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RESEARCH ARTICLE

Acute Effects of Two Stabilization Exercises on Cardiovascular Responses among Healthy Undergraduates in Obafemi Awolowo University, Ile-Ife, Osun State

Ojoawo AO, PhD[1*], Agbaje Imole Maria, BMRPT[1] and Adeniyi Temitope Isaac, BPT[2]

[1]*Department of Medical Rehabilitation, Faculty of Basic Medical Sciences, Obafemi Awolowo University, Ile Ife, Nigeria*

[2]*Department of Physiotherapy, Faculty of Medical Rehabilitation, University of Medial Sciences, Nigeria*

***Corresponding author:** *Ojoawo AO, PhD, Department of Medical Rehabilitation, Faculty of Basic Medical Sciences, Obafemi Awolowo University, Ile Ife, Nigeria, Tel: +2348033567577*

Abstract

Core-stabilization exercises have been reported to relieve pain, improving quality of life, strengthening the abdominals and supporting the spine. This study evaluated the effects of each of bridging and abdominal curl exercises on the breathing rate, pulse rate, pulse pressure and blood pressure among apparently healthy adults.

A total of 100 participants that participated in this study were allocated to two groups, 31 males and 19 females in abdominal curl exercise group (ACEG), and 24 males and 26 females in bridging (BEG) exercise. Blood pressure, pulse rate and respiratory rate, of the two groups were measured before, during and immediately after the exercise using standard protocols. The ACEG performed abdominal curl exercise for ten second three times. The BEG also performed bridging exercise for 10 second three times. The cardiopulmonary variables were measured three times, and the average was determined. Data was analyzed using descriptive and inferential statistics.

Results indicated that there was a significant increase in systolic blood pressure, pulse pressure, pulse rate, and breathing rate ($P < 0.05$) when the pre, during and post-intervention were compared. The bridging and abdominal curl exercises also had similar effects on the cardiovascular responses.

In conclusion both the bridging and abdominal curl exercises has acute increase in cardiovascular parameters and there was no significant differences in the cardiovascular effects between the two exercise. It implies that cardiovascular responses of patients that needs any of those exercises should be monitored before the application of the exercises.

Keywords

Bridging, Abdominal curl, Exercises, Cardiovascular responses

Introduction

The ability of cardiovascular system is impressive in responding immediately to the body's many and ever-changing needs. Numerous cardiovascular changes occur during exercise, all share a common goal they allow system to meet the increased demand placed on it and carry out its function with maximal efficiency [1]. Physical exercises are identified to increase heart rate in the initial transition of exercises, and the adjustment of heart rate lowers when the exercises continue [2]. 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 [3].

Cardiovascular response to exercise depends on muscle mass involved and the intensity of the exercise [4]. The circulatory responses to static exercise differ considerably from the response to dynamic exercise [5]. In isometric exercises the cardiovascular response are largely proportionate to the tension exerted relative to the greatest possible tension in the muscle group rather than absolute tension developed [6].

Core-stabilization exercise is a common and active form of exercise prescribed to individuals with the aim of relieving pain, improving quality of life and strengthening the abdominals and supporting the

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spine [7]. Core strengthening has a theoretical basis in treatment and prevention of various musculoskeletal conditions. The "core" has been described as a box with the abdominals in the front, paraspinals and gluteals in the back, the diaphragm as the roof, and the pelvic floor and hip girdle musculature as the bottom. The core is central for movement and function. Core serves as a muscular corset that works as a unit to stabilize the body and spine; the weakness in any of the core muscles can affect spinal stability and leave the lower back vulnerable to injury [8,9].

Core stabilization exercise through effective abdominal training helps to increase the strength, stability, balance and stamina [8,9]. So the training of trunk or spinal stabilizers is therefore supposed to helpful in improving the endurance of trunk extensors or mobilizers and preventing development of backaches in future [10]. It also describes the training of muscle around the lumbar spine and the abdomen and functions essentially to maintain spinal stability and pelvic balance [10]. Weakness in any of the core muscles can affect spinal stability and pelvic balance [11]. Core strength can be developed to help to maintain correct neutral positioning during both static and dynamic conditions.

Globally, studies have been carried out to determine the effect of core stabilization exercise on pulmonary parameters in different conditions including stroke [12] and substance abuse disorder [13]. The haemodynamic effects of abdominal strengthening exercise as used in some rehabilitation and fitness programs are largely unknown. Only a few published studies have examined the haemodynamic parameters before or after abdominal exercises. There are also previous studies on the effect of core stabilization exercise on cardiovascular response of low back pain patients [8,9] and physically inactive individuals. However little is known on the effects of core-stabilization exercises on cardiovascular responses among healthy undergraduates. Therefore the outcome of this study may help determine the acute effects of two core-stabilization exercises on cardiovascular responses of a different population such as healthy undergraduates.

The objectives of this study is to evaluate the acute effects of two core stabilization exercises namely; bridging and curl up exercises, on the cardiovascular responses, such as, blood pressure, pulse and respiratory rate among healthy undergraduates.

Materials and Method

Participants

Participants for this study were apparently healthy undergraduates of the Obafemi Awolowo University, Ile-Ife, Osun State.

Inclusion criteria

Eligible individuals for this study were:

i. Undergraduate male and female students of the Obafemi Awolowo University, Ile-Ife, Nigeria.

ii. Participants were between 15 to 30 years of age.

Exclusion criteria

The following participants were excluded from this study:

i. Participants did not present with any obvious physical impairment.

ii. Participants had no recent fracture, spondylitis, trauma, degenerative disc diseases or any neurologic condition.

Study population and design

This study was a pre and post-experimental study.

Sampling technique

The sampling technique was a sample of convenience participants were consecutively allocated to the two groups.

Determination of sample size

The study size for this study was calculated based on this formula:

$N = 4(Z)^2\ p\ (1\text{-}p)/D^2$

Where

Where p = pre-study estimate of proportion.

N = Sample size of the single study group

Z = Standard normal deviation (1.96)

D = Total width of expected confidence interval (0.2) [10]

Therefore,

$N = 4(1.96)^2 \times 0.2(1\text{-}0.2)/(0.2)^2$

$N = 35000/[1 + 35000(0.0036)]$

$N = 61.5$

In order to accommodate possible attrition, the sample size was rounded up to 50 per group making a total of 100 participants for this study.

Site of the study

The site for this study was conducted is Obafemi Awolowo University, Ile-Ife, Nigeria.

Instruments

Sphygmomanometer: This is an instrument used for measuring blood pressure, typically consisting of an inflatable rubber which is applied to the arm and connected to a column of mercury next to a graduated scale, enabling the determination of systolic and diastolic blood pressure by increasing and gradually releasing the pressure in the cuff.

Pulse oximeter: A noninvasive medical device that utilizes spectrophotometry to measure the oxygen saturation of circulating arterial blood in an individual by determining the percentage of oxygenated hemoglobin pulsating through a network of blood capillaries by way of a sensor attached typically to a finger, toe, or earlobe. Pulse oximeters are often used for estimating heart rate at rest and during exercise [11].

Procedure

Ethical approval for this study was obtained from the Research and Ethic Committee of the Institute of Public Health, College of Health Sciences, Obafemi Awolowo University. The purpose of and the procedure for the study was explained to the participant and their informed consent were obtained. The eligible participants were consecutively assigned into two different groups (A and B). Core stabilization exercises were administered to the participants. Group A did the abdominal curl up exercise while participants in group B performed bridging exercise. For participants in group A the exercise was carried out on a mat. Participants were required to lie on their back with their arms crossed over their chest. Their knees bent slightly until their feet are flat on the floor and about a foot away from their buttocks. A weight was used to hold down their feet to sustain a consistent form. The upper body was then raised off the group by contraction of the rectus abdominis muscles and stop only when the elbows reach the thighs. The upper body was then lowered back down solely by gravity. The entire curl up took approximately 3 seconds. 10 reps were carried out and 3 sets were performed. For participants in group B performing the bridging exercise, Participants were required to lie on their back on a mat. Their hands at their sides and palms rested flat against the ground. Their knees were bent and the feet flatly placed on the floor, beneath the knees. Lower back and abs were tightened and the glutes were flexed and hips pushed up. The heels of the feet were simultaneously pushed into the floor as to hold the bridge. A straight line from shoulders to knees was formed. The bridge was held for a duration of 12 secs then released and slowly lower hips back to the floor. 10 reps and 3 sets were performed by each participant.

Data of the cardiovascular responses, that is, blood pressure, pulse pressure, pulse rate and respiratory rate, of the participants in group A and group B were collected, before, during and immediately after the exercise. The blood pressure was measured using an aneroid sphygmomanometer. Pulse pressure was taken by subtracting the value gotten from diastolic blood pressure from systolic blood pressure. Pulse rate was checked by placing two fingers over the radial artery of participant's wrist. When pulse was felt, I counted the number of beats in 15 seconds and multiplied the number by four to calculate the beats per minute. Respiratory rate was also taken by counting the number of breaths taken over the course of one minute.

Data analysis

Descriptive statistics of mean, percentage were used to summarize the socio-demographic and individual characteristics of participants. Inferential statistic of repeated method ANOVA was used to compare the pre, during and after the intervention of the cardiovascular responses within the groups. Independent - t-test was used to compare the parameters between the groups. Alpha level was set at $P \leq 0.05$.

Results

Socio-demographic variables of respondents

Shown in Table 1, are the socio-demographic variables of participants. There were 31 (62%) male group and 19 (38%) female group who performed abdominal curl exercise, and 24 (48%) male group and 26 (52%) female group who performed bridging exercise. In total, we had 100 participants of which, 55 (55%) are in the male group and 45 (45%) are in the female group.

Physical characteristics of participant

Presented in Table 2, is the physical characteristics of the participants. The mean age, weight, height and BMI for abdominal curl group were 23.94 ± 2.08 years, 67.48 ± 8.97 kg, 1.68 ± 0.07 m and 23.72 ± 2.61 kg/m^2 respectively. The mean age, weight height and BMI for bridging group were 24.14 ± 2.14 years, 63.7 ± 7.57 kg,

Table 1: Socio-demographic variables of respondent N = 100.

Variables	Abd Curl n (%)	Bridging n (%)	Total n (%)
Female	19 (38)	26 (52)	45 (45
Male	31 (62)	24 (48)	55 (55)

Key: Abd curl: Abdominal curl

Table 2: Physical characteristics of participants N = 100.

Variables	Total N = 100 Mean + SD	AbdoC n = 50 Mean + SD	Bridging n = 50 Mean + SD	t	p
Age/Years	24.04 ± 2.10	23.94 ± 2.08	24.14 ± 2.14	-0.473	0.638
Weight (kg)	65.59 ± 8.47	67.48 ± 8.97	63.7 ± 7.57	2.276	0.025
Height (m)	1.68 ± 0.77	1.68 ± 0.07	1.69 ± 0.81	-0.192	0.848
BMI(kg/m^2)	22.98 ± 2.52	23.72 ± 2.61	22.24 ± 2.22	3.033	0.003

1.69 ± 0.81 m, and 22.24 ± 2.22 kg/m^2 respectively. The mean age, weight, height and BMI for total participants were 24.04 ± 2.10 years, 65.59 ± 8.47 kg, 1.68 ± 0.77 m and 22.98 ± 2.52 kg/m^2 respectively. The results showed there was no significant different ($p > 0.05$) in physical parameters of the participants.

Comparison among pre-exercise, during and post-exercise variables for abdominal curls

Shown in Table 3, was the comparison among pre-exercise, during and post-exercise variables. There was a significant difference in systolic blood pressure (f = 7.71, P = 0.001), pulse pressure (f = 6.60, P = 0.002), pulse rate (f = 13.87, P = 0.000), breathing rate (f = 28.44, P = 0.000).

Comparison among pre-exercise, during and post-exercise variables for bridging

Shown in Table 4, was the comparison among pre-exercise, during and post-treatment variables. There was a significant difference in systolic blood pressure (f = 7.04, P = 0.001), pulse pressure (f = 9.63, P = 0.000), pulse rate (f = 11.43, P = 0.000), and breathing rate (f = 40.16, P = 0.000).

Comparison between effects of Bridging and Abdominal curls on cardiovascular response

There was no significant difference on the effect of bridging and abdominal curl exercises on cardiovascular system (Table 5).

Table 3: Comparison among pre-exercise, during and post exercise for abdominal curl n = 50.

Variables	Mean + SD	F	P-value
Systolic			
Pre	115.68 ± 10.5^a		
During	121.74 ± 12.04^b	7.71	0.001**
Post	113.54 ± 9.76^a		
Diastolic			
Pre	73.00 ± 8.33^c		
During	73.68 ± 8.62^c	0.166	0.879
Post	72.82 ± 6.45^c		
Pulse Pressure			
Pre	42.28 ± 9.88^d		
During	48.00 ± 11.0^e	6.60	0.002*
Post	40.72 ± 10.6^d		
Pulse Rate			
Pre	69.98 ± 8.47^f		
During	80.18 ± 10.7^g	13.87	0.000**
Post	72.90 ± 10.5^f		
Breathing rate			
Pre	16.6 ± 3.36		
During	18.82 ± 3.73	28.44	0.000**
Post	22.14 ± 3.95		

Post hoc analysis using LSD,. Mean values with superscript of alphabet a,b,c --------j with the same superscript shows no significant difference, but mean values with different alphabet shows significant difference.

Discussion

This study evaluated the acute effects of two stabilization exercises on the cardiovascular responses which include systolic, diastolic blood pressure, pulse rate, pulse pressure and breathing rate among healthy undergraduates. The two stabilization exercises carried out were abdominal curl up and bridging exercises. Stabilization exercises have been reported to be effective in the management of low back pain [14-16]. There is paucity of data on the effects of exercises on the blood pressure, breathing and pulse rates. The study has affirmed that each of the abdominal curls and bridging exercises increased the systolic, pulse rate, pulse pressure and breathing rate significantly. The result gotten from this study corroborated that of Cavaggioni, et al. [17].

Study have reported that during the exercise, there is always an increase in the heart rate, it was emphasized that even before someone start an exercise, there is a release of adrenaline which can change the heart rate even before the activity begins. The process will result in upsurge in cardiac output and venous return simultaneously [18].

The cardiovascular response among pre, during and

Table 4: Comparison among pre-exercise, during and post exercise for bridging group n = 50.

Variables	Mean ± SD	F	P
Systolic			
Pre	112.40 ± 9.91^a	7.04	0.001**
During	118.20 ± 10.0^b		
Post	110.96 ± 10.71^a		
Diastolic			
Pre	71.98 ± 8.28^c		
During	72.18 ± 8.57^c	0.01	0.990
Post	71.98 ± 7.70^c		
Pulse Rate			
Pre	72.74 ± 11.2^f		
During	46.02 ± 8.15^e	11.43	0.000**
Post	76.62 ± 11.7^f		
Pulse Pressure			
Pre	40.42 ± 7.93^d		
During	46.02 ± 8.15^e	9.63`	0.000**
Post	38.98 ± 9.27^d		
Breathing rate			
Pre	15.42 ± 3.11^h		
During	17.66 ± 3.15^i	40.16	0.000**
Post	21.30 ± 3.63^j		

Post hoc analysis using LSD,. Alphabet a,b,c --------j with the same superscript shows no significant difference, but mean values with different alphabet shows significant difference.

Table 5: Comparison between effects of bridging and abdominal curls on cardiovascular response N = 100.

Variables	Abdominal Curl Mean + SD	Bridging Mean + SD	t	p
Systolic				
Pre	115.68 ± 10.5	112.40 ± 9.91	1.60	0.112
During	121.74 ± 12.04	118.20 ± 10.0	1.60	0.113
Post	113.54 ± 9.76	110.96 ± 10.71	1.26	0.211
Diastolic				
Pre	73.00 ± 8.33	71.98 ± 8.28	0.61	0.541
During	73.68 ± 8.62	72.18 ± 8.57	0.87	0.385
Post	72.82 ± 6.45	71.98 ± 7.70	0.59	0.556
Pulse Rate				
Pre	42.28 ± 9.88	72.74 ± 11.2	1.04	0.302
During	48.00 ± 11.0	46.02 ± 8.15	1.02	0.310
Post	40.72 ± 10.6	76.62 ± 11.7	0.87	0.387
Pulse Pressure				
Pre	69.98 ± 8.47	40.42 ± 7.93	-1.39	0.168
During	80.18 ± 10.7	46.02 ± 8.15	-1.62	0.109
Post	72.90 ± 10.5	38.98 ± 9.27	-1.66	0.100
Breathing Rate				
Pre	16.6 ± 3.36	15.42 ± 3.11	1.82	0.072
During	18.82 ± 3.73	17.66 ± 3.15	1.68	0.09
Post	22.14 ± 3.95	21.30 ± 3.63	1.11	0.272

post-exercise variables for abdominal curl showed there was a significant difference in systolic blood pressure, pulse pressure, pulse rate and breathing rate. The significant increase in the breathing rate could be as a result of increase in the gaseous exchange in the lung. This supported the work of Akodu, et al. and Brinkman, et al. [7,19] There is increase in oxygen consumption and increase in carbon dioxide production. The reaction is secondary to tissues metabolism responsible for breaking down of adenosine triphosphate in the tissues to release energy for the required activities of the muscles during the exercises [20]. There are several stabilization exercises for the low back pain, some of them are diaphragmatic breathing and abdominal bracing, bridging, side plank on knee, bird dog and abdominal curl. Bridging and abdominal curl look simple easy for patient to do carry out. It was observed from the study that was no significant difference in the effects of abdominal curl exercise and bridging exercises on the systolic blood pressure, pulse pressure and breathing rate. This implies that the effects of the two exercises on those parameters were comparable. One may not outmatch the other relatively.

Conclusion

In conclusion both the bridging and abdominal curl exercises have acute effects on cardiovascular parameters and there were no significant differences in the cardiovascular effects between the two exercises. It is then recommended that the blood pressure of patients that needs these exercises can be checked before embarking on it.

Conflict of Interest

No conflict of interest from any author.

Ethical of Approval

Ethical of approval HREC number - IPHOAU/12/1684) was obtained from the Health Research and Ethics Committee of Institute of Public Health Obafemi Awolowo University, Ile-Ife.

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