

Effect of neutral douche on autonomic variables in normal healthy individuals: A randomized controlled trial

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Received 02 June 2025; revised 18 February 2026; accepted 13 March 2026

Neutral douche or hydrotherapy modality using water of neutral temperature is widely used to induce relaxation and promote autonomic equilibrium. Despite its widespread clinical use, the autonomic physiological responses to neutral douche remain insufficiently characterized in controlled settings. Therefore, this study aimed to evaluate the impact of neutral douche on autonomic outcomes in healthy individuals. In a randomized controlled trial, 60 healthy volunteers aged 17-35 were randomly assigned to the experimental neutral douche group (n=30) or the control group (n=30), which underwent standing rest for 20 min without hydrotherapy exposure. The intervention consisted of a general body douche at 35°C-37°C for 20 min, while the control group stood in the same environment without receiving the treatment. Measurements of heart rate, blood pressure, respiratory rate, and heart rate variability (HRV) were taken pre- and post-intervention. Exposure to neutral douche resulted in a significant reduction in heart rate ($p<0.01$) as well as a prolongation of mean RR intervals, indicating that the neutral douche may enhance parasympathetic activity. The HRV analysis from this group also suggested that there was a significant decrease in low frequency power ($p<0.01$), and a significant increase in high frequency power ($p<0.01$), suggesting that neutral douche could prevail in parasympathetic dominance. Interestingly, the neutral douche group experienced a significant decrease in HR, while systolic blood pressure and diastolic blood pressure significantly increased ($p<0.05$). The increase in BP may be related to baroreflex regulation or the possible physical effects of the water perfusion pressure. Collectively, the findings suggest that neutral douche facilitates parasympathetic activity and alters blood pressure, potentially benefiting those with autonomic dysfunction or sympathetic dominance. Further research is needed to explore its therapeutic applications and long-term effects.

Keywords: Autonomic function, Blood pressure, Heart rate variability, Hydrotherapy, Neutral douche, Parasympathetic activity

IPC Code: Int Cl.²⁶: A61H 33/00, A61H 35/00

Hydrotherapy refers to the structured clinical application of water-based interventions, in various forms, to promote health or treat medical conditions¹. Hydrotherapy involves the use of water at multiple temperatures, including cold, neutral, warm, and alternating temperatures². Rational Hydrotherapy by Kellogg is a comprehensive treatise that thoroughly explains the various techniques and effects of hydrotherapy³.

Among hydrotherapeutic modalities, the douche technique is the most powerful and versatile, easily adaptable to a wide range of conditions and indications. It involves a single or multiple streams of water directed at a specific area of the body, offering a compound effect that combines both thermal and mechanical benefits. Among its various forms, neutral

douche is particularly employed for its relaxing and autonomic stabilizing properties and forms the primary intervention of this present study. It is a multifaceted therapy that integrates both thermal and mechanical actions. The thermal effects are achieved through the application of water at differing temperatures, while the mechanical effects stem from the force of water striking the body's surface. When administered at an appropriate intensity, this technique can induce significant physiological responses³. In the present study, we used the general-body horizontal douche application with neutral temperature, and it is one of the most useful forms of the douche in clinical hydrotherapy practice.

Several clinical studies have investigated the effects of various forms of douches on autonomic function, respiratory parameters, and the management of a range of physical and psychological conditions.

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Based on a self-controlled trial design study, the alternate douche has been shown to enhance parasympathetic activity, making it beneficial for managing lifestyle disorders associated with sympathetic dominance. It may be particularly effective for conditions such as insomnia, stress, endothelial dysfunction, low gastric secretion, thyroid disorders, and hypertension⁴. Neutral water douche is an effective non-pharmacological intervention for managing pain and systemic symptoms associated with primary dysmenorrhea⁵. Neutral douche and the gastro-hepatic pack have been shown to help reduce blood glucose levels in patients with Non-Insulin Dependent Diabetes Mellitus⁶. Cold water douching and ice massage are effective in reducing body temperature in patients suffering from external heat stroke⁷. Regular cold affusions may reduce the likelihood of respiratory infections and enhance overall subjective well-being⁸. Tonic hydrotherapies like the needle shower and Scotch douche benefit psychoneuroses and depression. For alcoholism, eliminative treatments such as electric cabinet, needle shower, Scotch douche, and dry pack help relieve toxemia⁹.

Despite the clinical backing for using douches in managing these conditions, there is a notable gap in the scientific literature regarding the specific impact of neutral douches on autonomic variables. Autonomic functions, including heart rate variability (HRV), blood pressure regulation, and other markers of autonomic nervous system balance, have not been thoroughly explored in the context of neutral water douching. Therefore, a study focused on evaluating these variables in response to neutral douche could provide new insights into their physiological effects and offer a deeper understanding of their potential therapeutic benefits.

Methodology

Sample size

The sample size was determined using G*Power 3.1.9, based on the previous literature, assuming a moderate effect size (Cohen's $d=0.6$) with a two-sided 5% significance level, 1:1 allocation ratio, 80% power. This yielded an initial requirement of 54 participants. After including a 10% attrition rate, the final sample size was set at 60, with 30 subjects per group^{4,5,10}.

Study design and sampling

A parallel-group randomized controlled trial design involving 60 apparently healthy adults randomly

allocated into two groups using a computer-generated randomization sequence with a 1:1 allocation ratio. Allocation concealment was ensured through sequentially numbered, sealed opaque envelopes prepared independently. The study group (30 participants) received a neutral douche, while the control group (30 participants) stood without treatment for 20 min. Due to the nature of the intervention, participant blinding was not feasible, and the outcome assessment was performed by an independent assessor who was blinded to group allocation. These assessments were conducted at baseline and after 20 min on the same day (Fig. 1).

Participants

Sixty normal healthy volunteers aged between 17 to 35 years were recruited from a residential college. Both male and female healthy volunteers were included. Female subjects were selected for autonomic variables, which have not been shown to vary with the phases of the menstrual cycle¹¹ and those who were taking medication that could influence autonomic function have been excluded¹². The study was conducted in a holistic health centre in the southern part of India. The institutional ethics committee approved the study protocol (EC-633), and written informed consent was obtained from each participant, which was prospectively registered in the clinical trial registry of India (CTRI) with registration number CTRI/2023/11/059595.

Intervention

Study group

Participants were instructed to wear minimal clothing and drink a glass of cold water before the treatment. The required pressure was regulated from a distance of 5 to 6 ft, the jet spray was directed with a pressure of 2 to 20 pounds, and the temperature of neutral douche: 35°C to 37°C³. Treatment was started from the feet and then to the back for 7 min. After completion of the back and legs subject was asked to change his side, and a douche was given on either side for 6 min. After that, the front of the body was treated with a douche. Care was taken to prevent excess pressure while applying to the chest region by crossing arms over each other, and palms were placed on the opposite shoulders so that the heart and lung areas are protected. Again, douche was given from the feet to both legs and abdomen in the anterior direction for 6 min, then the subject was asked to keep the hand

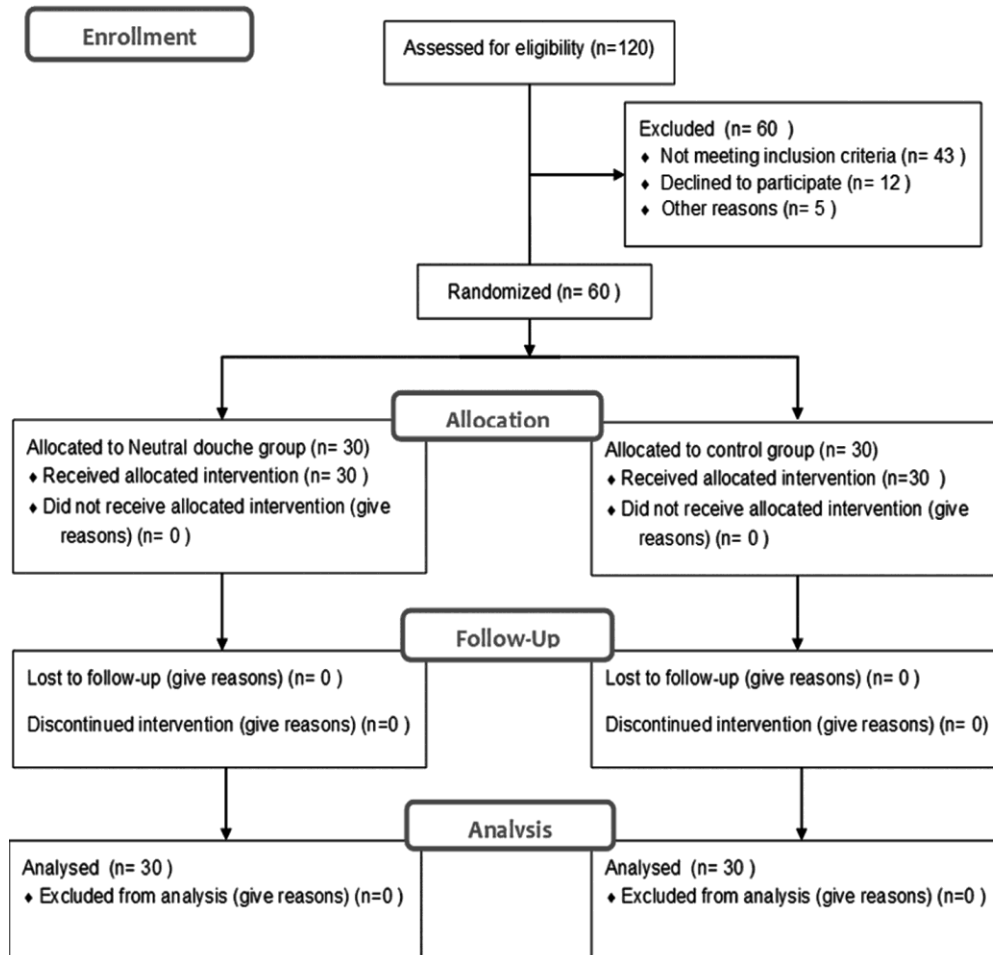


Fig. 1 — Illustration of the trial profile

down, and douche was given to the front side of the hand for 1 min. No application was made to the face³.

Control group

The control procedure was designed to replicate the intervention setting in terms of posture, environmental exposure, duration, and hydration, excluding hydrotherapy exposure. The subjects were advised to drink a glass of cold water and asked to stand in the same standardized position for 20 min. Although this approach minimized confounding variables, postural changes can influence autonomic changes through orthostatic effects, which represents a potential limitation of the study.

Outcomes

Blood pressure

Blood pressure was measured using a mercury sphygmomanometer (BPMR-120 Mercury BP Diamond Deluxe) while the subject was in the supine

position, both before and after the procedures. The measurements were taken by auscultating the right brachial artery. The first tapping sound, known as the Korotkoff sound, indicated the systolic pressure, while the point at which the sounds became muted indicated the diastolic pressure.

Body temperature

Body temperature was assessed using a mercury-in-glass thermometer placed in the left axillary region following standard measurement protocol¹³.

Respirogram

Respiration was recorded using a volumetric pressure transducer [stethograph] that was attached to the polygraph's AC amplifier and had its sensitivity adjusted as needed was used to capture respiration. As the participant sat upright, the stethograph was attached around the trunk, about 8 cm below the lower costal border.

Digital pulse volume

The digital pulse volume (DVP) is recorded by placing a transducer on the palmar surface of the left thumb's distal phalanx. Photoplethysmography enabled non-invasive recordings of arterial blood volume by measuring light absorption by hemoglobin. The DVP amplitude was measured in millimeters from the peak of pulse waves at 30-second intervals.

Heart rate variability spectrum (HRV)

Ag/AgCl pre-gelled electrodes and a bipolar limb lead II configuration (BIOPAC, Montana, USA; model No: BSL 4.0 MP 36) were used to record the electrocardiogram (ECG) while the patient was supine for five minutes. A 12-bit analog-to-digital converter (ADC) digitized the ECG, and the heart rate series was derived from the consecutive R-R intervals detected in the R waves.

Spectral analysis of HRV was performed using Fast Fourier Transform (FFT) algorithms, focusing on three frequency bands: extremely low frequency (0.0-0.05 Hz), low frequency (0.05-0.15 Hz), and high frequency (0.15-0.50 Hz). Normalized units expressed high-frequency and low-frequency values. The Kubios version 2.0 software extracted frequency domain metrics (VLF, LF, HF, LF/HF ratio) and time-domain metrics (mean RR interval, mean heart rate, RMSSD, NN50, pNN50) from the FFT analysis.

Statistical analysis

Data processing and inferential analyses were conducted using the Statistical Package for the Social Sciences (SPSS) software (Version 24.0). Distribution normality was assessed using the Shapiro-Wilk test,

and within-group comparisons were done by Paired sample T-test, Wilcoxon Signed-Rank test, and comparative analysis between the groups was done by Independent T-test and Mann-Whitney U test. p-value < 0.05 was considered significant. The statistical analyst was blinded in this study.

Results

The baseline was comparable, and the results of the Baseline, T1 data comparisons for both groups are detailed below (Table 1)

Within-group analysis

In neutral douche

When we compare the mean value of Heart Rate(HR) there was a significant reduction in the HR (p<0.01) from 81.46±8.76 to 74.97±9.62 and a reduction in the mean score of Pulse rate (PR) from 73.72±7.88 to 72.52±8.28, Respiratory rate (RR) from 14.67±1.46 to 14.6±1.3. BP Systolic(SBP), there was a significant increase in SBP from 111.27±11.87 to 116.33±10.09, Diastolic BP (DBP), there was a significant increase in DBP from 70.73±8.54 to 78.6667±22.25

In the standing rest group

When we compare the mean value of Heart Rate (HR) there was a significant reduction in the HR (p<0.01) from 84.05±8.14 to 81.22±8.85 and a reduction in the mean score of Pulse rate (PR) from 74.46±6.27 to 75.63±6.73, Respiratory rate (RR) from 15.11±1.12 to 15.36±0.95. BP Systolic (SBP), there was a significant increase in SBP from 112.33±12.45

Table 1 — Differences in primary and secondary effectiveness outcomes, both within groups and between groups

	Within group						Between group p value
	Study group			Control group			
	Pre (mean±SD)	Post (mean±SD)	MD [95% CI]	Pre (mean±SD)	Post (mean±SD)	MD [95% CI]	
HR	81.28±8.67	74.96±9.46***	6.3136[3.12, 9.51]	84.05±8.14	81.22±8.85	2.82* [0.42, 5.24]	0.01*
Mean RR	738.74±110.69	773.36±107.72**	-34.6 [-55.15, -14.09]	725.08±73.47	740.35±81.37	-15.26** [-25.50, -5.04]	0.266
PNN50	57.48±52.43	69.45±61.30	-4.13 [-9.49, 1.21]	66.15±53.23	71.24±57.94	-1.33 [-5.17, 2.51]	1
RMSSD	44.68±34.55	48.60±31.87	-3.91 [-10.86, 3.03]	42.55±19.41	40.77±16.55	1.781 [-6.40, 9.96]	0.236
LF	63.17±21.46	56.13±21.71*	7.04[0.52, 13.57]	62.19±14.66	62.63±17.54	-0.443 [-5.89, 5.01]	0.204
HF	36.83±21.46	43.87±21.71*	-7.04[-13.57, -0.52]	37.81±14.66	37.37±17.54	0.433 [-5.01, 5.89]	0.204
LF/HF Ratio	3.07±2.93	2.19±2.75	0.87 [-0.20, 1.95]	2.14±1.47	2.52±2.20	-0.389 [-1.01, 0.24]	0.326
PR	73.73±7.75	72.57±8.15	-1.15 [-1.18, 3.50]	74.46±6.26	75.63±6.73	-1.16 [-2.83, 0.51]	0.117
Resp	14.70±1.45	14.69±1.36	0.0149 [-0.39, 0.41]	15.11±1.11	15.36±0.94	-0.2506 [-0.65, 0.15]	0.028*
Temp	97.11±1.16	96.98±0.98	0.125 [-0.33, 0.58]	96.92±1.05	96.91±1.00	0.01 [-0.34, 0.35]	0.772
SBP	110.90±11.84	116.13±9.98**	-5.22 [-8.34, -2.11]	112.33±12.45	110.93±11.88	1.4 [-2.23, 5.03]	0.069
DBP	70.39±8.61	81.94±28.46	-11.54* [-22.52, -0.58]	69.60±15.83	72.27±7.89	-2.66 [-7.99, 2.65]	0.109

HR- heart rate, RR- the time interval between two consecutive R-waves on an electrocardiogram, pNN50 - Percentage of successive RR intervals that differ by more than 50 ms, RMSSD - Root mean square of successive RR interval differences, LF- low frequency band, HF – high frequency band, PR – pulse rate, SBP – systolic blood pressure, DBP – diastolic blood pressure. (p <0.05 *, <0.01 **, <0.001 ***)

to 110.93 ± 11.88 , Diastolic BP (DBP), there was a significant increase in DBP from 69.6 ± 15.84 to 72.27 ± 7.89 .

When we compared both groups, a significant difference was found on Heart rate ($p=0.011$), Respiratory RR ($P=0.012$).

In HRV, among the time domain analysis

When we compare the mean value of MEAN RR, there was a significant increase in the mean value ($p<0.01$) from 728.65 ± 97.01 to 764.43 ± 97.19 and an increase in the mean score of RMSSD from 43.05 ± 33.9 to 47.1 ± 31.29 , PNN50 from 16.49 ± 17.54 to 20.76 ± 20.48 . In the standing rest group, when we compare the mean value of MEAN RR, there was a significant increase in the mean value ($p<0.01$) from 725.08 ± 73.48 to 740.35 ± 81.37 and an increase in the mean score of RMSSD from 42.55 ± 19.42 to 40.77 ± 16.55 , PNN50 from 16.49 ± 17.54 to 20.76 ± 20.48 .

Among frequency domain analysis

When we compare the mean value of LF, there was a significant reduction in the mean value ($p<0.01$) from 64.66 ± 20.16 to 57.38 ± 20.92 and an increase in the mean score of HF from 35.34 ± 20.16 to 42.62 ± 20.92 , LF and HF Ratio from 3.16 ± 2.94 to 2.25 ± 2.78 . In the standing rest group, when we compare the mean value of LF, there was an increase in the mean value ($p<0.01$) from 62.19 ± 14.67 to 62.63 ± 17.55 and an increase in the mean score of HF from 37.81 ± 14.67 to 37.37 ± 17.55 , VLF, LF, and HF Ratio from 2.14 ± 1.47 .

Discussion

The present study, conducted to evaluate the effect of neutral douche on autonomic variables in healthy individuals, showed significant changes in HRV, along with HR and Blood pressure compared to its baseline.

These findings showed a significant increase in Mean RR along with a significant reduction in HR, which indicated parasympathetic dominance in the body post-exposure. The inverse correlation between mean RR and HR has already been studied and explained in a previous study¹⁴. Dysfunction in the autonomic nervous system is said to be one of the causes of altered cardiac automaticity, primarily causing arrhythmias¹⁵ and the above-mentioned results give an outlook of the mechanism of action of neutral douche on the same. Even though other metrics like RMSSD and PNN50 of the time domain in short-term HRV didn't show a significant increase,

they were comparatively higher than baseline, reflecting greater autonomic flexibility and vagal tone, which also explains the above-mentioned PNS activity^{16,17}.

The frequency domain of HRV also showed similar results. LF (low frequency), HF (high frequency), and LF/HF Ratio showed significant changes in favor of PNS activity. LF band, aka baroreceptor range, is produced by both SNS and PNS, along with baroreceptor activity related to blood pressure regulation^{18,19}. Significant reduction of LF values in our study explains the cardiac autonomic outflow modulation by baroreflexes²⁰ upon exposure to neutral douche. There was a significant increase in HF values, aka the respiratory band¹⁷, which explains the reduced respiratory rate post-intervention. HF primarily reflects PNS activity, related to respiration and respiratory sinus arrhythmias (RSA)²¹. LF/HF Ratio was significantly reduced, suggestive of autonomic balance and reduced SNS activity¹⁶. A significant association exists between pNN50 and RMSSD time domain measures, which further points to parasympathetic dominance in the body upon neutral douche intervention²². Similar study results on PNS activity have been obtained in earlier studies done with neutral temperatures.

Surprisingly, blood pressure monitoring showed a significant increase in (still falls in normal range) systolic blood pressure (SBP) and diastolic blood pressure (DBP) compared to its baseline, despite reduced HR, which is not typical of PNS activity. Neutral douche has 3 main factors that are active – temperature (neutral), pressure, and mass³. The increase in blood pressure might be due to the collective effect of factors as mentioned earlier, producing a mechanistic effect post-neutral douche intervention. Apart from the mechanical effect of neutral douche, increased BP might be due to baroreceptor reflex adaptation²³ or thermoregulatory vasoconstriction²⁴ along with increased stroke volume / cardiac output, improving O₂ transport²⁵. This shall also be considered as a BP modulatory capacity of the combined active factors of neutral douche. Hence, neutral douche can be regarded as a modality to be given to patients with autonomic dysfunction causing sympathetic dominance in the body.

The limitations are the minimum size, assessments were not done during the intervention, which would have given a better understanding of the physiology, and the intervention was given where humidity

(65%-80 %) was high. The study variables also have very small variability with less mean difference and less effect size, which needs to be addressed in further studies by making a validated protocol with a specific duration and pressure.

Conclusions

The present study concludes that neutral douche acts on parasympathetic activity and might have a blood pressure modulatory activity upon intervention. Neutral douche can also be given as a therapeutic modality for subjects with sympathetic dominance or those in need of relaxation (wellness).

Acknowledgements

The authors would also like to recognise the management of the SDMCNYS for providing the necessary facilities and support for conducting this research. The authors would like to express their sincere appreciation to all of the participants for their willingness to participate in the study and for their cooperation during this research project.

Funding

No funding sources in the public, private, or nonprofit sectors provided a particular grant for this study.

Author Contributions

All authors contributed to the study conception and design. Material preparation was conducted by PKP and VRA. Data collection was performed by PKP. Data analyses were performed by VRA and AS. The first draft of the manuscript was written by VRA and AS, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Conflict of Interest

The authors state that none of the work described in this publication appears to have been influenced by any known conflicting financial interests or personal ties.

Ethics Statement

The study protocol was approved by the SDM institutional ethics committee (EC-633), and all procedures were carried out in accordance with standard ethical guidelines for human research.

Informed Consent

Written informed consent was obtained from all participants before their inclusion in the study.

Data Availability

On request, the corresponding author will provide the datasets used in this work.

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