (Kromenacker et al., 2018).

The vagus nerve modulates the systemic immune response through two primary pathways: the hypothalamic-pituitary-adrenal axis (HPAA) and the cholinergic anti-inflammatory pathway (ChAP). Activation of vagal efferent fibers from the dorsal motor nucleus of the vagus (DMNV) triggers the release of acetylcholine (ACh), which then binds to the α7-nicotinic acetylcholine receptor (α7nAChR) on macrophages. This molecular binding effectively suppresses the release of pro-inflammatory cytokines such as TNF-α, IL-6, and IL-1beta, while simultaneously enhancing anti-inflammatory activity (Inoue et al., 2016; Wang, Yin, & Yao, 2016).

Intriguingly, a study found that vagal nerve activation via SDBE can increase IL-10 levels up to sixfold, even when pro-inflammatory cytokine profiles remain elevated. This confirms that the increase in IL-10 is an independent response to parasympathetic stimulation rather than a mere consequence of decreased pro-inflammatory cytokines. This integration process involves the nucleus tractus solitarius (NTS) in the medulla oblongata as the primary processing center for vagal sensory signals. From the NTS, signals are transmitted through the central autonomic network (CAN) to create a more stable autonomic homeostasis, which manifests clinically as a significant reduction in the subjects' blood pressure (Bonaz et al., 2017; Bonaz, Sinniger, & Pellissier, 2019).

Furthermore, the ChAP pathway also involves complex splenic mechanisms. Vagal activation during SDBE triggers the release of noradrenaline in the spleen, which stimulates T-lymphocytes to secrete acetylcholine (Bonaz et al., 2017). This acetylcholine subsequently inhibits the release of inflammatory mediators from systemic macrophages (Inoue et al., 2016). In conclusion, SDBE functions as a dual-action intervention that regulates blood pressure through autonomic stabilization while providing immunological protection by increasing the anti-inflammatory cytokine IL-10.

3.2.5. Analysis of Confounding Factors: Smoking and Antihypertensive Drugs

ANCOVA results demonstrated that smoking history and the consumption of antihypertensive medications (such as ACE-inhibitors or Beta-blockers) did not act as confounding variables for changes in IL-6 and IL-10 levels. While tobacco chemicals theoretically promote inflammation and antihypertensive drugs possess pleiotropic anti-inflammatory effects, the results of this study reinforce that the observed immune regulatory effects predominantly originated from the SDBE intervention.

4. Conclusion

Based on the results of this study, it can be concluded that a six-week intervention of slow deep breathing exercise (SDBE) had a significant impact on several physiological parameters in elderly individuals with hypertension. Although there was no statistically significant change in IL-6 levels

before and after the intervention, a significant increase in IL-10 levels was observed. This finding indicates that SDBE is capable of modulating the anti-inflammatory response through the activation of the parasympathetic nervous system, particularly via the cholinergic anti-inflammatory pathway (ChAP). In addition, both systolic and diastolic blood pressure showed significant reductions, as evidenced by the shift in blood pressure categories from hypertension to prehypertension and even to normal levels in some participants. These findings reinforce the evidence that SDBE can serve as an effective non-pharmacological intervention for lowering blood pressure and enhancing immune system regulation through increased IL-10 levels. This effectiveness is consistent with previous studies which have shown that deep breathing exercises can promote vasomotor relaxation, improve endothelial function, and enhance baroreflex sensitivity, thereby contributing to the reduction of blood pressure and the risk of inflammation-related cardiovascular complications.

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References

Azwaldi, Maharani, P., Maksuk, & Kumalasari, I. (2023). Determinant factors of hypertension in the elderly at Public Health Center in Palembang, South Sumateran. *Epidemiological Journal of Indonesia*, *2*(1), 1–6.

Balitbangkes RI. (2018). *Laporan Riskesdas 2018 Nasional*. Lembaga Penerbit Balitbangkes.

Bonaz, B., Sinniger, V., & Pellissier, S. (2017). Vagus nerve stimulation: A new promising therapeutic tool in inflammatory bowel disease. *Journal of Internal Medicine*, *282*(1), 46–63. https://doi.org/10.1111/joim.12611

Bonaz, B., Sinniger, V., & Pellissier, S. (2019). Vagus nerve stimulation at the interface of brain–gut interactions. *Cold Spring Harbor Perspectives in Medicine*, *9*(8), Article a034199. https://doi.org/10.1101/cshperspect.a034199

Cheng, W., Du, Y., Zhang, Q., Wang, X., He, C., He, J., Jing, F., Ren, H., Guo, M., Tian, J., & Xu, Z. (2022). Age-related changes in the risk of high blood pressure. *Frontiers in Cardiovascular Medicine*, *9*, Article 939103. https://doi.org/10.3389/fcvm.2022.939103

De Miguel, C., Rudemiller, N. P., Abais, J. M., & Mattson, D. L. (2014). Inflammation and hypertension: New understandings and potential therapeutic targets. *Current Hypertension Reports*, *17*(1), Article 507. https://doi.org/10.1007/s11906-014-0507-z

Dida, G. Y., Nayoan, C. R., & Sir, A. B. (2023). The risk factors of hypertension among the elderly in the working area of Sikumana Primary Health Care Center. *Journal of Public Health for Tropical and Coastal Region*, *6*(1), 21–29. https://doi.org/10.14710/jphtcr.v6i1.17541

Fauzan, D. R., Irawati, N. A. V., & Fadli, M. Y. (2020). Hipertensi dan inflamasi: Sebuah perspektif ke depan untuk target terapi baru. *JK Unila*, *4*(2), 135–146.

Guzik, T. J., & Touyz, R. M. (2017). Oxidative stress, inflammation, and vascular aging in hypertension. *Hypertension*, *70*(4), 660–667. https://doi.org/10.1161/HYPERTENSIONAHA.117.07802

Herawati, I., Mat Ludin, A. F., Mutalazimah, M., Ishak, I., & Farah, N. M. F. (2023). Breathing exercise for hypertensive patients: A scoping review. *Frontiers in Physiology*, *14*, Article 1048338. https://doi.org/10.3389/fphys.2023.1048338

Inoue, T., Abe, C., Sung, S. S. J., Moscalu, S., Jankowski, J., & Huang, L. (2016). Vagus nerve stimulation mediates protection from kidney ischemia-reperfusion injury through α7nAChR+ splenocytes. *Journal of Clinical Investigation*, *126*(5), 1939–1952. https://doi.org/10.1172/JCI83658

Jareebi, M. A. (2024). The association between smoking behavior and the risk of hypertension: Review of the observational and genetic evidence. *Journal of Multidisciplinary Healthcare*, *17*, 3265–3281. https://doi.org/10.2147/JMDH.S470589

Krisnadeva, N., & Hidayah, R. (2023). Reducing blood pressure in elderly with stage 2 primary hypertension using slow deep breathing exercise intervention. *Nurse and Holistic Care*, *3*(1), 13–20. https://doi.org/10.33086/nhc.v3i1.3850

Kromenacker, B. W., Sanova, A. A., Marcus, F. I., Allen, J. J. B., & Lane, R. D. (2018). Vagal mediation of low-frequency heart rate variability during slow yogic breathing. *Psychosomatic Medicine*, *80*(6), 581–587. https://doi.org/10.1097/PSY.0000000000000603

Kurnianto, A., Sunjaya, D. K., Rinawan, F. R., & Hilmanto, D. (2020). Prevalence of hypertension and its associated factors among Indonesian adolescents. *International Journal of Hypertension*, *2020*, Article 4262034. https://doi.org/10.1155/2020/4262034

Leszczak, J., Czenczek-Lewandowska, E., Asif, M., Baran, J., Mazur, A., & Wyszyńska, J. (2024). Risk factors and prevalence of hypertension in older adults from South-Eastern Poland: An observational study. *Scientific Reports*, *14*(1), Article 1391. https://doi.org/10.1038/s41598-024-52009-3

Lu, Y., Yan, H., Yang, J., & Liu, J. (2020). Occupational stress and psychological health impact on hypertension of miners in noisy environment in Wulumuqi, China: A case-control study. *BMC Public Health*, *20*(1), 1–10. https://doi.org/10.1186/s12889-020-09760-9

Magnani, J. W. (2023). Hypertension - A social disease in need of social solutions. *Hypertension*, *80*(7), 1414–1416. https://doi.org/10.1161/HYPERTENSIONAHA.123.21296

Rahmadhani, M. (2021). Faktor-faktor yang mempengaruhi terjadinya hipertensi pada masyarakat di Kampung Bedagai Kota Pinang. *Jurnal Kedokteran STM (Sains dan Teknologi Medik)*, *4*(1), 52–62. https://doi.org/10.30743/stm.v4i1.132

Rea, I. M., Gibson, D. S., McGilligan, V., McNerlan, S. E., Denis Alexander, H., & Ross, O. A. (2018). Age and age-related diseases: Role of inflammation triggers and cytokines. *Frontiers in Immunology*, *9*, Article 586. https://doi.org/10.3389/fimmu.2018.00586

Sangprasert, P., Palangrit, S., Pattaraarchachai, J., & Tiyoa, N. (2019). Preliminary study of slow deep breathing in mindfulness exercise effects on physical health outcome among hypertensive patients. *The Bangkok Medical Journal*, *14*(2), 48–54. https://doi.org/10.31524/bkkmedj.2018.09.009

Singh, S., Shankar, R., & Singh, G. P. (2017). Prevalence and associated risk factors of hypertension: A cross-sectional study in urban Varanasi. *International Journal of Hypertension*, *2017*, Article 5491838. https://doi.org/10.1155/2017/5491838

Tadic, M., & Lozic, M. (2022). Hypertension in women. *Frontiers in Cardiovascular Medicine*, *9*, Article 905504. https://doi.org/10.3389/fcvm.2022.905504

Thome, A. L., Arifa, N., Desiyani, C., & Wabula, L. R. (2018). The effectiveness of slow deep breathing to decrease blood pressure in hypertension: A systematic review. *The 9th International Nursing Conference 2018*, 370–373.

Vasuki, S. (2017). The study of usefulness of deep breathing exercise (non pharmacological adjunct) on blood pressure in hypertensive patients. *IOSR Journal of Dental and Medical Sciences*, *16*(02), 59–62. https://doi.org/10.9790/0853-1602045962

Wang, D. W., Yin, Y. M., & Yao, Y. M. (2016). Vagal modulation of the inflammatory response in sepsis. *International Reviews of Immunology*, *35*(5), 415–433. https://doi.org/10.3109/08830185.2015.1127369

Wehrwein, E. A., Orer, H. S., & Barman, S. M. (2016). Overview of the anatomy, physiology, and pharmacology of the autonomic nervous system. *Comprehensive Physiology*, *6*(3), 1239–1278. https://doi.org/10.1002/cphy.c150037

Widarti, R., Hermawati, & Wahyuni, E. S. (2024). The effect of slow deep breathing exercises on elderly women with hypertension. *Gaster*, *22*(1), 93–100. https://doi.org/10.30787/gaster.v22i1.1208

Zhang, Z., Zhao, L., Zhou, X., Meng, X., & Zhou, X. (2023). Role of inflammation, immunity, and oxidative stress in hypertension: New insights and potential therapeutic targets. *Frontiers in Immunology*, *13*, Article 1098725. https://doi.org/10.3389/fimmu.2022.1098725