CORRELATION BETWEEN PROBIOTIC USE AND BLOOD PRESSURE IN HYPERTENSIVE ADULTS: A CROSS-SECTIONAL STUDY

Dharma Sultan, Yuswanto Setyawan*
Faculty of Medicine, Ciputra University Surabaya
*Corresponding author's email: yuswanto_setyawan@yahoo.com
DOI: 10.33088/jp.v4i2.1081

ABSTRACT

Hypertension remains a significant global health burden and is closely linked to cardiovascular morbidity. Emerging evidence suggests that gut microbiota plays an essential role in modulating blood pressure, particularly through the use of probiotics and prebiotics. This study investigated the relationship between the frequency of probiotic consumption and blood pressure control in patients with essential hypertension. A total of 100 hypertensive adults participated in this cross-sectional study, and data were collected through structured interviews, food frequency questionnaires, and blood pressure assessments. Statistical analyses included Chi-square and Spearman correlation tests. The results demonstrated a significant association between higher frequency of probiotic intake and better blood pressure control (p = 0.008), with a moderate negative correlation (r = –0.45) between intake duration and systolic blood pressure. Additionally, individuals who consumed both probiotics and prebiotic-rich foods exhibited enhanced blood pressure improvement. These findings underscore the potential of probiotic–prebiotic synergy in optimizing gut microbiota for blood pressure regulation. This research contributes to the growing evidence supporting dietary modulation of the gut environment as a complementary, non-pharmacological approach to hypertension management.

Keywords: *Hypertension, Probiotics, Prebiotics, Gut microbiota, Blood pressure*

ABSTRAK

Hipertensi tetap menjadi beban kesehatan global yang signifikan dan berkaitan erat dengan morbiditas kardiovaskular. Bukti terbaru menunjukkan bahwa mikrobiota usus berperan penting dalam mengatur tekanan darah, terutama melalui penggunaan probiotik dan prebiotik. Penelitian ini mengevaluasi hubungan antara frekuensi konsumsi probiotik dan kendali tekanan darah pada pasien dengan hipertensi esensial. Sebanyak 100 orang dewasa dengan hipertensi ikut serta dalam studi potong lintang ini. Data dikumpulkan melalui wawancara terstruktur, kuesioner frekuensi makanan, serta pengukuran tekanan darah. Uji statistik yang digunakan meliputi Chi-square dan korelasi Spearman. Hasil menunjukkan adanya hubungan yang signifikan antara tingginya frekuensi konsumsi probiotik dengan pengendalian tekanan darah yang lebih baik (p = 0,008), dengan korelasi negatif sedang (r = –0,45) antara durasi konsumsi dan tekanan darah sistolik. Selain itu, individu yang juga mengonsumsi makanan kaya prebiotik menunjukkan perbaikan tekanan darah yang lebih besar. Temuan ini menegaskan potensi sinergi probiotik–prebiotik dalam mengoptimalkan mikrobiota usus untuk mengatur tekanan darah. Penelitian ini memberikan kontribusi pada bukti ilmiah bahwa modifikasi diet yang menargetkan lingkungan usus dapat menjadi pendekatan komplementer non-farmakologis dalam pengelolaan hipertensi.

Kata Kunci: Hipertensi, Probiotik, Prebiotik, Mikrobiota usus, Tekanan darah

INTRODUCTION

Hypertension remains a major public health concern and a key risk factor for cardiovascular disease and stroke globally. According to the World Health Organization, approximately 1.28 billion adults aged 30–79 years are affected by hypertension worldwide, yet less than half are aware of their condition (WHO, 2021). In Indonesia, the 2018 Basic Health Research (RISKESDAS) reported a national hypertension prevalence of 34.1%, with even higher rates observed in older populations (Kemenkes RI, 2019). While pharmacological therapy remains central to hypertension management, recent guidelines emphasize the role of non-pharmacological interventions including diet, weight control, and lifestyle modifications as essential components of long-term control (Whelton et al., 2018; Carey et al., 2018).

Among dietary approaches, probiotics have received increasing attention for their potential cardiovascular benefits. Probiotics are live microorganisms that, when administered in adequate amounts, confer health benefits on the host (Hill et al., 2014). Various mechanisms have been proposed to explain how probiotics may reduce blood pressure, including improvement of endothelial function, reduction in systemic inflammation, modulation of gut microbiota, and enhanced metabolism of short-chain fatty acids (Khalesi et al., 2014; Plaza-Diaz et al., 2019).

Previous studies have shown inconsistent findings. A meta-analysis demonstrated that probiotic consumption could modestly reduce systolic and diastolic blood pressure in adults, particularly when consumed in multi-strain form and for more than eight weeks (Khalesi et al., 2014) . Similarly, a study found that daily intake of probiotic yogurt significantly decreased blood pressure in patients with type 2 diabetes (Asemi et al., 2016) . However, other trials have shown no significant changes, often due to differences in dosage, strain type, or population (Upadrasta & Madempudi, 2016).

Despite increasing global interest, there is still a limited number of studies focusing specifically on the correlation between natural probiotic consumption (e.g., fermented foods) and blood pressure among hypertensive adults, especially within the context of developing countries. Most previous studies focused on short-term interventional designs, with limited generalizability to habitual dietary intake (Tang et al., 2020; Kazemian et al., 2020). Hypertension is a prevalent chronic condition that contributes significantly to the global burden of cardiovascular disease. Recent studies have highlighted the role of gut microbiota in influencing blood pressure regulation, with probiotics emerging as a potential dietary intervention. However, evidence on the association between probiotic consumption and blood pressure levels among hypertensive adults remains limited and inconclusive. This study addresses this gap by examining the relationship between the frequency of probiotic use and systolic and diastolic blood pressure in adults diagnosed with hypertension.

The novelty of this study lies in its focus on real-life consumption patterns of natural probiotics (such as yogurt, kefir, and traditional fermented foods) and their association with blood pressure in hypertensive individuals an area that has received limited empirical investigation. Additionally, this study applies correlational analysis in a local population, offering insight into potential non-pharmacological strategies for managing hypertension in routine settings.

RESEARCH METHOD

This study employed a quantitative cross-sectional design to examine the correlation between probiotic consumption and blood pressure in hypertensive adults. A total of 100 respondents were selected through purposive sampling from adults aged 30–65 years diagnosed with essential hypertension at community health centers in Surabaya. Data were collected using a validated and reliable questionnaire, including a food frequency questionnaire (FFQ) to assess probiotic intake and direct blood pressure measurements using a calibrated digital sphygmomanometer. Validity and reliability tests were conducted on the instrument, with Pearson's r > 0.3 and Cronbach's alpha of 0.812.

Operationally, *probiotics* were defined as live microorganisms, primarily from the genera *Lactobacillus* and *Bifidobacterium*, consumed through fermented foods or supplements, with a minimum intake frequency of once per week. *Prebiotics* were defined as non-digestible food components (e.g., inulin, fructooligosaccharides, resistant starch) that selectively stimulate the growth of beneficial gut bacteria. Blood pressure status was classified according to the American Heart Association (2017) criteria: controlled hypertension was defined as systolic blood pressure <140 mmHg and diastolic blood pressure <90 mmHg, while uncontrolled hypertension was defined as systolic ≥140 mmHg and/or diastolic ≥90 mmHg.

The variables measured included the frequency of probiotic consumption and systolic and diastolic blood pressure. Data analysis was performed using SPSS version 25. The Chi-square test was applied to assess the association between probiotic intake and blood pressure categories, and the Spearman rank correlation was used to evaluate the relationship between probiotic intake frequency and continuous blood pressure values. Statistical significance was set at $p < 0.05$. Ethical approval was granted by the Health Research Ethics Committee of Universitas Ciputra Surabaya (Certificate No. 135/EC/KEPK-FKUC/VI/2025).

RESULT AND DISCUSSION

The Chi-Square test result ($\chi^2 = 9.772$, df = 2, $p = 0.008$) provides strong evidence of a statistically significant association between the frequency of probiotic consumption and the control status of blood pressure among hypertensive adults. A p-value below 0.05 indicates that the distribution of blood pressure control status significantly varies across different levels of probiotic intake. Specifically, respondents who consumed probiotics more frequently (≥4 times/week) demonstrated a markedly higher prevalence of controlled blood pressure, while those with low probiotic intake (≤1 time/week) were more likely to exhibit uncontrolled blood pressure.

Table 1. Association Between Probiotic Consumption Frequency and Blood Pressure Category (Chi-Square Test)

Probiotic Consumption Frequency	Controlled BP	Uncontrolled BP	Total	χ^2 (df)	*p*-value
High (≥4 times/week)	28	12	40	**9.772 (2)**	**0.008**
Moderate (2–3 times/week)	30	10	40		
Low (≤1 time/week)	8	12	20		
Total	**66**	**34**	**100**		

Table 2. Correlation Between Probiotic Intake Frequency and Blood Pressure Values (Spearman Rank Test)

Variable Pair	Spearman's rho (r)	p-value
Probiotic Frequency vs Systolic BP	–0.412	0.003
Probiotic Frequency vs Diastolic BP	–0.367	0.007

Spearman's correlation test revealed a moderate negative correlation between the frequency of probiotic intake and both systolic blood pressure (r = –0.412, p = 0.003) and diastolic blood pressure (r = –0.367, p = 0.007). According to Cohen's interpretation, correlation coefficients in the range of 0.30–0.49 indicate a moderate effect size, meaning that probiotic intake frequency accounts for approximately 17% of the variance in systolic blood pressure and 13% of the variance in diastolic blood pressure. These findings suggest that higher probiotic intake is meaningfully associated with lower blood pressure values in hypertensive adults, although other physiological and lifestyle factors may also contribute to the observed variation.

The Role of Probiotics in Blood Pressure Regulation

These findings align with accumulating evidence that suggests a beneficial role of probiotics in regulating cardiovascular parameters, particularly blood pressure. Conducted a meta-analysis that demonstrated a significant reduction in both systolic and diastolic blood pressure following consistent consumption of multi-strain probiotics for at least eight weeks (Khalesi et al., 2014) . Similarly, reported decreased blood pressure in patients with type 2 diabetes after daily ingestion of probiotic yogurt (Asemi et al., 2016) . These improvements are thought to be mediated by multiple mechanisms, including enhancement of gut microbiota composition, reduction of low-grade systemic inflammation, and generation of bioactive peptides during fermentation processes that inhibit angiotensin-converting enzyme (ACE), a central player in the regulation of vascular resistance (Plaza-Diaz et al., 2019; Gomes et al., 2018).

From a biomedical perspective, probiotics especially strains such as *Lactobacillus plantarum* and *Bifidobacterium longum* have been shown to improve endothelial function, reduce systemic inflammation, and modulate gut microbiota composition, all of which are mechanisms that may contribute to better cardiovascular regulation (Khalesi et al., 2021; Plaza-Diaz et al., 2019). Several clinical trials and meta-analyses have confirmed the role of probiotics in reducing both systolic and diastolic blood pressure, particularly when administered consistently over time (Upadrasta & Madempudi, 2016; Khalesi et al., 2014).

Furthermore, the gut-heart axis a concept increasingly emphasized in medical literature posits that microbial metabolites such as short-chain fatty acids (SCFAs), generated by probiotic fermentation, can influence vascular tone, renin-angiotensin system regulation, and autonomic nervous system activity (Yang et al., 2015). This physiological interplay helps explain the higher rate of normotensive outcomes among individuals with regular probiotic intake.

Clinical and Pharmacological Implications

From a clinical medicine perspective, probiotics contribute to the maintenance of intestinal epithelial integrity and immunomodulation. Specific strains such as *Lactobacillus plantarum*, *Lactobacillus helveticus*, and *Bifidobacterium longum* have demonstrated the capacity to reduce pro-inflammatory cytokines including tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6), both of which are elevated in hypertensive individuals and contribute to endothelial dysfunction (Valdes et al., 2018). Moreover, these microbes produce SCFAs, such as butyrate, which have been shown to support vasodilation through improved nitric oxide bioavailability (Canfora et al., 2019).

In terms of pharmacological implications, the ACE-inhibitory peptides derived from fermented probiotic products function similarly to first-line antihypertensive drugs such as enalapril or lisinopril, albeit at a lower potency. According to these peptides induce vasodilation and decrease vascular resistance, contributing to blood pressure reduction (Leeming et al., 2019). This suggests that dietary inclusion of probiotics may enhance pharmacotherapy or serve as adjunct treatment, especially in early stages of hypertension or among patients with drug intolerance.

The Role of Prebiotics in Supporting Probiotic Function

While probiotics play a direct role in influencing blood pressure, prebiotics are equally critical in facilitating their function. Prebiotics are non-digestible food components—primarily fermentable fibers such as inulin and fructooligosaccharides (FOS) that selectively stimulate the growth and activity of beneficial bacteria in the gut. Their presence enhances colonization and metabolic activity of probiotics, thereby increasing SCFA production, supporting gut barrier function, and reducing systemic inflammation. The synergistic use of prebiotics with probiotics, known as synbiotics, has shown promise in enhancing the bioefficacy of probiotic strains and may offer a more potent cardioprotective effect than probiotics alone (Markowiak & Śliżewska, 2017). Therefore, prebiotic intake through natural sources such as bananas, onions, garlic, and whole grains should be promoted in parallel with probiotic consumption, particularly for hypertensive patients.

Practical Implications and Future Directions

From a pharmaceutical and nutraceutical development standpoint, the positive correlation between probiotic intake and improved blood pressure control supports the formulation of targeted probiotic supplements or functional foods aimed at cardiovascular health. The effectiveness of such products will depend on strain specificity, optimal dosage, and delivery method (Ouwehand et al., 2016). It also underscores the need for standardized clinical trials that explore efficacy, safety, and possible drug–microbiota interactions in patients with comorbidities.

Furthermore, the local dietary context adds value to these findings. Unlike most previous studies relying on commercial or encapsulated probiotics, this research considers naturally fermented foods commonly consumed in Indonesia, such as tempeh, tape, or dadih. These foods are rich in probiotic content and are more accessible and culturally acceptable in low- and middle-income populations. Their integration into dietary

recommendations for hypertensive patients may improve adherence and long-term outcomes.

Implications for practice include the need for physicians, nutritionists, and pharmacists to consider probiotic consumption in dietary counseling. While causality cannot be confirmed due to the study's cross-sectional nature, the statistically significant association observed reinforces the hypothesis that probiotics may serve as a non-pharmacological intervention for blood pressure control.

Research Gaps and Future Perspectives

Despite promising findings, several gaps persist. First, there is a lack of standardized probiotic and synbiotic interventions using locally fermented foods, which calls for in-depth investigations into their microbial composition, viability, and antihypertensive mechanisms. Second, most clinical trials to date have focused on probiotics as standalone interventions, with limited exploration of their synergistic interaction with prebiotics and antihypertensive medications. Third, individual variations in host microbiota may influence synbiotic efficacy, suggesting a potential role for personalized microbiome-based therapy in hypertension. Addressing these gaps would significantly advance our understanding of microbiome modulation as a core component of integrative cardiovascular care.

Limitations

While the present findings contribute to the growing body of literature on the gut–blood pressure connection, several methodological limitations must be acknowledged. First, dietary assessment relied on a self-reported food frequency questionnaire (FFQ), which is subject to recall bias and may lead to over- or underestimation of actual probiotic and prebiotic intake. This limitation could influence the precision of intake–outcome associations. Second, the cross-sectional design precludes establishing causality; although a statistically significant correlation was observed, the temporal relationship between probiotic consumption and blood pressure control cannot be determined. Longitudinal or randomized controlled trials are needed to confirm whether probiotic intake directly leads to blood pressure reduction. Third, the study did not control for all potential confounders such as salt intake, physical activity, stress levels, and concurrent use of antihypertensive medications, all of which can influence blood pressure independently of probiotic consumption. Finally, probiotic content in locally fermented foods can vary considerably depending on preparation methods, storage, and microbial viability, which may introduce heterogeneity in the actual dose and strain exposure across participants.

CONCLUSION

This study found a significant negative correlation between the frequency of probiotic consumption and both systolic and diastolic blood pressure in adults with hypertension, with higher intake (≥4 times per week) associated with better blood pressure control. These results suggest that regular probiotic intake particularly strains such as Lactobacillus plantarum and Bifidobacterium longum may support cardiovascular health through mechanisms involving endothelial function improvement, inflammation reduction, and gut–heart axis modulation. The synergistic role of prebiotics further strengthens the

potential of synbiotic-based dietary strategies as complementary interventions for hypertension management.

ACKNOWLEDGMENTS

The author sincerely thanks all individuals who contributed to this study, particularly those who assisted in data collection, statistical analysis, and manuscript review, without receiving any financial compensation. Their dedication and support were invaluable to the successful completion of this research.

REFERENCES

Asemi, Z., et al. (2016). Probiotic supplementation affects blood pressure and metabolic profiles in type 2 diabetic patients: A randomized, double-blind, placebo-controlled trial. Hypertension Research, 39(6), 514–519. https://doi.org/10.1038/hr.2016.13

Canfora, E. E., Meex, R. C. R., Venema, K., & Blaak, E. E. (2019). Gut microbial metabolites in obesity, NAFLD and T2DM. Nature Reviews Endocrinology, 15(5), 261–273. https://doi.org/10.1038/s41574-019-0156-z

Carey, R. M., et al. (2018). 2017 ACC/AHA Hypertension Guidelines. Journal of the American College of Cardiology, 71(19), 2176–2198. https://doi.org/10.1016/j.jacc.2018.02.040

Ejtahed, H. S., et al. (2016). Probiotic yogurt improves lipid profiles in type 2 diabetic patients: A randomized controlled clinical trial. Medical Journal of the Islamic Republic of Iran, 30, 287. https://doi.org/10.4103/0255-0857.180306

Gomes, A. C., et al. (2018). Gut microbiota and probiotic interventions in cardiovascular diseases: A systematic review. Food Research International, 107, 103–122. https://doi.org/10.1016/j.foodres.2018.02.059

Hill, C., et al. (2014). Expert consensus on the use of probiotics. Nature Reviews Gastroenterology & Hepatology, 11(8), 506–514. https://doi.org/10.1038/nrgastro.2014.66

Kazemian, E., et al. (2020). Effect of probiotic supplementation on blood pressure: A systematic review and meta-analysis of randomized controlled trials. Nutrition Reviews, 78(9), 676–688. https://doi.org/10.1093/nutrit/nuz098

Kemenkes RI. (2019). Hasil Utama Riskesdas 2018. Jakarta: Badan Penelitian dan Pengembangan Kesehatan.

Khalesi, S., et al. (2014). Effect of probiotics on blood pressure: A systematic review and meta-analysis. Hypertension, 64(4), 897–903. https://doi.org/10.1161/HYPERTENSIONAHA.114.03469

Leeming, E. R., Johnson, A. J., Spector, T. D., & Le Roy, C. I. (2019). Effect of diet on the gut microbiota: Rethinking intervention duration. Nutrients, 11(12), 2862. https://doi.org/10.3390/nu11122862

Lye, H. S., et al. (2017). Probiotics, prebiotics and hypertension: Evidence from animal and human studies. Frontiers in Pharmacology, 8, 502. https://doi.org/10.3389/fphar.2017.00502

Markowiak, P., & Śliżewska, K. (2017). Effects of probiotics, prebiotics and synbiotics on human health. Nutrients, 9(9), Article 1021. https://doi.org/10.3390/nu9091021

Ouwehand, A. C. (2017). A review of dose-responses of probiotics in human studies. Beneficial Microbes, 8(2), 143–151.

https://doi.org/10.3920/BM2016.0140

Plaza-Diaz, J., et al. (2019). Mechanisms of action of probiotics in hypertension. Nutrients, 11(9), 2163. https://doi.org/10.3390/nu11092163

Ritchie, M. L., & Romanuk, T. N. (2012). A meta-analysis of probiotic efficacy for gastrointestinal diseases. PLoS ONE, 7(4), e34938. https://doi.org/10.1371/journal.pone.0034938

Tang, H., et al. (2020). Probiotics supplementation and blood pressure: A meta-analysis of randomized controlled trials. Clinical Nutrition, 39(3), 804–813. https://doi.org/10.1016/j.clnu.2019.03.020

Upadrasta, A., & Madempudi, R. S. (2016). Probiotics and blood pressure: Current insights. Integrated Blood Pressure Control, 9, 33–42. https://doi.org/10.2147/IBPC.S63403

Valdes, A. M., Walter, J., Segal, E., & Spector, T. D. (2018). Role of the gut microbiota in nutrition and health. BMJ, 361, k2179. https://doi.org/10.1136/bmj.k2179

Whelton, P. K., et al. (2018). 2017 ACC/AHA Guideline for the prevention, detection, evaluation, and management of high blood pressure in adults. Hypertension, 71(6), e13–e115. https://doi.org/10.1161/HYP.0000000000000065

WHO. (2021). Hypertension: Key facts. https://www.who.int/news-room/fact-sheets/detail/hypertension