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Effect of Steam Bath on Spirometryvariables among healthy Individuals - A Randomized Control Trial

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Abstract: Background: Despite being widely usedin naturopathy clinics, yoga studios, and other health-related facilities all over the world, the mechanism underlying the therapeutic value of steam baths is not well understood. In order to learn how steam baths, alter spirometry measurements in healthy participants, our goal was to conduct research.

Materials and Methodology:

The study involved 300 healthy participants of both sexes, aged 26.1 ± 3.5 years, with 170 male and 130 female participants randomly assigned to intervention and control groups. Three sessions of 15-minute steam baths every alternate day were delivered, followed by cold showers, and the results were compared to the control group's sham steam bath. Using the spirometry parameters forced vital capacity (FVC, L), forced expiratory volume in the first second (FEV1, L), and FEV1/FVC ratio (absolute value) were measured. Additionally, as a secondary objective for this study, SBP, DBP, SpO2, and PR were assessed throughout each session.

Results:

Three hundred participants were followed for 2 weeks on the trial. For the all the parameters data were collected on 1st, 3rd, 6th during intervention sessions along with (1st and 2nd week) 2 follow-ups. During intervention data shows significant improvement in pulse rateat day-1 (P=0.05), at day-3 (P=0.03), at day-6 (P=0.05). However, improved FEV1has been reported in both the follow-ups(1st week; P=0.01) and (2nd week; P=0.001). Moreover, analysis of variance (ANOVA) shows significant improvement in FEV1 (P=0.0001), FEV1/FVCratio (P=.0001) in intervention group while significant improvementin FEV1/FVC ratio (P=0.0001) has been reported to be improved in control group.

Conclusion:

Regular steam bath improves the spirometers parameters among healthy participants. However, further clinical trial on respiratory conditions require to validate the study findings.

Keywords: Hydrotherapy, Lung Functions, Steam Bath, Spirometry, Healthy people.

I. INTRODUCTION

Water therapies have been employed for many years, constituting a customary naturopathic method of treatment that was prevalent in ancient societies such as India, Egypt, China, and others. The Greeks, for instance, held the belief that water possessed distinct remedial properties. In order to serve as a centre for social and recreational activities within the city, the Romans constructed public baths, which served as precursors to contemporary spa towns. Notably, it was the 19th-century advancements in hydrotherapy that piqued the curiosity of individuals such as Sebastian Kneipp and Vincent Priesnitz. Priessnitz sought to "strengthen" patients using the "shock treatment" and ice-cold water. Conversely, Reverend Sebastian Kneipp employed gentle hydrotherapy. Since the mid-20th century, spa treatments, water exercises, and the utilization of both hot and cold water have gained popularity as medicinal practices[1]. Moreover, hydrotherapy encompasses the external or internal application of water in any of its forms (liquid, solid, or steam) for the purpose of promoting health or treating a variety of ailments. It encompasses a broad range of temperatures, pressures, durations, and locations.

The study of diseases and their treatment through the therapeutic use of various aspects of water is commonly referred to as hydrotherapy[2].

This treatment approach is typically categorized based on the state of the water (liquid, solid, gas, or mixed state), but it can also be categorized based on the mechanical stimulation employed, such as whirlpools, or the inclusion of materials like mud or minerals[3]**.** Within both conventional and alternative medicine, hydrotherapy is considered an effective treatment method with minimal side effects, thus optimizing the benefits derived from the properties of water[4].

Temperature is a commonly utilized feature of water in hydrotherapy, with cold water causing brief peripheral vasoconstriction followed by vasodilation, which promotes adequate blood perfusion to vital organs. This enhanced blood flow may assist in the treatment of chronic wounds or lymphedema, and cold water may possess analgesic and antiphlogistic properties. On the other hand, warm water helps to relax muscles and reduce spasms by dilating blood vessels[5].In addition to its temperature-related effects, water offers numerous other advantages, including its accessibility, absence of physiological irritants, excellent solvency, high viscosity, high heat capacity, and good thermal conductivity[6].

The vast array of health-sustaining, disease-preventing, and disease-curing properties of water are primarily harnessed in hydrotherapy, a treatment modality within naturopathy[7].These positive health effects are attributed to the thermal, mechanical, and chemical actions of water, either individually or in combination. Furthermore, the environmental influences experienced during hydrotherapy in a natural setting may further enhance the psychological effects. Additionally, combining complementary and alternative therapies, such as massage, rest, music, or aromatherapy, can augment the body's inherent capacity for healing and positively impact overall health[8].

One of the most popular forms of hydro-therapeutic treatments is the steam bath, in which the entire body, with the exception of the head, is exposed to moist heat[9]. Steam baths can be classified into two types of hydrotherapy measures: dry (also referred to as sauna baths) and moist (also referred to as steam baths or Russian baths). During a steam bath, individuals experience humid heat throughout their body, excluding the head, which is covered with a cold compress and receives benefits that are almost akin to those of exercise[10].

In contrast to sauna steam, there is a gap in knowledge regarding the impact of a steam bath, including evidence on its effect on the respiratory system or spirometry variables. Therefore, it is imperative to obtain sufficient evidence to support clinical recommendations for respiratory conditions. The objective of the current study is to investigate the influence of a steam bath on spirometry variables among healthy volunteers. Additionally, respiratory diseases contribute significantly to global morbidity and mortality, affecting individuals of all age groups. However, current treatments only offer symptomatic management of the condition rather than a cure, prevention, and control. Moreover, the efficacy of communicable respiratory treatments is compromised due to the emergence of antibiotic resistance[11].There was a pre-post intervention done by pandiaraja et al. [12] in which Forty healthy adult volunteers of both sex (14 male and 26 female) aged 26.38 ± 8 years participated and spirometry parameters were taken pre and post intervention. In this study steam bath session (10–15 min) was given once a week for 12 weeks and post-intervention spirometry parameters showed significant ($p<0.05$) improvement.however this study lacks the control group and large sample size.Therefore, the purpose of this study is to identify the effect of steam bath sessions on the spirometry parameters combining with the healthy control participants and by including follow up assessment we aim to assess the long-term efficacy of intervention, addressing critical gap in the previous studies.

II. METHODOLOGY

Samples and Groups **-** This prospective randomized trial comprises 300 healthy volunteers selected from the student body of the esteemed Swami Vivekanand Subharti University. The inclusion of these 300 participantswas carried out in a consecutive manner, and only the first 300 participants(out of 400 screened participants) who fulfilled the inclusion criteria were included in the study. To ensure ethical standards, the research protocol was approved by the Institutional Ethical Committee and registered in the Clinical Trial Registry of India (CTRI/2021/07/034816). Following a randomization process utilizing an online randomizer (random number generating software) and concealing the 1:1 allocation, the participants were assigned to either the intervention or control group (Fig.1).

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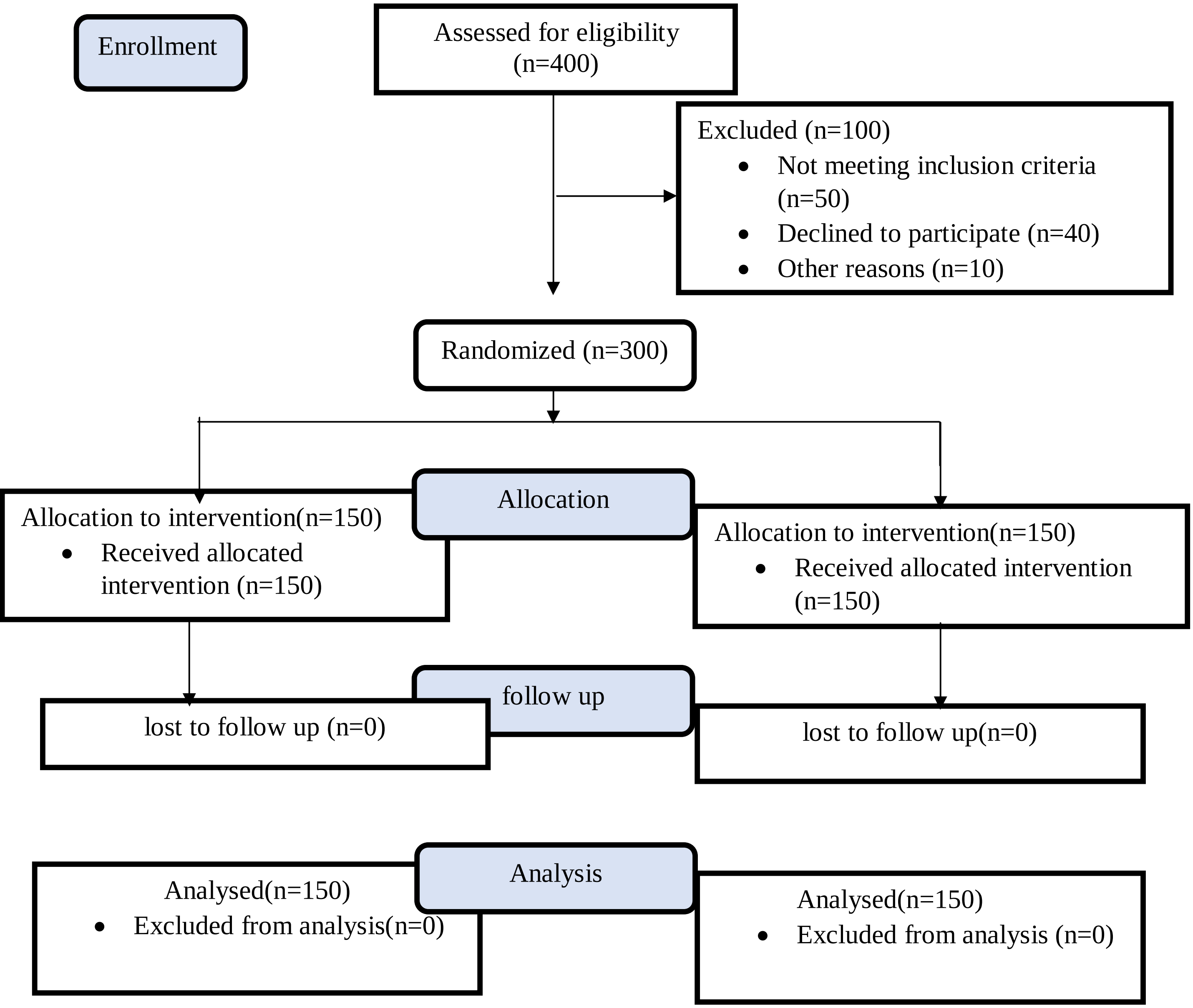

Figure 01: Study Plan

Inclusion –

- Both genders
- Age between 18 – 30 years.
- Healthy volunteers with no existing medical conditions.
- Subjects who are willing to participate in the study after signing the informed consent form.

Exclusion -

- Subjects under the influence of any psychoactive substances, sedatives, anxiolytics, anti-depressants and consuming alcohol and nicotine.
- Subjects having systemic illness and co-morbidity such as epilepsy, hypertension, diabetes mellitus.
- Pyrexia due to any reason
- Skin infections
- Cardiovascular comorbidities
- Female subjects during menstrual cycle will not participate.

III. MATERIALS AND METHODS

After the recruitment of participants, the researcher provided a verbal briefing to each participant regarding the nature of the study, the intervention, the assessment, and demonstrated the procedures involved. In order to maintain stable physiological conditions during the sessions, participants were instructed to abstain from consuming meals, beverages, and engaging in strenuous exercises within a period of 2 hours prior to the intervention. Prior to the steam bath, participants were instructed to consume a glass of water, followed by the application of sesame oil onto their bodies. Subsequently, participants were instructed to sit in a heated steam cabinet for a duration of 15 minutes, while simultaneously applying a cold compress to their heads. This was followed by taking a cold shower in order to restore their body temperatures to normal levels. Following this, participants were advised to relax for a period of time before the recording of secondary outcomes was conducted while they were seated. This process was repeated three times a week on alternate sessions.

Assessment

Primary outcome measures included the assessment of Force Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), and the ratio of FVC to FEV1. Secondary outcome measures encompassed the evaluation of Blood Pressure, Pulse Rate, and Oxygen Saturation.

For the spirometry assessments, the Clarity Model No. CMSP-01 was utilized. Demonstration of the appropriate technique to the patient was done which include all three distinct phases to the FVC maneuver, i.e., maximal inspiration, a “blast” of exhalation and continue complete exhalation to the end of the test. Measurements were performed in the sitting position. Three measurements were obtained, and the highest value of three technically satisfactory maneuvers was retained for FVC and FEV1[13,14].During the recordings, participants were seated and their nostrils were clamped using a nose clip. A certified pulmonology trainer provided a demonstration and clear instructions on the maneuver. Participants were instructed to inhale deeply, hold their breath for a duration of six seconds, and then forcefully exhale. They were then instructed to inhale once more to complete the data recording. Each participant underwent a minimum of three tests that adhered to the specified testing criteria, with the best three results being selected for final interpretation[15].The spirometer's measurements focused on Force Vital Capacity, Forced Expiratory Volume in one second, and the ratio of FVC to FEV1.

Data analysis

All the data underwent processing and analysis by employing Microsoft Office Excel (version 2010, Microsoft Corporation) and IBM SPSS Statistics (version 16) on the Windows platform. A paired and independent t-test was conducted to compare the group data at four different timepoints (baseline, post intervention, 1st week follow-up, and 2nd week follow-up). The statistical significance threshold was determined to be p 0.05.

For the analysis of two paired data sets within the group, the parametric test utilized was the Paired samples t-test, while for the comparison between unpaired groups, the Independent Sample t-test was employed. In this analysis, an alpha (α=0.05) level of significance was applied using SPSS.

IV. RESULTS

A total of 300 individuals both sex (170 male and F= 130 female), mean age 26 ±3.5 years (range 18-30)participated and successfully completed the three sessions of the steam bath and the corresponding evaluation as expected,with 150 participants assigned to each group. The demographic characteristics and average (± standard deviation) data of the participants are presented in Table 1.

Characteristic	N
No of Patients (N)	300
Age (years)	26 ±3.5 (18-30)
Gender	M=170 (56.67%) F= 130 (43.33%)
Weight (Kg)	54.98 ± 6.8
Height (m)	1.60 ± 0.08
BMI (kg/m^2)	21.4 ±2.6 (24.9-18.6)

Table-01: Descriptive characteristics of the healthy individuals included in the study

The intervention was well received without any reports of adverse events that could potentially arise from the intervention, including any issues associated with the thermal effects of the steam bath. Data was collected on the 1st, 3rd, and 6th days of the intervention sessions, as well as during the (1st& 2nd week) 2 follow-up sessions, for all the measured variables.

A. *Pulse rate, Blood pressure and Oxygen saturation measurement*

The pretest and posttest dataobtained during the intervention sessions (Day -1, Day-3, day-6) demonstrated a significant enhancement in the pulse rate beats/minute (bpm) at day-1 (77.9±6 bpm to 79±5.7 bpm, P=0.05), at day-3 (77.3±5 bpm to 78.3±4.8 bpm, P=0.03), at day-6(76.4±4.5 bpm to 77.3±5.1 bpm, P=0.05) (Table 02)(Fig 02). But in 2 successive follow up session (1st& 2nd week)no changes found in pulse rate in intervention group as compared to control group. There were no changes found in Blood pressure and Oxygen saturation measurement.

Pulse Rate (bpm)	Intervention group (N=150)			Control group (N=150)		
	Pre	Post	P- Value	Pre	Post	P value
Day1	77.9±6 (96-70)	79±5.7 (98-72)	0.05*	78.7±5 (96-72)	77.4±4.9 (97-70)	0.009**
Day3	77.3±5 (98-70)	78.3±4.8 (96-72)	0.03*	78.6±4.1 (92-72)	77.2±4.2 (90-70)	0.003**
Day6	76.4±4.5 (92-70)	77.3±5.1 (95-63)	0.05*	77.6±4.1 (90-71)	76.5±4.1 (89-70)	0.009**

*p-value < 0.05 is significant**p-value < 0.01 is highly significant

Table – 02: Pulse Rate Pre-Post comparison within the group

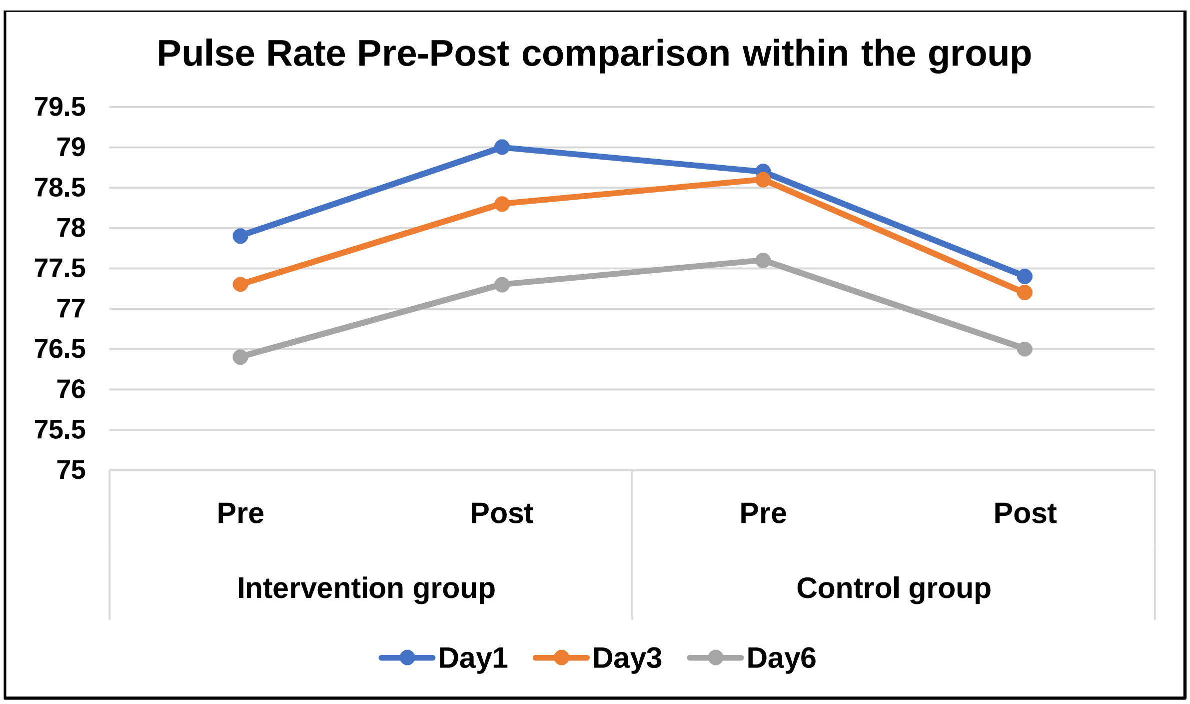

Figure 02: Pulse Rate (bpm)Pre-postcomparison within the group

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B. Spirometry Measurements

Conversely, in between group comparison both follow-up sessions exhibited asignificant improvement in FEV1(L) (1st week mean 2.7±1 L) and (2nd week mean 2.9±1 L) as compared to control group (1st week mean 2.5±1 L, P=0.01) and (2nd week2.6±1 L, P=0.001) but there were no significant changes observed in FVC (L) and FEV1/FVC ratio (%) at 1st& 2nd follow up session in between group comparison of intervention and control group. (Table03) (Table04) (Fig 03).

Post-op 1 Week	Intervention group (n=150)	Control group (n=150)	P Value
FVC (L)	2.6±1 (3.6-1.7)	2.5±1 (3.8-1.6)	0.2
FEV1 (L)	2.7±1 (3.8-1.8)	2.5±1 (3.6-1.7)	0.01**
FEV1/FVC (%)	96.6±2 (99.2-99.7)	96.7±2.2 (99.7-91.9)	0.4

**p-value < 0.01 is highly significant

Table – 03: Spirometry Postop 1st week comparison in between the group

Post-op 2 Week	Intervention group (n=150)	Control group (n=150)	P Value
FVC (L)	2.6±1 (3.6-1.7)	2.6±1 (3.8-1.6)	0.06
FEV1 (L)	2.9±1 (3.9-1.9)	2.6±1 (3.6-1.7)	0.001
FEV1/FVC (%)	97±2 (99.9-92.3)	97±2.2 (99.9-92.3)	0.4

**p-value < 0.001 is highly significant

Table – 04: Spirometry Postop 2nd week comparison in between the group

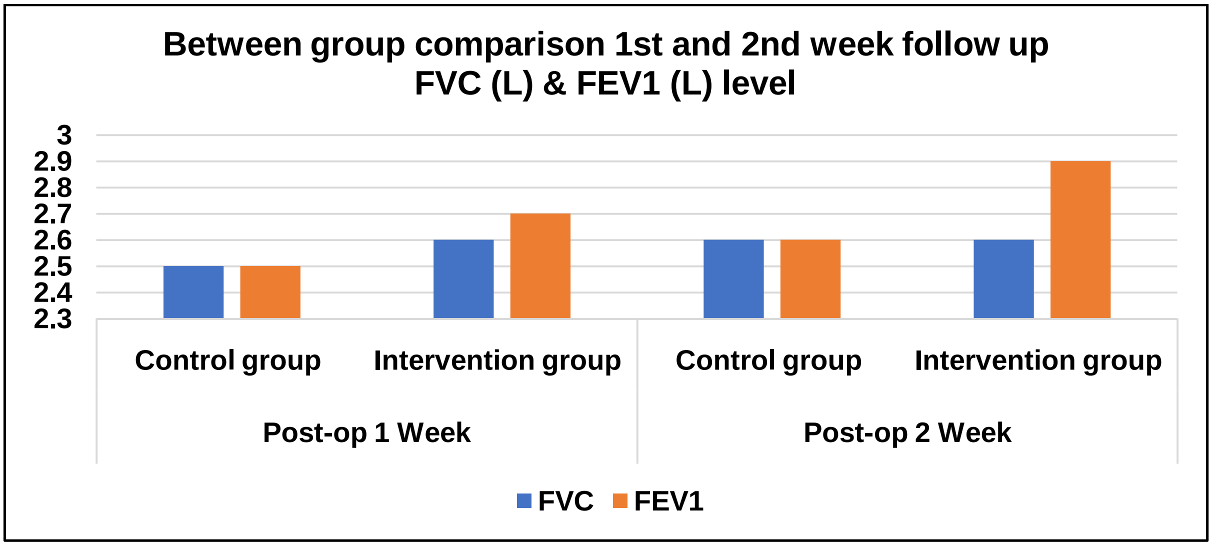

Figure 03: Between group comparison 1st and 2nd week follow up FVC (L)& FEV1 (L) level

Furthermore, the analysis of variance (ANOVA) in within group comparison revealed a statistically significant enhancement (from day 1 to follow up) in FEV1at day-1(2.5±0.5 L),at day-6 (2.5±0.5 L), at 1st week of follow up(2.7±0.5 L), at 2nd week of follow up(2.9±0.5 L), (P=.0001),whereas control group demonstrated no significant changes in FEV1 at day-1(2.5±0.5 L), at day-6 (2.5±0.5 L), at 1st week of follow up (2.5±0.5 L), at 2nd week of follow up (2.6±0.5 L) (Table 05) (Fig 04).

But the FEV1/FVC ratio (%)demonstrated significantly changes in both intervention and control groupat day -1 (96±2.1 % vs 96±2.2%), at day-6 (96.3±2.1 % vs 96.3±2.2%), at 1st week of follow up (96.7±2.1 % vs 96.7±2.2 %), at 2nd week of follow up(97±2.1 % vs 97±2.2) (P=.0001 vs P=0.0001)(Table 05).

	Intervention group (N=150)					Control group (N=150)				
	Pre	Post	Followup 1	Followup 2	P value	Pre	Post	Followup 1	Followup 2	P value
FVC (L)	2.5±0.5	2.6±0.5	2.6±0.5	2.6±0.5	0.1	2.5±0.5	2.5±0.5	2.5±0.5	2.5±0.5	0.1
FEV1 (L)	2.5±0.5	2.5±0.5	2.7±0.5	2.9±0.5	0.0001***	2.5±0.5	2.5±0.5	2.5±0.5	2.6±0.5	0.1
FEV1/FVC (%)	96±2.1	96.3±2.1	96.7±2.1	97±2.1	0.0001***	96±2.2	96.3±2.2	96.7±2.2	97±2.2	0.0001***

***p-value < 0.0001 is highly significant

Table – 05: Repeated measure ANOVA within the group

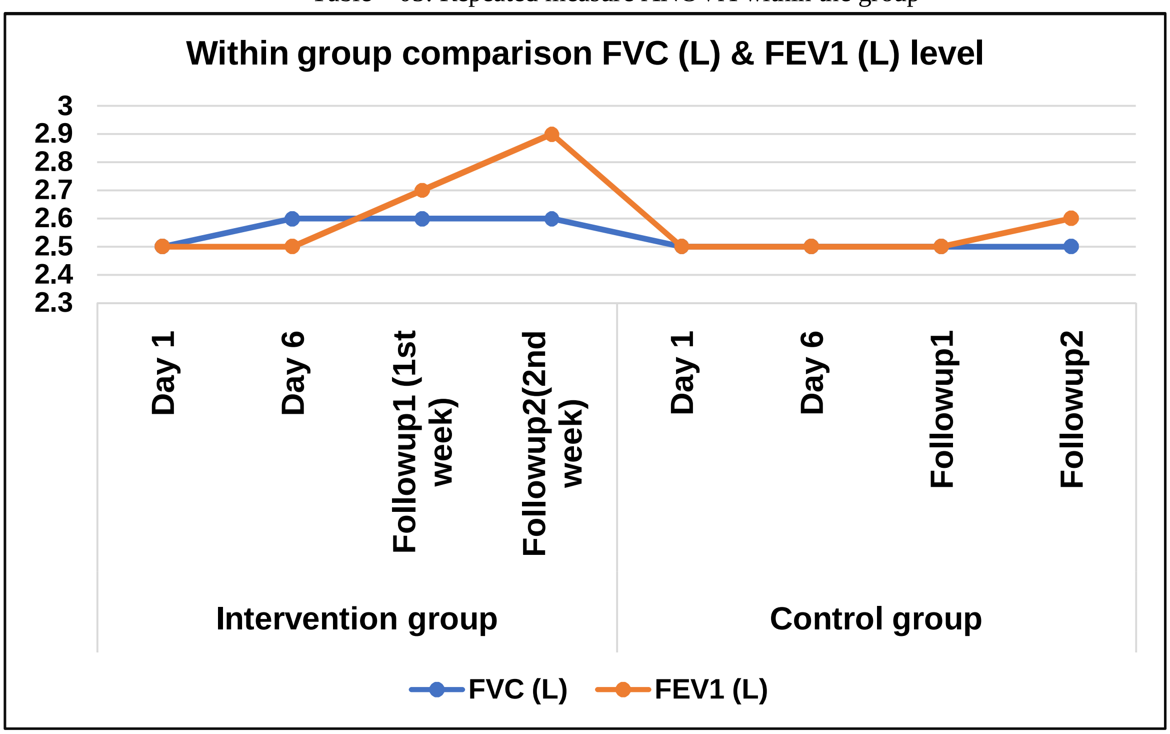

Figure 04: Within group comparison FVC (L)& FEV1 (L) level

V. DISCUSSION

The aim of this investigation was to examine the impact of steam baths on the spirometry measurements of healthy individuals. As indicated by the findings of the study, healthy volunteers who took steam baths experienced an increase in lung volume compared to those in the control group. Several factors may contribute to this phenomenon.

One possible explanation is the high humidity and increased perspiration in steam baths, which hinder the evaporation of sweat. Consequently, a wet sauna may feel significantly warmer than a dry sauna due to reduced evaporative cooling, placing additional strain on the heart.

Furthermore, exposure to high temperatures prompts a rapid and vigorous response from the body, leading to a temporary increase in perspiration. This, in turn, facilitates the faster excretion of various heavy metals, such as lead (17-fold), cadmium (25-fold), cobalt (7-fold), and aluminium (3.75-fold)[16], as compared to elimination through urine. Consequently, a steam bath can be beneficial for individuals suffering from numerous ailments, including cancer, fibromyalgia[18], and even depression[19], as it induces whole-body hyperthermia.

Additionally, the warm inspired air that passes over the bronchial mucosa during a steam bath causes broncho-dilation, resulting in the dilation of the bronchi[20].The effects of heated air on the respiratory muscles may also contribute to the improvement in forced vital capacity (FVC) and forced expiratory volume in one second (FEV1)[21].Previous research utilizing sauna baths (which involve dry heat) has indicated a significant enhancement in respiratory and cardiovascular parameters for both healthy individuals and patients with various ailments[22]. A Finnish sauna bath study further revealed that asthma patients experienced improvements in FVC, peak expiratory flow rate (PEFR), and FEV1, as well as a decreased incidence of the common cold[23].

Moreover, steam baths can decrease oxidative stress in lung tissues through a direct, non-lethal hyperthermia effect[24].

Lastly, frequent sauna use can elicit hormesis, which refers to the adaptive response of cells and organisms to moderate stress. This response activates protective mechanisms that repair cell damage and shield the body from further exposure to harmful stressors. Acclimating the body to heat through regular sauna use can improve the body's reaction to future heat exposures[25].

In summary, this study highlights the positive effects of steam baths on spirometry measurements in healthy individuals. The high humidity, increased perspiration, broncho-dilatating effect, decreased oxidative stress, and hormesis contribute to these beneficial outcomes.

Activation of Heat shock proteins (HSPs) has become increasingly significant as therapeutic targets in human medicine. Although recent studies have examined many aspects of HSP, there is still much uncertainty surrounding these elements. HSPs appear to be associated with various pathological diseases, but they are also widely expressed and play a physiological role[26]. HSPs have been implicated in a range of conditions, from acute lung injury[27] to lung carcinoma[28].

The defensive adaptive response to heat stress involves an increase in the production of heat shock proteins, which can be achieved through the use of a steam bath. In humans, heat stress notably elevates intracellular levels of HSPs[29]. For instance, Iguchi et al. observed that the levels of HSP72 in healthy individuals increased by 49% after spending 30 minutes in a heat stress chamber at 73 °C (163.4 °F)[30].

Prevention of respiratory diseases can be achieved through the regular use of a sauna. The Kuopio Ischemic Heart Disease Risk Factor Study (KIHD) demonstrated that using a sauna 4-7 times per week can reduce the risk of respiratory diseases by 41% among a cohort of Caucasian men aged 42–61 years. Similarly, using the sauna 2-3 times per week can lower the risk of pneumonia by 27%[31].

Using a sauna once or twice a week for a duration of six months can decrease the likelihood of contracting the common cold[32]. Furthermore, it has been found that sauna usage improves vital capacity, tidal volume, total ventilation, and forced expiratory volume, while also reducing pulmonary congestion[33].

The use of a sauna can lead to an improved sense of wellbeing. Hyperthermia induced by a sauna session results in increased plasma levels of beta endorphins and adrenocorticotrophic hormone (ACTH), as well as a decrease in met-enkephalin[34]. The elevated levels of beta endorphins following thermal stress may be attributed to an increase in the production of substance P[35].It has been proposed that beta endorphin plays a role in the mechanisms involved in body temperature regulation[36].The diverse reactions of ACTH, beta endorphin, and met-enkephalin to heat exposure suggest that hyperthermia elicits a specific neuroendocrine response[37].

VI. CONCLUSION

This study shows that taking a steam bath helps healthy people' respiratory function. Additional research is still required to corroborate our findings in various populations and to evaluate the efficacy and safety of steam baths for a range of respiratory diseases.

Informed consent – After detailing the study's duration, nature and protocol in both written & verbal form, informed consent was gained.

Ethical Approval – The University Ethics Committee (Medical) with reference number SMC/UECM/2021/268/155

Trial Registration – Trial is registered with Clinical Trials Registry of India – REF/2021/06/044831

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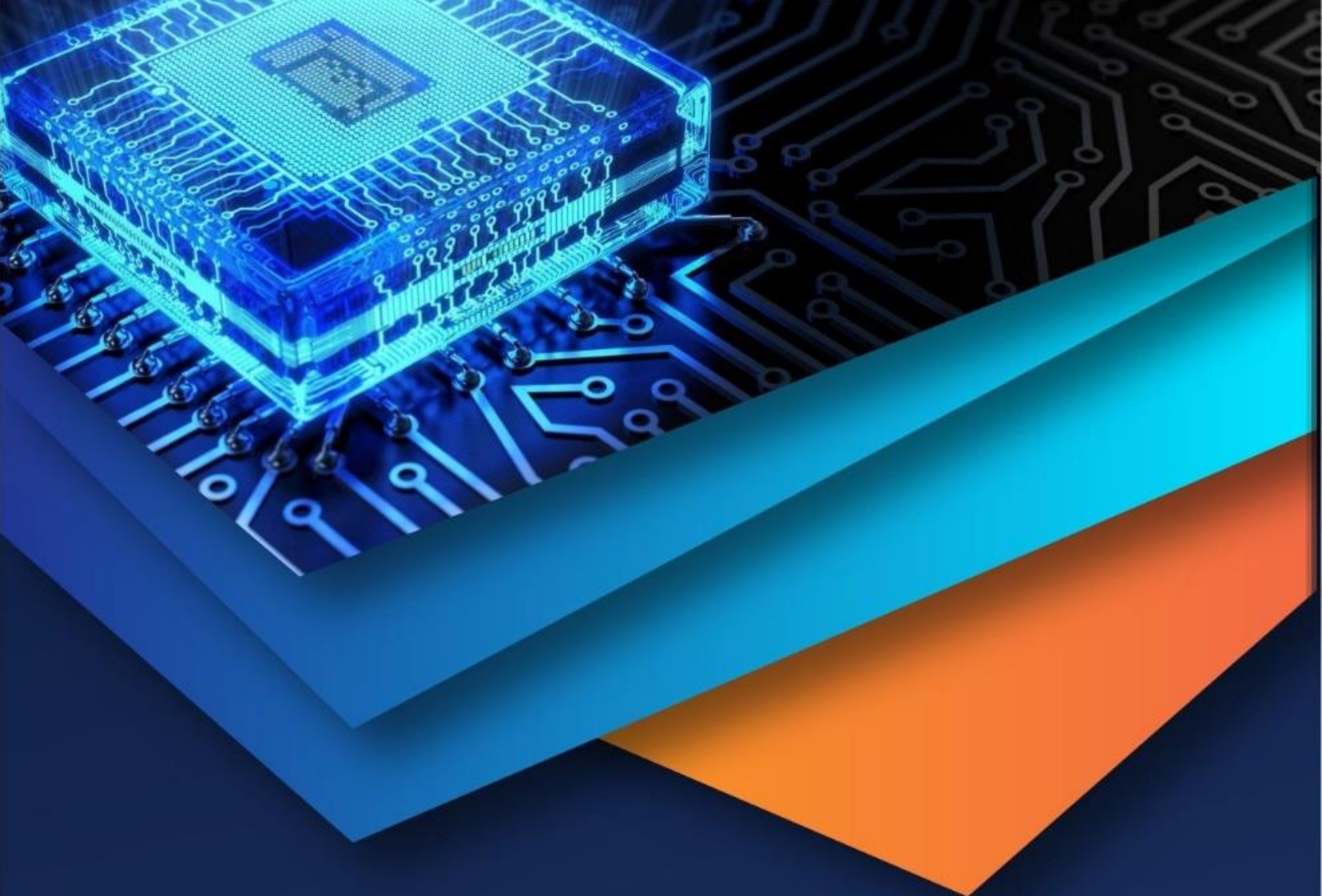

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