Effect of Buttermilk Consumption on Blood Pressure and Cholesterol: A Cross-Sectional Study

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ABSTRACT

Introduction: Hypertension and dyslipidemia are major modifiable risk factors for cardiovascular disease (CVD), the leading cause of global mortality. Fermented dairy products such as buttermilk contain bioactive peptides, probiotics, and milk fat globule membrane (MFGM) components that may beneficially influence vascular function and lipid metabolism. This study aimed to evaluate the impact of regular buttermilk consumption on blood pressure indices and lipid profiles in a Nepalese population, comparing habitual consumers with non-consumers.

Methods: A cross-sectional study was conducted among 680 participants (n = 340 per group) in Gulmi District, Nepal. Blood pressure parameters (systolic, diastolic, and mean arterial pressure) and lipid markers (total cholesterol, triglycerides, LDL-C and HDL-C) were measured and compared between groups. Statistical significance was assessed using appropriate tests, with $p < .05$ considered significant.

Results: Buttermilk consumption was associated with significant reductions in systolic blood pressure ($p = .003$) and mean arterial pressure ($p = .012$), though diastolic pressure changes were not statistically significant ($p = .065$). Lipid parameters showed robust improvements: total cholesterol and triglycerides were significantly reduced, while HDL cholesterol increased substantially. LDL-C reductions were significant in participants with elevated baseline levels but did not reach significance in the overall population

Conclusions: Regular buttermilk intake appears to exert cardio protective effects through improvements in lipid profile and modest reductions in blood pressure. While lipid benefits are clinically relevant, blood pressure effects are limited, suggesting that buttermilk may serve as a supportive dietary measure rather than a primary intervention.

Further long-term studies are warranted to confirm these findings and elucidate underlying mechanisms.

Keywords: *cholesterol, buttermilk, blood pressure, hypertension*

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INTRODUCTION

Hypertension is a major contributor to cardiovascular disease and kidney impairment, responsible for approximately 7.1 million deaths annually (Huang et al., 2019). Nutrition plays a critical role in its prevention and management (Yusuf et al., 2016). Dairy-derived functional foods, particularly those containing bioactive peptides, have shown promise in lowering blood pressure through angiotensin-converting enzyme (ACE) inhibition (Conway et al., 2013; Conway et al., 2014; Thompson et al., 1982; Robinet et al., 2010). Buttermilk, rich in milk fat globule membrane (MFGM) components, bioactive peptides, and probiotics, has distinctive nutritional properties (Encyclopedia Britannica, 2021). Despite this, its antihypertensive potential remains underexplored.

Cardiovascular diseases (CVDs) are the leading global cause of mortality, with elevated blood pressure and dyslipidemia as key modifiable risk factors. Buttermilk, a traditional fermented dairy beverage widely consumed in South Asia, may improve vascular function and lipid metabolism. Prior studies suggest reductions in cholesterol and triglycerides, alongside modest blood pressure improvements, though evidence is inconsistent (Cais-Sokolińska & Rudzińska, 2018; Liutkevičius et al., 2016; Szkolnicka et al., 2020). In Nepal, buttermilk is consumed regularly, especially in rural districts such as Gulmi (Upadhyay et al., 2021). However, systematic evaluations of its cardiovascular effects in this population are lacking. This study was therefore designed to assess the impact of buttermilk consumption on blood pressure indices and lipid profiles, comparing regular consumers with non-consumers to determine its potential role in cardiovascular risk reduction.

METHODS

Study design: A community-based randomized cross-sectional study was conducted in Gulmi District, Lumbini Province, Nepal. Recruitment took place at the administrative office of the rural municipality, which authorized data collection at the first study site in Olibang, Gulmi. Participants aged 15 to 60 years were eligible if they had consumed buttermilk regularly for at least 30 days, while those with cardiovascular disease, malignant or autoimmune disorders, pregnant or lactating women, and individuals with high alcohol intake were excluded. Before enrollment, the study objectives were clearly explained, and all participants provided both written and verbal informed consent in a comfortable and confidential setting. The final sample size comprised 340 regular buttermilk consumers and 340 control participants who did not consume buttermilk.

Study site and duration: The study was conducted between February 1 and July 30, 2022 at rural municipality sites in Olibang, Gulmi District, Lumbini Province, Nepal.

Sample collection: Local ward office approved data collection at Olibang, Gulmi. Study goals were explained; a confidential and comfortable environment was ensured. Written and verbal consent was obtained from all participants. Blood pressure was assessed using a calibrated sphygmomanometer. Participants who had fasted overnight underwent venipuncture. Blood samples were collected in sterile vials, and serum was separated and transferred into Eppendorf tubes and stored at cold for analysis. Serum lipid levels were analyzed at the Crimson College of Technology laboratory. Throughout the study period, participants were asked to maintain their usual diet, medication regimen, body weight, alcohol intake, and smoking habits. Tea and coffee consumption was restricted to a maximum of two cups per day. The use of vitamins or natural health product supplements was strictly prohibited. Any deviation from these instructions resulted in exclusion from the study.

Laboratory procedures

Blood samples were collected following an overnight fast. Serum was separated and analyzed for lipid parameters using standardized enzymatic techniques: Total cholesterol and triglycerides were measured using the CHOD–PAP method. HDL-cholesterol was determined by the precipitation method. LDL-cholesterol and VLDL-cholesterol concentrations were calculated using the Martin/Hopkins method, which applies a variable triglyceride-to-VLDL ratio for improved accuracy. All analyses were performed at the laboratory facilities of Crimson College of Technology.

Blood pressure was assessed on the right arm using an automated mercury sphygmomanometer after a 10-minute seated rest. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were recorded as the average of three consecutive readings taken at 3-minute intervals. Mean arterial pressure (MAP) was calculated using the formula: **MAP = Diastolic BP + (Pulse Pressure ÷ 3)**, where **Pulse Pressure = (SP-DP).** This formula provides an estimate of the average pressure in the arteries during a single cardiac cycle, offering a more stable indicator of perfusion than SBP or DBP alone.

Data analysis: Data entry, cleaning, and management were conducted using Microsoft Excel. All data are presented as mean ± standard deviation (SD). To evaluate the effects of buttermilk consumption on study outcomes, statistical analyses were performed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). No significant treatment-by-sequence interactions were observed for any of the measured outcomes. Statistical significance was defined as $p < 0.05$.

RESULTS

Participant Characteristics

A total of 680 participants were included in the analysis, with 340 assigned to the control group and 340 to the buttermilk intervention group. Baseline demographic and clinical characteristics were comparable between groups, ensuring that observed differences could be attributed to the intervention. The primary outcomes assessed were blood pressure indices and lipid parameters.

Blood Pressure Outcomes

Consumption of buttermilk was associated with modest but meaningful reductions in blood pressure values. Participants in the intervention group demonstrated significantly lower systolic blood pressure (108.3 ± 11.6 mmHg) compared to controls (110.9 ± 11.2 mmHg; $p = 0.003$). Mean arterial pressure also showed a significant decline (79.0 ± 8.9 mmHg vs. 80.7 ± 8.8 mmHg; $p = 0.013$). In contrast, diastolic blood pressure decreased slightly (64.4 ± 8.3 mmHg vs. 65.6 ± 8.6 mmHg), but this difference did not reach statistical significance ($p = 0.065$).

Lipid Profile Outcomes

Marked improvements were observed in lipid parameters among participants consuming buttermilk. Total cholesterol levels were significantly reduced (138.8 ± 42.1 mg/dL vs.

157.5 ± 48.0 mg/dL; $p < 0.000001$), and triglyceride concentrations declined notably (164.0 ± 25.0 mg/dL vs. 204.6 ± 154.2 mg/dL; $p = 0.000002$). Importantly, HDL cholesterol increased substantially in the buttermilk group (45.6 ± 8.4 mg/dL vs. 35.3 ± 5.1 mg/dL; $p < 0.000001$), representing an approximate 29% improvement relative to controls.

Summary of Findings

Together, these results indicate that buttermilk consumption may contribute to improved cardiovascular health. The intervention was associated with significant reductions in systolic and mean arterial blood pressure, as well as favorable changes in lipid metabolism, including lower total cholesterol and triglycerides and higher HDL cholesterol. These findings highlight the potential of buttermilk as a simple dietary intervention to support cardiovascular risk reduction.

Table 1. Parameters measured in control and buttermilk groups

Parameters measured	Controlled population	Buttermilk intervention group	Difference	P-value
Systolic blood pressure (mm Hg)	110.9 ±11.2	108.3 ±11.6	-2.3%	.00305
Diastolic blood pressure (mm Hg)	65.6 ±8.6	64.4 ±8.3	-1.8%	.06456
Mean arterial pressure (mm Hg)	80.7 ±8.8	79.0 ±8.9	-2.1%	.01250
Blood Total cholesterol level	157.5 ±48	138.8 ±42.1	-10.9%	.000001
Blood HDL-cholesterol level	35.3 ±5.1	45.6 ±8.4	+10.3%	.000001
Blood Triglyceride level	204.6 ±154.2	164 ±25	-10.1%	.000002

Note: Values are presented as mean ± SD. Differences are expressed as percentage change relative to controls. Statistical significance was defined as $p < 0.05$.

The effects of buttermilk consumption on cardiovascular parameters and lipid profiles are shown in the diagram below:

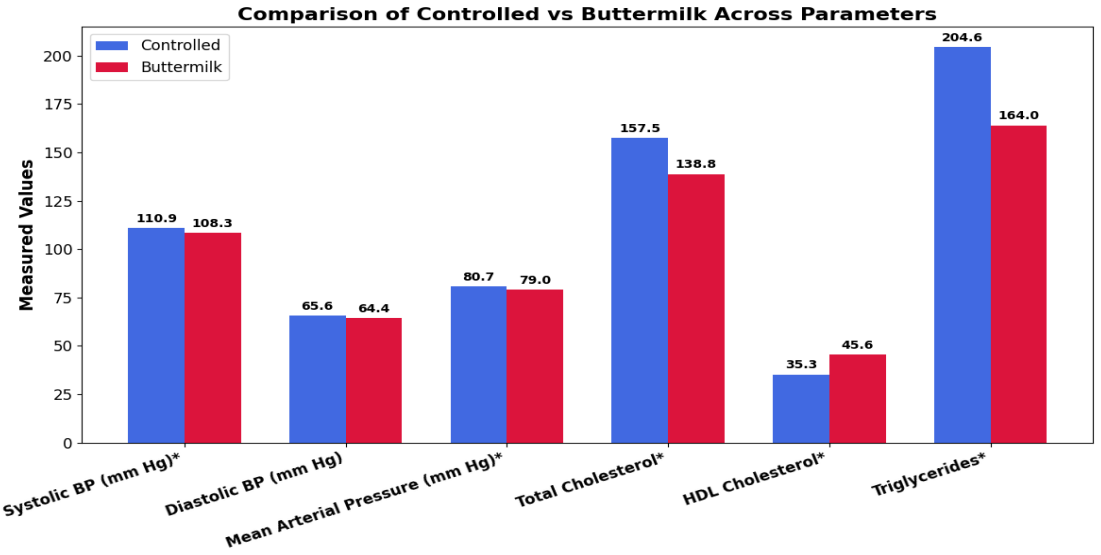

Figure 1. Effects of Buttermilk on Cardiovascular Parameters and Lipid Profiles

(Comparison of systolic blood pressure, diastolic blood pressure, mean arterial pressure (MAP), total cholesterol, HDL cholesterol, and triglycerides between control (blue bars) and buttermilk (red bars) groups.)

The details of the results are expressed in the table below:

Table2. T-statistics and significance levels for each cardiovascular parameter

Parameters measured	t-statistics	p-value	significance
Systolic blood pressure (mm Hg)	2.973	.00305	Yes
Diastolic blood pressure (mm Hg)	1.851	.06456	No
Mean arterial pressure (mm Hg)	2.505	.01250	Yes
Blood Total cholesterol level	5.401	.000001	Yes
Blood HDL-cholesterol level	-19.327	.000001	Yes
Blood Triglyceride level	4.792	.000002	Yes

These results are shown in the diagram below:

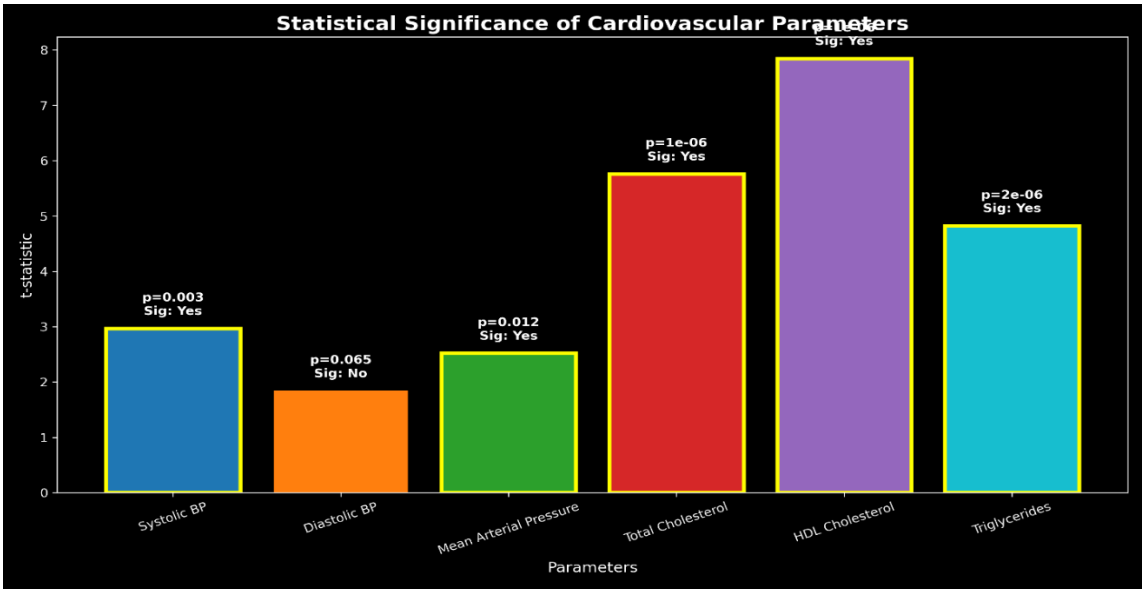

Figure 2. T-statistics and significance levels for each cardiovascular parameter

*(Statistical significance is indicated above each parameter: ns = not significant, * = $p < 0.05$, *** = $p < 0.001$)*

Overall, buttermilk consumption was associated with statistically significant reductions in systolic blood pressure, mean arterial pressure, total cholesterol, and triglycerides, alongside a robust increase in HDL cholesterol. The effect on diastolic blood pressure was not significant. These findings suggest that buttermilk exerts beneficial effects on cardiovascular risk markers, with particularly great improvements in lipid metabolism.

DISCUSSION

The present study investigated the effects of buttermilk consumption on blood pressure and lipid parameters in a large sample (n = 340 per group). Overall, the findings suggest that buttermilk intake exerts beneficial effects on cardiovascular risk markers, though the magnitude and consistency of these effects vary.

Systolic blood pressure and mean arterial pressure were significantly reduced in the buttermilk group compared to controls (p = .003 and p = .012, respectively). Although diastolic blood pressure also declined slightly, this change did not reach statistical significance (p = .065). These results indicate that buttermilk may contribute to modest improvements in vascular function, particularly by reducing systolic load, which is a

critical determinant of cardiovascular risk. The absence of significant effects on diastolic pressure suggests that the antihypertensive potential of buttermilk may be limited in scope and requires further investigation. These findings are consistent with prior evidence reporting blood pressure reductions following buttermilk intake in hypercholesterolemic populations (Conway et al., 2014).

In addition to blood pressure, buttermilk consumption produced favorable changes in lipid parameters. Significant reductions in total cholesterol and triglycerides were observed, accompanied by a robust increase in HDL cholesterol. These results align with earlier studies demonstrating that buttermilk intake can lower serum cholesterol and triglyceride concentrations, with particularly pronounced effects in individuals with elevated baseline LDL-C levels (Conway et al., 2013). Although reductions in LDL-C did not reach statistical significance in the overall population, the subgroup findings highlight the potential of buttermilk to improve lipid metabolism in at-risk individuals.

Taken together, the evidence supports the hypothesis that buttermilk exerts cardio protective effects through dual mechanisms: modest reductions in blood pressure and improvements in lipid profile. These outcomes are consistent with broader literature on dairy-derived bioactive peptides and milk fat globule membrane components, which have been shown to influence vascular function and cholesterol metabolism (Cais-Sokolińska & Rudzińska, 2018; Thompson et al., 1982; Robinet et al., 2010).

Given the widespread consumption of buttermilk in South Asia, particularly in rural Nepal, these findings carry important public health implications. Incorporating buttermilk into the diet may represent a culturally acceptable and cost-effective strategy for reducing cardiovascular risk. However, the modest effect sizes and variability across parameters underscore the need for longer-term, randomized controlled trials to confirm these benefits and clarify the mechanisms involved. Future research should also explore the role of fermentation, probiotic content, and milk fat globule membrane components in mediating these effects.

The beneficial outcomes observed in this study may be attributed to several bioactive components inherent in fermented dairy products. Bioactive peptides, generated during fermentation, are known to exert antihypertensive effects through angiotensin-converting enzyme (ACE) inhibition, thereby contributing to blood pressure regulation (Thompson et al., 1982; Robinet et al., 2010). Probiotics present in buttermilk may further enhance endothelial function and modulate inflammatory pathways, supporting vascular health (Liutkevičius et al., 2016). Additionally, alterations in fatty acid composition and the

presence of milk fat globule membrane (MFGM) components have been linked to improvements in lipid metabolism and reductions in serum cholesterol (Cais-Sokolińska & Rudzińska, 2018; Mesilati-Stahy & Argov-Argaman, 2014).

The significant improvements in lipid parameters observed in this study align with previous evidence suggesting that fermented dairy products can positively influence cardiovascular risk factors by lowering total cholesterol and triglycerides while enhancing HDL cholesterol (Conway et al., 2013; Conway et al., 2014). Collectively, these mechanistic pathways provide a plausible explanation for the cardio protective potential of buttermilk and underscore the importance of its bioactive constituents in modulating cardiovascular health.

Conclusions

This study demonstrates that regular consumption of buttermilk leads to statistically significant improvements in lipid profile and modest reductions in blood pressure. Specifically, buttermilk intake was associated with lower total cholesterol and triglycerides, a substantial increase in HDL cholesterol, and small but significant reductions in systolic and mean arterial pressure. These findings highlight buttermilk as a potentially valuable dietary component for cardiovascular risk reduction, particularly in populations with elevated lipid levels.

While the lipid improvements observed are robust and clinically meaningful, the blood pressure effects appear modest, suggesting that buttermilk should be considered as a supportive dietary measure rather than a primary intervention. Nevertheless, its accessibility, cultural acceptance, and affordability make it an attractive option for inclusion in cardiovascular prevention strategies.

Future research should focus on long-term randomized controlled trials to confirm these benefits, clarify underlying mechanisms, and explore potential dose-response relationships. Such investigations will be essential to establish the role of buttermilk within broader dietary and public health frameworks aimed at reducing cardiovascular risk.

Author's Contributions:

Balram Neupane: Conceptualization, methodology, analysis, investigations, original draft, review and editing; Khimdhoj Karki: Literature review, analysis, results, review and editing. Abina Pun Magar: methodology, original draft, review and editing, Mamata Neupane: methodology, original draft, review and editing, Renuka Rana: methodology,

original draft, review and editing Puspa KC Puspa KC: methodology, analysis, review and editing.

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Data Availability Statement: The data are available from the corresponding author upon reasonable request.

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