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Acute Cardiac Response to One-Minute Upper- and Lower-Extremity Callisthenic Exercise with Different Cadences

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Abstract: Callisthenic exercise is a systematic rhythmic isotonic exercise that is performed with four counts movements using the upper or the lower body parts. It can be performed with slow, moderate, or fast cadence and it is usually included in cardiac rehabilitation. The aim of this study was to explore the acute effect of callisthenic exercise time and cadence on the heart rate (HR) and percentage age predicted maximum heart rate (%APMHR). During February to May 2009, sixteen healthy female students (aged 22.5 ± 0.89 years) were recruited from College of Applied Medical Sciences (CAMS), King Saud University (KSU) to participate in this study. They practiced one-minute upper- and lower-extremity callisthenic exercise with slow, moderate and fast cadences. Resting, exercise and recovery HR was monitored using Polar wristwatch-like device and %APMHR was calculated. Results showed that progression through the exercise time and cadence resulted in progressive increase in HR and %APMHR. Lower-extremity one-minute callisthenic exercise showed higher increase in HR and %APMHR than upper-extremity one-minute callisthenic exercise. At the end of one-minute callisthenic exercise HR returned to the resting level or even lower indicating acceptable recovery pattern. Fast cadence one-minute lower-extremity callisthenic exercise could be considered as mild-intensity aerobic exercise. If the cardiac patient would respond the same way, callisthenic exercises could be used in phase I cardiac rehabilitation for patients reconditioning after cardiac event and as home program in phase II. It would serve for warm up and cool down.

Key words: Callisthenics exercise · Factors affecting heart rate response to exercise · Percentage of age predicted maximum heart rate · Cardiac rehabilitation

INTRODUCTION

Exercise is a common physiological stress that can elicit cardiovascular abnormalities which are not present at rest [1] and it is a core component of cardiac rehabilitation programs [2]. Callisthenic exercise is a form of organized systematic rhythmic bodily exercise consisting of a variety of simple movements that are performed without weights or equipment [3, 4]. It develops coordination, muscular endurance, flexibility and strength [4]. It is done in movement of 4 counts and it may be done in cadence. When doing callisthenic exercises at slow cadence, 60 counts per minute (CPM) are used, at a moderate cadence 80 CPM and at fast cadences 100 CPM are used [5].

Callisthenic exercises are used to be a part of the cardiac rehabilitation [6]. It is Phase II of cardiac rehabilitation in which callisthenics are used for warm-up and cool-down [7]. Callisthenics are also famous in phase I of cardiac rehabilitation in which exercise starting with one minute and increasing to 8 minutes [8]. As many activities of daily living require more arm work than leg work, persons with coronary artery disease are advised to use their arms as well as their legs in exercise training [9] and graded callisthenics used in cardiac rehabilitation settings include upper extremity, lower extremity and trunk activity exercises [10].

In response to an acute bout of exercise, both central and peripheral alterations are elicited [11]. The extent of these responses is dependent upon exercise intensity, duration and the subject's gender [11, 12]. The cardiovascular system immediate response to exercise is an increase in heart rate (HR) [1] to maintain a given level of cardiac output to match the increased skeletal muscle demand [13].

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Exercise intensity is critical and it should be controlled by the degree of physical effort as measured by physiological signs, especially heart rate [14]. On the other hand, it is always good to measure the maximum heart rate (MHR) to ensure stay within a safe range or use it to measure if the exercise is actually working well enough to raise the HR to acceptable ranges and levels. The best method of determining an individual MHR is to be clinically tested and monitored on a treadmill. The other method is by using an age-predicted maximum heart rate (APMHR) formula: 220-age [15-18] which is the most widely promoted and used calculation for getting a quick, rough estimate of the MHR [19]. Training at various percentages of APMHR (% APMHR) will help achieve different workout results [20].

As mentioned earlier, callisthenic exercises are frequently included in cardiac rehabilitation exercise programs; however, little information is available concerning the physiologic stress of these activities. Most studies on callisthenic exercises have involved healthy young male subjects but, women often respond to various work loads differently than men [21]. To accurately prescribe callisthenic exercise within cardiac rehabilitation program, physical therapist must understand the changes that occur in HR in response to specific variations in speed and technique of the exercise. Unfortunately, many of the cardiac rehabilitation programs recognize the exercise repetitions not the speed or duration at which the exercise should be performed [10]. On other words, knowledge of the expected physiological responses for a given exercise is necessary for the physical therapist to make decisions on safe and effective exercise programs [22].

The purpose of this study was to explore the acute cardiac response, in form of HR and % APMHR, to standardized one-minute upper-extremity and lower-extremity callisthenic exercises of selected cadences, resemble to that designed for in-patients during cardiac rehabilitation, on healthy young adult females. Specific objective were to determine the effect of exercise cadence and exercise time on cardiac response in addition to compare between the cardiac responses of upper- and lower-extremities.

MATERIALS AND METHODS

In this quasi-experimental study, sixteen college-female students were recruited through bulletin board announcement. A repeated-measures design was used with three independent variables including exercise time (10 sec interval measurements), exercise cadence (60, 80 and 100 CPM) and exercised extremity (upper, lower). Dependent variables were HR and %APMHR measurements. The study was approved by the Department of Rehabilitation Health Sciences, CAMS, KSU. It was conducted in the duration during February to May 2009.

The nature and purpose of the study were explained to the subjects before obtaining their consent. Inclusion criteria included; Saudi apparently healthy female with age ranged from 18 - 23 years. Not participating in regular sport activity and with normal body weight (Body Mass Index ranged from 18- 24.9%).

Subjects were oriented to the equipment and procedures and the exercises were carefully explained. Subjects practiced exercises until they could perform them with the correct rhythm and cadence.

A heart rate monitor was worn before the exercise; it consists of a strap worn across the chest that sends an electronic signal to a wristwatch-like device that converts the signal into beats per minute.

Each subject performed one upper-extremity exercise and one lower-extremity exercise. The upper-extremity exercise consisted of alternated right and left shoulder flexion to 90 degrees and extension to neutral position with elbows extended and fingers together. The lower-extremity exercise consisted of alternated right and left hip flexion to 90 degrees and extension to neutral position with knees flexed. During the exercise, a mirror was used to assure the 90 degrees range of motion.

Each exercise was performed for one minute at each cadence beginning with the slowest cadence. Upper-extremity exercise always preceded lower-extremity exercise. Rest periods were provided between the three cadences of at least 5 minutes or until the HR returns to the base-line measurement. In addition, 15 minutes between upper- and lower-extremity exercises. The cadences selected (60, 80 and 100 CPM) represented 15, 20 and 25 repetitions of the four-count movements of practiced exercises, respectively. The exercises were performed keeping cadence with a metronome which works in music mechanism to indicate the exact tempo in which a work is to be performed. The subjects were monitored and encouraged during exercise to maintain correct speed, technique and range of motion.

A sitting baseline measurement was obtained for HR pre-exercise. HR was monitored during the exercise at 10 seconds interval by Polar watch which record and save the measured HR values. HR was also monitored during the recovery period at 30 seconds and 5 minutes at the end of exercise. Relative exercise intensity was calculated as a percentage of the subject's APMHR using the formula of (APMHR= 220 minus the subject's age in years).

Data Analysis: For this study, the 0.05 level was adopted as the level of significance. The focus of this study was to evaluate the HR and % APMHR response according to exercise cadence, exercise time and extremity exercised. One way ANOVAs were used to compare means of HR and % APMHR between the three used cadences as well as upper and lower extremities. Tukey's Studentized post hoc test was used to examine differences among groups if analysis of variance revealed significance. Repeated measures ANOVA technique was used to follow the progression of HR and % APMHR in one cadence through each 10 sec interval measurement during the one-minute exercise.

RESULTS AND DISCUSSION

Exercise, in cardiac rehabilitation, has physical and psychological benefits but it can be life threatens as well if its intensity is not objectively prescribed. In cardiac rehabilitation, exercise repetition is usually used for prescription of callisthenic exercise. This contradicts the concept of cardiac rehabilitation which emphasis that exercise should be individually designed to ensure that exercise intensity is effective and at the same time safe.

Studding the acute cardiac response of callisthenic exercise on healthy subjects is a step preceding studying its effect on the cardiac patients. The majority of published studies were conducted with male participants while Pina and Hesich [21] confirmed that the HR response to exercise is influenced by several factors including gender. Carrying out this study on female would help to eliminate the shortage in knowledge regarding the female's physiological response to exercise.

Results of this study revealed that callisthenic exercise was following the normal physiological effect for exercise as it resulted in increased HR (Tables 1, 2). This HR increase is physiologically explained by increase in sympathetic outflow to the heart and systemic blood vessels with increased release of epinephrine and norepinephrine that stimulate receptors in the heart causing HR to increase [1, 13].

Progression from slow, moderate to fast cadences resulted in progressive increase in HR and % APMHR. This documented that exercise cadence had influenced the cardiac response. This was true for each 10 sec interval measurements. The progressive increase in HR and %APMHR was without significant differences in upper-extremity (Table 1). For the lower-extremity (Table 2), the effect of exercise cadence was more prominent specially in the second half of the one-minute exercise as there were significant increase in the HR and %APMHR in fast cadence more than in slow cadence ($P < 0.05$ between slow and fast cadences in the 40 sec, 50 sec and 60 sec measurements for HR and %APMHR).

The observed increase in HR with the increased exercise cadence is supported by Fletcher, Balady, Amsterdam, Chaitman, Eckel, Fleg *et al*. [1] as they stated that, during dynamic exercise, HR increases linearly with workload and O_2 requirement.

Exercise involving only the arms elicits a higher HR response than lower or whole body exercise [13]. However, current study results showed that HR and %APMHR responses to upper-extremity exercise had lower values than to lower-extremity exercise (Table 3). This was applied for each 10 sec interval measurement and for the slow, moderate and fast cadences.

Table 1: Acute HR and % APMHR responses to three cadences upper-extremity one-minute callisthenic exercise

Exercise time	Callisthenics cadence	N	HR Mean ± SD	P	% APMHR Mean ± SD	P
10 sec	Slow	16	85.8 ± 14.8	0.528	44.4 ± 9.5	0.715
	Moderate	16	90 ± 9.7		45.5 ± 4.9	
	Fast	15	90.2 ± 11.7		45.6 ± 6.0	
20 sec	Slow	16	86 ± 14.6	0.547	44.6 ± 6.6	0.660
	Moderate	16	90.6 ± 11		45.8 ± 5.5	
	Fast	15	90.6 ± 11.8		45.8 ± 6.0	
30 sec	Slow	16	87.6 ± 12.1	0.485	44.6 ± 5.7	0.823
	Moderate	16	90.6 ± 11.8		45.8 ± 6.0	
	Fast	15	92.6 ± 10.4		46.8 ± 5.2	
40 sec	Slow	16	89 ± 12	0.583	45.1 ± 6.1	0.825
	Moderate	16	91.6 ± 10		46.3 ± 5.0	
	Fast	15	93.6 ± 14.1		47.3 ± 3.1	
50 sec	Slow	15	91.8 ± 11.9	0.823	46.4 ± 6.0	0.689
	Moderate	16	92.8 ± 10.4		46.9 ± 5.3	
	Fast	15	94.5 ± 13.7		47.8 ± 7.0	
60 sec	Slow	15	92.1 ± 11.5	0.835	47.0 ± 5.8	0.682
	Moderate	16	93.8 ± 10.5		47.4 ± 5.3	
	Fast	15	94.8 ± 14.6		48.0 ± 7.4	

Table 2: Acute HR and % APMHR responses to three cadences lower-extremity one-minute callisthenic exercise

Exercise time	Calisthenics cadence	N	HR Mean ± SD	P	% APMHR Mean ± SD	P
10 sec	Slow	15	98.8 ± 9	0.533	50.0 ± 4.5	0.521
	Moderate	15	100.8 ± 13		51.0 ± 6.6	
	Fast	15	103.5 ± 11.6		52.4 ± 5.9	
20 sec	Slow	15	100.2 ± 12.2	0.311	50.7 ± 6.1	0.306
	Moderate	15	102.2 ±13.6		51.7 ± 6.9	
	Fast	15	107.1 ± 11.9		54.2 ± 6.1	
30 sec	Slow	15	101 ± 10.5	0.139	51.1 ± 5.3	0.137
	Moderate	15	105.2 ± 14.5		53.2 ± 7.4	
	Fast	15	110.3 ± 12.3		55.8 ± 6.3	
40 sec	Slow	15	101.2 ± 11.3	0.044 Slow vs. fast P < 0.05	51.2 ± 5.7	0.043 Slow Vs. fast P< 0.05
	Moderate	15	107 ± 14.1		54.2 ± 7.2	
	Fast	15	112.9 ± 11.5		57.1 ± 5.8	
50 sec	Slow	15	103.1 ± 11.5	0.027 Slow vs. fast P < 0.05	52.2 ± 5.8	0.028 Slow Vs. fast P< 0.05
	Moderate	15	110.2 ± 13.7		55.8 ± 7.0	
	Fast	15	115.6 ± 11.2		58.5 ± 5.7	
60 sec	Slow	15	106.3 ± 12.6	0.041 Slow vs. fast P < 0.05	53.7 ± 6.5	0.042 Slow Vs. fast P< 0.05
	Moderate	15	112.1 ± 12.6		56.7 ± 6.4	
	Fast	15	117.4 ± 9.8		59.4 ± 5.0	

Table 3: Comparison between acute HR and %APHR responses for upper- and lower extremity one-minute callisthenic exercises

Cadence	Time	Extremity	N	HR Mean ± SD	P	%APMHR Mean ± SD	P
Slow	10 sec	upper	16	85.8 ± 14.85	0.007	44.5 ± 9.64	0.056
		lower	15	98.8 ± 9.05		50.0 ± 4.51	
	20 sec	upper	16	86.37 ± 14.68	0.008	44.6 ± 6.56	0.013
		lower	15	100.2 ± 12.2		50.6 ± 6.11	
	30 sec	upper	16	87.6 ± 12.11	0.003	44.6 ± 5.72	0.003
		lower	15	101.0 ± 10.54		51.1 ± 5.29	
	40 sec	upper	16	89.06 ± 12.06	0.007	45.0 ± 6.08	0.007
		lower	15	101.2 ± 11.31		51.2 ± 5.68	
	50 sec	upper	16	91.75 ± 11.57	0.011	46.4 ± 6.00	0.012
		lower	15	103.13 ± 11.58		52.1 ± 5.78	
	60 sec	upper	16	92.1 ± 11.18	0.003	46.9 ± 5.83	0.006
		lower	15	106.1 ± 13.02		53.7 ± 6.52	
Moderate	10 sec	upper	16	90.06 ± 9.77	0.014	45.5 ± 4.93	0.014
		lower	15	100.8 ± 13.02		51.0 ± 6.55	
	20 sec	upper	16	90.68 ± 11.05	0.015	45.8 ± 5.54	0.014
		lower	15	102.20 ± 13.63		51.7 ± 6.89	
	30 sec	upper	16	90.6 ± 11.84	0.005	45.8 ± 5.94	0.004
		lower	15	105.2 ± 14.56		53.2 ± 7.36	
	40 sec	upper	16	91.62 ± 10.02	0.001	46.3 ± 5.04	0.001
		lower	15	107.06 ± 14.12		54.1 ± 7.15	
	50 sec	upper	16	92.81 ± 10.47	0.0001	46.9 ± 5.27	0.0001
		lower	15	110.20 ± 13.77		55.7 ± 6.98	
	60 sec	upper	16	93.8 ± 10.52	0.0001	47.4 ± 5.28	0.0001
		lower	15	112.1 ± 12.63		56.7 ± 6.41	
Fast	10 sec	upper	16	90.2 ± 11.39	0.003	45.6 ± 5.76	0.003
		lower	15	103.5 ± 11.66		52.4 ± 5.91	
	20 sec	upper	16	90.63 ± 11.44	0.0001	45.8 ± 5.76	0.0001
		lower	15	107.13 ± 11.95		54.2 ± 6.07	
	30 sec	upper	16	92.6 ± 10.13	0.0001	46.7 ± 5.09	0.0001
		lower	15	110.3 ± 12.37		55.8 ± 6.26	
	40 sec	upper	16	93.60 ± 13.62	0.0001	47.2 ± 6.87	0.0001
		lower	15	112.93 ± 11.56		57.1 ± 5.81	
	50 sec	upper	16	94.56 ± 13.31	0.0001	47.7 ± 6.69	0.0001
		lower	15	115.60 ± 11.26		58.5 ± 5.68	
	60 sec	upper	16	94.8 ± 14.20	0.0001	47.8 ± 7.17	0.0001
		lower	15	117.4 ± 9.80		59.4 ± 5.02	

Table 4: Progression of HR and %APMHR responses through one- minute upper-extremity callisthenic exercise in three cadences

Calisthenics cadence	Exercise time	N	HR Mean ± SD	P	Repeated Measures ANOVA post-test	P	%APMHR Mean ± SD	P
Slow	base	16	83.1 ± 11.6	0.0003				
	10 sec	16	85.8 ± 14.8				44.4 ± 9.5	0.992
	20 sec	16	86.0 ± 14.6				44.6 ± 6.6	
	30 sec	16	87.6 ± 12.1				44.6 ± 5.7	
	40 sec	16	89.0 ± 12.0				45.1 ± 6.1	
	50 sec	15	91.8 ± 11.9		base Vs. 50 sec	< 0.01	46.4 ± 6.0	
	60 sec	15	92.1 ± 11.5		base Vs. 60 sec	<0.001	47.0 ± 5.8	
Moderate	base	16	83.1 ± 11.6	0.0001				
	10 sec	16	90 ± 9.7		base Vs 10 sec	< 0.01	45.5 ± 4.9	0.176
	20 sec	16	90.6 ± 11		base Vs 20 sec	< 0.001	45.8 ± 5.5	
	30 sec	16	90.6 ± 11.8		base Vs 30 sec	< 0.001	45.8 ± 6.0	
	40 sec	16	91.6 ± 10		base Vs 40 sec	< 0.001	46.3 ± 5.0	
	50 sec	16	92.8 ± 10.4		base Vs 50 sec	< 0.001	46.9 ± 5.3	
	60 sec	16	93.8 ± 10.5		base Vs 60 sec	< 0.0001	47.4 ± 5.3	
Fast	base	16	83.1 ± 11.6	0.0001				
	10 sec	15	90.2 ± 11.7		base Vs 10 sec	< 0.01	45.6 ± 6.0	0.030
	20 sec	15	90.6 ± 11.8		base Vs 20 sec	< 0.01	45.8 ± 6.0	
	30 sec	15	92.6 ± 10.4		base Vs 30 sec	< 0.001	46.8 ± 5.2	
	40 sec	15	93.6 ± 14.1		base Vs 40 sec	< 0.001	47.3 ± 3.1	
	50 sec	15	94.5 ± 13.7		base Vs 50 sec	< 0.001	47.8 ± 7.0	
	60 sec	15	94.8 ± 14.6		base Vs 60 sec	< 0.001	48.0 ± 7.4	

Table 5: Progression of HR response through one- minute lower-extremity callisthenic exercise in three cadences

Calisthenics cadence	Exercise time	N	HR Mean ± SD	P	Repeated Measures ANOVA post-test	P
Slow	base	15	85.9 ± 15.7	0.0001		
	10 sec	15	98.8 ± 9		base Vs. 10 sec	P < 0.001
	20 sec	15	100.2 ± 12.2		base Vs. 20 sec	P < 0.001
	30 sec	15	101 ± 10.5		base Vs. 30 sec	P < 0.001
	40 sec	15	101.2 ± 11.3		base Vs. 40 sec	P < 0.001
	50 sec	15	103.1 ± 11.5		base Vs. 50 sec	P < 0.001
	60 sec	15	106.3 ± 12.6		base Vs. 60 sec	P < 0.001
Moderate	base	15	85.9 ± 15.7	0.0001		
	10 sec	15	100.8 ± 13		base Vs. 10 sec	P < 0.001
	20 sec	15	102.2 ±13.6		base Vs. 20 sec	P < 0.001
	30 sec	15	105.2 ± 14.5		base Vs. 30 sec	P < 0.001
	40 sec	15	107 ± 14.1		base Vs. 40 sec	P < 0.001
	50 sec	15	110.2 ± 13.7		base Vs. 50 sec	P < 0.001
					10 sec Vs. 50 sec	P < 0.05
	60 sec	15	112.1 ± 12.6		base Vs. 60 sec	P < 0.001
					10 sec Vs. 60 sec	P < 0.01
					20 sec Vs. 60 sec	P < 0.01
Fast	base	15	85.9 ± 15.7	0.0001		
	10 sec	15	103.5 ± 11.6		base Vs. 10 sec	P < 0.001
	20 sec	15	107.1 ± 11.9		base Vs. 20 sec	P < 0.001
	30 sec	15	110.3 ± 12.3		base Vs. 30 sec	P < 0.001
					10 sec Vs. 30 sec	P < 0.05
	40 sec	15	112.9 ± 11.5		base Vs. 40 sec	P < 0.001
					10 sec Vs. 40 sec	P < 0.01
	50 sec	15	115.6 ± 11.2		base Vs. 50 sec	P < 0.001
					10 sec Vs. 50 sec	P < 0.001
					20 sec Vs. 50 sec	P < 0.01
	60 sec	15	117.4 ± 9.8		base Vs. 60 sec	P < 0.001
					10 sec Vs. 60 sec	P < 0.001
					20 sec Vs. 60 sec	P < 0.001

Table 6: Progression of % APMHR response through one-minute lower-extremity callisthenic exercise in three cadences

Calisthenics cadence	Exercise time	N	%APMHR Mean ± SD	P	Repeated Measures ANOVA post-test	P
Slow	10 sec	15	50.0 ± 4.5	0.0006	10 sec Vs. 60 sec	P < 0.001
	20 sec	15	50.7 ± 6.1		20 sec Vs. 60 sec	P < 0.01
	30 sec	15	51.1 ± 5.3		30 sec Vs. 60 sec	P < 0.05
	40 sec	15	51.2 ± 5.7		40 sec Vs. 60 sec	P < 0.05
	50 sec	15	52.2 ± 5.8			
	60 sec	15	53.7 ± 6.5			
Moderate	10 sec	15	51.0 ± 6.6	0.0001	10 sec Vs. 40 sec	P < 0.01
					10 sec Vs. 50 sec	P < 0.001
					10 sec Vs. 60 sec	P < 0.001
	20 sec	15	51.7 ± 6.9		20 Vs. 40 sec	P < 0.05
					20 Vs. 50 sec	P < 0.001
					20 Vs. 60 sec	P < 0.001
	30 sec	15	53.2 ± 7.4		30 sec Vs. 50 sec	P < 0.05
					30 sec Vs. 60 sec	P < 0.001
	40 sec	15	54.2 ± 7.2		40 sec Vs. 60 sec	P < 0.05
	50 sec	15	55.8 ± 7.0			
	60 sec	15	56.7 ± 6.4			
Fast	10 sec	15	52.4 ± 5.9	0.0001	10 sec Vs. 30 sec	P < 0.001
					10 sec Vs. 40 sec	P < 0.001
					10 sec Vs. 50 sec	P < 0.001
					10 sec Vs. 60 sec	P < 0.001
	20 sec	15	54.2 ± 6.1		20 Vs. 40 sec	P < 0.01
					20 Vs. 50 sec	P < 0.001
					20 Vs. 60 sec	P < 0.001
	30 sec	15	55.8 ± 6.3		30 sec Vs. 50 sec	P < 0.01
					30 sec Vs. 60 sec	P < 0.001
	40 sec	15	57.1 ± 5.8		40 sec Vs. 60 sec	P < 0.05
	50 sec	15	58.5 ± 5.7			
	60 sec	15	59.4 ± 5.0			

The fact that cardiac hemodynamic and maximal sympathetic drive is influenced by muscle mass involvement [23] could explain those results. Nevertheless, Miles, Cox and Bonze [24] opposed this explanation as they stated that; the central and peripheral responses to either upper or lower body exercise appear to be independent of the muscle mass but directly related to the exercise intensity. The reverse results of current study, lower HR for upper-extremity exercise than lower-extremity exercise, could be explained by the short time of exercise, one minute and very low intensity of the exercise so that the subject did not reach to their peaks or the sub-maximal HR. But anyway the results supported the concept that there is difference in physiological cardiac response between the upper- and lower-extremity exercises. Marais, Dupont, Maillet, Weissland, Vanvelcenaher and Pelayo [25] confirmed that cardiorespiratory and efficiency responses between arm and leg exercises are not always similar. Results also fostered the researcher believe that exercise prescription is very complex process especially when it is applied on cardiac patient during cardiac rehabilitation. Understanding differences in physiologic response between upper- and lower-body exercises enables the clinician to design exercise programs using both exercise modes. Furthermore, maximum oxygen uptake for arm exercises does not strongly relate to leg exercise maximum oxygen uptake; thus, one can not predict accurately one's aerobic capacity for arm exercise from a test using the legs and vice versa. Thus further substantiates the concept of aerobic fitness specificity [26].

On the other hand, studying the effect of exercise time on the acute cardiac response showed that, progression through each 10 sec interval measurement of the one-minute exercise time resulted in progressive increase in the HR and %APMHR (Tables 4-6).

For upper-extremity exercise, within the same cadence, there was progressive increase in HR from the base-line measurement to the 60 sec measurement. This increase was of significant difference with P value of 0.0003 for slow cadence, 0.0001 for moderate cadence and 0.0001 for fast cadence (Table 4). Repeated measures ANOVA post-test showed that the significant difference in slow cadence is between the base-line HR measurement and 50 sec and 60 sec HR measurements. While in the moderate and fast cadences, the significant differences existed between the base-line HR measurement and every 10 sec interval measurement all through the one-minute calisthenic exercise. For slow and moderate cadences, there were no significance differences in the %APMHR for any 10 sec interval measurement through the one-minute calisthenic exercise. For the fast cadence, there was progressive significant increase from the base-line measurement to the 60 sec. measurement with P value of 0.030.

For one-minute lower-extremity callisthenic exercises, with the three used cadences, there was progressive increase in HR with progression of the exercise time (P = 0.0001 for the three cadences). There were significant differences between the base-line HR measurement and every 10 sec interval HR measurements (Table 5).

Repeated measures ANOVA (Table 6) showed that there was progressive increase in %APMHR from the first 10 sec of one-minute lower-extremity callisthenic exercises to the 60 sec. This was applied to slow, moderate, as well as fast cadences (P = 0.0006, 0.0001 and 0.0001, respectively).

It was interesting that exercise cadence factor which showed modest effect on HR and %APMHR when it was studied separately, it had an undutiful effect when exercise time factor was studied. Results showed that with slow cadence, there was significant difference between the 10 sec and 60 sec measurements ($P < 0.05$). While with the moderate cadence, there were differences between the 10 sec measurement and that of the 50 sec and 60 sec measurements ($P < 0.05$ and $P < 0.01$, respectively). In addition, there was difference between the 20 sec and 60 sec measurements ($P < 0.01$). In case of fast cadence, there were differences between the 10 sec measurement and 30 sec, 40 sec, 50 sec and 60 sec measurements ($P < 0.05$, $P < 0.01$, $P < 0.001$ and $P < 0.001$ respectively). Furthermore, there were differences between the 20 sec measurement and 50 sec and 60 sec measurements ($P < 0.01$ and $P < 0.001$, respectively). It would be said that exercise time factor was the translator for the exercise cadence factor. On other words, exercise cadence effect was cumulative one needed more exercise time to be showed-up. The relation between these two independent variables, exercise cadence and time, could be descried as multicollinearity which is defined by Osborn [27] as the interrelatedness of the independent variables. He stated that when two independent variables are highly correlated with each other, a phenomenon often termed multicollinearity; it is difficult to separate the effects of each independent variable on the dependent variable.

Callisthenic exercise in this study showed an acceptable recovery pattern as the HR declined after the exercise and retuned to the base line measurement or even less after 5 minutes (Figure 1a, b). Fletcher, Balady, Amsterdam, Chaitman, Eckel, Fleg *et al*. [1] supported those results as they stated that in the post-exercise phase, hemodynamic returns to baseline within minutes of termination.

Compel this recovery pattern with the minimal increase in %APMHR would recommend the one-minute callisthenic exercise as a safe exercise for cardiac rehabilitation. Safe HR was defined as a HR that is typically about 60% of the MHR and that it helps to reduce the amount of stress on the heart while gaining good effects of exercise [15].

Another question was raised, could callisthenic exercise be considered as an aerobic exercise? The modest effect on the HR and % APMHR did not strongly guarantee callisthenic exercise as an aerobic exercise. It could be hardly said that one-minute lower-extremity fast cadence exercise is a low intensity aerobic exercise. This is because the recommended target HR range for aerobic exercise is 60-90% of the MHR [19]. Giam, Ong and Teh [4] also considered callisthenic exercise as a non-aerobic exercise. They said that in cardiac rehabilitation program, there is need to include non-aerobic exercises which specifically improve components

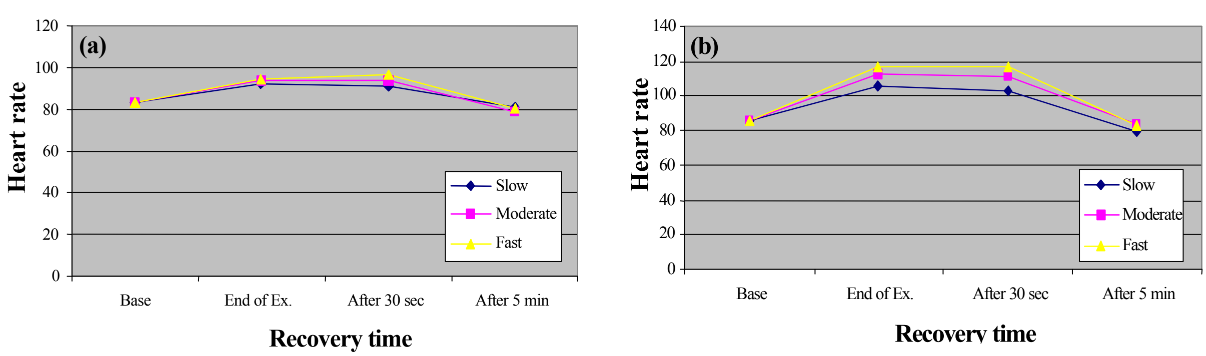

Fig. 1: Heart rate recovery after one-minute upper (a) and lower (b) extremity callisthenic exercise with three cadences

of overall physical fitness other than aerobic or cardiorespiratory endurance fitness. These non-aerobic exercises include judicious callisthenic and isometric exercises.

In conclusion, in healthy college-females, one-minute upper and lower-extremity callisthenic exercise produced modest increase in HR and % APMHR. If same acute cardiac responses would be achieved from cardiac patient, callisthenic exercise could be a safe exercise for cardiac rehabilitation especially in phase I and as home program in phase II. It would serve for warming up and cooling down.

RECOMMENDATION

It is recommended to re-apply the study on cardiac patients. It is also recommended to apply it for longer duration, more than one-minute.

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