Lifestyle change reduces augmentation index and central systolic pressure in prehypertensive individuals

Mudança no estilo de vida reduz o índice de aumento e a pressão sistólica central em indivíduos pré-hipertensos

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ABSTRACT
The current study aimed to analyze the influence of a lifestyle change (LC) on arterial stiffness and the behavior of central systolic pressure (CSP) in prehypertensive individuals. For group analysis, the sample was separated according to CSP ≥ 118 mmHg and < 118 mmHg. Fifty-nine patients with prehypertension were studied before and after a three-month LC that included the Dash diet and aerobic exercise. The LC resulted in a significant reduction in AI-x in the group with CSP ≥ 118 mmHg (pre: 91.42 ± 9.12 vs. post: 82.36 ± 13.6 %), compared to CSP < 118 mmHg (pre: 78.82 ± 14.51 vs. post: 79.04 ± 13.1 %), and in CSP in the group with CSP ≥ 118 mmHg (pre: 124.51 ± 4.54 vs. post: 107.12 ± 12 mmHg), compared to CSP < 118 mmHg (pre: 107.78 ± 7.86 vs. post: 106.89 ± 11.1 mmHg). The lifestyle change promoted a significant reduction in CSP, through reduced arterial stiffness, suggesting vascular improvement in individuals with prehypertension.

Keywords: exercise, arterial, blood pressure.
1 INTRODUCTION

Prehypertension is characterized by systolic blood pressure (SBP) levels between 120 and 139 mmHg and diastolic blood pressure (DBP) between 85 and 89 mmHg. It is associated with an increased cardiovascular risk and mortality in hypertensive patients. The likelihood of developing arterial hypertension can reach values of up to 30% within four years.

The main associated risk factors include an increase in the waist-hip circumference ratio, elevated levels of sugar and circulating lipids, and a decrease in HDL cholesterol. Other factors such as smoking, alcohol consumption, and physical inactivity also contribute to the risk. This combination of factors leads to alterations in the metabolic profile, which negatively affects the arterial endothelium. It further progresses with damage to the microvasculature, atherosclerosis, endothelial dysfunction, arterial stiffness, and an increase in central blood pressure levels, whether systolic or diastolic.

Central blood pressure, measured in the aorta, holds greater significance in predicting cardiovascular outcomes and mortality compared to peripheral blood pressure. Even in the prehypertensive state, alterations in endothelial function can affect central systolic pressure.

However, currently, there are no studies that have specifically aimed to establish normal levels of central systolic blood pressure in prehypertensive patients by utilizing specific biomarkers while considering risk factors such as age, overweight, and endothelial health. The closest study on this topic was conducted by Weber et al. They examined the behavior of central systolic pressure over 24 hours in a cohort of 2423 untreated individuals to determine reference values for central systolic pressure based on the age group of the population under study.

Therefore, the objective of the current study was to analyze the impact of a lifestyle change (LC) on arterial stiffness and the behavior of central systolic pressure (CSP) in individuals with prehypertension.
2 METHODS

This study is a retrospective, paired cohort study. The sample consisted of randomly recruited patients who attended the hypertension outpatient clinic at the School of Medicine of São José do Rio Preto in Brazil. The study procedures were approved by the Local Ethics Committee, specifically, the Research Ethics Committee of the School of Medicine of São José do Rio Preto (protocol nº 2205/2009), by the guidelines outlined in resolution 466/12 of the National Health Council. An opt-out consent approach was used for the utilization of medical records. Prior to participation, all volunteers were fully informed about the study's purpose, procedures, and potential risks and discomforts, and informed consent was obtained from all subjects.

The inclusion criteria for this study were individuals aged between 30 and 70 years who met the prehypertension criteria, with systolic blood pressure (SBP) measurements ranging from 120 to 139 mmHg and diastolic blood pressure (DBP) measurements ranging from 80 to 89 mmHg. Exclusion criteria included low life expectancy, prior use of antihypertensive medications, presence of cardiovascular disease, and pregnancy. All participants completed a standardized questionnaire to assess cardiovascular risk factors and were provided with comprehensive information regarding the study's purpose and procedures. From the initial cohort, a total of 69 prehypertensive patients were eligible for the present study and were categorized for analysis based on their central systolic pressure (CSP) levels: 40 patients with CSP ≤ 120 mmHg and 19 patients with CSP > 120 mmHg.

For the present study, anthropometric data and biochemical parameters were collected, including measurements of total cholesterol (TC), high-density lipoprotein cholesterol (HDL-c), triglycerides (TG), glucose, and serum creatinine. Peripheral hemodynamic parameters such as systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), pulse pressure (PP), and heart rate (HR) were also examined. To assess arterial stiffness, a radial artery application tonometer (HEM 9000AI – OROM) was used to measure central parameters, including the augmentation index (AI) and AI-75 value normalized to
a pulse rate of 75. These central parameters, particularly central systolic pressure, were directly correlated with arterial stiffness.

A 12-week lifestyle change counseling (LC) protocol was implemented, which included the Dietary Approaches to Stop Hypertension (DASH) diet, aerobic exercise (30 minutes of walking, five times per week), and the promotion of healthy lifestyle habits (smoking cessation, reduced alcohol consumption, and guidelines for effective blood pressure control). The LC was delivered through a lifestyle change manual, developed in the PREVER study, which was provided to all patients for them to follow the guidelines at home. Additionally, the researchers themselves provided personalized guidelines to the participants. It is important to note that these guidelines represent the standard information provided to patients by medical teams in Brazil. Descriptive statistics were calculated using paired t-tests and one-way measures. Correlation analyses were conducted using the Spearman method. The Prism statistics program and SPSS were used for the data analysis. An alpha error of 5% was considered acceptable for determining statistical significance. The sample size for this study was determined based on a previous study, considering a p-value of 0.05 and a statistical power of 80% to detect a difference of 6.06 mmHg in central systolic pressure before and after the lifestyle change (LC). The calculated sample size was 50 individuals.

3 RESULTS

The anthropometric and biochemical variables did not show significant differences between the groups with central systolic pressure (CSP) ≤ 120 mmHg and CSP > 120 mmHg. However, the lifestyle changes had a more significant impact on the group with CSP > 120 mmHg, resulting in a significant reduction in both systolic blood pressure (SBP) (pre: 130.73 ± 4.73 mmHg vs. post: 117.40 ± 9.61 mmHg) and diastolic blood pressure (DBP) (pre: 76.35 ± 5.49 mmHg vs. post: 67.24 ± 8.87 mmHg) (p<0.01). In comparison, the group with CSP ≤ 120 mmHg experienced a less significant reduction in SBP (pre: 119.65 ± 6.53 mmHg vs. post: 115.51 ± 11.11 mmHg) and DBP (pre: 68.49 ± 6.53 mmHg vs. post: 67.77 ± 8.18 mmHg) (Table 1).
Table 1. Effects of lifestyle changes on biochemical and tonometry parameters of the study patients subdivided according to the median value of central systolic pressure

<table>
<thead>
<tr>
<th>Variables</th>
<th>CSP ≤ 120 mmHg</th>
<th>CSP &gt;120 mmHg</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Biochemical parameters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glucose, mg/dL</td>
<td>92.93 ± 12.47</td>
<td>87.71 ± 17.32</td>
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<tr>
<td>HDL-c, mg/dL</td>
<td>50.72 ± 10.16</td>
<td>46.23 ± 6.81</td>
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<tr>
<td>LDL-c, mg/dL</td>
<td>127.75 ± 33.92</td>
<td>118.36 ± 40.39</td>
</tr>
<tr>
<td>Total cholesterol, mg/dL</td>
<td>204.55 ± 35.01</td>
<td>186.50 ± 45.27</td>
</tr>
<tr>
<td>Triglycerides, mg/dL</td>
<td>131.03 ± 55.24</td>
<td>110.42 ± 31.70</td>
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<tr>
<td>Serum creatinine, µg/min</td>
<td>0.90 ± 0.20</td>
<td>0.88 ± 0.23</td>
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<tr>
<td>Urinary albumin excretion, µg/min</td>
<td>25.02 ± 12.45</td>
<td>6.68 ± 6.12</td>
</tr>
<tr>
<td>Tonometry parameters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP, mm Hg</td>
<td>119.65 ± 6.53</td>
<td>115.51 ± 11.11</td>
</tr>
<tr>
<td>DBP, mm Hg</td>
<td>68.49 ± 6.52</td>
<td>67.77 ± 8.18</td>
</tr>
<tr>
<td>PP, mm Hg</td>
<td>51.15 ± 7.41</td>
<td>49.72 ± 8.23</td>
</tr>
<tr>
<td>HR, beats/min</td>
<td>72.59 ± 10.98</td>
<td>73.71 ± 10.92</td>
</tr>
</tbody>
</table>

Abbreviations: HDL, High-density lipoprotein cholesterol; LDL, light-density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; PP, pulse pressure; HR, heart rate; CSP, central systolic pressure.

Source: Author, 2024.

The lifestyle change (LC) resulted in a significant reduction in AI-x (augmentation index normalized to a pulse rate of 75) in the group with central systolic pressure (CSP) > 120 mmHg (pre: 91.42 ± 9.12% vs. post: 82.36 ± 13.6%), compared to the group with CSP ≤ 120 mmHg (pre: 78.82 ± 14.51% vs. post: 79.04 ± 13.1%). Additionally, there was a significant reduction in CSP in the group with CSP > 120 mmHg (pre: 124.51 ± 4.54 mmHg vs. post: 107.12 ± 12 mmHg), compared to the group with CSP ≤ 120 mmHg (pre: 107.78 ± 7.86 mmHg vs. post: 106.89 ± 11.1 mmHg) (Figure 1A and C). Furthermore, there were linear correlations between the changes (post-pre = dt) in CSP and AI (p = 0.505; p < 0.002), SBP (p = 0.867; p < 0.001), and DBP (p = 0.780; p < 0.001), indicating moderate to high effects, respectively (Figure 1D-F).
Figure 1. The AI (A), AI-75 (B), and CSP (C) values (mean±SD) at pre- and post-lifestyle change counseling in CSP ≤ 120 mmHg and CSP > 120 mmHg. Two-way ANOVA for repeated measurements: *Pre versus Post (P<0.01 for group, training, and interaction effects). The scatterplot between changes in CSP and AI (D), SBP (E), and DBP (F).

Source: Author, 2024.
DISCUSSION

The management of blood pressure in prehypertensive patients has commonly involved lifestyle changes, particularly exercise and diet modifications, to achieve blood pressure control. The findings of this study align with existing literature and demonstrate significant reductions in blood pressure among prehypertensive patients with central systolic pressure > 120 mmHg who underwent a lifestyle change (LC) intervention. These results support the effectiveness of lifestyle changes in lowering blood pressure and are in line with previous studies in this field.

Furthermore, the study observed a significant reduction in central systolic pressure (CSP) following the lifestyle change protocol. This reduction was found to be correlated with the augmentation index, suggesting a possible decrease in arterial resistance due to an increase in nitric oxide (NO) bioavailability and subsequent vasodilation. It is worth noting that the vasodilatory effect resulting from increased NO bioavailability may occur independently of the reduction in arterial stiffness and may require longer durations of lifestyle change programs. Similar vasodilatory effects have been observed with the use of antihypertensive medications possessing vasodilating properties.

CONCLUSION

The objective of the current study was to analyze the impact of lifestyle changes on arterial stiffness and the behavior of CSP in individuals with prehypertension. To the best of our knowledge, this is the first study to demonstrate short-term changes in central pressure outcomes, specifically improvements in arterial stiffness and central systolic pressure, following lifestyle changes in prehypertensive individuals with values below and above 120 mmHg. The observed response in central systolic pressure is directly associated with alterations in peripheral hemodynamics resulting from the implemented lifestyle modifications. These findings are of great significance for managing prehypertensive individuals who are often overlooked or prescribed antihypertensive medications without considering lifestyle changes, thereby improving the clinical treatment of these individuals. The current study has some limitations that should...
be mentioned. Firstly, a significant limitation was the lack of monitoring of lifestyle modifications without adjustments in exercise or diet dosages. This lack of continuous monitoring may have affected the accuracy and consistency of the lifestyle change interventions. Secondly, the study design did not include a control group. Instead, the study group was used as its control for comparison before and after the lifestyle change intervention. While this approach provides some insights into the impact of the intervention, it limits the ability to assess the specific effects of the lifestyle change by not having a separate control group for comparison. Lastly, another study limitation was the relatively short duration of the lifestyle modification period. A longer duration of the intervention would have provided a more comprehensive understanding of the sustained impact of lifestyle modifications. Furthermore, further studies with this population are necessary for a better understanding of this topic.

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REFERENCES


