



EFFECT OF CONVENTIONAL VERSUS SWISS BALL ABDOMINAL STABILIZATION EXERCISE ON CARDIOVASCULAR PARAMETERS IN NORMAL INDIVIDUAL: A COMPARATIVE STUDY

Dr. Khyati Shah¹, Mr. Jugal D.Pawar², Ms. Nidhi Maradiya³

¹Assistant Professor, Shrimad Rajchandra College of Physiotherapy, Uka Tarsadia University, Bardoli-Mahuva Road, Tarsadi-394350, Dist.-Surat, Gujarat, India.

^{2,3}Final year BPT students, Shrimad Rajchandra College of Physiotherapy, Uka Tarsadia University, Bardoli-Mahuva Road, Tarsadi-394350, Dist.-Surat, Gujarat, India.

Abstract:

Background: Abdominal muscle stabilization is novel technique and benefits of abdominal muscle stabilization become more frequently accepted and employed in therapeutic setting to maintain proper posture and prevention of abnormal posture in normal and affected population. Since abdominal muscle stabilization is given to normal population, it is better to understand the physiological changes occurring in cardiovascular system. This study was aimed to find out the difference in acute cardiovascular response of conventional and Swiss ball abdominal stabilization exercises in normal individuals.

Materials and Methodology: In present study 50 participants were selected by normal BMI sampling method and screened as per inclusion criteria. The resting level systolic, diastolic blood pressure and heart rate were recorded. Then all participants performed Conventional Abdominal Stabilization Exercises for period of 3 minutes and post exercises values of systolic diastolic blood pressure and heart rate were recorded. It was followed by a 10 minutes rest period and again pre exercise data were taken. Then abdominal stabilization exercises was performed on Swiss ball by all participants and post exercise cardiovascular parameters were recorded. The values were tabulated on master chart and subjected to statistical analysis.

Results: Statistically the Swiss ball abdominal stabilization exercise is not having significant effect on cardiovascular response ($p < 0.05$) as compared to the conventional abdominal stabilization exercise in normal individual. But clinically the Swiss ball abdominal stabilization exercise is having significant effect on cardiovascular response as compared to the conventional abdominal stabilization exercise in normal individual.

Conclusion: The current study after analyzing statistically strongly emphasizes that the Swiss ball abdominal stabilization exercises has effect on acute cardiovascular response than compared to the conventional abdominal stabilization exercises of healthy individual clinically but not significantly for longer duration.

Keywords: Abdominal stabilization exercise, Swiss ball, Core stabilization, Acute cardiovascular response, Vestibular ball exercise.

INTRODUCTION

Trunk control is related to measure of balance, gait and functional activity in patient. Counter rotation between the upper and lower trunk is the mobility over stability task which is essential for all the functional movement. Trunk training exercises are given to improve their trunk stability and balance ⁽¹⁾. Therapeutic exercise ball have gained popularity in many rehabilitation setting therapist in-corporate exercise ball into treatment plans to address limitation in range of motion. Strength, balance and co-ordination endurance, proprioception cardiovascular fitness and flexibility across many patient populations. The abdominal muscles necessary for trunk stabilization may be strengthened with exercise performed on such device ⁽²⁾.

Swiss ball were used primarily by individuals with low back problems in physical therapy clinics. However Swiss ball and now more commonly used in orthopedic rehabilitation programs, with the physically active in fitness centers, in physical education classes, and with special needs populations and the elderly much fitness and the use of Swiss ball has expended in to sport conditioning program⁽³⁾. Athletes capable of sustaining the highest cardiac outputs during prolonged exercise achieve this through chronic adaptation, particularly of the heart and cardiovascular system.

Through training, the heart is capable of adapting in structure and function to meet the demands of an increasing workload. Despite this, maximal cardiac output remains a major limitation on oxygen delivery and therefore limits exercise capacity ^(4, 5). It has been studied that exercise induced stress could unmask a latent tendency towards hypertension ⁽⁵⁾. There may be exaggerated Blood Pressure response to exercise in normotensive subjects ⁽⁶⁾.

During physical exertion there is an increase in cardiac output, a rise in systolic blood pressure is a natural consequence of dynamic exercises. Diastolic blood pressure remains unchanged or shows only a slight increase as a consequence of metabolic vasodilatation of the peripheral vessels ⁽⁷⁾.

Cardiovascular response to demands of exercise, in exercise lasting longer than a minute or two, cardiac output and heart rate linearly increase with peripheral oxygen uptake. The mean systolic arterial pressure increases and vascular resistance inactive muscle fall leading to a large increase in blood flow to the muscles. Blood is pumped back to the heart by muscular contractions and the cardiac output determined by the venous return. Cardiac output and heart rate recorded at maximal exercise have been viewed at maximum limiting values. But both increased when exercise by the abdominal strengthening, stabilization exercise or arms is added to maximal leg exercise. Thus, increasing energy demand dominates increase in cardiovascular response ⁽⁸⁾.

The Swiss ball abdominal stabilization exercise has significant effect on acute cardiovascular response than compared to the firm surface abdominal stabilization exercise of healthy individual ⁽⁹⁾.

Since abdominal muscle stabilization is given to both normal and affected population, it is better to understand the physiological changes occurring in cardiovascular system. Even though, various studies shows that the physiological changes are seen in cardiovascular system in exercising people or population. Cardiovascular responses for abdominal stabilization exercise are underreported ⁽¹⁰⁾. Since abdominal stabilization exercises produce a significant increase in systolic, diastolic blood pressure, heart rate and saturation of peripheral oxygen (SpO₂) so when the abdominal muscle strengthening is given, the exercise should be prescribed within the safety limit guidelines. Respiratory and cardiovascular works in close coordination, hence its effects need to be monitored ⁽¹¹⁾.

Also many types of therapeutic exercises recommended ranging from aggressive strengthening to stability, training on to enhance cardiovascular system function. The rationale of this study is to investigate and report, the cardiovascular response in abdominal stabilization exercise on Swiss ball and abdominal stabilization exercise on firm surface ⁽¹²⁾. Thus it will be easy to decide the intensity, duration and frequency for the abdominal stabilization exercise according to the physiological changes occurring in cardiovascular system. However no such studies have been done in normal individuals at particular age group 18-25 years. So, the present study is aim to find out the acute cardiovascular response of conventional & Swiss ball abdominal stabilization exercises ⁽¹³⁾.

METHODOLOGY

This study was a Comparative study. Sample Size was calculated using G Power. Total 50 participants were enrolled from the Uka Tarsadia University Campus. The inclusion criteria were all willing Male and Female participants of 18-25 years age group and with normal body mass index of 18.5-24.9 kg/m². Participants were excluded if they had a history of heart and respiratory diseases, musculoskeletal disorder, overweighted and underweighted individuals, participants who had undergone abdominal or thoracic surgery within the past 6 months. The study protocol was approved by Institutional Review Board. All procedures performed were in accordance with the ethical standards of the institutional research committee. All participants gave their signed informed consent before enrolling the study. Introduction about the study was given to all participants. The outcome measures selected in this study were Systolic Pressure, Diastolic Pressure, SpO₂, Heart Rate, Cardiac Output Estimate ⁽¹⁴⁾.



Figure 1 & 2 Illustrate conventional abdominal stabilization exercise & swiss ball abdominal stabilization exercise

All Participants performed the test in comfortable sitting position, his/her cardiovascular parameters were recorded using a Semi-automated oscillometric monitor (OMRON REM- 1). The participant was then asked to sit on firm surface (stool) with feet flat on the floor, shoulder width apart, participant laced their fingers together and placed his/ her hands at back of their head. Performed a chin tuck, set their pelvis in posterior tilt by looking forward. Participant was then asked to roll forward on stool until the knee joint was flexed 90 degree. Then they were asked to recline to a point of perceived maximum contraction of abdominal musculature. While stabilizing the pelvis the piece of tape was placed on the floor anterior to participant's toes and verbal cues were given to maintenance of position for 3 minutes. The post exercise cardiovascular response was recorded immediately after exercise. 10 minutes of recovery period was given. The resting level cardiovascular response was recorded once again and the participants were then asked to sit on Swiss ball & follow the same guidelines as on stool while stabilizing the pelvis. Once participant assumed the testing position a piece of tape was placed on the floor anterior to Swiss ball & another just anterior to the toes, maintaining this position for 3 minutes. The post exercise cardiovascular response was recorded immediately after exercise ⁽¹⁵⁾.

STATISTICAL ANALYSIS

Data were analyzed using the statistical software package SPSS16.0 version for Windows. Results were expressed as means \pm standard deviation for baseline characteristics. Differences between groups pre- and post- measurements were compared using Independent Sample t-Test & within group Pair Sample t-test was used. Difference was considered to be significant if p value <0.05 & confidence interval was set at 95 %. Descriptive statistics of age & BMI distribution among 50 participants was done.

RESULT

50 participants including males & females willing to participate & matching the inclusion criteria was recruited into the study. The demographic data are shown in Table 1.

Table 1 Baseline demographic data for participants included in the study (Mean \pm SD)

	Age	BMI	Height	Weight
Mean	20.88	21.10	163.25	55.98
SD	0.00	2.00	9.58	7.48

Table 2 Illustrate Mean and Standard Deviation of pre and post conventional abdominal stabilization exercises for all participants

	Mean	SD
SBP Before 3 min	105.5400	6.20799
SBP After 3 min	118.5200	5.12393
DBP Before 3 min	64.6600	3.67346
DBP After 3 min	72.4000	4.39852
Spo2 Before 3 min	98.0800	1.00691
Spo2 After 3 min	98.700	0.64681
HR Before 3 min	77.2000	6.59623
HR After 3 min	92.2400	4.94876
CO _{EST} Before 3 min	18.368	3.80638
CO _{EST} After 3 min	21.9872	3.28314

Table 3 Illustrate t values of Conventional Abdominal Stabilization Exercise for all participants

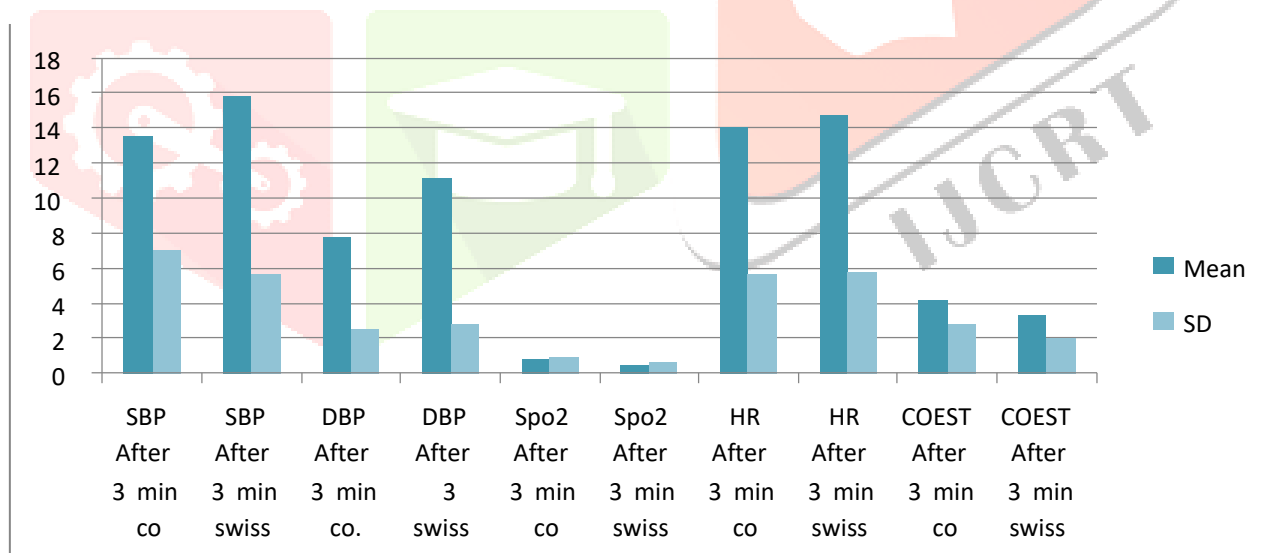
	t value	Significance
SBP	-13.614	P<0.0001
DBP	-18.929	P<0.0001
Heart rate	-16.388	P<0.0001
Spo2	-4.265	P<0.0001
CO _{EST}	-7.504	P<0.0001

Table 4 Illustrate Mean and Standard Deviation of pre and post swiss ball abdominal stabilization exercises for all participants

	Mean	SD
SBP Before 3 min	106.4600	6.19483
SBP After 3 min	122.9400	5.96129
DBP Before 3 min	64.2600	4.86894
DBP After 3 min	75.2600	5.79870
Spo2 Before 3 min	98.5600	0.81215
Spo2 After 3 min	98.9600	0.5700
HR Before 3 min	76.42	6.30546
HR After 3 min	92.28	5.80654
CO _{EST} Before 3 min	18.8944	3.88282
CO _{EST} After 3 min	76.42	6.30546

Table 5 Illustrate t values of Swiss ball Abdominal Stabilization Exercise for all participants

	t value	Significance
SBP	-20.824	P<0.0001
DBP	-23.650	P<0.0001
Spo2	-4.041	P<0.0001
CO _{EST}	-8.262	P<0.0001
Heart rate	-19.223	P<0.0001



Graph1 Illustrate comparison of mean and standard deviation of Conventional and Swiss ball abdominal stabilization exercise for 25 participants in each group

According to t value there is increase ($p < 0.0001$) in all mean values after both the exercise but more seen in the Swiss ball abdominal stabilization exercise. Statistically the Swiss ball abdominal stabilization exercise is not having significant effect on cardiovascular response as compared to the Conventional abdominal stabilization exercise in normal individual. But clinically the Swiss ball abdominal stabilization exercise is having significant effect on cardiovascular response as compared to the Conventional abdominal stabilization exercise in normal individual.

DISCUSSION

The present study was conducted to assess and compare the cardiovascular response to firm surface and Swiss ball abdominal stabilization exercise in healthy individuals. A total of 50 healthy participants between age group 18-25 years were randomly selected. The resting level systolic, diastolic blood pressure and pulse rate (SBP, DBP & HR) were recorded. Then participantt performed Conventional abdominal stabilization exercises for period of 3 minutes and post exercise values of (SBP, DBP & HR) were recorded. It was followed by a 10 minutes rest period and then abdominal stabilization exercise was performed on Swiss ball the post exercise cardiovascular parameters were recorded. The values were tabulated on master chart and subjected to statistical analysis. The results showed that the mean value of SBP (mean 13.84 $p<0.0001$). Mean value of DBP (mean 11.12 $p<0.0001$) and mean value of HR (mean 14.78, $p<0.0001$) on Swiss ball abdominal stabilization exercise was significantly higher than mean value of SBP (mean 13.58 $p<0.0001$) mean value of DBP (mean 7.88 $p<0.0001$) and mean value of HR (mean 14.78 $p<0.0001$) on Conventional abdominal stabilization exercise.

During exercise, HR increased to accommodate the increased oxygen demands of skeletal muscles. The HR responses substantial the relationship between HR and work intensity with each of abdominal exercises there was significant increase in HR relative to resting values. The increased HR for both exercises suggests that the work intensities were at level that elicited stress to the cardiovascular system ⁽¹⁶⁾.

Blood pressure was determined pretest and immediately post test of each exercise as work intensity increases, HR increases which result in increased cardiac output. The increase in cardiac output creates an increase in BP, which also indicates work load intensity ⁽¹⁷⁾. The immediate response of cardiovascular system is increased in sympathetic outflow and decrease in vagal tone. The SBP rises with increasing level of workload. DBP increases slightly within 10mmHg or remains the same or drop slightly within 10mmHg .SBP rises during exercise because increase in cardiac output is greater than decrease in peripheral resistance. The normal response to exercise is vasodilatation of cardiac and skeletal muscle vasculature and vasoconstriction in renal, liver, gut and skin ⁽¹⁸⁾. Thus, there is redistribution of blood away from non-working muscle. It is also found from our result that at normal and sub maximal exercise the heart rate increases linearly as the workload increases ⁽¹⁹⁾.

We observe from our analysis that SBP, DBP, HR, CO, SpO₂ were higher but lacks statistical power when work was performed with the Swiss ball abdominal stabilization exercise than the firm surface abdominal stabilization exercise because greater work demand was placed on abdominal muscles ^(20, 21). Thus, the result of study strongly support the idea that the swiss ball abdominal stabilization exercise performed for 3 minutes can produce an increase in the acute cardiovascular response of healthy individuals. Hence it may pose a relative risk for a patient with cardiovascular pathology or dysfunction if performed for longer duration.

CONCLUSION

The current study after analyzing statistically strongly emphasizes that the Swiss ball abdominal stabilization exercises as compared to conventional abdominal stabilization exercise has not got significant effect on acute cardiovascular responses of healthy individual but clinically there is increase in acute cardiovascular responses following Swiss ball abdominal stabilization exercise. Those effects were lost once the exercise gets stopped & within few minutes resting state data can be achieved by participants. So it is suggested to implement Swiss ball abdominal stabilization exercise in disease population with precaution.

LIMITATIONS OF THE STUDY

The sample size was small. Less number of outcome measures were taken due to unavailability of other devices. Study was confined to abdominal muscle only as participants were asked to perform only a few abdominal stabilization exercises. Other limitation of the study was not adding control group which would have better determine the difference between Swiss ball vs firm surface abdominal stabilization exercises.

FUTURE SCOPE

Future study can be done taking large sample size, different age groups & more outcome measures. Similar study can be undertaken with disease population.

ACKNOWLEDGEMENT: We would like to express our sincere gratitude towards all the participants, College & university authorities & supporting members of this study.

ETHICAL CLEARANCE: The study was approved by the ethical committee of Shrimad Rajchandra College of Physiotherapy, Maliba Campus, Bardoli, Surat.

CONFLICT OF INTEREST: None

REFERENCES

- 1) PM Davis. Problems associated with loss of selective trunk activity in hemiplegia 1990:31-65
- 2) Cardiorespiratory response to abdominal stabilization exercise performed on therapeutic exercise ball Cassady, Sandra L, Levsen. *Cardiopulmonary Physical Therapy Journal* Sep 2001.
- 3) Jonson SM, Stolberg PC. *Sports Experience and You* McGraw Hill Book Company: New York, 1961,461.
- 4) A D' Silva, S Sharma - *The ESC Textbook of Sports Cardiology*, 2019
- 5) Matthews CE, Pate RR, Jackson KL, Ward DS, Mecera CA, Kohl HW, Blair SN Exaggerated blood pressure response to dynamic exercise and risk of future hypertension *J Clin Epidemiol*. 1998; 51:29-35
- 6) Singh JP, Larson MG, Manolio TA, O'Donnell CJ, Lauer M, Evans JC, Levy D. Blood pressure response during treadmill testing as a risk factor for new-onset hypertension. *Circulation* 1999; 99:1831-1836
- 7) Franz IW. Ergometry in the assessment of arterial hypertension *Cardiology*.1985; 72:147-159.
- 8) Jones NL and Kilian KJ, Exercise limitation in health and disease. *New England Journal of Medicine* Vol 343, No.9 August 31, 2000, 632-40.
- 9) Pawadshetty, Vishvanath et al. "Acute Cardiovascular Response of Conventional and Swiss Ball Abdominal Stabilization Exercises in Normal Individuals-A Comparative Study." *Indian Journal of Physiotherapy and Occupational Therapy—An International Journal* 11 (2017): 159.
- 10) Faiz, Ahamed, and C. Jubilet Gnanachellam. "Effect of Swiss ball training on cardiovascular endurance and abdominal strength of physical education students." *International Journal of Physiology, Nutrition and Physical Education* 3.1 (2018): 1378-81.
- 11) Arun B., et al. "Influence of core stability exercises on cardiovascular parameters in physically inactive individuals." *International Journal of Multidisciplinary Research and Development*
- 12) Shinde, Shrikrishna G., and Bafna Payal Sunilkumar. "Comparison of Swiss Ball Exercises versus Conventional Therapy on Improving Trunk Control in Patients with Acute and Subacute Stroke."
- 13) Rajan Balakrishnan, Eman Yazid, and Mohamad Fazlee Bin Mahat. "Effectiveness of the core stabilisation exercise on floor and Swiss ball on individual with non-Specific low back pain." *International Journal of Physical Education Sports and Health* 3.1 (2016): 347-56.
- 14) Escamilla, Rafael F., et al. "Core muscle activation during Swiss ball and traditional abdominal exercises." *journal of orthopaedic & sports physical therapy* 40.5 (2010): 265-276.
- 15) Balakavi, Gayathri, et al. "Cardio vascular response to core stability exercises in healthy individuals." (2019).
- 16) Datta, Aashima, S. Siddhartha, and S. Siddhartha."Effects of core strengthening on cardiovascular fitness, flexibility and strength on patients with low back pain." *J Nov Physiotherapy* 2 (2014): 202.
- 17) Multani, Gurmeet Kaur, et al. "Effect of core strengthening on cardiovascular fitness and flexibility in obese individuals: experimental study." *International Journal of Community Medicine and Public Health* 6.5 (2019): 2235.
- 18) Srivastav, Prateek, et al. "Swiss ball versus mat exercises for core activation of transverse abdominis in recreational athletes." *Journal of clinical and diagnostic research: JCDR* 10.12 (2016): YC01.
- 19) Gaikwad, Pranali Ravindra, Reshma Dhiraj Shete, and Abhijit Diwate. "Effect of Lumbar Core Muscle Stability Exercises on Cardiovascular Parameters of Young Adults-A Cross Sectional Study".
- 20) O'Sullivan, Susan B., Thomas J. Schmitz, and George Fulk. *Physical rehabilitation*. FA Davis, 2019.
- 21) Koenig, Julian, et al. "Estimating cardiac output from blood pressure and heart rate: the Liljestrand & Zander formula." *Biomedical sciences instrumentation* 51 (2015): 85.