

## A Comparative Study On Effect Of Exercise Intensity On Cardiovascular Variables During Concentric And eccentric Resistive Knee Extension Exercise On Healthy Male

Dr. Ankur Khant\*, Dr. Maulik Shah\*\*

\*Associate Professor, \*\*Assistant Professor, School of Physiotherapy, RK University, Kasturbadham, Bhavnagar Highway, Rajkot -360020

**Abstract : Background and Objectives:** Resistance training in the form of concentric and eccentric exercise is a highly recommended form of exercise for athletes and an individual with or at risk of cardiovascular diseases. So the purpose of this study was to compare the effect of exercise intensity on cardiovascular changes during concentric and eccentric resistive knee extension exercise on healthy males. **Methods:** A sample of 50 healthy subjects between the age group (18-25 years) were randomly selected and divided into 2 groups, A (concentric exercise) and B (Eccentric exercise). Each group exercised knee extension at 3 different intensities 75% of 1 RM, 85% of 1 RM, 1 RM). 5 minutes warm up was given and 5 minute rest was given after each exercise. SBP, DBP, HR, MAP and RPP were measured before and after each exercise. **Results:** Statistical analysis done with related t-test and unrelated t-test. Both the group improved but significantly more improvement was seen in concentric group when compared to eccentric group. **Conclusion:** The result of the study suggests that eccentric exercise produce lower cardiovascular response than concentric exercise. [Khant Ankur et al NJIRM 2013; 4(6) : 116-121]

**Key Words:** Resistance exercise, concentric exercise, Eccentric exercise, cardiovascular parameter, Exercise intensity.

**Author for correspondence:** Dr. Ankur Khant , D School of Physiotherapy, RK University, Kasturbadham, Bhavnagar Highway, Rajkot -360020. E- mail: ankur.khant@rku.ac.in

**Introduction:** Exercising to develop and maintain muscular strength, muscular endurance and muscle mass is called as resistance training.<sup>1</sup> There are several types of resistance exercise like isometric, dynamic constant (isotonic), concentric and eccentric, variable resistance, isokinetic/hydraulics/pneumetics resistance exercise.<sup>2</sup> Dynamic muscle action can be perform with two types (1) concentric action (2) eccentric action

Resistance training is highly recommended form of exercise for athletes and individual with or at risk for cardiovascular disease.<sup>3</sup> It can be beneficial in the prevention and management of other chronic conditions, e.g. low back pain, osteoporosis, obesity and weight control, sarcopenia, diabetes mellitus, elderly persons as well as in the prevention and rehabilitation from orthopedic injury.<sup>4</sup> There are many physical and physiological adaptations that occurs as a result of consistent resistance training.<sup>3</sup> Those changes includes muscles strength, endurance and size, increased bone density and strength, reduced body fat, increased muscle to fat ratio and elevated metabolism.<sup>3</sup> Resistance exercise has a positive effect on human musculature, connective tissue, bone formation and metabolism.<sup>5,6</sup> One of the

most cardiovascular adaptation to resistance training is the ability to tolerate higher blood pressure (BP) responses during exercise.<sup>3</sup>

During resistance exercise several cardiovascular changes occur including increased systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), mean arterial pressure (MAP) and rate pressure product (RPP).<sup>5,7</sup> There is an increased BP during resistance training possibly due to mechanical compression, pressure reflex, and/ or increase of intrathoracic pressure reflex, and/ or increase of intrathoracic pressure caused by valsalva maneuver.<sup>1,8</sup>

However, only data regarding a comparison of the cardiovascular response to dynamic or eccentric and concentric skeletal muscle contractions have been reported in few studies.<sup>9,10</sup> Reports from those studies indicate that the cardiovascular response during eccentric exercise was smaller than that during concentric exercise and the age of the subject had no influence on the results.<sup>7</sup> In 1990, the American college of sports medicine first recognized resistance training as a significant component of a comprehensive fitness program for healthy adults of all ages.<sup>4</sup> In recent years, the use of resistance training has been promoted as a

physical activity for the prevention and treatment of lifestyle related diseases as well as for the prevention of disabilities because of instability and falls in elderly adults.<sup>4,7</sup> It is strongly recommended for implementation in primary and secondary cardiovascular disease-prevention program.<sup>4</sup> Intense resistance training at loading levels greater than 60% of 1RM has attained positive results with respect to general health.<sup>11,12</sup>

Compared to concentric contractions, dynamic muscle contractions involving a significant eccentric component are thought to produce a greater degree of muscle injury resulting in exacerbated reductions in muscle strength and ROM, while concomitantly producing muscle soreness and swelling/inflammation.<sup>13</sup>

As the acute elevation in BP during exercise is known to become accentuated with aging,<sup>14</sup> it would be dangerous to prescribe resistance loads nearer to the voluntary maximum in the elderly.<sup>7</sup> Therefore, this study is important to clarify the cardiovascular response to concentric and eccentric muscle contraction in younger subjects. So that findings may be extrapolated to middle age and elderly individuals in order to better prescribe resistance training for the prevention of falls during instability.

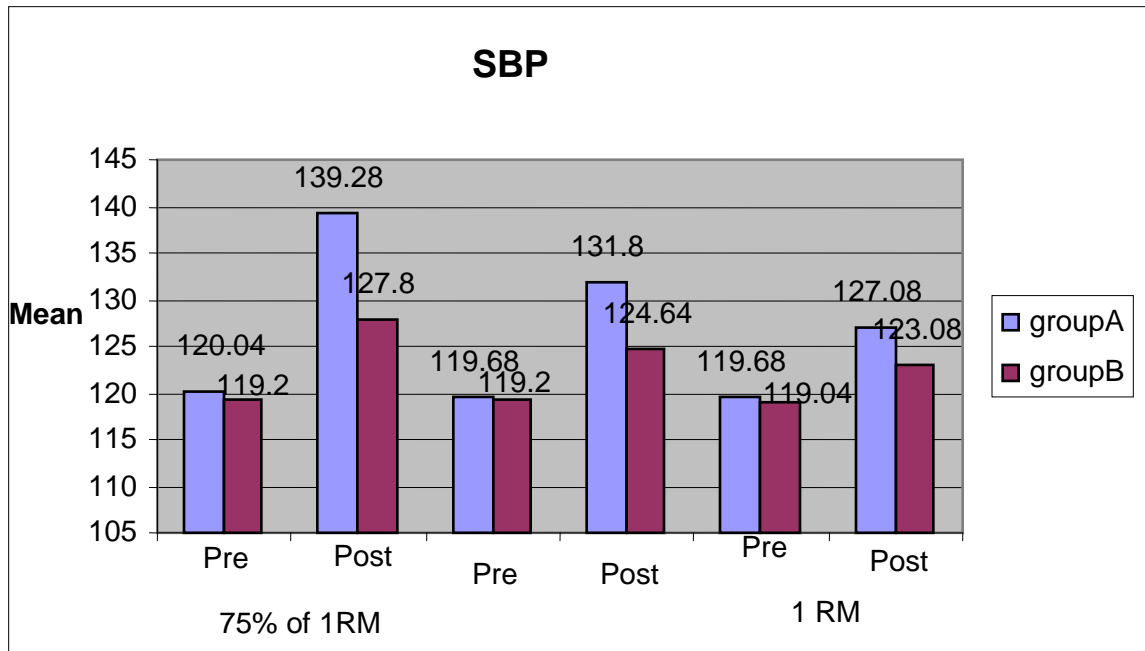
**Material & Methods:** An experimental study was conducted in CITY Hospital Research & Diagnostic Center, Physiotherapy Department, Mangalore. 50 normal subjects for this study are randomly selected using random sampling technique from City College of Physiotherapy in the age group of 18-25 years. **Inclusion criteria:** Healthy males, Age group: 18-25 years and willingness to participate in the study. **Exclusion criteria:** Females, Subjects with any orthopedic problems like Fracture of lower limb, Pain in leg, Any deformity of leg like genu valgus or varus etc., Subjects with any neurological problems like weakness / paralysis of muscle, tightness or shortening of muscle, spasticity etc., Subjects with any cardio pulmonary problems like High / low blood pressure, Cardiac diseases, Cardiopulmonary surgery, COPD or asthma problems etc. materials used in present study were Semi automatic oscillometer device,

Stethoscope, Quadriceps Table, Watch and Weights.

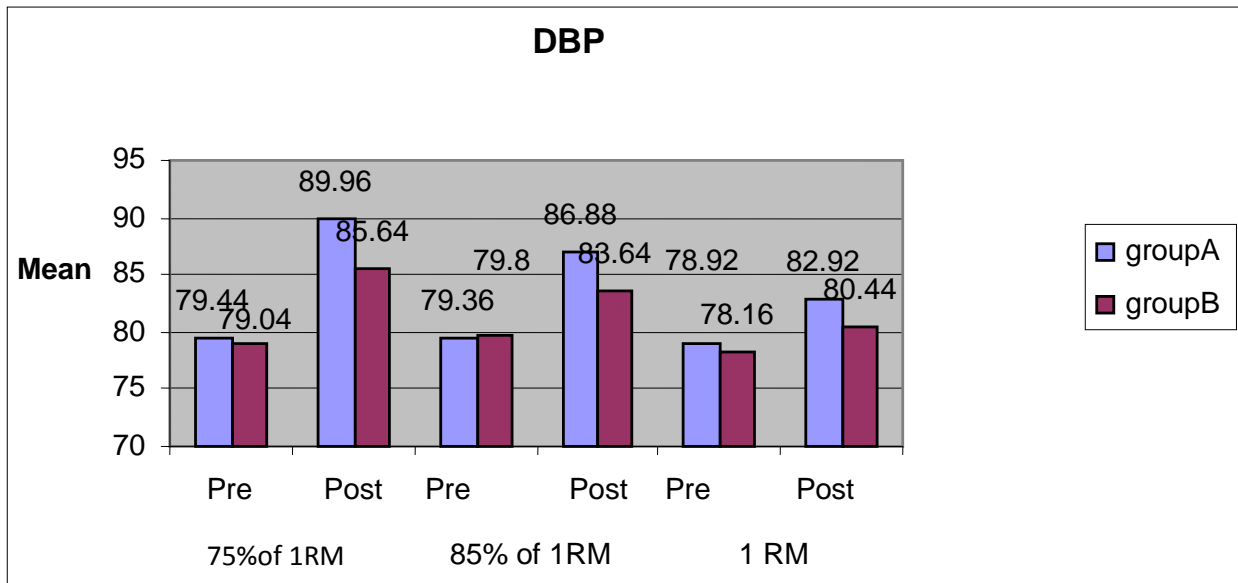
**Methodology:** Fifty subjects were taken for this study. They were randomly divided into two groups, group A (n=25) for concentric exercise and group B (n=25) for eccentric exercise. Instruction in both groups: The purpose of the study and procedure was explained to each subject in their own language, Formal informed consent given to all subjects. All subjects were asked to wear comfortable, non-restrictive clothing, All subjects received warm up exercise for 5 minutes then subjects were asked to do 1RM and according to 1RM, 75% of 1RM and 85% of 1RM were calculated, SBP, DBP, HR, MAP and RPP measured for each subject before and after each exercise using stethoscope at 5<sup>th</sup> intercostal space and semi-automatic oscillometer device and 5 minutes of rest period was given for each subject after exercise. Instruction for group - A: 25 subjects were asked to sit on quadriceps table with comfort and to do concentric resistive knee extension exercise from 90 degree of right knee flexion to full knee extension at 3 different intensities (75% of 1RM, 85% of 1RM, 1RM). The weight was lifted down by therapist after each concentric resistive knee extension to avoid resistive eccentric contraction. Subjects were done repetitions till a voluntary failure to do contraction. Instruction for group - B: 25 subjects were asked to sit on quadriceps table with comfort and to do eccentric resistive knee extension exercise from full right knee extension to 90 degree of knee flexion at 3 different intensities (75% of 1RM, 85% of 1RM, 1RM). The weight was lifted up by therapist after each eccentric resistive knee extension to avoid resistive concentric contraction. Subjects were done repetitions till a voluntary failure to do contraction.

**Result:** Data clearly shows that there is significant improvement in both concentric and eccentric groups when comparing between these two groups, the result shows more improvement in concentric group.

**Graph – A: Comparison of SBP for concentric and eccentric groups at 75% of 1RM, 85% of 1RM and 1RM**



**Graph B: Comparison of DBP for concentric and eccentric groups at 75% of 1RM, 85% of 1RM and 1RM**



**Discussion:** Resistance exercise in the form of concentric and eccentric exercise produce cardiovascular stress. Results of the study showed that both exercise were effective but there was a high significant improvement with concentric exercise than eccentric exercise in SBP, DBP, HR, MAP and RPP. Therefore the present study provides research evidence for the use of eccentric

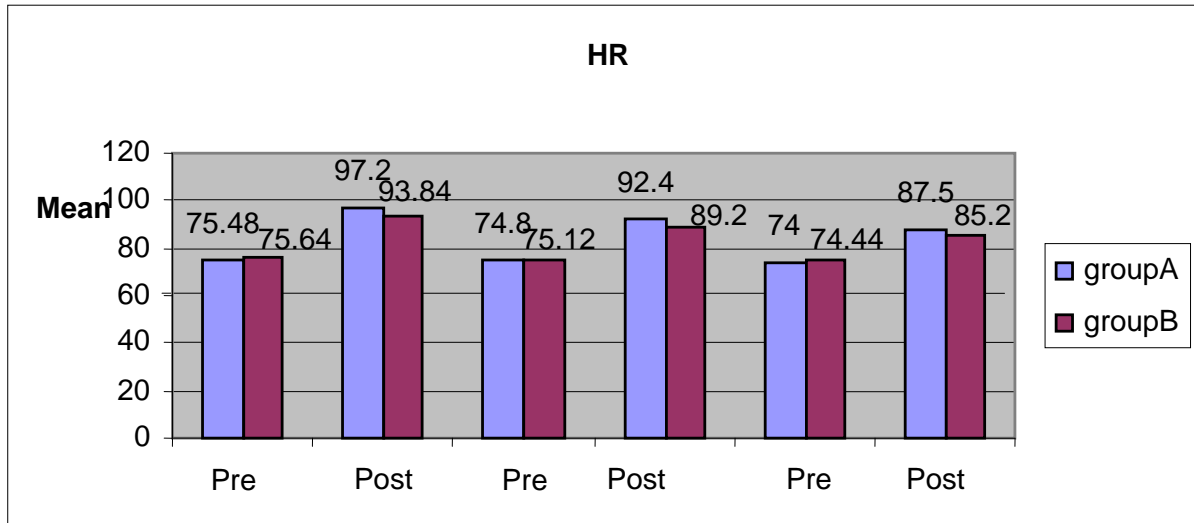
exercise in cardiac rehabilitation, athletes and elderly individuals.

Okamoto T et al<sup>7</sup> in their study shown that SBP, DBP, HR, MAP & RPP during eccentric exercise were significant smaller compared with concentric exercise.

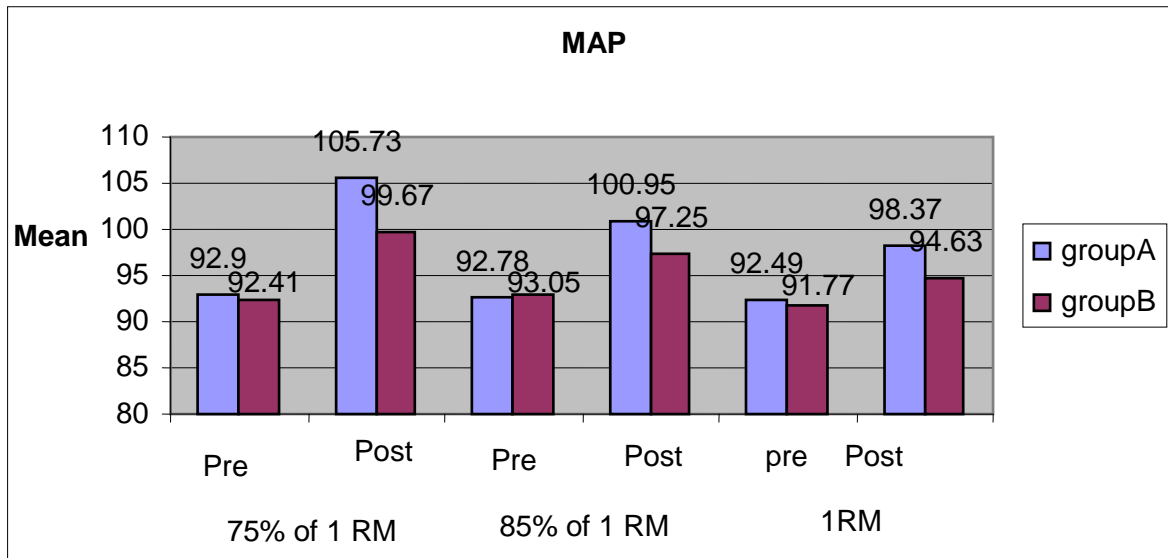
The oxygen consumption required to do the eccentric work was equal to or less than that required to do the concentric work discussed in study, Lastayo PC et al<sup>15</sup>. The smaller cardiovascular response during eccentric contraction as compared to concentric contraction

in this study may be attributable to the difference in active muscle mass utilized in these two modes of muscle contraction. Skeletal muscle recruitment is known to be less during eccentric contraction than concentric contraction.<sup>12,16,17,18</sup>

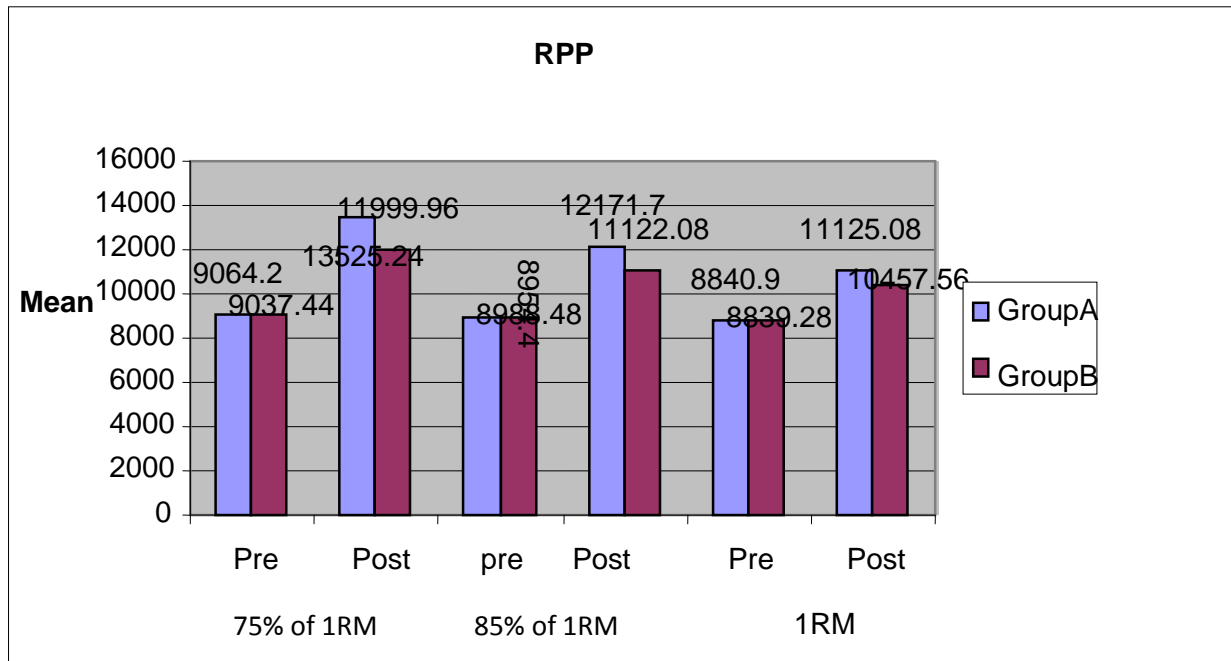
**Graph C: Comparison of HR for concentric and eccentric groups at 75% of 1RM, 85% of 1RM and 1RM**



**Graph D: Comparison of MAP for concentric and eccentric groups at 75% of 1RM, 85% of 1RM and 1RM**



**Graph E : Comparison of RPP for concentric and eccentric groups at 75% of 1RM, 85% of 1RM and 1RM**



Cardiovascular response during exercise are known to be directly related to the intensity, duration and degree of active muscle mass recruited during exercise.<sup>7</sup> This suggests that eccentric contraction exerts more muscle force than concentric and isometric contractions and placing a lower burden on the cardiovascular system owing to a smaller activation of muscle mass.<sup>19</sup> Fewer muscle fibers are recruited during eccentric contraction as compared to concentric contraction. The result from comparison between concentric and eccentric exercise suggest that active muscle mass may be different depending on the mode of muscle contraction.

This result is applicable to prescribing resistance training regimens in elderly individuals for prevention of disabilities because of falls and instability. Recently, the resistance training also use for the prevention and treatment of lifestyle related diseases.<sup>7</sup> Resistance training for the purposes of increasing muscle strength and hypertrophy requires loading levels equal to or greater than 60% of 1RM, and has achieved satisfactory results.<sup>11,20</sup>

**Conclusion:** The data clearly indicate that both concentric and eccentric exercise increase all cardiovascular variables SBP, DBP, HR, MAP and RPP. In both groups at 75% of 1RM, the value of all variables are increase more and gradually reduced to 85% of 1RM and 1RM. When comparing both groups, concentric exercise shows more improvement than eccentric exercise. This study concludes the eccentric exercise produce a lower stress on the cardiovascular system.

**Limitations:** This study was conducted on normal subjects, so result of this study cannot generalize on patients.

**Clinical Implication:** Resistance exercise is highly recommended form of concentric and eccentric exercise for athlete, individual with or at risk of cardiovascular disease and elderly individual at different intensity. Both exercises increase cardiovascular stress. The result of this study shows that eccentric exercise produces less cardiovascular stress than concentric exercise. So, this finding is useful in selection of concentric and eccentric exercise for increase muscle strength in the clinical field.

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