Bay leaf decoction water and low-impact aerobic exercise impact on blood cholesterol levels

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Abstract

Hypercholesterolemia is a global health concern, including in Indonesia, potentially leading to coronary artery disease, heart failure, and stroke if left untreated. This study aimed to assess the effectiveness of bay leaf decoction and low-impact aerobic exercise on reducing blood cholesterol levels in patients. Used a quasi-experimental design with 120 participants, randomly assigned to two groups, the first group consumed bay leaf decoction (100 ml, twice daily for 7 days), while the second group underwent low-impact aerobic exercise (3 times a week for 7 days). Blood cholesterol levels were measured, and paired t-tests were employed for statistical analysis. Results revealed that both interventions significantly lowered cholesterol levels after 7 days ($p<0.001$ for bay leaf decoction and $p=0.001$ for low-impact aerobics). The bay leaf decoction group achieved the highest reduction at 25.3 mg/dl. In conclusion, this study highlights the potential of bay leaf decoction and low-impact aerobic exercise as non-pharmacological approaches to manage blood cholesterol levels. It reinforces the notion that these interventions can be valuable in addressing hypercholesterolemia.

Introduction

Cholesterol is a fatty substance that circulates in the blood, produced by the liver, and essential for the body's functioning. Approximately 80% of the cholesterol in the blood is produced by the body itself, while the remaining 20% comes from dietary sources.[1] However, excessive consumption of cholesterol-rich foods can lead to elevated blood cholesterol levels, a condition known as hypercholesterolemia.[2] Various factors contribute to hypercholesterolemia, including dietary choices, physical inactivity, obesity, and age.[3,4] This condition can lead to serious cardiovascular complications such as coronary heart disease, heart attacks, heart failure, deep vein thrombosis, stroke, and even death.[5–7]

Global data from the World Heart Report indicates that over 160 million people worldwide have hypercholesterolemia, with total cholesterol levels exceeding 200 mg/dl, which is considered high. Furthermore, more than 34 million American adults have total cholesterol levels exceeding 240 mg/dl, which requires therapeutic intervention.[8,9] In Indonesia, national data from the Basic Health Research shows a prevalence of high cholesterol among individuals aged 15 and above to be 15.8%, with 5.4% in men and 9.9% in women. Elevated cholesterol levels increase the risk of coronary heart disease, stroke, and compromised blood circulation.[10–12] While hypercholesterolemia is not listed among the top 10 major diseases in Samarinda according to the Samarinda City Health Office's 2022 data, the Sempaja Samarinda Health Center has reported the highest number of hypercholesterolemia cases in the Health Office records.[13]

Cardiovascular diseases, as described by Hidayat *et al.* (2021),[14] often result from disruptions in lipid metabolism caused by hyperlipidemia or elevated lipid fractions in the bloodstream. The primary lipid fraction disorder is elevated triglycerides, while high levels of Low-Density Lipoprotein (LDL) and cholesterol are major contributors to atherosclerosis.[12,15,16] Control of hyperlipidemia can be achieved through various means, including non-pharmacological methods such as physical activity and dietary changes, as well as pharmacological interventions.[17,18] When lifestyle modifications alone cannot adequately control hypercholesterolemia, pharmacotherapy with chemically synthesized drugs such as niacin and fibrates becomes an alternative. However, these drugs often have side effects like liver toxicity, nausea, abdominal pain, and indigestion.[19,20,21]

Non-pharmacological approaches, such as natural ingredients and physical activities like yoga and aerobic exercises, offer alternative means to manage hypercholesterolemia.[22,23–26] Utilizing readily available natural ingredients and engaging in physical activities can help reduce hyperlipidemia and hypercholesterolemia, as demonstrated by the effects of basil extract and bay leaves.[14,27] Bay leaves, or Syzygium polyanthum, commonly used as a food flavoring spice in Indonesian kitchens, have demonstrated potential in reducing cholesterol levels.[28] The use of herbal remedies and natural ingredients has gained popularity worldwide as a means to manage cholesterol levels. This growing interest in herbal medicine aligns with the abundant potential of medicinal plants in Indonesia. Previous studies have explored bay leaves, often in the form of tea, for their cholesterol-reducing properties.[29]

Research conducted by Batool (2020)[30] highlighted the phytochemical content of bay leaves, including flavonoids, tannins, eugenol, citric acid, carbohydrates, steroids, alkaloids, triterpenoids, and essential oils. These compounds can function as antioxidants, alleviate stomach discomfort, clear lung mucus, and exhibit antidiabetic properties.[30,31] While studies on the reduction of total cholesterol levels remain limited, the phytochemical content of bay leaves suggests potential cholesterol-lowering effects.

In this study, researchers explored a different preparation method – bay leaf decoction – as a cost-effective alternative. Additionally, physical activity, particularly low-impact aerobic exercise, was chosen as an intervention to impact blood cholesterol levels positively. Engaging in aerobic exercise for 50 minutes, three times a week, has been shown to help control blood pressure and lipid levels.[32,33] Aerobic exercise induces muscle contractions, requiring energy in the form of Adenosine Triphosphate (ATP). The metabolism of ATP in mitochondria converts consumed food into energy rather than cholesterol, thereby reducing overall cholesterol levels.[34–36] Through this study, researchers aimed to investigate the effects of bay leaf decoction and low-impact aerobic exercise on blood cholesterol levels.

Materials and Methods

Research design

This study employed a quantitative quasi-experimental design with a pre-test and post-test group design. The research was conducted from March 14 to June 6, 2023.

Population and sample

The study's population comprised patients with hypercholesterolemia residing within the service area of Sempaja Health Center, Samarinda City, Indonesia. The sample consisted of 120 individuals, selected using simple random sampling, and evenly allocated into two groups. Inclusion criteria encompassed hypercholesterolemia patients aged 20-50 years, having blood cholesterol levels greater than or equal to 200 mg/dl, the ability to engage in physical activity without assistance, and a willingness to participate as respondents. Exclusion criteria included patients with comorbid conditions like stroke and respondents unable to attend or complete the intervention.

Data collection methods

The first group comprised 60 individuals who received an intervention involving the consumption of bay leaf decoction. For this decoction, 10 large dried bay leaves were washed under running water. After washing, the bay leaves were placed in a pot and boiled with 300 ml of water. The mixture was allowed to simmer until it reduced to 150 ml, becoming cloudy and yellow in color. Subsequently, the boiled water was strained and measured using a measuring cup, ensuring it amounted to 150 ml before packaging. The resulting decoction was consumed daily, 75 ml in the morning (06:00-07:00) and 75 ml in the afternoon (16:00-17:00), over the course of 1 week.

The second group comprised 60 individuals who underwent a low-impact aerobic exercise intervention. This exercise involved light-intensity movements that combined hand, shoulder, and foot movements, such as walking in place and forward-and-backward walking with clapping. The low-impact aerobic exercise routine consisted of warm-up exercises (5 movements), core exercises (11 movements), and cool-down exercises (2 movements). The exercise sessions lasted for 45 minutes, divided into a 10-minute warm-up, a 20-minute core exercise, and a 15-minute cool-down. These exercises were performed three times in the morning at 07:00 over the course of 1 week.

Blood cholesterol levels were measured using blood drawn from the fingertips. Measurements were conducted using the GCU Meter Device (Glucose, Cholesterol, Uric Acid), lancet needles, cholesterol test strips, alcohol swabs, hand scoons, and an observation sheet to record the results of blood cholesterol levels. In this study, blood cholesterol levels were measured before the intervention (bay leaf decoction and low-impact aerobic exercise) and again after 7 days of intervention (post-test).

Data analysis

Data analysis was performed using the dependent t-test with data processing software. The normality of variables was assessed through a normality test. For pre-test and post-test blood cholesterol levels of bay leaf decoction and low-impact aerobic exercise, paired *t*-tests were employed, with a significance level set at $\alpha=0.05$.

Results

A total of 120 participants with hypercholesterolemia were included in the study and divided into two groups, as shown in Table 1. The table presents the characteristics of respondents based on age, gender, occupation, education, and duration of hypercholesterolemia at Sempaja Samarinda Health Center in 2023.

Table 1 illustrates the characteristics of the respondents based on age, gender, occupation, education, and duration of hypercholesterolemia. The majority of respondents in both intervention groups were aged 41-50 years, with 63.3% in the bay leaf decoction water group and 50% in the low-impact aerobic exercise group. Female respondents predominated in both groups, with 83.3% in the bay leaf decoction water group and 73.3% in the low-

impact aerobic exercise group. Furthermore, respondents who were not working constituted a significant portion in both groups, with 60% in the bay leaf decoction water group and 43.3% in the low-impact aerobic exercise group. Regarding education, the high school level was predominant in both groups, accounting for 43.3% in the bay leaf decoction water group and 40% in the low-impact aerobic exercise group. In terms of the duration of suffering from hypercholesterolemia, those with less than 1 year of duration comprised the majority in both groups, with 50% in the bay leaf decoction water group and 23.3% in the low-impact aerobic exercise group.

Table 2 shows that, in the bay leaf decoction group, mean pre-test cholesterol was 269.3 mg/dl (SD 37.3), decreasing to 255.8 mg/dl (SD 37.03) post-test. In the Low Impact Aerobic group, mean pre-test cholesterol was 269.3 mg/dl (SD 35.51), decreasing to 244 mg/dl (SD 35.4) post-test.

Table 3 illustrates the impact of bay leaf decoction water and low-impact aerobics. Significant differences in cholesterol levels were observed for both groups ($p<0.001$ for bay leaf and $p=0.001$ for aerobics), with the highest reduction in the bay leaf group at 25.3 mg/dl.

Discussion

This study revealed a significant impact of bay leaf decoction water and low-impact exercise on blood cholesterol levels. These findings indicate a substantial reduction in cholesterol levels in both intervention groups. This study aligns with research conducted by Emilia (2023),[37] which also demonstrated a significant decrease in cholesterol levels before and after the administration of

Table 1. Characteristics of respondents with hypercholesterolemia.

Characteristics	Bay leaf intervention group		Low impact aerobic exercise intervention group	
	n	%	n	%
Age				
20-30 years	6	10.0	20	33.3
31-40 years old	16	26.7	10	16.7
41-50 years old	38	63.3	30	50.0
Gender				
Male	10	16.7	16	26.7
Female	50	83.3	44	73.3
Jobs				
Work	24	40.0	34	56.7
Not working	36	60.0	26	43.3
Education				
Primary school	20	33.3	6	10.0
Junior high	8	13.3	6	10.0
High school	26	43.4	24	40.0
Higher education	6	10.0	24	40.0
Duration of hypercholesterolemia				
<1 year				
1-3 years	30	50.0	14	23.3
4-7 years	18	30.0	18	30.0
>7 years	10	16.7	22	36.7
2	3.3	6	10.0	
Total	60	100.0	60	100.0

Table 2. Blood cholesterol levels before and after bay leaf and aerobic interventions.

Blood cholesterol levels	Mean	± SD
Bay leaf decoction water		
Pre test	269.3	37.30
Post test	255.8	37.03
Low impact aerobic exercise		
Pre test	269.3	35.51
Post test	244	35.40

Table 3. Paired *t*-test results for blood cholesterol levels in bay leaf and aerobic exercise groups (pre-test and post-test)

	Pre Mean ± SD	Post Mean ± SD	Difference	Paired *t*-test p
Bay leaf decoction water	269.3±37.30	255.8±37.03	25.30	0.000
Low impact aerobics exercise	269.3±35.51	244±35.40	12.00	0.001

bay leaf cooking water ($p=0.000<\alpha=0.05$). The observed reduction in cholesterol levels can be attributed to the active compounds present in bay leaf cooking water, including flavonoids, saponins, tannins, vitamin C, and fiber. These compounds have the potential to lower cholesterol content in the bloodstream.[31,38] Flavonoids act as antioxidants, preventing lipid peroxidation, while tannins contribute to improved lipid profiles. According to Laka (2022),[39] saponins found in bay leaves function as hypocholesterolemics by binding cholesterol with bile acids, effectively reducing cholesterol levels. Flavonoids and tannins inhibit pancreatic cholesterol esterase, bind to bile acids, and reduce cholesterol solubility in cell membranes, inhibiting cholesterol absorption and ultimately leading to reduced blood cholesterol levels. Additionally, other studies, such as the one conducted by Mubarak *et al.*,[40] have shown that light and moderate-intensity aerobic exercises have a significant impact on total cholesterol levels ($p=0.01 <\alpha=0.05$). This effect is attributed to the utilization of fat oxidation as a source of energy when glycogen stores in muscles are depleted.

Furthermore, the reduction in cholesterol levels observed in the low-impact aerobic exercise group can be explained by the nature of aerobic exercise, which combines specific rhythmic movements. This type of exercise requires energy derived from ATP stored in muscles, which is converted into energy during physical activity. Aerobic exercise contributes to the reduction of fat deposits in various parts of the body.[41,42] According to Hwang C, aerobic exercise is an effective method for weight loss and significantly reduces body fat percentage and body weight.[43] Low-impact aerobic exercise specifically converts fatty acids into energy, minimizing the potential for excessive sterol core synthesis and, consequently, preventing excessive cholesterol formation.[44] Continuous-intensity exercise actively affects fat degradation, mainly due to the release of epinephrine and norepinephrine from the adrenal medulla during physical activity, as well as increased lipoprotein lipase enzyme activity. Lipoprotein lipase helps transport LDL cholesterol from the bloodstream to the liver, where it is either converted into bile or secreted, resulting in decreased LDL levels.[45] This study has several limitations. Firstly, it employs a quasi-experimental design, which may have inherent biases and limitations compared to randomized controlled trials. Secondly, the variables measured are limited to total blood cholesterol levels, and the study does not include the assessment of High-Density Lipoprotein (HDL) and LDL levels, which could provide a more comprehensive understanding of lipid profiles.

Conclusions

The intervention involving bay leaf boiled water and low-impact aerobic exercise offers a cost-effective non-pharmacological therapy option for individuals with hypercholesterolemia, promoting a healthier lifestyle. Both interventions have demonstrated their effectiveness in reducing blood cholesterol levels, albeit through different mechanisms. The presence of active compounds in bay leaf cooking water, including saponins, catechins (flavonoids), tannins, vitamin C, and fiber, plays a crucial role in lowering cholesterol levels. It is our hope that individuals will incorporate the regular consumption of bay leaf decoction and engage in consistent physical activity to maintain controlled cholesterol levels. For future research endeavors, the adoption of a Randomized Controlled Trials (RCTs) design could be considered, and additional variables such as HDL and LDL levels should be included for a more comprehensive evaluation of lipid profiles.

References

1. Simonen P, Öörni K, Sinisalo J, et al. High cholesterol absorption: A risk factor of atherosclerotic cardiovascular diseases? Atherosclerosis 2023;376:53-62.
2. Doi T, Langsted A, Nordestgaard BG. Dual elevated remnant cholesterol and C-reactive protein in myocardial infarction, atherosclerotic cardiovascular disease, and mortality. Atherosclerosis 2023;379.
3. Nindya TS, Mahmudiono T, Rachmah Q. The estimation of cholesterol intake in elderly: Reliability and validity of short, semi-quantitative food frequency questionnaire (SQ-FFQ). J Nutrition Health 2021;54:95-103.
4. Kalanjati VP, Oktariza RT, Suwito BE, et al. Cardiovascular disease risk factors and anthropometry features among seemingly healthy young adults. Int J Publ Health Sci 2021;10:77-82.
5. Hidayat A, Suwondo A, Pujiastuti RrSE, Setiadi R, Mulyani RI. Effect of Sweet Basil Extract (Ocimum Basilicum l) on Lipid Profile of Hyperlipidaemia Mice (Mus Musculus). Int Me J 2021;28:69-72.
6. Jazayeri MA, Emert MP. Sudden Cardiac Death: Who Is at Risk? Med Clinics North Am 2019;103:913-30.
7. Doi T, Langsted A, Nordestgaard BG. Dual elevated remnant cholesterol and C-reactive protein in myocardial infarction, atherosclerotic cardiovascular disease, and mortality. Atherosclerosis 2023;379.
8. Cesare M Di, Bixby H, Gaziano T, Hadeed L, Kabudula C, McGhie DV, et al. World Heart Report 2023: Confronting the World's Number One Killer. Geneva, Switzerland; 2023.
9. Roth GA, Mensah GA, Johnson CO, Addolorato G, Ammirati E, Baddour LM, et al. Global Burden of Cardiovascular Diseases and Risk Factors, 1990-2019: Update From the GBD 2019 Study. J Am Coll Cardiol 2020;76:2982-3021.
10. Kementerian Kesehatan RI. Laporan Riskesdas 2018 [basic health research report 2018]. Laporan Nasional Riskesdas, 2018.
11. Padoli P, Suwito J, Hariyanto T. Self Affirmation Reduces the Anxiety, LDH and Troponin I in the Clients with Coronary Heart Disease (CHD). Jurnal Ners 2019;14:310-5.
12. Bosch J, Lonn EM, Jung H, et al. Lowering cholesterol, blood pressure, or both to prevent cardiovascular events: Results of 8.7 years of follow-up of Heart Outcomes Evaluation Prevention (HOPE)-3 study participants. Eur Heart J 2021;42:2995-3007.
13. Kalimantan Timur DK. Penyakit Tidak Menular atau Degeneratif Provinsi Kaltim Tahun 2019-2022. 2022.
14. Hidayat A, Suwondo A, Pujiastuti RrSE, Setiadi R, Mulyani RI. Effect of Sweet Basil Extract (Ocimum Basilicum l) on Lipid Profile of Hyperlipidaemia Mice (Mus Musculus). Int Med J 2021;28(1):69-72.
15. Simonen P, Öörni K, Sinisalo J, et al. High cholesterol absorption: A risk factor of atherosclerotic cardiovascular diseases? Atherosclerosis 2023;376:53-62.
16. Mohamed-Yassin MS, Baharudin N, Daher AM, et al. High prevalence of dyslipidaemia subtypes and their associated personal and clinical attributes in Malaysian adults: the REDISCOVER study. BMC Cardiovasc Disord 2021;21.
17. Adi AC, Tawakal AI, Rasyidi MF, et al. Effect of cocoa husk Criollo tea on hypercholesterolemia in animal model. Foods Raw Mat 2023;11:206-14.
18. WHO. World health statistics 2023: monitoring health for the

SDGs, sustainable development goals. 2023.
19. Andrianto, Puspitasari M, Ardiana M, et al. Association between single nucleotide polymorphism SLCO1B1 gene and simvastatin pleiotropic effects measured through flow-mediated dilation endothelial function parameters. Ther Adv Cardiovasc Dis 2022;16.
20. Widada W, Ontoseno T, Purwanto B, et al. The effect of the blood cupping therapy on high density lipoprotein (HDL) and low density lipoprotein (LDL) in hypercholesterol patients. Indian J Forensic Med Toxicol 2020;14:3556-62.
21. Pirillo A, Catapano AL. Pitavastatin and HDL: Effects on plasma levels and function(s). Atheroscler Suppl 2017;27:e1-9.
22. Asiah ASS, Norhayati MN, Muhammad J, Muhamad R. Effect of yoga on anthropometry, quality of life, and lipid profile in patients with obesity and central obesity: A systematic review and meta-analysis. Complement Ther Med 2023;76:102959.
23. Antunes BM, Rossi FE, Oyama LM, et al. Exercise intensity and physical fitness modulate lipoproteins profile during acute aerobic exercise session. Sci Rep 2020;10:4160.
24. Antunes BM, Rosa-Neto JC, Batatinha HAP, et al. Physical fitness status modulates the inflammatory proteins in peripheral blood and circulating monocytes: role of PPAR-gamma. Sci Rep 2020;10:14094.
25. Pan B, Ge L, Xun Y qin, et al. Exercise training modalities in patients with type 2 diabetes mellitus: a systematic review and network meta-analysis. Int J Behavioral Nutrition Physical Activity 2018;15:72.
26. Kuete V. Other Health Benefits of African Medicinal Spices and Vegetables. In: Kuete VBTMS and V from A, editor. Medicinal Spices and Vegetables from Africa: Therapeutic Potential Against Metabolic, Inflammatory, Infectious and Systemic Diseases. Academic Press; 2017. p. 329-49.
27. Batool S, Khera RA, Hanif MA, Ayub MA. Bay Leaf. In: Hanif MA, Nawaz H, Khan MM, Byrne HJBTMP of SA, editors. Medicinal Plants of South Asia: Novel sources for drug discovery. Elsevier; 2020. p. 63-74.
28. Aditya R, Santoso B, Widjiati W. Anti-inflammatory and antioxidant potential of Syzygium polyanthum (Wight) Walp. bioactive compounds in polycystic ovary syndrome: An in silico study. J Pharm Pharmacogn Res 2022;10:725-36.
29. Susyani, Zurio A, Terato. The Bay Leaves Tea Can Decrease Cholesterol Levels Of Patients With Cardiovascular Disease. World J Adv Healthc Res 2020;4:173-7.
30. Batool S, Khera RA, Hanif MA, Ayub MA. Bay Leaf. In: Medicinal Plants of South Asia: Novel Sources for Drug Discovery. Elsevier; 2019. p. 63-74.
31. Batool S, Khera RA, Hanif MA, Ayub MA. Bay Leaf. In: Hanif MA, Nawaz H, Khan MM, Byrne HJBTMP of SA, editors. Medicinal Plants of South Asia: Novel sources for drug discovery. Elsevier; 2020. p. 63-74.
32. Liu X, He M, Gan X, et al. The effects of six weeks of fasted aerobic exercise on body shape and blood biochemical index in overweight and obese young adult males. J Exerc Sci Fit 2023;21:95-103.
33. Karami H, Dehnou VV, Nazari A, Gahreman D. Regular training has a greater effect on aerobic capacity, fasting blood glucose and blood lipids in obese adolescent males compared to irregular training. J Exerc Sci Fit 2021;19:98-103.
34. Babaei Bonab S, Parvaneh M. Effect of 12-week of aerobic exercise on hormones and lipid profile status in adolescent girls with polycystic ovary syndrome: A study during COVID-19. Sci Sports 2023;38:565-73.
35. Costa RR, Buttelli ACK, Fagundes A de O, Fonseca GA, Pilla C, Barreto MF, et al. The beneficial effects of a water-based aerobic exercise session on the blood lipids of women with dyslipidemia are independent of their training status. Clinics (Sao Paulo) 2020;75:e1183.
36. Ghamarchehreh ME, Shamsoddini A, Alavian SM. Investigating the impact of eight weeks of aerobic and resistance training on blood lipid profile in elderly with non-alcoholic fatty liver disease: a randomized clinical trial. Gastroenterol Hepatol Bed Bench 2019;12:190-6.
37. Emilia E. Efektivitas Pemberian Rebusan Daun Salam Terhadap Kolesterol Total Dengan Hiperkolesterolemia Di Wilayah Kerja Puskesmas Desa Gedang Kota Sungai Penuh Provinsi Jambi Tahun 2022. Jurnal Multidisiplin Dehasen (MUDE). 2023 May;2(2 SE-Ilmu Kesehatan).
38. Hartanti L, Yonas SMK, Mustamu JJ, et al. Influence of extraction methods of bay leaves (Syzygium polyanthum) on antioxidant and HMG-CoA Reductase inhibitory activity. Heliyon 2019;5:e01485.
39. Laka K, Makgoo L, Mbita Z. Cholesterol-Lowering Phytochemicals: Targeting the Mevalonate Pathway for Anticancer Interventions. Front Genet 2022;13:841639.
40. Mubarak S, Kinanti RG, Raharjo S. Pengaruh Senam Aerobik Intensitas Ringan Dan Sedang Terhadap Kadar Kolesterol Total Pada Perempuan Obes Di Kota Batu [The Effects of Light and Moderate Intensity Aerobic Exercise on Total Cholesterol Levels in Obese Women in the City of Batu]. J Sport Sci 2019;9(1).
41. Yol Y, Turgay F, Yigittürk O, et al. The effects of regular aerobic exercise training on blood nitric oxide levels and oxidized LDL and the role of eNOS intron 4a/b polymorphism. Biochimica et Biophysica Acta (BBA) - Molecular Basis of Disease 2020;1866:165913.
42. Antunes BM, Rossi FE, Oyama LM, et al. Exercise intensity and physical fitness modulate lipoproteins profile during acute aerobic exercise session. Sci Rep 2020;10:4160.
43. Hwang CL, Lim J, Yoo JK, et al. Effect of all-extremity high-intensity interval training vs. moderate-intensity continuous training on aerobic fitness in middle-aged and older adults with type 2 diabetes: A randomized controlled trial. Exp Gerontol 2019;116:46-53.
44. Fraccari-Pires N, Coelho-Júnior HJ, Gambassi BB, et al. Cardiovascular Autonomic Responses to Aerobic, Resistance and Combined Exercises in Resistance Hypertensive Patients. de Athayde Costa e Silva A, editor. Biomed Res Int 2022;2022:8202610.
45. Chiu YH, Tsai SC, Lin CS, et al. Effects of a 12-week walking intervention on circulating lipid profiles and adipokines in normal weight and abdominal obese female college students. J Exerc Sci Fit 2023;21:253-9.