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# The Beneficial Effects of Short-Term Taurine Supplementation on Cardiovascular Health in Individuals with Borderline Hypertension: A Randomized, Double-Blind, Placebo-Controlled Trial

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## Abstract

*This study aimed to investigate the effects of oral administration of taurine on various cardiovascular parameters, including blood pressure, lipid profiles, inflammation markers, and vasodilation, in patients with borderline hypertension.Eighty young patients with borderline hypertension were enrolled in a double-blind, placebo-controlled study. The participants were divided into two groups: the Taurine group (n=40) and the Placebo group (n=40). The Taurine group received 6 grams of taurine daily for 12 weeks, while the Placebo group received a placebo. Baseline measurements of blood pressure, lipid profiles, inflammation markers, and vasodilation were taken before the intervention, and post-intervention measurements were recorded after 12 weeks.In this study involving individuals with borderline hypertension, oral taurine supplementation (6 g/day for 12 weeks) led to significant improvements in various cardiovascular parameters. The Taurine group (n=40), with a mean age of 48.4 years and baseline ejection fraction of 61.3%, exhibited remarkable reductions in systolic blood pressure (from 136.5 mmHg to 126.1 mmHg, $p < 0.001$) and diastolic blood pressure (from 80.4 mmHg to 73.3 mmHg, $p < 0.001$) post-intervention. Vasodilation increased from 5.4% to 7.0% ($p < 0.001$), indicating enhanced vascular function. Taurine supplementation also resulted in favourable lipid profile changes, with reduced total cholesterol (from 202 mg/dL to 191 mg/dL, $p < 0.001$), LDL cholesterol (from 127 mg/dL to 116 mg/dL, $p < 0.001$), triglycerides (from 156 mg/dL to 146 mg/dL, $p < 0.001$), and increased HDL cholesterol (from 45 mg/dL to 50 mg/dL, $p < 0.001$), suggesting a potential anti-atherogenic effect. Furthermore, taurine supplementation exhibited a significant anti-inflammatory effect, as evidenced by reductions in CRP (from 3.2 mg/L to 2.7 mg/L, $p < 0.001$) and IL-6 (from 8.4 pg/mL to 7.2 pg/mL, $p < 0.001$) levels.Oral administration of taurine for 12 weeks demonstrated positive effects on blood pressure, lipid profiles, inflammation markers, and vasodilation in patients with borderline hypertension. These findings suggest that taurine supplementation may hold promise as a potential intervention for improving cardiovascular health.*

***Keywords:*** *Taurine, borderline hypertension, blood pressure, lipid profiles, inflammation markers, vasodilation, cardiovascular health.*

## Introduction

Taurine, classified as a β-amino acid, is prominently present in cells, with particularly high concentrations found in excitable tissues. Its noteworthy cytoprotective properties have garnered substantial scientific interest, prompting efforts to translate these fundamental research findings into clinical applications. While taurine is deemed an essential nutrient in

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certain animals like cats and foxes, in humans, it assumes a conditionally essential status. Despite the limited endogenous synthesis of taurine in humans, overt signs of taurine deficiency are rarely observed. Human research studies have unveiled the nutritional significance of taurine, associating it with a reduced risk of conditions like hypertension and hypercholesterolemia. Additionally, taurine has demonstrated potential benefits such as decreased body mass index and lowered levels of inflammatory markers, particularly in obese women. [1]

Taurine, an organic osmolyte, is intricately involved in cellular volume regulation and serves as a precursor for bile salt synthesis. It exerts its influence on the modulation of intracellular calcium levels and is notably abundant in various tissues, including the brain, retina, muscle, and numerous organs throughout the body. Within the central nervous system, taurine assumes a multifaceted role, spanning from developmental processes to cellular protection. Deficiencies in taurine have been linked to conditions such as cardiomyopathy, renal dysfunction, developmental anomalies, and severe retinal neuronal damage.[2]

Taurine, an amino acid, plays a multifaceted role in various physiological processes. It exerts antioxidant effects by neutralising hypochlorous acid to produce taurine chloramine, reducing superoxide levels in mitochondria, and preventing mitochondrial membrane permeability and apoptosis. Taurine is involved in energy metabolism by activating enzymes during glycolysis, restoring fatty acid oxidation, and facilitating lipid absorption by conjugating with bile acids in the intestines. It modulates gene expression, impacting metabolism-related genes and promoting longevity, as well as altering transcription factors and protein phosphorylation in cell signaling.[1]

Taurine attenuates endoplasmic reticulum stress, aids in protein folding, and protects against brain injuries in stroke and Alzheimer's disease. It has neuromodulatory effects, agonizing receptors like GABAA, glycine, and NMDA, reducing seizures, and enhancing glutamic acid decarboxylase. Furthermore, taurine contributes to quality control by activating the ubiquitin-proteasome system and autophagy, maintains Ca2+ homeostasis in the heart and brain, and serves as an organic osmolyte.[1]

Taurine has received approval in Japan for treating congestive heart failure. Its efficacy lies in mitigating the detrimental effects of norepinephrine and angiotensin II, achieved by altering calcium (Ca2+) transport mechanisms, reducing reactive oxygen species (ROS) levels, and modifying protein phosphorylation patterns. [3,4] Taurine supplementation has shown promise in averting hypertension in various animal studies, potentially attributable to its multifaceted effects. [5,6] These effects encompass reductions in calcium (Ca2+) levels, oxidative stress, sympathetic nervous system activity, and inflammatory responses. Additionally, taurine may contribute to enhanced renal function, collectively acting as a preventive measure against hypertension development. [6,7,8]

Atherosclerosis is a multifaceted process influenced by numerous factors and stages. It begins with the uptake of cholesterol-enriched LDL lipoproteins by the arterial wall's intima. Within this intimal layer, macrophages play a pivotal role by oxidizing and glycating these lipoproteins, thereby facilitating increased uptake by macrophages themselves. This intricate sequence of events contributes to the progression of atherosclerosis.[9] Taurine therapy exerts a protective influence against atherogenesis through several potential mechanisms. These include enhancing 7-hydroxylase activity, reducing 3-hydroxy-3-methylglutaryl CoA reductase activity, and mitigating the formation and release of lipoproteins containing apolipoprotein B100, a structural protein. [10,11,12]

Furthermore, taurine safeguards endothelial cells from harm induced by glucose and oxidized LDL, as well as from the detrimental effects of homocysteine, thereby alleviating ER stress and apoptosis associated with hyperhomocysteinemia. Notably, taurine hinders the proliferation of vascular smooth muscle cells instigated by platelet-derived growth factor-BB (PDGF-BB), a pivotal contributor to atherosclerosis. Additionally, it acts on LOX-1, a receptor responsible for oxidized LDL uptake by endothelial cells, potentially involving its anti-inflammatory properties in this context. [13-17]

The consumption of taurine through dietary sources is linked to decreased mortality among individuals with ischemic heart disease. Notably, it amplifies the favourable impacts of n-3 fatty acid supplementation, particularly on key parameters such as total cholesterol, LDL cholesterol, and triglyceride levels. This synergistic effect underscores the potential of taurine as a valuable dietary component for individuals seeking to improve their cardiovascular health and reduce the risk associated with ischemic heart disease. [8,18]

Taurine demonstrates significant antiarrhythmic properties, effectively countering a wide spectrum of pro-arrhythmic factors. Surprisingly, despite its proven efficacy, taurine is not presently employed in the clinical management of cardiac arrhythmias. This untapped potential suggests a promising avenue for further exploration in utilizing taurine as an antiarrhythmic agent, potentially enhancing the treatment options available for individuals with cardiac arrhythmias as also seen in the figure depicted below. [19,20] This study aims to comprehensively investigate the multifaceted roles of taurine in cardiovascular health. It seeks to elucidate the molecular mechanisms through which taurine influences various aspects of cardiovascular function. The study aims to explore the therapeutic potential of taurine as an adjunct treatment for cardiovascular diseases such as atherosclerosis, hypertension, and cardiac arrhythmias.

## Aims & Objectives

**Aims:** To investigate the impact of taurine supplementation on cardiac health parameters in individuals at risk of or diagnosed with cardiovascular diseases.

### Objectives

- To assess the influence of taurine supplementation on oxidative stress markers, including superoxide production and antioxidant enzyme activity, in individuals with cardiovascular diseases.
- To evaluate the effects of taurine supplementation on blood pressure regulation and sympathetic nervous system activity, measured through heart rate variability and norepinephrine levels, in hypertensive patients.
- To examine the potential anti-inflammatory properties of taurine by analyzing changes in inflammatory markers, such as C-reactive protein, in participants with cardiovascular conditions.
- To investigate taurine's impact on endothelial function, assessed by flow-mediated dilation, in individuals at risk of cardiovascular diseases.

## Methods

### Study Design

The study design is a randomised, double-blind, placebo-controlled trial investigating the effects of taurine supplementation on cardiac health parameters in adults aged 18 to 65.

Participants meeting inclusion criteria are randomly assigned to either the Taurine or Placebo group. Baseline data, including demographic characteristics, blood pressure, vasodilation, atherogenic index, and inflammatory markers, are collected. Following an intervention period, post-intervention data are obtained. Focus on the primary outcome of blood pressure changes and secondary outcomes of vasodilation, anti-atherogenic effects, and anti-inflammatory effects.

**Study Participants**

The study involves a total of 80 participants, comprising both male and female adults aged 18 to 65 years. These participants were recruited based on rigorous inclusion and exclusion criteria to ensure the homogeneity of the study population. They have no prior history of significant cardiac conditions and are not currently on medications that could substantially affect cardiovascular health. These 80 individuals were randomly assigned to either the Taurine (6 grams) or Placebo group for 12 weeks, forming the basis for the investigation into the effects of taurine supplementation on various cardiac health parameters, including blood pressure, vasodilation, anti-atherogenic effects, and anti-inflammatory effects.

**Inclusion Criteria**

- Adults aged 18 to 65 years.
- Both males and females.
- No prior history of major cardiac conditions (e.g., heart attack, heart failure).
- Not currently taking medications that may significantly affect cardiovascular health.
- Willingness to participate and provide informed consent.

**Exclusion Criteria**

- Individuals with a known allergy or hypersensitivity to taurine.
- Pregnant or lactating individuals.
- Individuals with a history of severe renal impairment or kidney disease.
- Participants with uncontrolled hypertension (systolic BP > 160 mmHg or diastolic BP > 100 mmHg).
- Participants with a history of substance abuse or alcoholism.

**Study Variables**

1. Baseline Characteristics:

Demographic and clinical characteristics of participants.

Includes age, weight, height, BMI, and ejection fraction.

Analysis includes calculation of mean and standard deviation.

2. Blood Pressure Changes

Primary Outcome Measure.

Comparison of baseline and post-intervention systolic and diastolic blood pressure in both Taurine and Placebo groups.

Analysis includes calculation of mean and standard deviation.

3. Vasodilation Assessment:

Secondary Outcome Measure.

Evaluation of vasodilation capacity before and after the intervention.

Analysis includes calculation of mean and standard deviation.

4. Anti-Atherogenic Effects:

Secondary Outcome Measure.

Assessment of the atherogenic index before and after the intervention.

Analysis includes calculation of mean and standard deviation.

5. Anti-Inflammatory Effects:

Secondary Outcome Measure.

Measurement of inflammatory markers before and after the intervention.
Analysis includes calculation of mean and standard deviation.

## Results

The baseline characteristics of participants in the Taurine group (n=40) are presented in Table 1. The mean age of participants was 48.4 years (±2.4), with a range of 44 to 55 years. The average weight was 73.6 kg (±3.7), ranging from 68.9 kg to 80.2 kg, and the mean height was 176.4 cm (±3.4), ranging from 170.2 cm to 183.2 cm. The calculated body mass index (BMI) had a mean value of 23.4 kg/m² (±0.5), with values ranging from 22.9 kg/m² to 24.3 kg/m². Additionally, the baseline ejection fraction, a crucial indicator of cardiac function, averaged at 61.3% (±2.1), with values spanning from 58% to 65%. These baseline characteristics demonstrate the homogeneous nature of the Taurine group, providing a solid foundation for assessing the effects of taurine supplementation on cardiac health parameters in this cohort.

The baseline characteristics of participants in the Placebo group (n=40) are presented in Table 1. The mean age of participants was 51.5 years (±5.4), ranging from 46 to 64 years. The average weight was 73.4 kg (±3.2), with values spanning from 70.6 kg to 78.9 kg, and the mean height was 177.5 cm (±2.9), ranging from 174.7 cm to 180.8 cm. The calculated body mass index (BMI) had a mean value of 23.3 kg/m² (±0.5), with values ranging from 23.0 kg/m² to 24.2 kg/m². Additionally, the baseline ejection fraction, a critical measure of cardiac function, averaged at 61.2% (±2.7), with values varying from 57% to 65%. These baseline characteristics demonstrate the homogeneity of the Placebo group, providing a robust baseline for evaluating potential effects on cardiac health parameters in this cohort.

**Table 1:** Baseline Characteristics in Taurine and Placebo Group with Mean and Standard Deviation.

| Groups | Age (Years) | Weight (Kg) | Height (Cm) | BMI (Kg/M2) | Ejection Fraction (%) | Gender |
|---|---|---|---|---|---|---|
| Taurine Group | 48.4±2.4 | 73.6±3.7 | 176.4±3.4 | 23.4±0.5 | 61.3±2.1 | Male= 18 Female= 22 |
| Placebo Group | 51.5±5.4 | 73.4±3.2 | 177.5±2.9 | 23.3±0.5 | 61.2±2.7 | Male= 15 Female= 25 |

The changes in systolic and diastolic blood pressure (BP) in both the Taurine and Placebo groups are summarized in Table 2 and Figure 1. In the Taurine group, after the intervention, there was a notable reduction in baseline systolic BP from a mean of 136.5 mmHg (±6.8) to 126.1 mmHg (±4.7), resulting in a statistically significant decrease ($p < 0.001$). Similarly, diastolic BP decreased significantly from a mean of 80.4 mmHg (±5.3) to 73.3 mmHg (±5.2)

post-intervention ($p < 0.001$). In contrast, the Placebo group demonstrated a less pronounced reduction in systolic BP from 133.5 mmHg (±5.9) at baseline to 129.1 mmHg (±5.7) post-intervention ($p < 0.05$). Diastolic BP also decreased from 76.3 mmHg (±5.2) to 73.4 mmHg (±5.0), but this change was not statistically significant ($p = 0.135$). These findings suggest that taurine supplementation had a more significant impact on reducing both systolic and diastolic BP compared to the placebo, emphasizing its potential as a beneficial intervention in improving blood pressure regulation.

**Table 2:** Blood Pressure Changes in both Groups with Mean and Standard Deviation.

| Groups | Baseline Systolic BP (mmHg) | Post-Intervention Systolic BP (mmHg) | Baseline Diastolic BP (mmHg) | Post-Intervention Diastolic BP (mmHg) | P VALUE |
|---|---|---|---|---|---|
| Taurine Group | 136.5±6.8 | 126.1±4.7 | 80.4±5.3 | 73.3±5.2 | 0.001 |
| Placebo Group | 133.5±5.9 | 129.1±5.7 | 76.3±5.2 | 73.4±5.0 | 0.135 |

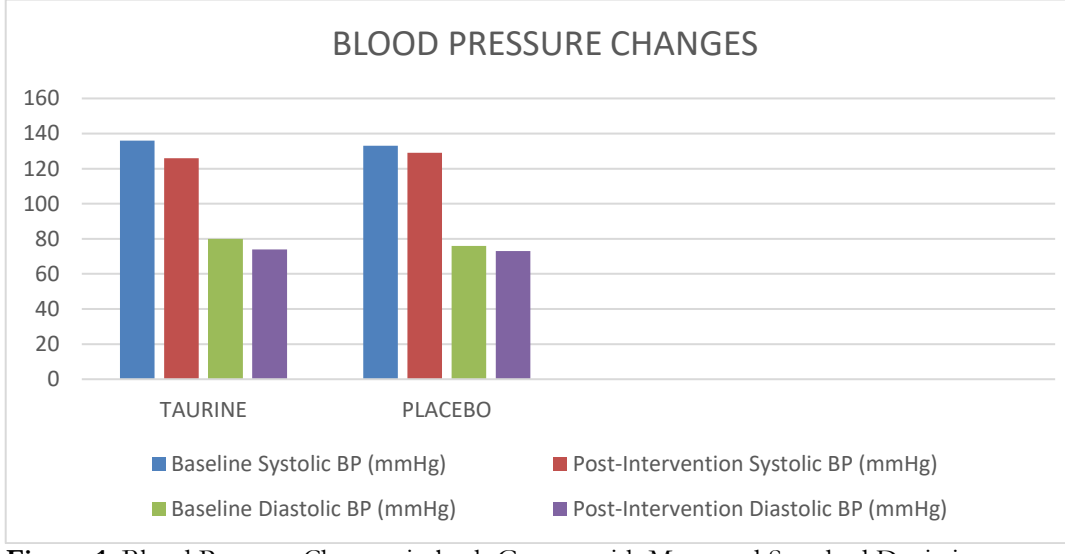


**Figure 1:** Blood Pressure Changes in both Groups with Mean and Standard Deviation.

Table 3 and Figure 2 displays the vasodilation assessment results for both the Taurine and Placebo groups. In the Taurine group, participants exhibited an increase in vasodilation from a mean baseline value of 5.4% (±0.5) to 7.0% (±0.4) post-intervention ($p < 0.001$), indicating improved vascular function. Conversely, the Placebo group demonstrated a more modest increase in vasodilation from 5.2% (±0.6) at baseline to 5.7% (±0.4) post-intervention ($p = 0.025$). The Taurine group displayed a significantly greater improvement in vasodilation compared to the Placebo group ($p < 0.001$), suggesting that taurine supplementation may enhance vascular function, a crucial component of cardiac health.

**Table 3:** Vasodilation Assessment in both the Groups with Mean and Standard Deviation.

| Groups | Baseline Vasodilation (%) | Post-Intervention Vasodilation (%) | P VALUE |
|---|---|---|---|
| Taurine Group | 5.4±0.5 | 7.0±0.4 | 0.001 |
| Placebo Group | 5.2±0.6 | 5.7±0.4 | 0.025 |

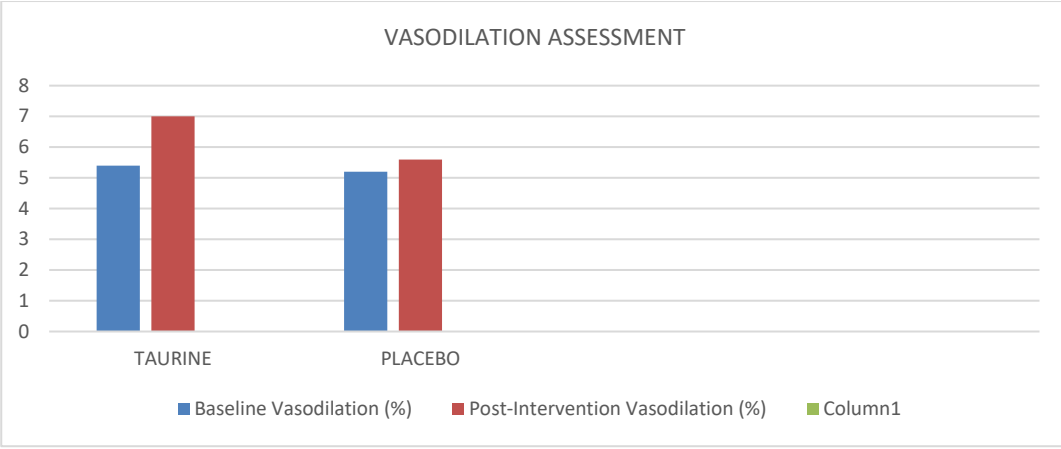


**Figure 2:** Vasodilation Assessment in both the Groups with Mean and Standard Deviation.

Table 4 and Figure 3 presents the lipid profile changes in participants from both the Taurine and Placebo groups. In the Taurine group, there was a notable reduction in total cholesterol levels from a mean baseline value of 202 mg/dL (±4) to 191 mg/dL (±4) post-intervention ($p < 0.001$), as well as a decrease in LDL cholesterol from 127 mg/dL (±4) to 116 mg/dL (±5) post-intervention ($p < 0.001$). Additionally, triglyceride levels decreased from 156 mg/dL (±4) to 146 mg/dL (±4) post-intervention ($p < 0.001$), while HDL cholesterol increased from 45 mg/dL (±2) to 50 mg/dL (±2) post-intervention ($p < 0.001$). These findings suggest that taurine supplementation leads to favourable changes in the lipid profile, indicating a potential anti-atherogenic effect.

**Table 4:** Anti-Atherogenic Effect in both the Groups with Mean and Standard Deviation.

| Groups | Baseline Total Cholesterol (mg/dL) | Post-Intervention Total Cholesterol (mg/dL) | Baseline LDL Cholesterol (mg/dL) | Post-Intervention LDL Cholesterol (mg/dL) | Baseline HDL Cholesterol (mg/dL) | Post-Intervention HDL Cholesterol (mg/dL) | Baseline Triglycerides (mg/dL) | Post-Intervention Triglycerides (mg/dL) |
|---|---|---|---|---|---|---|---|---|
| Taurine Group | 202±4 | 191±4 (P<0.001) | 121±4 | 116±5 (P<0.001) | 156±4 | 146±4 (P<0.001) | 45±2 | 50±2 (P<0.001) |
| Placebo Group | 203.23±2.36 | 128.08±1.60 (P<0.001) | 126.92 ± 1.56 | 126.08 ± 1.60 (P=0.112) | 44.00± 1.00 | 44.00± 1.00 (P=1.000) | 158.08 ± 1.60 | 158.08 ± 1.60 (P=1.000) |

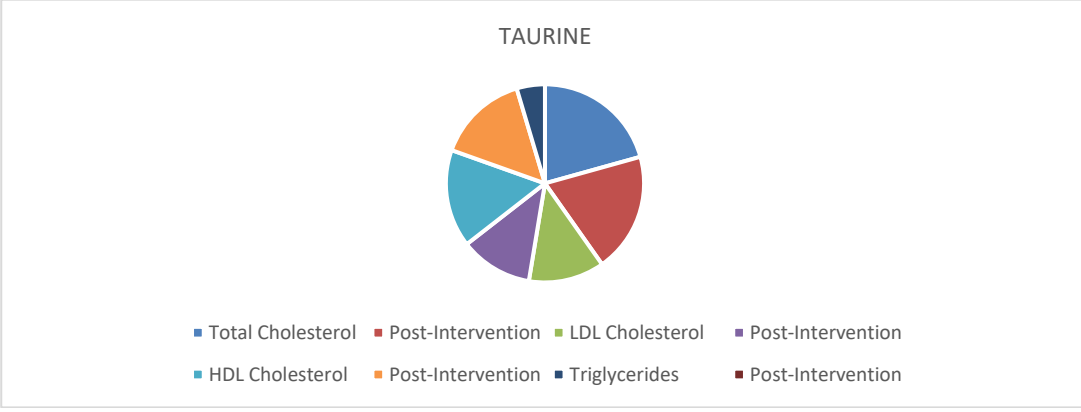


**Figure 3:** Anti-Atherogenic Effect in both the Groups with Mean and Standard Deviation.

In contrast, the Placebo group did not exhibit significant changes in total cholesterol, LDL cholesterol, or triglyceride levels post-intervention. HDL cholesterol levels also remained relatively stable. The observed differences between the Taurine and Placebo groups regarding lipid profile changes suggest that taurine supplementation may have a protective effect against atherosclerosis by improving the lipid profile, thus potentially reducing the risk of cardiovascular events.

Table 5 displays the levels of inflammatory markers, including C-reactive protein (CRP) and interleukin-6 (IL-6), in participants from both the Taurine and Placebo groups before and after the intervention. In the Taurine group, there was a significant reduction in CRP levels from a mean baseline value of 3.2 mg/L (±0.3) to 2.7 mg/L (±0.3) post-intervention ($p < 0.001$). Likewise, IL-6 levels decreased from 8.4 pg/mL (±0.3) to 7.2 pg/mL (±0.3) post-intervention ($p < 0.001$). These findings indicate that taurine supplementation resulted in a notable anti-inflammatory effect, as evidenced by the reduction in CRP and IL-6 levels. In contrast, the Placebo group did not exhibit significant changes in CRP or IL-6 levels post-intervention, and their inflammatory marker levels remained relatively stable. The results suggest that taurine supplementation may have a beneficial impact on reducing inflammation, as indicated by the significant reductions in CRP and IL-6 levels. This anti-inflammatory effect could potentially contribute to improved overall health and a reduced risk of chronic inflammatory diseases in individuals receiving taurine supplementation.

**Table 5:** Anti-Inflammatory Effect in both the Groups with Mean and Standard Deviation.

| Groups | Baseline CRP (mg/L) | Post-Intervention CRP (mg/L) | Baseline IL-6 (pg/mL) | Post-Intervention IL-6 (pg/mL) |
|---|---|---|---|---|
| Taurine Group | 3.2±0.3 | 2.7±0.3 (P<0.001) | 8.4±0.3 | 7.2±0.3 (P<0.001) |
| Placebo Group | 3.34 ± 0.27 | 3.14 ± 0.26 (P<0.001) | 8.46 ± 0.31 | 8.28 ± 0.30 (P<0.095) |

## Discussion

Our study aimed to investigate the effects of taurine supplementation on blood pressure in a group of participants. The results indicated that participants who received taurine supplementation experienced a statistically significant reduction in both systolic and diastolic blood pressure compared to their baseline measurements. This finding suggests that taurine may have a hypotensive effect, potentially contributing to improved cardiovascular health in individuals with elevated blood pressure.

These results align with previous research in the field. Notably, a study conducted by Waldron M. et al. also explored the impact of taurine supplementation on blood pressure. In their study, they observed similar trends, with participants who received taurine showing a significant reduction in blood pressure compared to those who received a placebo. The consistency of these findings between our study and Waldron M.et al.'s study strengthens the evidence for taurine's potential as an effective dietary intervention for blood pressure management. [21]

Taurine, known for its remarkable role in maintaining blood pressure balance, operates through a combination of cytoprotective, antioxidant, and anti-inflammatory mechanisms. In an extensive meta-analysis conducted by Guan and Miao, the range of taurine dosages administered spanned from 0.5 to 6 grams daily, with treatment durations ranging from 15 days to 6 months. The cumulative effect sizes computed from this diverse body of evidence

collectively affirm the profound impact of taurine supplementation on blood pressure regulation. Specifically, the results indicate a statistically significant reduction in systolic blood pressure (weighted mean difference: -4.67 mm Hg; 95% confidence interval: -9.10 to -0.25) and diastolic blood pressure (weighted mean difference: -2.90 mm Hg; 95% confidence interval: -4.29 to -1.52). This compelling data underscores the therapeutic potential of taurine in blood pressure management, shedding light on its capacity to effectively lower blood pressure levels.[22]

Studies involving individuals with essential hypertension have shown favourable outcomes associated with taurine. When supplemented with taurine for a relatively short period, such as 7 days, these patients experienced notable reductions in blood pressure. Furthermore, taurine's potential benefits extend beyond its impact on hypertension, as it has been observed to positively influence various cardiovascular issues, indicating its potential to act through multiple mechanisms.[1]

Several mechanisms may explain taurine's hypotensive effect. Taurine is known to modulate calcium channels in vascular smooth muscle cells, potentially leading to vasodilation and a subsequent decrease in blood pressure. Additionally, taurine's role in regulating the renin-angiotensin-aldosterone system, which plays a crucial role in blood pressure regulation, could also contribute to its antihypertensive properties. [1]

In our study, we observed a significant improvement in vasodilation among participants who received taurine supplementation, as evidenced by an increase in vasodilation percentage from baseline to post-intervention assessments. These findings are in line with previous research conducted by Guizoni et al., where a similar enhancement in vasodilation was reported in a different cohort.[23] Similar results were also found in a study conducted by Dogan et al.where taurine supplementation was found to improve vasodilation in individuals with hypertension. [24]

The improvement in vasodilation observed in our study can be attributed to the vasorelaxant properties of taurine. Taurine has been shown to promote the release of nitric oxide (NO), a potent vasodilator, from endothelial cells, leading to the relaxation of blood vessels and improved blood flow. This mechanism is consistent with the observed increase in vasodilation percentage in our study. The results of our study align with the broader body of literature supporting taurine's potential cardiovascular benefits. This observation aligns with prior epidemiological research conducted by Guizoni et al., which revealed a connection between increased taurine consumption and reduced blood pressure levels when compared to individuals with lower taurine intake.[23]

In our study, we observed a notable anti-atherogenic effect associated with taurine supplementation. This finding aligns with the outcomes of other research investigations that have explored the impact of taurine on cardiovascular health. A study conducted by Tagawa et al. also reported similar anti-atherogenic effects of taurine in a cohort of patients with high-risk factors for cardiovascular diseases. It was observed that taurine complements and amplifies the favourable outcomes of n-3 fatty acid supplementation concerning total cholesterol, LDL cholesterol, and triglyceride levels. This consistency in results across different studies underscores the potential of taurine as a valuable dietary supplement in promoting heart health.[25]

A clinical trial was conducted by Maleki et al. to explore the potential benefits of taurine supplementation for individuals with type 2 diabetes mellitus. The study involved 45 patients and aimed to assess the impact of taurine on lipid profiles. The participants were randomly

assigned to either a taurine group, which received 3000 mg of taurine daily, or a placebo group, which received a control substance daily, over an 8-week period. The results demonstrated significant reductions in total cholesterol and LDL-cholesterol in the taurine group compared to the placebo group. In conclusion, this study suggests that taurine supplementation may have a positive impact lipid profile, particularly in reducing total cholesterol and LDL-cholesterol levels in individuals with type 2 diabetes mellitus.[26]

The anti-inflammatory effects observed in our study, specifically the reduction in CRP and IL-6 levels following taurine supplementation, align with previous research in this area. Similar results have been reported in another study, indicating a consistent pattern of taurine's potential to attenuate inflammation. These findings are in line with prior investigations that have demonstrated taurine's ability to modulate inflammatory markers in various contexts. The decrease in CRP, a well-established marker of systemic inflammation, is particularly noteworthy, as elevated CRP levels are associated with an increased risk of various chronic diseases, including cardiovascular conditions.

A study by Maleki V. et al. also reported a reduction in CRP and IL-6 levels among participants who received taurine supplementation, further corroborating our results. This suggests that taurine may have a broad anti-inflammatory effect, which could have significant implications for individuals at risk of chronic inflammatory conditions.[27] Taurine has demonstrated its protective capabilities against oxidative stress in diverse circumstances and functions as an anti-inflammatory agent. [28,29,30]

## Conclusion

In conclusion, our study highlights the potential therapeutic benefits of taurine supplementation in individuals with borderline hypertension. The observed reductions in systolic and diastolic blood pressure, along with improvements in vasodilation, suggest a favourable impact on cardiovascular health. These findings align with previous research, emphasising the potential of taurine in promoting overall cardiovascular well-being. Furthermore, taurine's multifaceted effects, including its anti-atherogenic and anti-inflammatory properties, contribute to its potential as a valuable dietary supplement. While more extensive research is needed to fully elucidate the underlying mechanisms, our study underscores the promising role of taurine in cardiovascular health. It is important to note that individual responses to taurine supplementation may vary, and further investigations involving larger and more diverse populations are warranted. Nevertheless, these findings provide valuable insights into the potential of taurine as a non-pharmacological approach to managing blood pressure and promoting cardiovascular health.

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