Effect of Ice Massage to Abdomen on Blood Glucose Level and Cardiovascular Function in Healthy Individuals: A Single-group Pre-test and Post-test Experimental Study

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Background: Ice massage is commonly employed in the management of non-communicable diseases like hypertension and diabetes. However, there is a paucity of evidence regarding abdominal ice massage on blood glucose level (BGL) and cardiovascular function either in healthy or pathological conditions. Thus, this study was conducted to assess the effects of ice massage to the abdomen on BGL and cardiovascular functions in healthy individuals.

Materials and methods: In our single-group pre-test and post-test experimental study, 50 healthy (27 females and 23 males) volunteers aged 24.72 ± 5.48 years were recruited. All the subjects underwent only one session of ice massage to the abdomen for 20 min. Random BGL and cardiovascular functions such as systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse rate (PR), pulse pressure, mean arterial pressure (MAP), rate pressure product (RPP), and double product (Do-P) were assessed before, immediately after, and 20 min after the intervention.

Results: The study showed a significant reduction in PR, RPP, and Do-P in the post-test assessments, whereas in the follow-up assessment (i.e., 20 min after the intervention), a significant reduction was found in random blood glucose, SBP, DBP, PR, MAP, RPP, and Do-P compared to the pre-test assessments. No adverse effects were reported by any of the participants during and after the intervention.

Conclusion: Twenty minutes of ice massage to the abdomen improves cardiovascular function immediately after the intervention, whereas after 20 min of intervention, it reduces BGL in addition to improving cardiovascular function in healthy individuals. However, long-term randomized controlled trials in patients with diabetes are recommended with a larger sample size to warrant the clinical efficacy of this study.

KEYWORDS: Ice; hydrotherapy; massage; blood glucose; blood pressure

INTRODUCTION

Blood glucose monitoring plays a crucial role in recognizing the trends in blood glucose fluctuations that arise from factors like dietary choices, physical activity, medication use, and underlying medical conditions such as diabetes mellitus. Abnormally elevated or reduced blood sugar levels can pose significant risks in immediate emergencies and long-term health consequences.[1,2] Blood pressure (BP) emerges from the interplay between cardiac output and peripheral resistance, with cardiac output being influenced by heart rate (HR) and stroke volume. Consequently, HR is a key determinant of BP. Indicators like systolic blood pressure (SBP) and diastolic blood pressure (DBP) are recognized as prime predictors of cardiovascular disease (CVD) risk.[3] Non-communicable diseases (NCDs), such as CVDs, diabetes, cancers, and chronic respiratory disorders, cause

41 million deaths yearly, 74% of global deaths, with 17 million premature deaths before the age of 70 years, 86% in low- and middle-income countries.[4] The development of NCDs appears to be influenced by a combination of biological and behavioral risk factors, including tobacco use, alcohol consumption, lack of physical activity, overweight and obesity, inadequate consumption of fruits and vegetables, elevated levels of BP, blood glucose, and cholesterol, as well as high intake of fats and sodium.[5,6] The naturopathic approach to health care stands out as one of the most commonly utilized complementary and alternative medicine modalities for addressing NCDs. Naturopathic treatments such as hydrotherapy, mud therapy, and massage have been demonstrated to individually contribute to maintaining glycemic control and cardiovascular function.[7] Hydrotherapy involves using water, whether as liquid, ice, or steam, externally or internally, to promote health or treat different diseases, utilizing varying temperatures, pressures, durations, and application sites.[8] Ice massage, characterized by its simplicity, ease of use, and cost efficiency, has been evidenced in prior research to significantly decrease SBP, DBP, and HR, while concurrently enhancing heart rate variability (HRV) toward vagal dominance in healthy subjects.[9] Furthermore, the application of cold abdominal pack has been reported to lower blood glucose levels (BGLs) and BP.[10] However, there is a paucity of evidence regarding the effects of ice massage to the abdomen on BGL and cardiovascular function. This study aimed to assess the effects of ice massage to the abdomen on BGL and cardiovascular functions among healthy individuals.

MATERIALS AND METHODS

Study Design

This study was designed as a single-group pre-test and post-test experimental study. All the eligible subjects were given an ice massage to the abdomen for 20 min. Assessments were taken before and after the intervention (Figure 1).

Participants

Fifty healthy (27 females and 23 males) volunteers aged 24.72 ± 5.48 years and who fulfilled the eligibility criteria were recruited from a yoga and naturopathy medical college and hospital in Chennai, using convenient sampling techniques. The inclusion criteria were as follows: participants aged 18–35 years, body mass index less than 30 kg/m^2, and willing to provide consent. The exclusion criteria were as follows: participants with any systemic diseases, under any conventional medications, alcohol, smoking, or drug abuse. The study protocol was approved by the Institutional Ethics Committee of Government Yoga and Naturopathy Medical College, Chennai, India. All the subjects provided written informed consent. The participants were intimated that they could withdraw from the study whenever they wanted either with or without any valid reason.

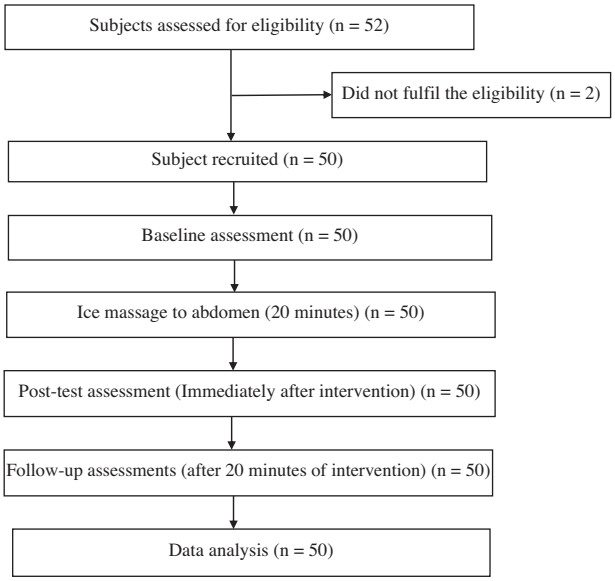

Figure 1. Trial profile.

Intervention

Ice massage to the abdomen

All participants were asked to lie on the massage table in a supine position without any discomfort. A rubber bag was filled with broken ice (1–2°C), and the mouth of the bag was closed with a suitable lid.[9] The massage was performed on the participant's abdomen using continuous circular motions starting from around the umbilicus to peripheral area and vice versa in clockwise direction at the rate of approximately 4 (around the umbilicus) to 10 s (peripheral area)/circle for 20 min.

Intervention to all the participants was provided by one of the authors.

Outcome Measures

Random blood glucose

The random blood glucose (RBG) level was measured using capillary blood by a glucometer (Accu-Chek Extra Care Roche Diabetes Care India Pvt. Ltd., Mumbai, Maharashtra, India).

Blood pressure

SBP, DBP, and pulse rate (PR) were assessed using a digital sphygmomanometer (Omron HEM, Omron Corporation, Kyoto, Japan). Pulse pressure (PP), mean arterial pressure (MAP), rate pressure product (RPP), and double product (Do-P) were derived by using the following formulas. PP was calculated as SBP − DBP; MAP as DBP + ⅓PP; RPP as HR × SP/100; and Do-P as HR × MAP/100.[10,11] The outcomes were assessed three times, i.e., before the intervention (pre-test), immediately after the intervention (post-test), and 20 min after the intervention (follow-up test). All the outcomes were assessed by one of the authors of this study.

Data Analysis

Repeated measures of analysis of variance with post hoc analysis and Bonferroni adjustment for multiple comparisons were used to assess the differences between the pre-test, post-test, and follow-up tests using Statistical Package for the Social Sciences (SPSS) for Windows (version 16.0, SPSS Inc., Chicago, USA).

RESULTS

The study initially approached 52 participants, who were then screened for eligibility. Among them, 2 participants did not meet the eligibility criteria, leaving a total of 50 eligible participants who underwent the intervention. Notably, there were no dropouts during the study. Finally, post-intervention assessments and statistical analysis were conducted for the complete group of 50 participants. Baseline and demographic details are shown in Table 1. The study showed a significant reduction in PR, RPP, and Do-P in the post-test assessments, whereas in the follow-up assessment (i.e., 20 min after the intervention), a significant reduction was found in RBG, SBP, DBP, PR, MAP, RPP, and Do-P compared to the pre-test assessments (Table 2). No adverse effects were reported by any of the participants during and after the intervention.

TABLE 1. Demographic Details of the Study Participants

Variables	*Study Participants (n = 50)*
Age (years)	24.72 ± 5.48
Gender	Female (n = 27), male (n = 23)
Height (m)	1.60 ± 0.07
Weight (kg)	60.62 ± 10.18
Body mass index (kg/m^2)	23.68 ± 3.11

Note: All values are in mean ± standard deviation, except gender.

DISCUSSION

To the best of our knowledge, this is the first-ever study to assess the effect of ice massage to the abdomen on BGL and cardiovascular function in healthy individuals. The results of this present study showed a significant reduction in RBG, SBP, DBP, PR, MAP, RPP, and Do-P, and an insignificant decrease in PP compared with its baseline. This study indicates that ice massage to the abdomen effectively reduces BGL and BP. The reduction in RBG could be achievable through the following mechanism: Using cold application results in a decrease in skin temperature and triggers the constriction of peripheral blood vessels under signals from the hypothalamus. Consequently, deeper blood vessels dilate, prompting increased blood flow to the tissues, which in turn boosts metabolism and the utilization of glucose.[12] Exposure to cold temperatures activates the transient receptor potential melastatin-like 8 (TRPM8) ion channel, a thermosensitive ion channel.[13] Activation of TRPM8 significantly influences the adipogenic browning process of white adipose tissue, potentially augmenting energy expenditure. The primary function of brown adipose tissue, induced through this process, is to mediate non-shivering thermogenesis.[14] The cold exposure may contribute to a reduction in glycemia

TABLE 2. Pre-test, Post-test, and Follow-up Assessments of the Study Group (n = 50)

Parameter	*Pre-test (a)*	*Post-test (b)*	*Follow-up (c)*	*p-value (a) vs. (b)*	*p-value (a) vs. (c)*
SBP (mmHg)	115.76 ± 10.67	114.94 ± 9.87	111.58 ± 9.99	0.939	<0.001[b]
DBP (mmHg)	76.70 ± 7.48	76.08 ± 8.09	74.38 ± 8.30	1.000	0.037[b]
PR (beats/min)	81.66 ± 11.41	77.74 ± 10.39	77.40 ± 11.55	0.002[a]	<0.001[b]
PP (mmHg)	39.06 ± 9.38	38.86 ± 7.69	37.20 ± 7.03	1.000	0.125
MAP (mmHg)	89.72 ± 7.46	89.03 ± 7.93	86.78 ± 8.26	0.857	<0.001[b]
RPP	94.88 ± 17.61	89.67 ± 16.15	86.79 ± 17.44	0.001[a]	<0.001[b]
Do-P	73.47 ± 12.89	69.55 ± 13.07	67.60 ± 14.03	0.001[a]	<0.001[b]
RBG (mg/dl)	105.80 ± 14.00	107.12 ± 14.46	102.06 ± 11.15	1.000	0.033[b]

Note: All values are in mean ± standard deviation.
[a]$p < 0.05$ in the post-test compared to pre-test assessments.
[b]$p < 0.05$ in the follow-up compared to pre-test assessments based on repeated measures of analysis of variance with post hoc analysis and Bonferroni adjustment for multiple comparison.
DBP = diastolic blood pressure; Do-P = double product; MAP = mean atrial pressure; PP = pulse pressure; PR = pulse rate; RBG = random blood sugar; RPP = rate pressure product; SBP = systolic blood pressure.

through improved energy expenditure and enhanced non-shivering thermogenesis, mediated by TRPM8 activation. Furthermore, cold exposure is postulated to improve insulin sensitivity via the promotion of glucose transporter 4 translocation, a critical transporter facilitating glucose uptake into myocytes and adipocytes.[15] Cold exposure may activate peripheral cold receptors, potentially triggering an initial surge in sympathetic nervous system activity. This increase in sympathetic activity could lead to a rise in central arterial pressure, subsequently engaging the baroreflex mechanism. The baroreflex plays a crucial role in attenuating sympathetic nerve activity and facilitating a shift toward parasympathetic dominance.[16] The parasympathetic nervous system significantly influences pancreatic functions by promoting insulin secretion and contributes to the reduction of BGLs through the suppression of the gluconeogenesis pathway in the liver.[17]

The study showed a significant improvement in various cardiovascular parameters. The significant reductions in HR might be attributed to parasympathetic dominance.[3] Likewise, reduction in SBP and DBP might be attributed to the effects on either baroreceptor reflex or significant reduction of HR/PR. Because BP = cardiac output (CO) × peripheral resistance, wherein CO = HR × stroke volume, thus HR forms one of the determinants of BP.[9] Significant reduction in MAP might be attributed to the reduction in SBP (a component of PP, i.e., PP = SBP − DBP). Autonomic dysfunction is one of the leading causes of morbidity and mortality in diabetics. RPP and Do-P are the important indirect indicators of myocardial oxygen consumption and load on the heart. Moreover, when HRV analysis is not available, RPP can be used as a simple measure of the overall HRV. The results of the study showed a significant reduction in RPP and Do-P. This indicates strain-lowering effects and better autonomic regulation of the heart.[10,11] Hence, 20 min of ice massage to the abdomen not only reduces BGL but also improves cardiovascular functions. A previous study has shown that 20 min of a cold abdominal pack was effective in improving BGL and cardiovascular function in patients with type 2 diabetes mellitus.[10] This supports our results and suggests the positive impact of 20 min of ice massage to the abdomen on BGL and cardiovascular function in healthy individuals.

Strengths of the Study

This study represents a pioneering endeavor, being the first to investigate the impact of abdominal ice massage on BGLs and cardiovascular function in healthy individuals. Notably, none of the participants

experienced any adverse effects during the procedure.

Limitations of the Study

It is important to note that this study exclusively involved healthy individuals, focusing solely on the immediate effects of abdominal ice massage on BP without evaluating HRV. Additionally, the study had a small sample size, the sample size was not calculated based on any previous studies, and the study lacked both a control group and an assessment of the intervention's long-term effects and underlying mechanisms.

Future Directions of the Study

To consolidate these findings, it is advisable to replicate the study with a larger cohort to ensure their generalizability. Furthermore, extending the investigation to include longitudinal follow-up would offer valuable clinical insights, particularly regarding the effects of abdominal ice massage on BGL and cardiovascular function across various CVD conditions.

CONCLUSION

Twenty minutes of abdominal ice massage reduces BGL and improves cardiovascular function in healthy individuals. However, long-term randomized controlled trials in patients with diabetes are recommended with a larger sample size to warrant the clinical efficacy of this study.

CONFLICT OF INTEREST NOTIFICATION

The authors declare there are no conflicts of interest.

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