ORIGINAL ARTICLE

IJPHY

REPETITIVE MCKENZIE SPINAL EXTENSION EXERCISES ON CARDIOVASCULAR RESPONSES IN CLASS I OBESE SUBJECTS

*[1]Karthikeyan Selvaganapathy
[1]Roshini Rajappan
[2]Nagaletchumy Supramanian
[1]Syed Abudaheer
[1]Jubish KV
[1]Karthikeyan Rajendran

ABSTRACT

Background: Obese population is dramatically increasing worldwide. There is a strong association between obesity and low back pain. The 1-month prevalence of low back pain ranges from 30% to 40% in the general population. McKenzie method is commonly used in the diagnosis and management of patients with back pain. The objective of the study is to examine the cardiovascular responses of two common exercises namely, extension in lying (EIL) and extension in standing (EIS) used in the McKenzie system with different repetitions among class I obese subjects.

Method: 50 class I obese subjects (25 males and 25 females) were randomly selected within the age range of 20-40 years. Baseline measures of resting heart rate (HR), blood pressure (BP) and rate pressure product (RPP) were taken before and after exercises. Multiple comparisons were done to analyze the significance within groups. One-way analysis of variance for repeated measures was used to compare the dependent values obtained at rest and after 10, 15 and 20 repetitions. Independent "t" test was used to determine the significance between groups.

Results: No significant differences (p>0.05) were found in SBP and DBP after 10 repetitions in group 1 and among HR and SBP after 10 and 15 repetitions in group 2. There was a significant difference (p<0.05) in RPP after 15 and 20 repetitions within and between the groups.

Conclusion: Increased repetitions of spinal extension exercises in prone lying bring more cardiovascular stress when compared to the same performed in the standing position among class 1 obese subjects.

Keywords: McKenzie spinal extension exercises, extension in lying, extension in standing, rate pressure product, blood pressure, heart rate.

Received 02nd August 2016, revised 23rd September 2016, accepted 06th October 2016

www.ijphy.org

10.15621/ijphy/2016/v3i5/117454

[1]Senior Lecturer, Department of Physiotherapy, Faculty of Therapeutic Sciences, Asia Metropolitan University, Cheras, Selangor, Malaysia.
[2]Physiotherapist, Department of Physiotherapy, Faculty of Therapeutic Sciences, Asia Metropolitan University, Cheras, Selangor, Malaysia.
[1]Senior lecturer, Department of Physiotherapy, Faculty of Therapeutic Sciences, Asia Metropolitan University, Cheras, Selangor, Malaysia.
[1]Senior lecturer, Department Of Physiotherapy, Faculty of Therapeutic Sciences, Asia Metropolitan University, Cheras, Selangor, Malaysia
[1]Senior lecturer, Department Of Physiotherapy, Faculty of Therapeutic Sciences, Asia Metropolitan University, Cheras, Selangor, Malaysia.

CORRESPONDING AUTHOR

*[1]Karthikeyan Selvaganapathy

Senior Lecturer,
Department of Physiotherapy,
Faculty of Therapeutic Sciences,
Asia Metropolitan University,
Cheras, Selangor, Malaysia.

INTRODUCTION

Obesity is a fatal global problem. In general, fitness levels of obese adults are lowered compared to the normal population. Obesity and blood pressure are very often correlated. In all age groups, obese people manifest higher blood pressure than normal people [1]. There is a dramatic increase in the count of obese people worldwide. In a meta-analysis, it has been concluded that obesity is associated with an increased risk of low back pain (LBP). LBP, the most widespread musculoskeletal condition is also a cause of work-related disability and absenteeism in developed nations. The lifetime prevalence of LBP (at least one episode of LBP in a lifetime) in developed countries is estimated to be up to 85%. One-month prevalence of LBP ranges from 30% to 40% in the general population. The annual prevalence of LBP ranges from 25% to 60% and of chronic LBP from 10% to 13%. Fifth most common reason for visiting a physician would be LBP in 60-80% of people throughout their lifetime [2,3].

McKenzie method is commonly used for mechanical diagnosis and management of patients with spinal disorders. This method is used to categorize the patient as having any one of the following three syndromes such as postural, dysfunction and derangement and to lead proper intervention [4-6]. In this method, exercises are performed in different body positions, which include repeated flexion and extension spine movements as part of a regular spinal assessment and intervention plan. This approach is a booming method for lessening and centralizing the pain and also to enhance spinal movements in patients with mechanical LBP [5,7]. McKenzie has recommended 10 to 15 repetitions, but patients will be instructed sometimes to do more than these repetitions to get "centralization of symptoms" [8].

Patients who perform 10 to 15 repetitions of exercises based on the McKenzie approach every two hours during their home program indicate that end-range exercise will be attained 80 to 100 times a day. Despite the fact that only 10 to 15 repetitions are suggested for a home exercise program based on the McKenzie approach, some patients, who consider "the more the better," may execute more than the recommended number of repetitions [9]. The physiologic demand of exercises is mainly determined by the type of exercise and the number of repetitions [10]. The association between the increasing number of repetitions of these exercises and its cardiovascular effects have not been investigated extensively. Due to this negligence, physical therapists might presume that these exercises comprise a safe submaximal load with no appreciable cardiovascular effects, even when performed quite a few times a day as proposed for a home program [9]. Patients suffering with low back pain and coexistent cardiac problems who perform repetitive McKenzie exercises as a therapeutic intervention could have significant effects in their hemodynamic responses. Warnings of possible adverse effects on the cardiovascular system are not provided for patients while performing repetitive spinal extension McKenzie exercises. Hence, comprehending the cardiovascular responses to McKenzie spinal extension exercises can be handy for physical therapists who utilize these exercises for both diagnosis and treatment purposes [11].

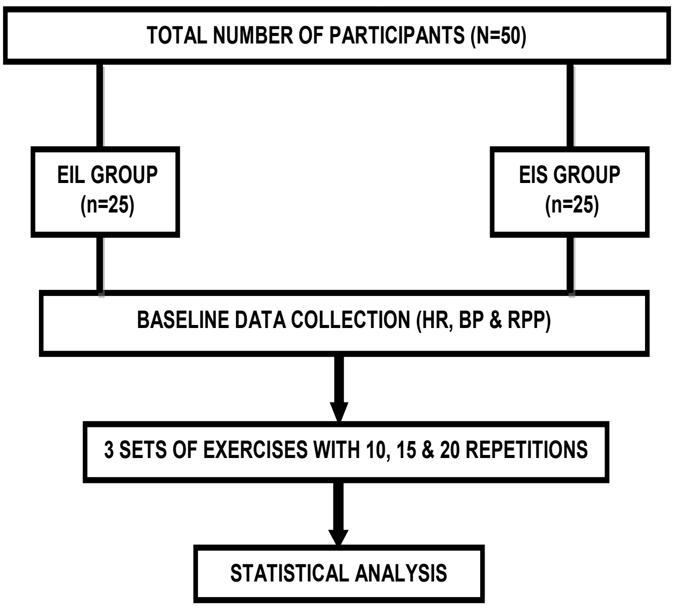
Up-to-date, there are very few studies that have been conducted on cardiovascular responses during repetitive McKenzie exercises. Globally, least attempt has been made to identify the effects of McKenzie exercises in class I obese subjects. The objective of this research was to observe the cardiovascular responses of two common exercises, namely, extension in lying (EIL) and extension in standing (EIS) used in the McKenzie system with different repetitions among class I obese subjects. We hypothesized that there would be a significant effect on the cardiovascular responses after performing McKenzie spinal extension exercises in lying and standing with multiple repetitions in class I obese subjects.

MATERIALS AND METHODS

STUDY DESIGN, SETTING AND POPULATION

Fifty subjects (25 males and 25 females) were randomly selected to participate in this study from Asia Metropolitan University (AMU), Malaysia. Subjects were randomly assigned in each group. They were selected between the age ranges of 20 - 40 years. This age range was selected because according to McKenzie, those who are in this range have the highest risk of developing pathology of the spine [5,7]. BMI was calculated for all the subjects and class I obese subjects were only included for this study. The methodology used in this study is illustrated in figure 1. Subjects who have anemia, smoking habit, cardiovascular and/or pulmonary diseases, recent musculoskeletal trauma, low back pain, spine pathology and metabolic diseases were excluded from the study. Subjects who agreed to participate were informed about the objective of this study and their rights to withdraw any time from the study. The university research ethical committee approved the study and informed consent was obtained from all subjects after the study protocol had been explained to them.

Figure 1: Flow diagram showing the procedure used in the study.



EXPERIMENT PROCEDURES AND OUTCOME MEASURES

There were two experimental groups assigned in this study. Group 1 subjects received extension exercises in lying (EIL) and group 2 subjects received extension exercises in standing (EIS). The exercises given strictly followed the established clinical standards for performing repetitive spinal extension exercises as advocated by McKenzie. Subjects were taught the proper McKenzie method by verbal instructions, demonstration and practice.

Subjects in group 1 were requested to lie in prone. Then, they were instructed to lift up their upper body off the couch with their hand supporting the body. Their hips should remain intact with the couch. For the subjects in group 2, they were instructed to bend backwards in the standing position with hands at the waist. Repetitive spinal extension McKenzie exercises performed by the subjects in group 1 and 2 are shown in figures 2 and 3 respectively. Each subject performed 3 sets of exercises with 10, 15 and 20 repetitions. Subjects were given a rest period of 15 minutes following each set to make sure that their heart rates and blood pressure came to baseline before they perform the next level of repetitions. Subjects usually completed 10 repetitions in one minute. Subjects were informed to perform exercises in a continuous rhythm with constant speed. They were instructed to complete each exercise to their maximum possible end-range and were held for 1-2 seconds. Subjects were told not to hold their breath during exercises.

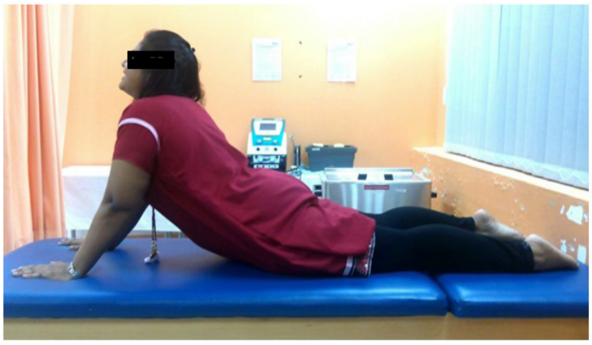
Age, sex, weight, height and body mass index (BMI) were taken for evaluating the demographic characteristics. Baseline outcome measures of heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP) and rate pressure product (RPP) were taken before the exercises were performed. After the subject completed 1 set of exercises, HR and BP were taken in the sitting position within 30 seconds using a digital sphygmomanometer (OMRON). HR and BP were recorded twice to obtain mean values and RPP was calculated. RPP is simple and non-invasive method that illustrates myocardial oxygen demand in working heart during exercises. RPP was calculated by multiplying mean HR and mean systolic BP and then multiplying the product by 10^{-2}. The RPP is proven to be an excellent index of myocardial oxygen demand and work of the heart [12,13].

STATISTICAL ANALYSIS

Data were analyzed using SPSS version 23. Demographic statistics were analyzed for both groups. Multiple comparisons were done to analyze the significance within each group. In addition, one-way analysis of variance (ANOVA) for repeated measures was used to compare the values obtained at rest and after 10, 15, and 20 repetitions. Independent 't' test was used to determine the statistical differences between the two groups. The level of significance was set at 0.05.

Figure 2: Repetitive McKenzie spinal extension exercises in lying (EIL).

2.1: Starting position



2.2: End position

Figure 3: Repetitive McKenzie spinal extension exercises in standing (EIS).

3.1: Starting position

3.2: End position

RESULTS

The participants' demographic characteristics are explained in Tables 1 and 2. The mean scores for all variables such as HR, SBP, DBP and RPP for the 2 groups at baseline and at different repetitions (10, 15 and 20) are shown in Table 3. Very fewer differences were noticed in the groups with regard to both demographic data and resting cardiovascular measurements, which indicates that both the groups were homogenous.

Table 1: DEMOGRAPHIC CHARACTERISTICS OF SUBJECTS

VARIABLES	EIL			EIS		
	Mean	SD	Minimum to Maximum	Mean	SD	Minimum to Maximum
Gender: Male/Female	12/13			13/12		
Age (Years)	30.3	6.5	20 - 40	30.2	6.2	20 - 40
Height (cm)	161.8	6.5	147 - 179	163	8.1	146 - 176
Weight (kg)	84.4	9.3	69 - 99	85.6	7.9	72 - 99
Body Mass Index (BMI)	32.1	1.3	30 – 34.2	32.2	1.4	30 – 34.8

Table 2: DISTRIBUTION OF DIFFERENT AGE GROUPS

AGE RANGE	NUMBER OF SUBJECTS		PERCENTAGE (%)	
	Group EIL	Group EIS	Group EIL	Group EIS
20-25	7	7	28	28
26-30	5	6	20	24
31-35	6	5	24	20
36-40	7	7	28	28
Total	25	25	100	100

Table 3: MEAN SCORES OF HR, SBP, DBP AND RPP

Variables	Groups	Baseline	10 Reps	15 Reps	20 Reps
HR	Group I (EIL)	83.12	87.76	95.12	103.04
	Group II (EIS)	82.6	88.68	90.4	89.44
SBP	Group I (EIL)	114.28	118.12	125.08	129.44
	Group II (EIS)	109.6	111.72	114.16	118.96
DBP	Group I (EIL)	77.88	79.92	84.48	88.88
	Group II (EIS)	76.24	78.16	79.36	81.08
RPP	Group I (EIL)	95.32	103.05	117.53	131.08
	Group II (EIS)	90.85	96.94	100.2	103.73

Multiple comparisons result from both groups revealed that the HR, SBP, DBP and RPP increased proportionately with increasing repetitions as explained in tables 4 & 5 and graphs 1 & 2. Few variables did not prove its significance in this study. In group 1, SBP and DBP after 10 repetitions did not show any significance whereas HR and SBP did not show any significance after 10 and 15 repetitions in group 2. The RPP values were not statistically different among groups at the baseline (Graph 2). But they were statistically different after 10, 15 and 20 repetitions in the groups. There were not much differences in RPP values among the 2 groups after 10 repetitions. Whereas, marked differences were found after 15 and 20 repetitions in both the groups. The work of the heart during EIL was much higher than EIS after 20 repetitions.

Table 4: Multiple comparisons to find the significance within Group I (EIL) for HR, SBP, DBP and RPP

Group I (EIL)	Repetitions	Mean Diff	Standard Deviation	Std. Error Mean	t value	Significance (2 tailed)
Baseline HR	After 10	-4.64	2.812	0.56	-8.251	0.00**
	After 15	-12	6.91	1.38	-8.683	0.00**
	After 20	-19.92	9.35	1.87	-10.648	0.00**
Baseline SBP	After 10	-3.84	9.77	1.95	-1.966	0.06*
	After 15	-10.8	10.15	2.03	-5.319	0.00**
	After 20	-15.16	10.41	2.08	-7.281	0.00**
Baseline DBP	After 10	-2.04	7.31	1.46	-1.396	0.17*
	After 15	-6.60	8.21	1.64	-4.022	0.00**
	After 20	-11.00	9.57	1.92	-5.745	0.00**
Baseline RPP	After 10	-7.72	8.69	1.74	-4.445	0.00**
	After 15	-22.20	12.56	2.51	-8.837	0.00**
	After 20	-36.47	18.10	3.62	-10.072	0.00**

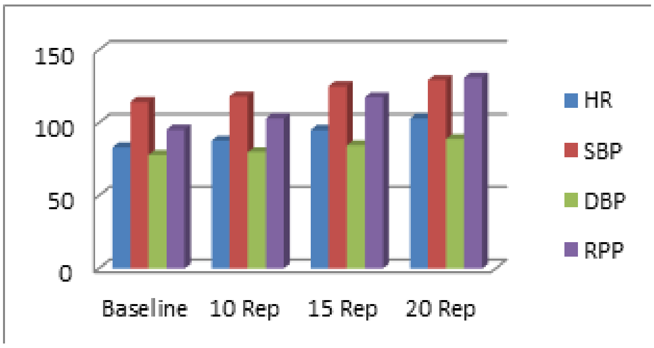
**Not significant; **Significant*

Table 5: Multiple comparisons to find the significance within Group II (EIS) for HR, SBP, DBP and RPP

Group II (EIS)	Repetitions	Mean Diff	Standard Deviation	Std. Error Mean	t value	Significance (2 tailed)
Baseline HR	After 10	-2.12	8.34	1.67	-1.270	0.21*
	After 15	-4.56	9.67	1.94	-2.356	0.02*
	After 20	-9.36	10.25	2.05	-4.566	0.00**
Baseline SBP	After 10	-1.92	6.67	1.33	-1.439	0.16*
	After 15	-3.12	6.59	1.32	-2.367	0.02*
	After 20	-4.84	8.44	1.69	-2.866	0.00**
Baseline DBP	After 10	-6.08	3.59	0.72	-8.461	0.00**
	After 15	-7.44	6.26	1.25	-5.944	0.00**
	After 20	-6.84	8.14	1.63	-4.200	0.00**
Baseline RPP	After 10	-6.09	8.77	1.76	-3.470	0.00**
	After 15	-9.35	10.73	2.15	-4.356	0.00**
	After 20	-12.88	15.26	3.05	-4.221	0.00**

**Not significant; **Significant*

Graph 1: Mean scores of group 1 with different repetitions



Graph 2: Mean scores of group 2 with different repetitions

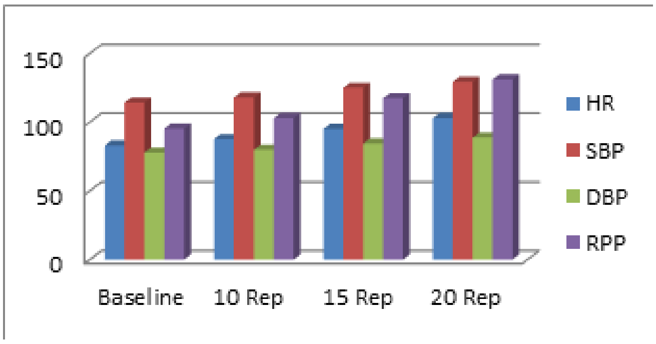


Table 6 shows the summary of one way ANOVA for repeated measures for both groups in relation to HR, SBP, DBP and RPP with different repetitions. No significant differences (p>0.05) were found after 10 repetitions for all variables. A significant difference (p<0.05) in all variables was noticed after 15 and 20 repetitions. Independent 't' test was used to find out the significance for all measurements between EIL and EIS on the basis of 10, 15 and 20 repetitions which is explained in Table 7. All the variables such as HR, SBP, DBP and RPP were significant (p<0.05) when compared between EIL and EIS after 15 and 20 repetitions, except after 10 repetitions. From the above analysis, it was very clear that cardiovascular changes were more marked in EIL group after 20 repetitions.

Table 6: ANOVA Analysis

Variables	Source	Sum of Squares	df	Mean Square	F	p
HR - 10	Between Groups	10.580	1	10.580	.286	0.59*
	Within Groups	1778.000	48	37.042		
SBP - 10	Between Groups	512.000	1	512.000	4.096	0.04*
	Within Groups	5999.680	48	124.993		
DBP - 10	Between Groups	38.720	1	38.720	.617	0.43*
	Within Groups	3011.200	48	62.733		
RPP - 10	Between Groups	466.346	1	466.346	2.586	0.11*
	Within Groups	8656.902	48	180.352		
HR - 15	Between Groups	322.580	1	322.580	10.756	0.00**
	Within Groups	1439.600	48	29.992		
SBP - 15	Between Groups	1490.580	1	1490.580	20.529	0.00**
	Within Groups	3485.200	48	72.608		
DBP - 15	Between Groups	327.680	1	327.680	7.725	0.00**
	Within Groups	2036.000	48	42.417		
RPP - 15	Between Groups	3753.245	1	3753.245	31.187	0.00**
	Within Groups	5776.710	48	120.348		
HR - 20	Between Groups	2312.000	1	2312.000	57.887	0.00**
	Within Groups	1917.120	48	39.940		
SBP - 20	Between Groups	1372.880	1	1372.880	14.832	0.00**
	Within Groups	4443.120	48	92.565		
DBP - 20	Between Groups	760.500	1	760.500	14.575	0.00**
	Within Groups	2504.480	48	52.177		
RPP - 20	Between Groups	9844.851	1	9844.851	63.447	0.00**
	Within Groups	7447.964	48	155.166		

*Not significant; **Significant*

Table 7: Independent t test to find out the significance between EIL & EIS groups after 10, 15 & 20 repetitions

Outcome Measures	Rep	EIL		EIS		Mean Change	95% CI of Mean Change	p
		Mean	SD	Mean	SD			
HR	10	87.76	6.2	88.68	5.8	-0.92	-4.38, 2.54	0.59*
	15	95.12	6.3	90.04	4.4	5.08	1.96, 8.19	0.00**
	20	103.04	7.8	89.44	4.3	13.60	10.00, 17.19	0.00**
SBP	10	118.12	10.7	111.72	11.5	6.4	0.04, 12.7	0.04*
	15	125.08	6.3	114.16	10.2	10.92	6.05, 15.78	0.00**
	20	129.44	10.5	118.96	8.6	10.48	2.72, 5.00	0.00**
DBP	10	79.92	8.2	78.16	7.6	1.7	-2.74, 6.26	0.43*
	15	84.48	6.7	79.36	6.2	5.12	1.41, 8.82	0.00**
	20	88.88	7.5	81.08	6.90	7.80	3.69, 11.90	0.00**
RPP	10	103.04	13.4	96.94	13.4	6.1	-1.52, 13.7	0.11*
	15	117.52	11.6	100.20	10.2	17.32	11.08, 23.56	0.00**
	20	131.79	14.7	103.73	9.6	28.06	20.98, 35.14	0.00**

*Not significant; **Significant*

In addition, independent 't' test and one-way ANOVA were used to analyze the RPP changes in group 1 on the basis of gender and different age ranges respectively. From tables 8 and 9, it is very clear that gender and different age ranges did not bring any significant changes over the RPP.

Table 8: Independent 't' test to find out the significance in RPP on the basis of gender in group 1.

Variable	Gender	Mean	SD	Mean Change	95% CI of Mean Change	p
RPP	M	132.2	13.5	0.77	-11.5, 13.1	0.89*
	F	131.4	16.2			

*Not significant

Table 9: One way ANOVA to find out the significance in RPP on the basis of age ranges in group 1

Source	Sum of Squares	df	Mean Square	F	p
Between Groups	959.357	3	319.786	1.586	0.22*
Within Groups	4234.693	21	201.652		

*Not significant

DISCUSSION

The hypothesis of our study is strongly supported by the results that repetitive McKenzie spinal extension exercises produce cardiovascular effects after performing in positions like prone lying and standing with multiple repetitions in class I obese subjects. These effects were observed in healthy class I obese subjects without any spinal impairments and cardiovascular insufficiencies. Cardiovascular demands were directly related to the numbers of repetitions. A non-invasive method was used to calculate RPP which shows an increase in RPP during multiple repetitions in EIL and EIS. An increased RPP denotes a high cardiac work load. This study finding reinforces the view that marked hemodynamic strain is possible in patients with suspected cardiovascular pathology who perform McKenzie's spinal extension exercises repetitively.

HR, SBP, DBP and RPP increases after 15 and 20 repetitions of spinal extension exercises in both EIL and EIS. When compared between both the groups, results of our study showed that cardiovascular changes were more marked in EIL than EIS. This result is consistent with known physiology [10,14]. The cardiac demand in standing position is lesser than in lying position due to cephalad fluid shifts in lying. Spinal extension in the prone position is brought about by an activation of upper limb muscles [9]. Several authors [10,13,15-17] have reported that arm exercises increase HR, BP and RPP than leg exercises at a constant work rate. As shown by Astrand et al [18], both HR and BP are much higher while performing dynamic arm exercises than leg exercises. As highlighted by Martin-Du Pana, [19] cardiac output and arterial pressure fall in standing position due to distension of venous system below the heart resulting in decreased venous return with rapid accumulation of blood in the legs.

As highlighted by Richardson D, [20] blood flow is also affected by the magnitude and frequency of active muscular contractions. The muscle metabolism increases in response to voluntary contractions and therefore, blood flow increases to the active musculature. The results of this study found that 10 repetitions of spinal extension exercises in prone lying or standing position is linked with minimal cardiovascular demand. The results also indicate that classic McKenzie exercise of "extension in standing" is hemodynamically less stressful when compared with "extension in lying" and therefore, theoretically the least risky. Moreover, there is no change in RPP based on gender and different age ranges. This result might be due to the selection of healthy class 1 obese subjects. In general, the response of spinal extension McKenzie exercises in prone lying position on the cardiovascular system is similar in both genders. This finding is consistent with the previous study findings [21].

The study exhibited lack of power calculation and blinding as limitations. Further studies are necessary to investigate the effect of repetitive McKenzie spinal extension exercises on cardiovascular and respiratory variables among different classes of obese population with mechanical back pain.

CLINICAL IMPLICATIONS

Cardiovascular risk factors need to be ruled out by a physiotherapist before prescribing McKenzie spinal extension exercises. Physical deconditioning, obesity and smoking are some of the risk factors for back pain which are also linked with cardiovascular diseases. Ruling out these risk factors should be done both on the basis of subjective and objective measures. Cardiovascular status of HR and BP needs to be checked before, during and after McKenzie spinal extension exercises on a regular basis. Caution should be taken when home exercise programs are prescribed. Patients should be educated properly regarding the method of performing the exercise program at home. Strict instructions should be given not to exceed the prescribed number of repetitions. It is important to emphasize patients to monitor cardiovascular parameters who are at risk of developing cardiovascular diseases. Awareness of cardiovascular effects is important for accurate and safe assessment and management of all patients with mechanical low back pain.

CONCLUSION

Repetitive McKenzie spinal extension exercises have cardiovascular effects on class 1 obese subjects. This effect is heightened as the number of repetitions increase. Repetitive spinal extension exercises in prone lying bring more cardiovascular stress when compared to the same performed in the standing position. Adequate cautions need to be taken while prescribing spinal extension exercises in prone lying for class 1 obese patients complaining of low back pain with symptomatic or asymptomatic cardiovascular disease.

ACKNOWLEDGEMENT

We would like to extend our heartfelt thanks to all the participants.

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Citation
Karthikeyan, S., Roshini, R., Nagaletchumy, S., Abudaheer, S., K.V, Jubish., & Karthikeyan, R. (2016). REPETITIVE MCKENZIE SPINAL EXTENSION EXERCISES ON CARDIOVASCULAR RESPONSES IN CLASS I OBESE SUBJECTS. *International Journal of Physiotherapy,* 3(5), 630-636.