“ACUTE EFFECT OF LL- BFRT AND HLRT ON RATE OF PERCEIVE EXERTION AND PERFUSION INDEX IN RECREATIONAL ATHLETES: AN EXPERIMENTAL STUDY”

A Dissertation Submitted to the

UTKAL UNIVERSITY

Bhubaneswar, Odisha

SUBMITTED BY

CHETHAN MR

In Partial fulfillment of the requirements for the degree of

MASTER OF PHYSIOTHERAPY (M.P.T)

In

SPORTS

Under the guidance of

Dr. CHINMAYA KUMAR PATRA (PT)

Principal,ABSMARI

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE

Bhubaneswar, Odisha 2023-2024

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled **“Acute effect LL-BFRT on rate of perceive exertion and perfusion index in recreational athletes”** is a bonafide and genuine research work carried out by me under the guidance of **Dr.chinmaya Kumar patra, principal**, Abhinav Bindra Sports Medicine and Research Institute.

Date: Signature of the candidate

Place: Bhubaneswar **Chethan M R**

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **“Acute effect LL-BFRT on rate of perceive exertion and perfusion index in recreational athletes”** is a bonafide research work done by **Chethan M R,** in partial fulfillment of the requirement for the degree of **MPT-Master of Physiotherapy**.

Date: Signature of the guide

Place: Bhubaneswar DR.Chinmaya Kumar Patra (PT)

ENDORSEMENT BY THE PRINCIPAL

This is to certify that the dissertation entitled **“Acute effect LL-BFRT on rate of perceive exertion and perfusion index in recreational athletes”** is a bonafide research work done by **Chethan M R** under the guidance of **Dr. Chinmaya Kumar Patra (PT) , Principal**, Abhinav Bindra Sports Medicine and Research Institute.

Date: Seal & Signature of the Principal

Place: Bhubaneswar **Prof. Chinmay Kumar Patra**

<u>ENDORSEMENT BY THE DEAN</u>

This is to certify that the dissertation entitled **“Acute effect LL-BFRT on rate of of perceive exertion and perfusion index in recreational athletes”** is a bonafide research work done by **Chethan M R** under the guidance of **Dr. Joseph Oliver Raj,** Dean, Abhinav Bindra Sports Medicine and Research Institute.

Date: Signature of the Dean

Place: Bhubaneswar **Prof. Joseph Oliver Raj**

COPYRIGHT

Declaration by the candidate

I Chethan M R of **Abhinav Bindra Sports Medicine Research & Institute** hereby declare that the Utkal University and Abhinav Bindra Sports Medicine & Research Institute, Bhubaneswar,Odisha shall have the perpetual rights to preserve, use and disseminate this dissertation/thesis in print or electronic format for academic/research purpose.

Date: Signature of the candidate

Place : Bhubaneswar Chethan M R

ACKNOWLEDGEMENT

At the completion of this dissertation I would like to thank lord the almighty for showering his grace upon me and for being with me throughout the dissertation. My sincere thanks to **Dr. Apjit S Bindra, Chairman,** ABSMARI, **Mr. Abhinav A Bindra, Founder**, ABSMARI, **Dr. Digpal Singh Ranawat**, **Director,** ABSMARI for all the inspiration and benevolent support during my entire course.

I owe a deep sense of gratitude to all those who helped me in various ways for the successful completion of my dissertation. I would like to express my heartfelt gratitude and sincere thanks to **Prof. Chinmaya Kumar Patra, Principal ,** Abhinav Bindra Sports Medicine & Research Institute for all his support, guidance, patience, and motivation all throughout my dissertation.

I wish to thank ,**Prof. Joseph Oliver Raj, Dean** ABSMARI for his constant support and advice.

A special note of thanks to **Dr.Deepak Kumar Pradhan**, Class Coordinator, for giving me instructions and support through the entire process.

Date Signature of the candidate Place

Chethan M R

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

LIST OF ABBREVIATIONS

1 **ABSMARI =** Abhinav Bindra Sports Medicine and Research Institute.

2 **BFRT-LL=** Blood flow restriction training -Low load

3 **HLRT**= high load resistance training

4 **PI** = perfusion index

5 **RPE**= rate of perceive exertion

6 **SD-** Standard Deviation

ABSTRACT

Title: Acute effect LL-BFRT and HLRT on rate of perceive exertion and perfusion index in recreational athletes: an experimental study.

Background and objective: Blood flow restriction (BFR) training involves restricting blood flow in muscles during exercise, creating an environment that promotes muscle hypertrophy and strength gains. BFR can achieve results similar to heavy-load resistance training (HLRT) with significantly lower loads. Recent research supports its efficacy, especially for individuals unable to perform high-intensity exercises LL-BFR training appears equally effective of producing gains in maximal voluntary muscle strength compared to HLRT in recreational players.This study aims to evaluate the acute effects of low-load blood flow restriction training (LL-BFRT) and high-load resistance training (HLRT) on perceived exertion and perfusion index in recreational athletes. It seeks to understand how these factors reflect internal load and physiological stress, facilitating better control of training intensity. Additionally, the research will quantify tissue perfusion rates and their role in enhancing muscle size and strength.

Methods:50 participants took part in the study, of which 25 were group A is BFRT-LL and 25 were B is HLRT were randomly assigned ,The mean age of the participants were 23.32 and 22.60 respectively The participants were recruited from university.day1 ,muscular strength were assessed,follwing next day Protocol exercise for HLRT and BFRT-LL group performed Resistance exercise consist of bilateral knee extension using an leg extension machine, a low-intensity resistance exercise at 20% to 30 % 1RM (LL-BFRT) given to group A and high-intensity resistance exercise at 70% to 80% 1RM (HL-RT) to the group B, PFI (perfusion index) were assessed before and after training session, and RPE (rate of perceive exertion) after training session..

Results: The result of this study within a group of perfusion index there was a significant no difference in pre and post values of group A ($p<0.41$) and there was a significant difference in pre and post values of group B ($p<0.000$).However,there was statistically significant difference between group A and group B,for Rate of percive index within a group there was a significant no difference post values of group A and group B .However,there no statistically significant difference between group A and group B ($p<0.06$)**.**

Conclusion:LL-BFRT and HLRT both enhances peripheral blood flow, oxygenation of tissues, and energy expenditure during training. LL-BFRT techniques yield reducing session duration needed to achieve targeted energy expenditures, there by imposing greater demands on the musculoskeletal system with lower workloads for recreational athletes.

KEYWORDS: BFRT,Resistance training,Recreatinal player,Perfusion index,Rate of perceive exertion,Leg extension machine.

INTRODUCTION

Resistance training, also known as strength training or weight training, is a form of physical exercise designed to enhance muscular contraction through the use of resistance. This training method aims to improve muscle strength, endurance, and size. The resistance can be provided by various sources, including free weights (e.g., dumbbells, barbells), resistance bands, weight machines, or even body weight. Traditionally, resistance training was primarily performed by groups such as strength athletes and bodybuilders seeking muscle hypertrophy. However, there is now a broader understanding of the extensive health benefits of resistance training. As a result, national health organizations like the American College of Sports Medicine and the American Heart Association recommend resistance training for diverse populations, including adolescents, healthy adults, the elderly, and both professional and recreational athletes.[17,18]

Recreational athletes are defined as individuals who participate in sports activities primarily for enjoyment, social interaction, and personal satisfaction rather than for professional competition or monetary incentives. They often engage in these activities during their leisure time, and their level of commitment and intensity can vary widely. The primary motivation for recreational athletes is the intrinsic value they derive from the activity, such as fun, fitness, and social engagement, rather than achieving elite performance levels or external rewards. [19]

The American College of Sports Medicine (ACSM) recommends that adults engage in regular heavy-load resistance training (HLT) using external loads of 60-90% of their 1-repetition maximum (1RM) to enhance maximal muscle force strength. While high levels of musculoskeletal loading can significantly increase strength, they may also endanger supporting tissues such as tendons, bones, and cartilage. This is especially concerning for individuals with compromised musculoskeletal strength due to limited physical activity,[5] such as recreational athletes.

Recent research has shown that augmenting low-load resistance training with blood flow restriction (LL-BFR) to the active muscles can lead to significant hypertrophy and strength gains, even with loads as low as 30% of 1RM. BFR training has been found to produce hypertrophy responses similar to those achieved with heavy-load resistance training (HLRT), such as 20% vs. 70% of 1RM.[4]

Blood flow restriction (BFR) is a training method partially restricting arterial inflow and fully restricting venous outflow in working musculature during exercise . Performing exercise with reduced blood flow achieved by restriction of the vasculature proximal to the muscle.[3] It was discovered in 1966 by Dr. Yoshiaki Sato Mechanism of BFR is hypothesized that an ischaemic and hypoxic muscular environment is generated during BFR to cause high levels of metabolic stress, along side mechanical tension when BFR is used in tandem with exercise. These proposed mechanisms include elevated systemic hormone production, cell swelling, production of reactive oxygen species, intramuscular anabolic/anti-catabolic signaling, and increased fasttwitch fiber recruitment. However,at present these are mainly hypothetical and theoretical-based associations.[1,2],

The effects of high-intensity resistance training (HLRT) and blood flow restriction (BFR) cuff tightness on energy expenditure have not been explored in recreational athletes [20] .

Monitoring exercise internal training load during resistance training for BFRT and HLRT is an essential constituent to a favourable outcome in a periodized model. Therefore, strength and conditioning professionals have been using training volume and training intensity (load) to control external and internal load during resistance exercise. However, the use resistance training volume and intensity may be inadequate to estimate the internal load and the physiological stress imposed by the resistance exercise session. Alternatively, studies have shown that the rating of perceived exertion (RPE) is a valid and reliable measure of internal training load during resistance exercise.[6]

During Resistance exercise changes in blood flow and tissue perfusion occure, Kilgas et al have hypothesized that BFR-induced reductions in arterial blood flow during exercise that application of moderate pressure would elicit considerable metabolic stress which would induce muscle size and strength, hence quantifying tissue oxygenation with resistance exercise is essestial to provided indirect insight into the level of blood flow and metabolic stress (vascular physiology) associated with resistance exercise. [7]

During exercise,Limb oxygenation has been studied in claudication by measurement of perfusion index during exercise testing in normal subjects,assessing the limb oxygenation the perfusion index is more reliable , perfusion index is calculated from the pulse oximetry signal, can reflect clinical signs of decreased peripheral perfusion,the test is easy to perform, reproducible, non-invasive, highly specific, and directly reflective of the underlying vascular physiology.[8],

Till date there were no reports documenting any changes in the Acute Effect of LL-BFRT and HLRT on Rate of perceive exertion and Perfusion index in recreational athletes,henc this study is intend to uncover the internal load and physiological stress imposed by BFRT-LL and HLRT training, by using RPE as an outcome . LL-BFRT and HLRT training effect on tissue reperfusion rate are the factor that likely contribute to rebust increase in the muscle size and strength so perfusion will be quantifies from perfusion index in this study.

NEED OF THE STUDY

- LL-BFR training appears equally effective of producing gains in maximal voluntary muscle strength compared to HLRT in general population [3].
- Athletic population have already acheived high level of muscular development, LL BFR would not normally facilitate such benefits so the need of study arises for recreational players as they have physical limits compared to elite athletes.
- There is dreath of studies have evalute the during evalute the variables such as RPE,PFI-combined acute effect on LL BFR and HLRT together in a recreational athletes .

Aim of the study

To compare acute effect of LL-BFRT and HLRT on rate perceive exertion, Perfusion index in recreational athletes.

Objective of the study

1. Acute Effect of LL- BFRT on Rate perceive exertion in recreational athletes.
2. Acute effect of LL-BFRT on perfusion index in recreational athletes.
3. Acute Effect of HLRT on Rate perceive exertion in recreational athletes
4. Acute effect of HLRT on perfusion index in recreational athletes
5. Compare the acute effect of LL-BFRT and HLRT on rate perceive exertion in recreational athletes.
6. Compare the acute effect of LL-BFRT and HLRT on perfusion index in recreational athletes.

Hypothesis

Null hypothesis :

H_o- There will be no acute effect of BFRT on RPE in recreational athletes
H_o- There wll be no acute effect of BFRT on PFI in recreational athletes
H_o -There will be no acute effect of HLRT on RPE in recreational athletes
H_o- There wil be no acute effect of HLRT on PFI in recreational athletes
H_o -There will be no significant changes in acute effect of HLRT and BFRT on PFI in recreational athletes
H_oThere will be no significant changes in acute effect of HLRT and BFRT on RPE in recreatinal athletes

Alternate hypothesis:
H_1- There will be acute effect of BFRT on RPE in recreational athletes
H_1- There will be acute effect of BFRT on PFI in recreational athletes
H_1-There will be acute effect of HLRT on RPE in recreational athletes
H_1- There will be acute effect of HLRT on PFI in recreational athletes
H_1 - There wil be significant changes in acute effect of BFRT and HLRT on PFI in recreational athletes.
H_1-There will be significant changes in acute effect of BFRT and HLRT on RPE in recreational athletes.

REVIEW OF LITERATURE

1. Hayato et al. (2019) conducted a study titled "Blood Flow Restriction Increases the Neural Activation of the Knee Extensors During Very Low-Intensity Leg Extension Exercise in Cardiovascular Patients: A Pilot Study." This research examined the effects of BFR on muscle activation in the rectus femoris (RF), vastus lateralis (VL), and vastus medialis (VM) during the concentric and eccentric contraction phases of low-intensity leg extension exercises (10% and 20% of one-repetition maximum) in seven cardiovascular patients, both with and without BFR. The study found that BFR significantly increased muscle activation across individual knee extensor muscles during very low-intensity (10%) knee extension exercises; however, this effect plateaued at the low-intensity level (20%).
2. Zhen et al. (2019) conducted a study titled "Blood-Flow-Restriction Training: Validity of Pulse Oximetry to Assess Arterial Occlusion Pressure." In this research, a total of 94 subjects participated. The participants were positioned in a supine position, and a 12-cm-wide cuff was applied in a counterbalanced order at the most proximal part of the right upper and lower limbs. The cuff pressure was incrementally increased until the pulse was no longer detectable using Doppler ultrasound (DU) and pulse oximetry (PO). The study found no significant differences between the DU and PO methods for measuring arterial occlusion pressure (AOP) in the upper limb. However, both methods exhibited considerable discrepancies in the lower limbs, observed in both men and women. Therefore, it can be concluded that PO is a reasonably accurate method for determining AOP in the upper limbs. For the lower limbs, however, PO appears to be less precise for standardized BFR in exercise interventions compared to DU, which remains the current gold standard.

3. Ancito et al. (2016) conducted a study titled, “Is the Rating of Perceived Exertion a Valid Method to Monitor Intensity During Blood Flow Restriction Exercise?” In this research, twelve trained men participated in an orientation session followed by two experimental sessions: LL-BFR and HLRT for arm curl and leg extension exercises. These exercises were standardized with a total volume of three sets of 16 repetitions at 35% of one-repetition maximum (1RM) for LL-BFR, and three sets of 8 repetitions at 70% of 1RM for BFRT. Blood flow restriction (BFR) was applied to the proximal regions of both the upper and lower limbs. Blood lactate concentration ([La]), as well as RPE in the active muscles and overall body RPE, were measured at rest and at the end of each set using the OMNI-RES scale. For statistical evaluation, data were presented as means ± standard deviations, with statistical significance accepted at $p < 0.05$ for all analyses. Perceptual variables (RPE-AM and RPE-O) were compared using a 2-way ANOVA, considering lactate [La] as the independent variable and RPE (AM and O) as dependent variables. The findings of this study indicated that the RPE scale is a valid method for monitoring and regulating intensity during resistance exercise combined with BFR in both upper and lower limbs.

4. Gabriel et al. (2016) conducted a study titled, “Acute Effects of Resistance Exercise with Continuous and Intermittent Blood Flow Restriction on Hemodynamic Measurements and Perceived Exertion.” In this research, ten recreationally trained men participated in three experimental protocols performed in a randomized order: (a) low-intensity resistance exercise (RE) at 20% of one-repetition maximum (1RM) with intermittent blood flow restriction (LI + IBFR), (b) low-intensity RE at 20% 1RM with continuous blood flow restriction (LI + CBFR), and (c) high-intensity RE at 80% 1RM. The outcomes included RPE measured using the OMNI-RE Scale, and plasma lactate was assessed with the Bioclin kit, along with measurements of blood pressure (BP), heart rate (HR), and double product (DP). Before and after each RE session, BP was recorded using a stethoscope and sphygmomanometer. For statistical analysis, the Shapiro–Wilk test was employed for normality, and Levene’s test was used for homogeneity. The findings indicated that a greater percentage change in DP and lactate was observed with continuous BFR compared to intermittent BFR, while RPE was lower for intermittent BFR.

5. Ruberta et al. (2016) conducted a study titled “Acute Resistance Exercise with Blood Flow Restriction in Elderly Hypertensive Women: Hemodynamic, Rating of Perceived Exertion, and Blood Lactate.” In this study, eighteen hypertensive women (average age = 67) participated in three randomized sessions: (i) three sets of 10 repetitions at 20% of one-repetition maximum (1RM) with BFR, (ii) three sets of 10 repetitions at 65% of 1RM without BFR, and (iii) a no-exercise control session with BFR. The exercise sessions were carried out on knee extension

equipment. Blood lactate levels were measured before and within 2–3 minutes after each experimental and control session. After each exercise session, participants rated their perceived exertion. Hemodynamic measurements were taken during the exercise using a digital photoplethysmography device to estimate variables such as heart rate (HR), stroke volume (SV), cardiac output (CO), and systemic vascular resistance (SVR). For statistical analysis, a two-way repeated-measures ANOVA was used to compare variations in hemodynamic parameters and RPE, while a one-way ANOVA was employed to analyze differences in blood lactate levels. The study's findings suggested that systolic (SBP) and diastolic blood pressure (DBP), heart rate (HR), stroke volume (SV), and cardiac output (CO) were significantly higher during all exercise sessions compared to the control session, with no significant differences detected between the exercise sessions. However, SBP, DBP, and systemic vascular resistance were elevated, and SV and CO were reduced during the rest intervals in the BFR session. Perceived exertion was significantly higher during traditional high-intensity resistance exercise compared to the exercise with BFR. Blood lactate levels were also higher in the traditional high-intensity resistance exercise than in the BFR session.

6 Murat et al. (2015) conducted a study titled, "Hemodynamic Responses and Energy Expenditure During Blood Flow Restriction Exercise in an Obese Population." In this study, thirty-four young, sedentary, obese individuals (18 men and 16 women) participated. The study calculated oxygen (O2) uptake, carbon dioxide (CO2) output, and the respiratory exchange ratio (RER; VCO2/VO2) using a breath-by-breath metabolic measurement system. Perceived exertion was assessed using Borg's 6–20 scale. Heart rate was monitored before, during, and after the testing session for a total of 31 recordings using a Polar Heart Rate monitor, while systolic and diastolic blood pressure were manually recorded using a sphygmomanometer. For statistical analysis, a one-way ANOVA was applied to determine significant differences in mean values between sessions at baseline. The findings of this study suggest that the BFR training technique can reduce the time required per session to achieve a certain level of energy expenditure, while imposing greater cardiovascular demands at lower workloads in young obese adults.

7 Amilton et al. (2014) conducted a study titled "Session Rating of Perceived Exertion Following Resistance Exercise with Blood Flow Restriction." In this study, thirteen young, resistance-trained men with prior training experience participated in a protocol involving two groups in a counterbalanced design: (i) high-intensity exercise (HIE) performed in a single session at 80% of 1-RM, and (ii) low-intensity exercise with BFR. The study found that low-intensity resistance exercise with BFR elicited a higher session rating of perceived exertion (SRPE) compared to high-intensity exercise without BFR.

8 Alexandre et al. (2002) conducted a study titled “Use of a Peripheral Perfusion Index Derived from the Pulse Oximetry Signal as a Noninvasive Indicator of Perfusion.” In this study, 108 healthy adult volunteers (group A) and 37 critically ill adult patients (group B) were included. Measurements of capillary refill time, peripheral perfusion index, and arterial oxygen saturation were taken in healthy adults (group A). In critically ill patients (group B), capillary refill time, peripheral perfusion index, arterial oxygen saturation, central-to-toe temperature difference, and hemodynamic variables were measured during various peripheral perfusion profiles. The Philips Medical Systems Viridia/56S monitor was used to measure the peripheral perfusion index and arterial oxygen saturation. For statistical analysis, the Mann-Whitney test was employed to assess differences between or within groups for nonparametric data. The study concluded that the distribution of the peripheral perfusion index in the normal population is highly skewed. Changes in the peripheral perfusion index correspond to changes in the core-to-toe temperature difference, suggesting that peripheral perfusion index measurements can effectively monitor peripheral perfusion in critically ill patients.

METHODOLOGY

Study design : Experimental study
Sampling : Purposive sampling
Sample size : 45
Study Duration : 1 year

Inclusion criteria
Recreational Athlets
Have a minimum of one year experience of recreational running/participation in sports
Age - 18 - 40 yrs
Gender - Male and female

Exclusion criteria
Responding positively to any items of the Physical Activity Readiness Questionnaire.
Having any recent Cardiovascular or orthopedic or neurological Diseases.
Engaging in smoking.

Participants :
50 participants took part in the study, of which 25 were group A and 25 were B. The mean age of the participants were 23.32 and 22.60 respectively. The participants were recruited from university.

Ethical Statement: The research met all applicable standards for ethics and was approved by the ABSMARI ethical committee Bhubaneshwar.

Materials used
BFR cuffs
Pulse oximeter

Outcome measures
Rate of percive exertion [RPE].
Perfusion index [PFT] in percentage.

1.1 Blood flow restriction cuff (BFR)

1.2 Pulse oximeter

Procedure:

- Each participant was informed about the study procedure. Before commencing the study, a detailed briefing and written consent were obtained from all 50 participants. The subjects recruited had practiced noncompetitive resistance exercise for muscle hypertrophy and did not regularly perform Blood Flow Restriction (BFR) exercises. Group allocation was conducted using a randomized double-blind method.

Group A: 25 subjects were placed : BFRT-LL (Blood Flow Restriction Training - Low Load).

Group B:25 subjects were placed : HLRT (High Load Resistance Training).

- The muscular strength of all subjects was assessed using the 1RM (one-repetition maximum) test. The BFR pressure was set to 180 mmHg in the lower limbs, as this moderate BFR can minimize muscle function loss during exercise while still producing a training effect [10].

The exercise protocol involved bilateral leg extensions on a leg extension machine for both the HLRT and BFRT groups. After completing the experiment, the following assessments were conducted for both groups:

1. Blood perfusion index[PI] of the exercised limb using a pulse oximeter.
2. Ratings of perceived exertion using Borg's scale.[RPI]

One repetition maximum testing

- The 1RM leg extension strength test was performed using a leg extension machine. Each subject sat with their torso against the backrest and was instructed to hold the handles at the sides of the device tightly. The backrest was adjusted to align the anatomic axis of the knees with the mechanical axis of the machine. Shin pads were placed against the subject's legs.
- To determine the 1RM, the load was progressively increased. Subjects were instructed to perform two repetitions with each load. The load was increased in increments of 2.5 kg until the subject could complete one repetition but was unable to complete the second. A maximum of five attempts were allowed for each load, with a minimum interval of 3 minutes between attempts.
- On the second day, the same procedure was followed. The 1RM was considered as the higher value obtained on both days. Subjects were advised not to perform the Valsalva maneuver during the test [9].

Exercise protocols

- The resistance exercise consisted of bilateral knee extensions using a leg extension machine. Two protocols were performed:

1. Group A: Low-intensity resistance exercise at 20% to 30% of 1RM (LL-BFRT).
2. Group B: High-intensity resistance exercise at 70% to 80% of 1RM (HL-RT).

- Both groups performed a warm-up on the leg extension machine for 1 minute, followed by a rest period of 1 to 2 minutes.

Protocol for HL-RT (Group B):

- Participants completed five sets of six repetitions using 70% to 80% of 1RM.
- There was a 1-minute rest between all sets and a 1-minute rest between exercises.

Protocol for LL-BFRT (Group A):

-Participants completed one set of 30 repetitions followed by three sets of 15 repetitions using 20% to 30% of 1RM.

- There was a 30-second rest between all sets and a 1-minute rest between exercises.

- Participants performed the exercise while wearing specially designed elastic cuffs on both thighs, attached to the most proximal part. The cuff pressure was maintained throughout the exercise, except for a 30-second deflation during the rest period between sets.
- The duration of each repetition cycle was established at 4 seconds (2 seconds for the concentric phase and 2 seconds for the eccentric phase) and was controlled by a metronome.

1.1 The participant is performing leg extensions with Low Load -Blood Flow Restriction training (BFRT-LL) cuffs applied to the upper thighs in bilateral leg extension machine.

1.2 The participant is performing leg extensions with high load resistance training (HLRT) in bilateral leg extension machine.

RESULTS

A total 50 participants took part in the study they were randomly allocated into 2 separate groups. Paired sample T test was used to assess for the normality of data. Table 1 shows demographic and baseline characteristics of both the groups .

TABELE 1 DEMOGRAPHIC AND BASELINE DATA

BASELINE CHARACTERISTICS	*GROUP A*	*GROUP B*	*P VALU*E
Participants	n=25	n=25	
Age	23.32	22.60	O.323
gender	13(F)12(M)	12(F)13(M)	
Weight	64.08	67.76	0.897
HEIGHT	163.48	166.60	0.006

PERFUSION INDEX

TABLE 2 COMPARISON OF PRE- AND POST-PERFUSION INDEX WITHIN AND BETWEEN GROUP A AND GROUP B.

GROUPS	*PRE-INTERVENTION*	*POST-INTERVENTION*	*MEAN DIFFERENCE*	**P VALUE**
	MEAN+_SD	*MEAN+_SD*	**1.23**	**0.04**
GROUP A	*1.4720+_1.01*	*0.9880+_1.54*		**0.141**
GROUP B	1.4040+_0.76	3.6280+_1.86		**0.000**

Within group

- There is no significant difference within group A pre and post values ($p>0.04$) supporting null hypothesis and
- There is a significant difference within group B pre and post values ($p<0.04$) supporting alternate hypothesis .

Between group

- However, a statistically significant difference between groups A and B was observed ($p = 0.04$), supporting the alternative hypothesis.

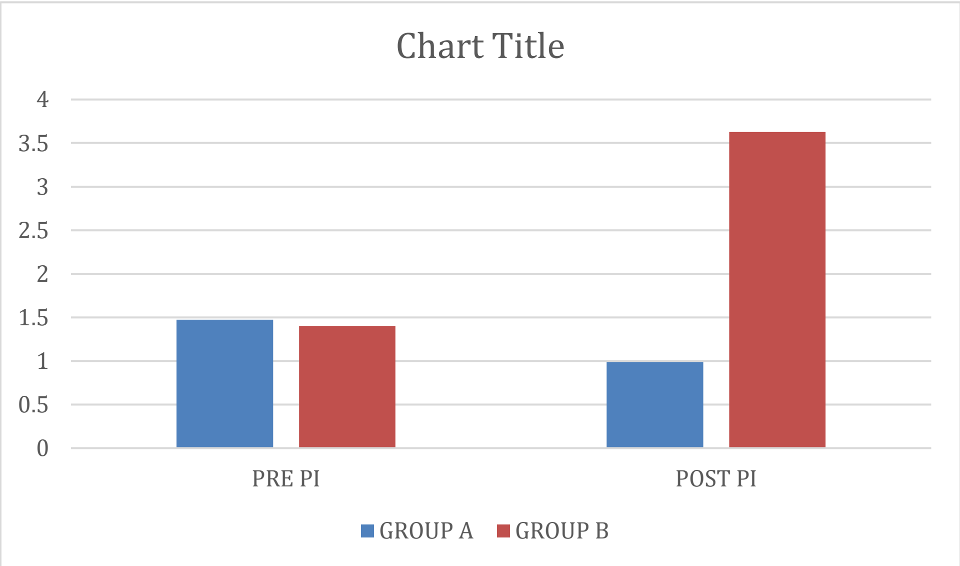

FIG 1: GRAPHICAL REPRESENTATION OF PRE AND POST INTERVENTION OF PERFUSION INDEX(PI)

RPE POST INTERVENTION

TABLE 3 BETWEEN-GROUP COMPARISON FOR RATE OF PERCEIVED EXERTION (RPE) POST-INTERVENTION

GROUPS	MEAN+_SD	M D	P VALUE
		3.04000	0.06
Group A	8.320+_0.69		
Group B	5.280+_1.21		

- There is no significant difference post values of group A and group B supporting null hypothesis .
- However,there is no statistically significant difference between groups A and B supporting null hypothesis (p<0.06).

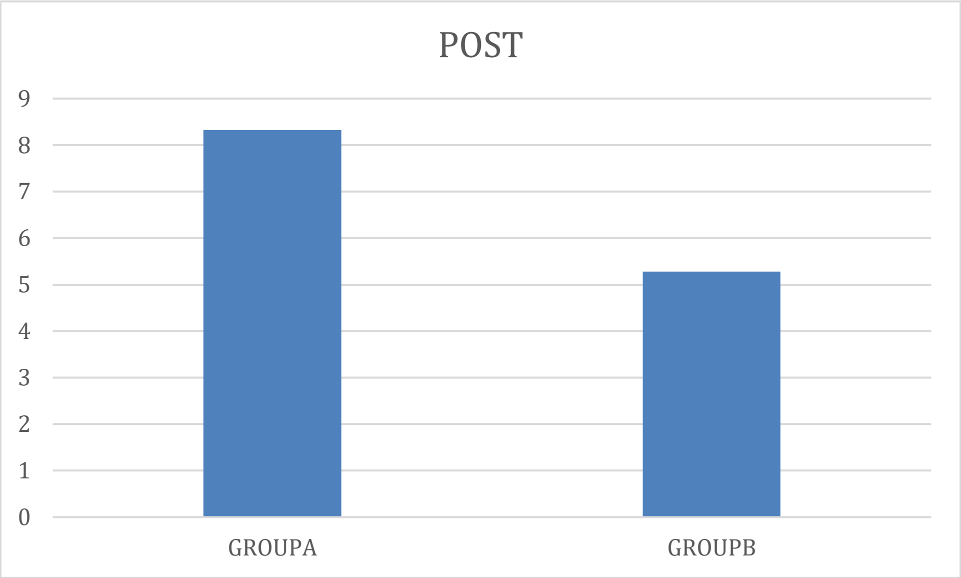

FIG 2: GRAPHICAL REPRESENTATION OF POST INTERVENTION OF RATE OF PERCEIVED EXERTION (RPE)

DISCUSSION

This study sought to examine the Acute Effect of LL- BFRT and HLRT on Rate perceive exertion, Perfusion index in recreational athletes. In recent years, a number of systematic reviews and meta-analyses have demonstrated BFR-RE to effectively increase skeletal muscle strength and/or hypertrophy in healthy young and older populations, as well as load compromised populations in need of rehabilitation,. It is well documented that muscle hypertrophy and strength adaptations with BFR-RE are significantly greater than those achieved with low-load resistance exercise (LL-RE) alone in most.(11).

Main findings of this experiment for perfusion index There was a significant no difference within group in pre and post values of BFRT-LL ($p<0.41$) and there was a significant difference within group in pre and post values of HLRT($p<0.000$).However,there was statistically significant difference between BFRT-LL and HLRT and in RPE scale post value There was a significant no difference within group post values of group BFRT-LL and HLRT .However,there no was statistically significant difference between groupBFRT-LL and HLRT ($p<0.06$).

For perfusion index Primary observation of this experiment is that the LL-BFRT exercise protocol led to a decrease in the perfusion index, while the HLRT protocol led to an increase. When comparing before and after exercise results, the LL-BFRT group showed a decrease in perfusion index, but this change was not significant. In contrast, the HLRT group showed a significant increase in the perfusion index. This means there is a clear difference in how these two exercise protocols affect blood flow and oxygen delivery to tissues.

One possible reason results is that the perfusion index, which is directly co-related to peripheral perfusion and tissue oxgygenation[8]. After exercise, the HLRT group experienced a significant increase in blood flow and oxygenation, while the LL-BFRT group saw a decrease. This suggests that the HLRT protocol may be more effective at improving blood flow and oxygen delivery to tissues than the LL-BFRT protocol.[12]

In the BFRT-LL group of the present study, post-exercise perfusion index levels decreased due to reduced blood flow, potentially explained by the skeletal muscle pump. During HLRT exercise, this pump typically increases venous return and facilitates greater arterial blood flow. However, following the exercise with a BFR cuff, the absence of the skeletal muscle pump may result in reduced blood flow to the exercised limb.[13] and In the HLRT group post-exercise, the level of perfusion index increased due to ischemia, characterized by greater hyperemia after occlusion, indicating enhanced vasodilation mediated by the endothelium. This also elevated the basal blood flow in healthy individuals, resulting in increased peripheral blood flow to the exercised limb[14], RPE scale, which is traditionally to quantify the physiological stress imposed by resistance exercise Sweet et al [7], The correlation between RPE and lactacidosis confirms that perceived effort is a valid measure for evaluating the intensity of RE + BFR and HLRT sessions. The study found a significant positive correlation between lactacidosis and RPE[16]. when analysed in the context , suggest that the alternation in oxygen saturation may change the supply of intramuscular oxygen, producing a more acidic and anabolic environment [12], which could affect the participants' perceived exertion. In our findings, RPE responses were higher in the LL-BFRT protocol compared with HLRT protocol so Low-intensity with BFR resulted in greater energy expenditures However,there was no statistically significant difference between group and within group,This result may be attributed to the greater muscle mass in the thigh segment and the seated position on the leg extension machine, which enhances blood flow restriction (BFR) in the lower limbs, leading to greater changes in lactate concentration ([La]) and perceived exertion (RPE). The higher RPE observed in resistance exercise with blood flow restriction (RE + BFR) may be due to the metabolic stress induced by LL BFR, compared to high-load resistance training (HLRT), which primarily generates mechanical stress (strain).[16] other possible explanation could be attributed to the use of the BFR cuff, which induces hypoxia by restricting blood flow in the exercised muscles, resulting in increased accumulation of lactate ([La]) and other metabolites such as H+ ions and inorganic phosphate. These metabolic changes, combined with discomfort from the BFR cuff application, may have contributed to cumulative fatigue during the RE + BFR session and subsequently elevated RPE. In contrast, HLRT, which does not involve BFR, allows for partial resynthesis of adenosine triphosphate-creatine phosphate (ATP-CP) during the recovery interval between sets (1 minute), reducing the cumulative fatigue effect throughout the session which explains low RPE compared to BFRT-LLgroup.[16]

An analysis of these findings suggests that the lower perfusion index in the BFRT-LL group is due to the creation of a hypoxic environment within the muscle, which increases the accumulation of metabolites. This environment enhances the stimulus for BFR-induced improvements in muscle size and strength compared to the HLRT group, which exhibited a higher perfusion index. According to Ganesan et al. [13], the BFRT-LL training technique can reduce the time required per session to reach a certain level of energy expenditure while placing greater demands on the cardiovascular and musculoskeletal systems at lower workloads in young recreational athletes, as compared to the HLRT group, which showed lower RPE in our results [15]. Exercise specialists suggest that using considerably lower loads during BFR could be an alternative training method for individuals who cannot perform high-intensity resistance exercises, such as recreational players with physical limits compared to elite athletes [2]. However, the results of the present study indicate that this practice should be approached with caution. The training internal load observed in low-intensity exercise with BFR was higher than that observed in high-intensity exercise. It is important to note that our subjects were mildly to moderately resistance-trained individuals accustomed to training at mild to moderate intensities.[16]

Clearly, this study examined the acute effects, so further research is needed to investigate chronic training variations with different training volumes and resting intervals between sets, using BFRT-LL and HLRT.

LIMITATIONS

These data were collected using a bilateral leg extension machine in a seated position, which differs from the positions used in most upper-body and lower-body exercises performed seated or standing. This highlights the necessity for future research exploring the effects of BFR -LL and HLRT during various dynamic exercises.

CONCLUSION

This study compared the acute effects of low-load blood flow restriction training (LL-BFRT) and high-load resistance training (HLRT) on rate of perceived exertion and perfusion index in recreational athletes. Both methods effectively improved peripheral perfusion, tissue oxygenation, and energy expenditure. However, LL-BFRT led to greater muscle size and strength gains compared to HLRT, while also reducing the time needed to reach a specific energy expenditure. Additionally, LL-BFRT placed more significant demands on the musculoskeletal system at lower workloads, making it a potentially more efficient training option for recreational athletes. These findings suggest that LL-BFRT could be a valuable technique for optimizing training outcomes with less intensity.

REFERENCE

1. Sato Y. The history and future of KAATSU training. International Journal of KAATSU Training Research. 2005;1(1):1-5.
2. Neto GR, Novaes JS, Salerno VP, Gonçalves MM, Piazera BK, Rodrigues-Rodrigues T, Cirilo-Sousa MS. Acute effects of resistance exercise with continuous and intermittent blood flow restriction on hemodynamic measurements and perceived exertion. Perceptual and motor skills. 2017 Feb;124(1):277-92.
3. Scott BR, Loenneke JP, Slattery KM, Dascombe BJ. Exercise with blood flow restriction: an updated evidence-based approach for enhanced muscular development. Sports medicine. 2015 Mar;45:313-25.
4. Hughes L, Paton B, Rosenblatt B, Gissane C, Patterson SD. Blood flow restriction training in clinical musculoskeletal rehabilitation: a systematic review and meta-analysis. British journal of sports medicine. 2017 Jul 1;51(13):1003-11.
5. Grønfeldt BM, Lindberg Nielsen J, Mieritz RM, Lund H, Aagaard P. Effect of blood-flow restricted vs heavy-load strength training on muscle strength: systematic review and meta-analysis. Scandinavian journal of medicine & science in sports. 2020 May;30(5):837-48.
6. Vieira A, Gadelha AB, Ferreira-Junior JB, Vieira CA, de Melo Keene von Koenig Soares E, Cadore EL, Wagner DR, Bottaro M. Session rating of perceived exertion following resistance exercise with blood flow restriction. Clinical physiology and functional imaging. 2015 Sep;35(5):323-7.
7. Kilgas MA, McDaniel J, Stavres J, Pollock BS, Singer TJ, Elmer SJ. Limb blood flow and tissue perfusion during exercise with blood flow restriction. European journal of applied physiology. 2019 Feb 6;119:377-87.
8. Hauser CJ, Shoemaker WC. Use of a transcutaneous PO2 regional perfusion index to quantify tissue perfusion in peripheral vascular disease. Annals of surgery. 1983 Mar;197(3):337.
9. Hendrix CR, Housh TJ, Mielke M, Zuniga JM, Camic CL, Johnson GO, Schmidt RJ, Housh DJ. Acute effects of a caffeine-containing supplement on bench press and leg extension strength and time to exhaustion during cycle ergometry. The Journal of Strength & Conditioning Research. 2010 Mar 1;24(3):859-65.
10. Ishizaka H, Uematsu A, Mizushima Y, Nozawa N, Katayanagi S, Matsumoto K, Nishikawa K, Takahashi R, Arakawa T, Sawaguchi T, Yasuda T. Blood flow restriction increases the neural activation of the knee extensors during very low-intensity leg extension exercise in cardiovascular patients: A pilot study. Journal of clinical medicine. 2019 Aug 19;8(8):1252.
11. Patterson SD, Hughes L, Warmington S, Burr J, Scott BR, Owens J, Abe T, Nielsen JL, Libardi CA, Laurentino G, Neto GR. Blood flow restriction exercise: considerations of methodology, application, and safety. Frontiers in physiology. 2019 May 15;10:533.
12. Neto GR, Sousa MS, Costa e Silva GV, Gil AL, Salles BF, Novaes JS. Acute resistance exercise with blood flow restriction effects on heart rate, double product, oxygen saturation and perceived exertion. Clinical physiology and functional imaging. 2016 Jan;36(1):53-9.
13. Kilgas MA, McDaniel J, Stavres J, Pollock BS, Singer TJ, Elmer SJ. Limb blood flow and tissue perfusion during exercise with blood flow restriction. European journal of applied physiology. 2019 Feb 6;119:377-87.
14. Umpierre D, Stein R. Hemodynamic and vascular effects of resistance training: implications for cardiovascular disease. Arquivos brasileiros de cardiologia. 2007;89:256-62.
15. Vieira A, Gadelha AB, Ferreira-Junior JB, Vieira CA, de Melo Keene von Koenig Soares E, Cadore EL, Wagner DR, Bottaro M. Session rating of perceived exertion following resistance exercise with blood flow restriction. Clinical physiology and functional imaging. 2015 Sep;35(5):323-7.
16. Aniceto RR, Robertson R, Silva AS, Costa PB, Araújo L, Silva J, Cirilo-Sousa M. Is rating of perceived exertion a valid method to monitor intensity during blood flow restriction exercise?. Human Movement. 2021;22(2):68-77.
17. Kraemer WJ, Ratamess NA. Fundamentals of resistance training: progression and exercise prescription. Medicine & science in sports & exercise. 2004 Apr 1;36(4):674-88.

18. Ratamess NA, Alvar BA, Evetoch TK, Housh TJ, Kibler WB, Kraemer WJ, Triplett NT, American College of Sports Medicine. Progression models in resistance training for healthy adults. Medicine & Science in Sports & exercise: Official Journal of the American College of Sports Medicine. 2009;41(3):687-708.
19. Casper JM, Andrew DP. Sport commitment differences among tennis players on the basis of participation outlet and skill level. Journal of Sport Behavior. 2008 Sep 1;31(3).
20. Karabulut M, Garcia SD. Hemodynamic responses and energy expenditure during blood flow restriction exercise in obese population. Clinical physiology and functional imaging. 2017 Jan;37(1):1-7.

ANNEXURES.1

CONSENT FORM

Title of the study -

"**Acute Effect of Low load - Blood Flow Restriction Training and High Load Restriction Training on Rate of perceived exertion and Perfusion index in recreational athletes' "-An Experimental study.**

I have been informed by Mr.Chethan M R: pursuing MPT (SPORTS) conducting the above-mentioned study under the guidance of Dr. Chinmaya Kumar Patra Principal, ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE (ABSMARI), BHUBANESWAR.

I have no objection and will be a part of the experiment. I also understand that the study does not have any negative implications for my health. I understand that the information produced by the study will become a part of the institute's record and will be utilized, as per the confidentiality regulations of the institute. I am also aware that the data might be used for medical literature and teaching purposes, but all my personal details will be kept confidential.

I am well informed to ask as many questions as I can to Mr. Chethan M R either during the study or later,

I understand that my assent is voluntary and I reserve the right to withdraw or discontinue the participation from the study at any point of time during the study.

I have explained to MR/MISS/MRS
the purpose of the research, and the procedure required in the language he/she could understand to the best of my ability.

(Investigator) (date)

ANNEXURES.2

ASSESMENT FORM

DEMOGRAPHICDATA:

Name-
Age-
Gender-
Address-
Phone number-

Date of Baseline assessment-

Pre test-
Post test-

GROUP-

HISTORY-

-Having any recent Cardiovascular or orthopedic or neurological Diseases.
-Engaging in smoking.

ON EXAMINATION

OUTCOME	PRE INTEVENTION SCORE	POST INTEVENTION	
Rate of perceive exertion (RPE)			
Perfusion index (PI)			

ANNEXURES.3

MASTER CHART

GROUP	AGE	GENDER	SPORT	WEIGHT [KG]	HEIGHT[CM]	PI pre	PI after	PI[pre-after]
A	25	F	Badminton	62	158	0.7	0.7	0
A	22	F	cricket	62	156	1.1	0.3	0.91
A	23	F	Throw ball	53	163	1.1	0.4	0.7
A	25	F	Badminton	63	166	1.1	0.5	0.6
A	21	F	Badminton	50	152	3.8	1.0	2.8
A	25	F	cricket	67	154	0.7	0.6	0.1
A	24	F	cricket	69	161	1.4	0.5	0.9
A	24	F	volley ball	80	163	0.6	0.5	0.1
A	24	F	Volley ball	58	158	1.7	0.6	1.1
A	25	F	Foot ball	48	155	0.4	0.5	0.1
A	19	F	Badminton	57	154	0.8	0.8	0
A	23	F	Badminton	55	163	0.7	0.6	0.1
A	25	M	Foot ball	75	163	1.9	0.4	1.5
A	24	M	cricket	70	170	1.2	0.3	0.9
A	25	M	Foot ball	57	166	0.6	0.4	0.2
A	20	M	cricket	56	168	0.9	0.5	0.4
A	23	M	cricket	67	161	3.2	0.6	2.6
A	19	M	Foot ball	88	170	3.5	1.1	2.4
A	26	M	cricket	56	173	1.0	1.3	0.3
A	19	M	volley ball	61	172	0.6	0.7	0.1
A	24	M	Foot ball	57	159	1.8	0.9	0.9
A	25	M	Foot ball	85	179	0.9	0.9	0
A	24	M	Foot ball	65	168	1.2	1.1	0.1
A	26	M	Football	75	172	3.4	1.2	2.2
A	23	F	throw ball	66	163	2.5	8.3	5.8

ANNEXURES.4

GROUP	AGE	GENDER	SPORT	WEIGHT [KG]	HEIGHT[CM]	PI pre	PI after	PI[pre-after]
B	23	F	Badminton	64	162	1.1	3.4	2.3
B	18	F	volley ball	49	162	0.3	1.9	1.6
B	22	F	Badminton	64	171	1.1	4.9	3.8
B	25	F	Badminton	54	162	2.7	2.8	0.1
B	21	F	cricket	66	159	0.6	1.1	0.5
B	19	F	cricket	63	154	0.5	1.1	0.6
B	18	F	cricket	64	164	1.0	4.0	3
B	24	F	throw ball	80	158	1.4	5.3	3.9
B	25	F	Badminton	60	155	0.5	1.2	0.7
B	25	F	Badminton	68	164	1.5	4.5	3
B	18	F	volley ball	43	153	2.1	7.1	5
B	25	F	Badminton	78	173	1.5	5.3	3.8
B	25	M	cricket	80	180	1.7	3.0	1.3
B	23	M	cricket	74	178	1.6	2.8	1.2
B	23	M	Badminton	86	163	0.3	1.5	1.2
B	25	M	Foot ball	65	166	1.7	4.2	2.5
B	18	M	kho kho	71	176	0.6	3.1	2.5
B	21	M	cricket	52	164	2.6	8.1	5.5
B	19	M	Foot ball	67	162	1.3	4.1	2.8
B	25	M	volley ball	86	182	1.5	4.4	2.9
B	25	M	Foot ball	74	166	2.1	6.1	4
B	25	M	volley ball	64	174	2.6	2.9	0.3
B	24	M	cricket	86	178	0.6	1.1	0.5
B	25	M	cricket	64	166	2.8	2.9	0.1
B	24	M	Cricket	72	173	1.4	3.9	2.5

ANNEXURE-5

ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,
BHUBANESWAR, ODISHA

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2023/042

Date: 12/08/2023

APPROVAL LETTER

APPENDIX- VIII

MEMBERS

Dr. Smaraki Mohanty,
Clinician

Dr. Satyajit Mohanty,
Basic Medical Scientist

Dr. Ashok Singh Chouhan
Basic Medical Scientist

Mr. Shib Shankar Mohanty
Legal Expert

Ms. Annie Hans,
Social Scientist

Ms. Subhashree Samal,
Lay Person

Mr. Deepak Ku. Pradhan,
Scientific Member

IEC-SECRETARIAT

Mr. Gouranga Ku. Padhy
Mr. Susant Ku. Raychudamani

ABSMARI ETHICS COMMITTEE BHUBANESWAR Dt.................

To,

CHETHAN M.R
ABSMARI
273, PAHAL, BHUBANEWAR-752101

Protocol Title: Acute Effect of Low load- Blood Flow restriction training and High load resistance training on Rate perceive exertion, Perfusion index in recreational athletes: Experimental study

Protocol ID.: ABS-IEC-2023-PHY-001

Subject: Approval for the conduct of the above referenced study

Dear Mr./Mrs./Dr **CHETHAN M.R**

With reference to your Submission letter dated 12/08/2023 the ABSMARI IEC has of the Ethics reviewed and discussed your application for conduct of clinical trial on dated 12/08/2023 (Sat Day).

The following documents were reviewed and discussed

S.N.	Documents	Document (Version/Date)
1	IEC Application Form	08-08-2023
2	Informed Consent Form	08-08-2023
3	Undertaking form PI	08-08-2023
4	CRF	08-08-2023
5	COI from the Investigators	08-08-2023

The following members were present at meeting held on 12-08-2023

S.N.	Name of the Member	Designation & Qualification	Representation as per NDCT 2019	Gender (M/F)	Affiliation with the Institution (Y/N)
1	Prof. Dr. E. Venkata Rao	Professor (MBBS, MD, Dept. of Community Med.) IMS & Sum Hospital, BBSR	Chair Person	M	N
2	Dr. Satyajit Mohanty	Director-Medcare Hospital, BBSR	Basic Medical Scientist	M	N
3	Dr. Ashok Singh Chouhan	PhD. Pharmacology, Assoc. Prof. Dept. of Pharmacology, Hi-Tech Medical College & Hospital, BBSR	Basic Medical Scientist	M	N

1

Utkal Signature, Plot No.-273, Ground Floor, Pahal, Bhubaneswar-752101 +91-63707-03654 iec@absmari.com

ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE, BHUBANESWAR, ODISHA

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2023/042

Date: 12/08/2023

S.N.	Name of the Member	Designation & Qualification	Representation as per NDCT 2019	Gender (M/F)	Affiliation with the Institution (Y/N)
4	Dr. Smaraki Mohanty	Asst. Prof-IMS & Sum Hospital/MBBS, MD (Community Med)	Clinician	F	N
5	Mr. Chinmaya Kumar Patra	Principal-ABSMARI, MPT	Member Secretary	M	Y
6	Mr. Shiba Sankar Mohanty	Junior Counsel-Lt. Ramachandra Sarangi's Chamber / BA LLB	Legal Expert	M	N
7	Ms. Annie Hans	Disability Inclusive Development Co-Ordinator in Humanity and Inclusion (India/Nepal/Srilanka). /MA in Social Work	Social Scientist	F	N
8	Ms. Subhashree Samal	Ret. Reader-Pol Sc.	Lay Person	F	N
9	Mr. Deepak Kumar Pradhan	Asst. Prof-ABSMARI, MPT	Scientific Member	M	Y

This is to confirm that only members who are independent of the Investigator and the Sponsor of the trial have voted/ provided opinion on the trial.

This Committee approves the documents and the conduct for the trial in the presented form with necessary recommendation.

The ABSMARI IEC must be informed about the progress of the study, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent and requests to be provided a copy of the final report.

The ABSMARI IEC follows procedures that are in compliance with the requirements of ICH (International Conference on Harmonization) guidance related to GCP (Good Clinical Practice) and applicable Indian regulations.

ABSMARI ETHICS COMMITTEE
Dt.........
BHUBANESWAR

Yours sincerely,

12.8.23

Mr. Chinmaya Kumar Patra
Member Secretary
ABSMARI Ethics Committee
Member Secretary
ABSMARI ETHICS COMMITTEE
Pahal, Bhubaneswar

2

Utkal Signature, Plot No.-273, Ground Floor, Pahal, Bhubaneswar-752101
+91-63707-03654
iec@absmari.com