

ACUTE EFFECTS OF UNILATERAL VERSUS BILATERAL RESISTANCE TRAINING ON HEART RATE, BLOOD PRESSURE AND RATE OF PERCEIVED EXERTION

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Abstract

Resistance training (RT) refers to a method of physical conditioning of complex programming which consists of progressive and various training techniques to achieve the desired training goals. An appropriate programme design is the key to success; where exercise selection is one of the critical factors. The selection of exercise will expose different stimulation as in the application of the specific adaptation on imposed demand principle. The option of choosing either bilateral (BI) or unilateral (UNI) exercise is an important decision to perform in the construction of any strength or RT programme. This study aimed to investigate the physiological responses of unilateral versus bilateral acute RT on heart rate (HR), blood pressure (BP) and rate of perceived exertion (RPE). Sixteen ($n = 16$) trained women with mean age of 23.31 ($SD = 1.35$) years old went through a total body exercise session for each unilateral and bilateral protocols which both consisted of major muscles group for 80% 1RM, 10 repetitions to maximal effort for 3 sets. The results revealed that all variables examined including HR, systolic blood pressure (SBP), diastolic blood pressure (DBP) and RPE were statistically changed ($p < .001$) across the times. Apart from that, unilateral and bilateral RT imposed significantly different stimulus on SBP ($p < .05$).

Keywords: Resistance training, unilateral, bilateral, heart rate, systolic blood pressure, diastolic blood pressure and rate of perceived exertion

INTRODUCTION

Over the past twenty years, resistance training (RT) has massively grown in popularity for improving athletic performances (Kraemer & Ratamess, 2004), cardiovascular, body composition, improving health (Blair & Connelly, 1996) increasing bone mass (Allison, Folland, Rennie, Summers & Brooke-Wavell, 2013) as well as enhancing mental health (Kirkcaldy, Shephard, & Siefen, 2002).

RT refers to a method of physical conditioning of complex programming which consists of progressive and various training techniques to achieve the desired training goals (Miller, Cheatham, & Patel, 2010). Most if not all of RT exercises can be perform either unilaterally or bilaterally.

Unilateral (UNI) exercise refers to a loading on one limb at a time (arm or leg) during an exercise movement such as lunges and one-sided (UNI) chest press. It often used as a variation for bilateral (BI) exercise such as BI bench press and squat (McCurdy, K. W., Langford, Doscher, Wiley, & Mallard, 2005; Waller & Whitall, 2008).

BI exercises provides a simultaneous loading on both limbs (either legs or arms) during exercise such as in the BI squat, BI bench press and BI bench pull. BI exercise involves the combination of efforts from both limbs to produce force against a single load (Baechle & Earle, 2008). As the exercise selection exposes different stimulation to the body, the options of either BI or UNI RT should also be prioritized in the construction of a RT programme (Lauder & Lake, 2008; Makaruk, Winchester, Sadowski, Czaplicki, & Sacewicz, 2011). Apart from that, according to Makaruk et al. (2011) and Shaner, Vingren, Hatfield, Budnar, Duplanty, and Hill (2014), RT affects physiological changes however little is known specifically on UNI versus BI.

The selection of exercise will expose different stimulation as in the application of the specific adaptation imposed demand (SAID) principle (Lauder & Lake, 2008; Makaruk et al., 2011). This principle suggested that different exercises such as high intensity, low intensity, functional or traditional and even UNI and BI exercises provide different stimulation to the body. Thus, it is crucial to understand of the nature of exercise stimulus (Kraemer, 1988). This was also supported by Shaner et al. (2014); who claimed that exercise modes did not produced the same physiological responses thus, evaluating the efficacy of each exercise is needed to ensure optimal benefits of a programme. Therefore, the option of choosing either BI or UNI exercise is a necessity in the construction of a strength or RT programme.

There is a need to understand the effects of UNI or BI exercise approached (Arin, Jansson, & Skarphagen, 2012). Apart from that, previous study mostly measured the acute effects from a single exercise, or lower and upper part of the body. Little was known about the acute responses of total body UNI versus BI RT; which is practically used for any training regimen (Migiano, Vingren, Volek, Maresh, Fragala, Ho, Thomas, Hatfield, Häkkinen, & Ahtiainen, 2010).

Steele, Fisher, McGuff, Bruce-Low and Smith (2012) claimed the need to conduct more studies specifically on the acute responses of RT on heart rate (HR), rate of perceived exertion (RPE) and blood pressure (BP). This was suggested because numerous previous studies were based

on VO₂ max from cardiovascular training as compared to RT. Numerous numbers of previous studies measured the effect of VO₂ max from cardiovascular training on RPE compared to the used of RT (Steele et al., 2012). Therefore specific response of UNI versus BI RT onto RPE is needed to be investigated. The RPE scale is adopted from (Baechle & Earle, 2008) to indicate the training effort.

The main purpose of this study was to investigate the effects of UNI versus BI RT response on HR, systolic blood pressure (SBP), diastolic blood pressure (DBP) and RPE among trained women.

METHODS

Sampling

Sixteen trained volunteered female students were recruited for this study. As the inclusion criteria for this study, all participants were healthy females aged between 19 to 26 years old. Participants were free from any injuries and had at least six months of experiences in RT to ensure for safety and accuracy of data collected. They understood and performed correct exercise techniques. This study excluded participants whom had been or has been taking any type of performance enhancing supplementations or with known medical conditions.

Participants with severe musculoskeletal injuries or spinal injuries within 6 months before the study were also excluded from the study. The participants were instructed to refrain from exercise or any heavy physical activity prior to each session. The participants fasted 10 hours prior to the exercise interventions (session 3 for bilateral and session 4 for unilateral) (Stokes et al., 2013). All participants were informed of the testing procedures and possible risks involved and provided written consent to participate. ECG (Omron, HCG-801) and PAR-Q were used as the qualifying screening test. Ethical approval was obtained from University's Research Ethic Committee.

Based on the effect size formula by Cohen (1988), large effect size was set at 0.8. Recruitments of minimum 8 participants (Migiano et al., 2010) were sufficient to create a large effect size sample. 16 participants were recruited in this study to overcome the risk of participants' dropout. Effect size was calculated by using the formula below:

$$\text{Effect size} = \frac{\text{mean A} - \text{mean B}}{\text{SD pooled group}}$$
$$\text{SD pooled group} = \sqrt{[(\text{SD}^2 \text{A} + \text{SD}^2 \text{B}) / 2]}$$

(Cohen, 1988)

Instrumentation

Calibrated heights measuring machine (Pro Series, Health-o-meter) was used to measure participant's weight and height. Par-Q screening form and ECG (Omron, HCG-801) were used to screen the participants into this study. A form was used to record participant's details (such as name, age, body weight, height, training status and supplementation details), physiological tests as well as resistance load for training programme. Stopwatch (Casio, Japan) was used to measure total exercise time and the timing for the continuous repeated tests of physiological responses after the exercise interventions. While, exercises speed (tempo) was paced by a metronome (Yamaha, Japan) that was set to 60 b.min⁻¹

Procedures

Each participant was required to read and sign an informed consent and the study was approved by the university's ethical board. HR was measured with HR watch, while SBP and DBP was measured with an automatic BP monitor. RPE scale was adapted from Baechle and Earle (2008).

Participants performed two different acute RT (UNI versus BI) for total body in a crossover design. Each participant participates in 4 training sessions. Session 1 and session 2 were for familiarization as well as to determine the 1RM strength of each participant. Session 3 was dedicated to determine the physiological responses towards BI RT, while session 4 determined the physiological responses towards UNI RT among trained women. 72 to 92 hours of rest were designed prior to session 1 and session 2, while a week of rest was fixed prior to session 3 and session 4 to prevent data contamination (Jones, Ambegaonkar, Nindl, Smith & Headley, 2012). All dependent variables were measured before exercise session (pre-test) and after exercise session (post-test). HR rate and BP were measured before exercise (PRE), immediately after (IP), and after exercise session at minute 5th after exercise (5P), minute 15th after exercise (15P), and minute 30th after exercise (30P). RPE was measured before (PRE) and after (IP) each of UNI and BI RT.

Crossover design consisted of pre and posttest was used to measure the training effects following a single bout of UNI versus BI exercise sessions. This design is most accurate because the characteristics of the participants were accurate and similar compared to the used of different individuals (Stokes, Gilbert, Hall, Andrews, & Thompson, 2013). Apart from that, the total body exercise protocol consisted of major muscles group was used to allow an optimum response and influenced the metabolic demand (Migiano et al., 2010).

HR indicates the frequency of heart beat which pumps blood to the whole body in one minute. HR is measured in beat per minute (bpm). BP determines the pressure exerted on the wall of arteries and it is illustrated with systolic and diastolic. SBP estimates the BP exerted against the arterial walls as blood was forcefully ejected during ventricular contraction. DBP is used to estimate the pressure exerted against the arterial walls when no blood was being forcefully ejected through the vessels. It provided an indication of peripheral resistance (McArdle, Katch & Katch, 2010). RPE indicated the effort specifically from the muscles during an exercise. Pain was scaled from 6 to 20 which indicated low to higher magnitude of effort exerted by the skeletal muscles in overall during the training (Baechle & Earle, 2008).

Treatment

Session 3 required participants to perform a bout of total body BI RT session consisted of seven (7) exercises with 80% of 1RM of 10 repetitions, 3 sets for each exercises and 60 to 90 seconds of rest in between exercises and sets (Bompa & Haff, 2009). Session 4 required the participants to perform a bout of UNI RT session consisted of seven (7) similar total body exercises to session 3, but unilaterally.

When participant failed to complete 10 repetitions because of fatigue on any sets, the load was adjusted lower until the participants accomplished 10 reps in total (drop sets). The participants are recommended to perform each of the exercise until failure to allow for a hundred percents (100%) muscle recruitment. The exercise intervention was paced by a calibrated metronome (Yamaha, Japan) at 60 b.min-1. 72 to 96 hours of rest were required prior to session 1 and session 2, while 7 days of rest prior to session 3 and session 4 to avoid data contamination. This study used 80% of intensity because trained population required higher volume of training, at least similar to their daily training to stimulate greater response (Cadore, Lhullier, Brentano, da Silva, Ambrosini, Spinelli, Silva, & Krueel, 2008).

In order to avoid from biases, this study adopted single-blind method (on the participants) and used the same well-prepared and knowledgeable data collectors throughout the study. In order to avoid contamination of test results, each participant was given a week of rest between two different exercises sessions (session 3 and session 4) (Goto, Ishii, Kizuka & Takamatsu, 2005; Shaner et al., 2014).

Statistical Analyses

All the data was analyzed by using Statistical Package of Social Sciences (SPSS) programme software version 21.0. The demographic data (e.g. age, height, weight) was analyzed by using descriptive statistic then summarized into mean and standard deviation.

Data was analyzed using repeated measure analysis of variance to measure the HR, SBP, DBP and RPE on multiple time measurements between UNI and BI RT. Significant value was set at .05. This statistical analysis was used in other previous parallel studies (Jones et al., 2012; Wickwire, McLester, Green & Crews 2009).

RESULTS

Table 1 shown the physical characteristics of 16 trained women including age, height and weight. It was presented in mean (*M*) and standard deviations (*SD*), minimum (*Min*) and maximum (*Max*). The mean age of participants was 23.31 (*SD* = 1.35) years old, mean height was 157.03 (*SD* = 6.15) cm, while mean weight was 58.63 (*SD* = 9.11) kg.

Table 1: Physical Characteristics of the Participants

	<i>N</i>	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
Age (year)	16	23.31	1.35	21	26
Height (cm)	16	157.03	6.15	147	168.5
Weight (kg)	16	58.63	9.11	48	76

Heart rate

Table 2 shown the mean HR patterns for selected time measurement between UNI and BI RT. Figure 1 shows description details on HR observation across times before intervention (PRE), immediate post (IP), 5 minutes after (5P), 15 minutes after (15P) and 30 minutes after (30P) the intervention following UNI versus BI RT. Based on the observation, both UNI and BI RT abruptly elevated HR from PRE to IP while IP to 5P shown a steep decreased of HR.

Repeated measure analysis of variance was shown that there was a significant effect of HR across times ($p < .001$) which between PRE, IP, 5P, 15P and 30P. However, there was no significant difference on heart rate response between UNI versus BI RT ($p = .109$).

Table 2: HR patterns for selected time measurement between UNI and BI RT

Time	Unilateral RT			Bilateral RT		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
PRE	16	71.19	4.89	16	73.31	4.60
IP	16	165.44	3.86	16	165.94	4.34
5P	16	95.56	5.93	16	97.75	4.71
15P	16	82.00	4.26	16	86.88	4.88

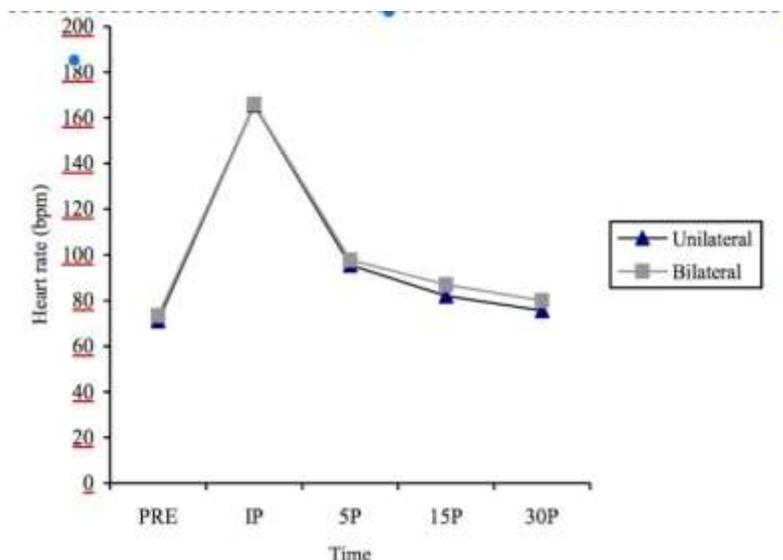


Figure 1: Effects of UNI and BI training on the HR

Systolic blood pressure

There was significant interaction between group and time observed in SBP between UNI versus BI RT, $F(2.91, 48.39) = 2.80, p = .047$, partial eta squared = .09. Table 3 shows the Post Hoc analysis shown a significant difference between interventions observed at 30P, $p = .05$. The result suggested that UNI RT caused a slower recovery time than BI RT.

Figure 2 shown SBP in both UNI and BI RT were elevated from PRE to IP, after which they continuously drop from IP to 30P. Post hoc analyses was conducted in order to specifically compare and determine the significant point of SBP.

Table 3: Post Hoc analysis of UNI versus BI RT on SBP

Time	<i>p</i> -value	Partial Eta Squared
PRE	.15	.07
IP	.34	.03
5P	.78	.003
15P	.46	.03
30P	.05*	.12

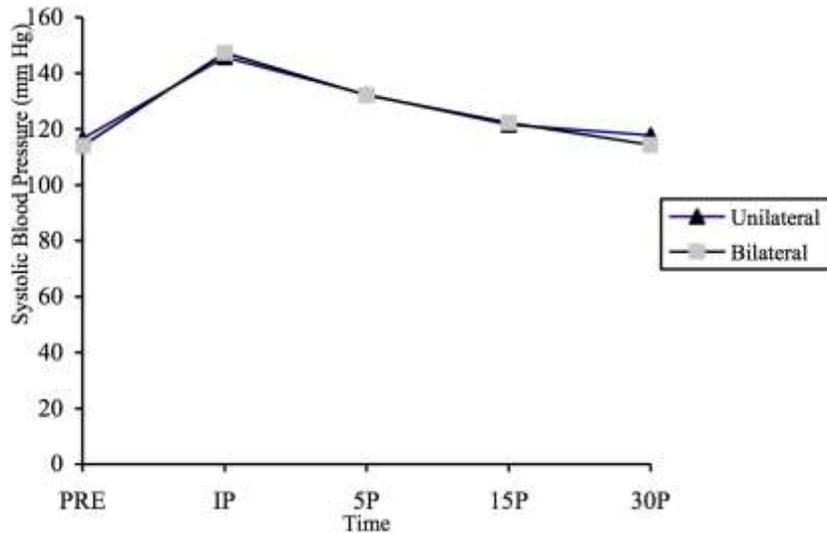


Figure 2: Effects of UNI and BI RT on SBP

Based on Table 4, results revealed that all SBP interaction measured across times was statistically different ($p < .001$), except the interaction between PRE and 30P ($p = 1.0$). Therefore, it suggested that SBP was significantly increase and decrease after RT, and significantly decrease across all times (IP, 5P, 15P) and the total recovery of SBP is at 30P, in which there is no significant difference of SBP between PRE and 30P.

Table 4: SBP interaction across times

Variable(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	p-value	
SBP	PRE	IP	-31.31*	1.03	<.001
		5P	-17.00*	1.13	<.001
		15P	-6.69*	.77	<.001
		30P	-.78	.62	1.000
	IP	5P	14.31*	.95	<.001
		15P	24.63*	.91	<.001
		30P	30.53*	.95	<.001
	5P	15P	10.31*	.70	<.001
		30P	16.23*	.95	<.001
	15P	30P	5.91*	.72	<.001

Diastolic Blood Pressure

Post hoc analyses in Table 5 revealed a significant difference ($p < .05$) of DBP was observed across times, except between PRE and 15P ($p = 1.00$), and between PRE and 30P ($p = .22$). It suggested that DBP is significantly increased after bout of RT and recovered at 15P after an RT.

Whereas, Figure 3 shows description details on DBP observation across times (PRE, IP, 5P, 15P and 30P) following UNI versus BI RT. The observation revealed that DBP experienced a sheer incline in both UNI and BI training from PRE to IP, and a sheer decline from IP to 5P. DBP gradually decreased from 5P to 30P. There is no significant difference was observed in DBP patterns between UNI versus BI RT, Wilk's Lambda = .76, $F(4, 27) = 2.10$, $p = .11$, partial eta squared = .24.

Table 5: Effect of RT on DBP across times

Variable	(I) Time	(J) Time	Mean Difference(I-J)	Std. Error	p-value
DBP	PRE	IP	-14.56*	1.15	<.001
		5P	-3.31*	.73	<.001
		15P	-.47	.82	1.00
		30P	1.97	.82	.22
	IP	5P	11.25*	.83	<.001
		15P	14.09*	.87	<.001
		30P	16.53*	.84	<.001
	15P	15P	2.84*	.63	<.05
		30P	5.28*	.74	<.001
	30P	30P	2.44*	.80	<.05

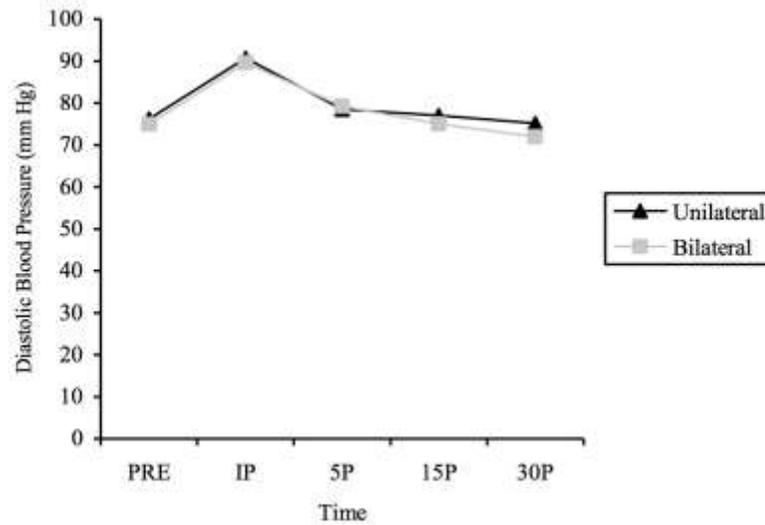


Figure 3: Effects of UNI and BI RT on DBP.

Rate of perceived exertion

Figure 4 shows description graph of RPE observation before and after the intervention following UNI versus BI RT among trained women ($p = .001$). Both group shown an increment of RPE from PRE to IP. However, repeated measure analysis of variance shown no significant difference between groups on RPE, Wilk's Lambda = .98, $F(1, 30) = .69$, $p = .41$, partial eta squared = .02 (small effect).

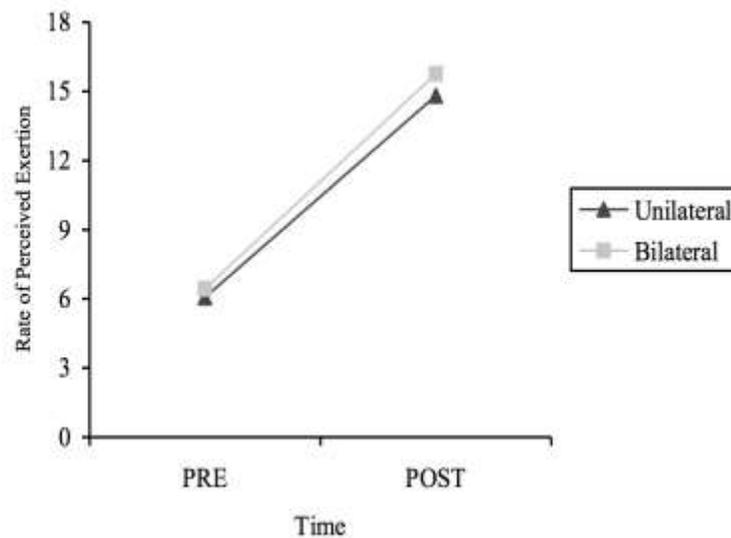


Figure 4: Effects of UNI and BI RT on RPE

DISCUSSIONS

Observation in the present study found significant differences across times in all variables (HR, SBP, DBP and RPE). The result also revealed a significant difference on SBP between UNI versus BI RT. In contrast, no significant difference was reported on HR, DBP and RPE.

Heart Rate

The intervention was significantly affected HR across times (PRE, IP, 5P, 15P and 30P); where HR was elevated rapidly from PRE to IP, rapid drops from IP to 5P. While, gradually decreased from 5P to 30P.

During the RT, the body demands blood which contains oxygen and nutrients to be transported to the whole system. The heart needs to supply the demands therefore it started to pump vigorously in one minute. Hence this explained the rapid elevation of HR from PRE to IP. However, after the intervention, body was in sudden, started to go back to rest thus, does not demand much blood transportation compared to during exercise, therefore this leads to the rapid drops of HR from IP to 5P. HR was continuously drops at point 15P and 30P because participant was started to rest; less blood was needed to be transported across times. It was also significantly different in between PRE and 30P. This suggested that 30 minutes of rest was not enough for the heart to recover back to the normal state. This probably because the heart need to “repay” the oxygen debt created by the body during the intervention.

Results revealed that there was no significant difference was observed on HR between these two protocols. The insignificant might be due to the treatment and the population used. Although this study was using a greater intensity (80%) as compared to other study by Cruz, Rosa, Santos, Dias, Simao, Novaes, and Dantas (2006) which was using 70%, it shown a contrasting result. According to Baechle and Earle (2008), a higher training intensity elicits greater response as compared to lower exercise intensity. Cruz et al., (2006) used a 70% intensity with single lower body exercise to measure the specific effect of UNI versus BI exercise to HR, hence the heart was measured only for that particular time or exercise. However, this present study was using a total body with 80% intensity exercise that mimicking a proper exercise session which would be beneficial and practically related to a bout of exercise session. Hence this may explain why Cruz recorded a significant effect between two protocols while the present study was shown an insignificant results.

Apart from that, the insignificant results of UNI versus BI was also probably due to the population that had been used. Perhaps, the trained population might be not easily affected by the exercise selection and intensity. It is recommended for the future study to use a greater intensity exercise (85% of 1RM) among trained population, studying on different populations and/or comparing the treatment to different groups.

In previous study by Shaner et al. (2014) using different exercise selection, observed the HR response was increased in lower body free weight compared to machine weight exercises. It probably because, the free weight exercises involve more muscles recruitments to stabilize

movements compared to machine weight exercises. Thus, heart need to work harder and pump the blood to the specific working muscles, as well as to other stabilizing muscles resulting in a greater HR for free weight exercises. In the present study although bilateral was producing simultaneous movement at a time, both protocols worked on both limbs thus, demanded a great amount of blood supply and therefore HR need pump harder. Besides, unilateral protocol has encountered the demand due to time (more time required). Apart from that, it was also in contrast to Wickwire et al. (2009) which observed significant higher HR during traditional method (2 seconds concentric, 4 seconds eccentric per rep) compared to super slow exercise (tempo of 10 seconds concentric, 5 seconds eccentric per rep). The traditional methods will allow a repetitive contraction of muscles fibers; thus, efficient blood transportation is needed for the skeletal muscles, compared to slow methods (which did not require the blood being profusely pumped).

Moreover, Wickwire et al. (2009) whereas suggested that HR was significantly higher during traditional method (2 seconds concentric, 4 seconds eccentric per rep) compared to super slow exercise (tempo of 10 seconds concentric, 5 seconds eccentric per rep). It is quite visible that exercise selection might stimulate the body physiology differently.

Systolic Blood Pressure

Results also revealed that intervention was significantly affected SBP across times; it was significantly different in all times interactions (PRE, IP, 5P, 15P and 30P), except the interaction between PRE and 30P. This study claimed that, valsava maneuver activity such as RT did affecting SBP. This suggested that from PRE to IP, pressure to arterial walls increased because the heart pumped a greater amount of blood with higher frequencies, therefore a greater pressure created on the arterial walls to comply with the demands created by the skeletal muscles. This explained the steep increment of SBP. SBP decrement was probably due to vasodilation occurred immediately after cessation of the intervention. A vasodilation refers to the widening of blood vessels, results from relaxation of the muscular walls of the vessels. However, when exercise was stop from IP to 30P, steep significant decrement was observed. Therefore, it suggested that the SBP recovery was very fast but when refer to the mean, 30P SBP was still a bit higher than PRE SBP; which no significant difference between PRE to 30P. The present finding is consistent to Wickwire et al. (2009) and should be able to support Steele et al. (2012) which questioned the effect of RT on BP.

There was a significant difference was observed on SBP across times between interventions; it is concluded that the recovery rate for BI RT was faster than UNI RT at 30P. PRE mean value of BI SBP was lower than UNI. However after the intervention, SBP elevated at IP of BI was higher than unilateral. Thus, this mean, valsava maneuver did occur to a greater degree in the BI RT, thus, BP response was elevated during BI training. BI RT demanded an effective greater amount of blood to be transported to both limbs of the skeletal system compared to UNI. UNI demands less blood to be transported at a time. Thus, BI created a higher pressure on the arterial walls. Baechle and Earle (2008) claimed that generally BP response increased nonlinearly with the magnitude of active muscle mass in which BI stimulated greater active muscle mass at a time

compared to UNI RT. However, BI recovery of SBP at 30P was significantly faster than UNI. The mechanism underlying to this result is not well-understood. Therefore, it is recommended for the future research to explain the mechanism of the slower recovery in UNI training. Thus, this finding provided evidence that exercise selection might induce different stimulus to the body as well as intensity, time and other important variables.

Cruz et al. (2006) who also studied the effect of UNI and BI RT on SBP reported a significant result; but BI knee extension was significantly increase SBP as compared to UNI RT. The result was probably different from the present study because of the treatment used; Cruz et al. (2006) was using only the dominant limb in unilateral RT therefore least muscle groups was used as compared to BI training. This might leads to bias in the study. Involving bigger numbers of the skeletal muscles elevated a greater SBP.

The present finding was in contrast with Wickwire et al. (2009) which observed no difference of SBP between traditional method (2 seconds concentric, 4 seconds eccentric per rep) and super slow method (10 seconds concentric, 5 seconds eccentric per rep) probably due to different intervention used. The present finding will assist the related fitness organization in formulating recommendations because up to this point, there is no specific guideline regarding UNI versus BI RT effects onto SBP.

Diastolic Blood Pressure

Findings suggested that the intervention was affected DBP across times; except between PRE to 15P, and between PRE to 30P. The pressure on the artery at 15P and at 30P were not significantly high as compared to at rest. Besides, diastolic experienced faster recovery DBP compared to SBP. Valsava maneuver activity in UNI and BI RT did affected DBP differently across the times. DBP was used to estimate the pressure exerted against the arterial walls when there was no blood is being forcefully ejected through the vessels (diastole). DBP was increased from PRE to IP, and decrease from IP to 5P in rapid patterns probably because in parallel to the increment of HR and SBP to comply the body demands. Then, gradually decreased from 5P to 30P because the body was started to recover; less pressure on the artery was created.

In the present study, it was recorded that no significant difference between intervention groups was shown in DBP. This result is quite expected because previous research by Wickwire et al. (2009) also observed insignificant difference in DBP; because DBP is not easily being fluctuate by an intervention as compared to systolic. The present findings and Wickwire et al. (2009)'s should also be able to assist the review by Steele et al. (2012) in regards to UNI and BI RT effect on DBP.

Rate of Perceived Exertion

The significant difference of RPE was observed across times (PRE and IP) indicated the effort of muscles exerted for the intervention. Greater pain in RT which probably attributed to greater ischemic response and thus, elevated RPE. An ischemic response was due to an insufficient supply of oxygen to the organs and the arteries were block especially during RT, as well as due to an

arterial pressure elevation. Apart from that pain will also leads to adrenaline release (Wickwire et al., 2009) and caused cardiovascular response (HR) to increase. Therefore, the researcher was expected that there will be changes of RPE across times because both interventions demand an effort from the skeletal muscles to perform the programme. Similar findings were recorded by Wickwire et al. (2009) and Shaner et al. (2014).

A specific response of UNI versus BI RT onto RPE investigated in this study revealed that there was no significant difference of RPE between the protocols. As discussed previously, RPE was done to specifically measure the effort of muscles exerted during RT. This meant that both intervention groups required a similar effort of the skeletal muscles to perform the task. The insignificant result was probably due to a small effect size for the present variable (.022).

The present study was parallel to Shaner et al. (2014) which observed an insignificant effects of RPE between free weight and machine weight exercise, similar to this study because the study used several exercises thus, the RPE scale is more overall. In contrast, Wickwire et al. (2009) studied on tempo reported that traditional RT recorded significantly higher RPE compared to slow method RT. This was because the study was conducted with only one exercise with four (4) sets, hence RPE reported was specifically on the particular muscles involved. Little is known about the direct effect of RPE on UNI versus BI RT. It lends support to this study which did not observed significant RPE effect between both intervention groups. The present findings should be able to assist Steele et al. (2012) which raised a question about the effect of RT on RPE. Up to this point, there is no specific guideline regarding UNI versus BI RT effects thus, the value of the findings of this study in assisting to formulate future training guidelines.

CONCLUSION

Based upon the results of the study, it is conclusively shown that BI protocol provides faster recovery in SBP. Whereas UNI and BI provide similar responses on HR, DBP and RPE. Hence, UNI and BI RT did not exactly instituted similar stimulus to the body. BI RT exposed individuals to higher SBP compared to UNI training, which might be not very suitable for specific fragile population that recommended for low to moderate exercise intensity for instance elders diagnosed with hypertension, however BI promote a faster recovery time.

RECOMMENDATIONS

In line with the findings of the study and the experience gained, the researcher has come out with a few suggestions and recommendations for future research to further examine those areas of concern in details.

It would be interesting for the future study to investigate the underlying mechanism of UNI RT that leads to slower recovery rate as compared to BI RT. Due to some limitation, a peak HR

cannot be obtained for the study. Therefore, future research is necessary to examine peak HR induced by UNI and BI RT.

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