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Kertas Asli/*Original Article*s

Blood Glucose Response to Unilateral and Bilateral Resistance Training Among Trained Women

(Respon Glukosa Darah ke atas Latihan Bebanan Satu Anggota Badan dengan Dua Anggota Badan dalam Kalangan Wanita Terlatih)

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ABSTRACT

Exercise selection is one of crucial factors in designing a comprehensive training programme. The exposure of different exercise selection may stimulate the specific adaptation imposed demand. In the construction of any resistance training (RT) programme, it is important to choose whether to apply bilateral (BI) or unilateral (UNI) exercise. The present study aimed to look into the physiological responses of blood glucose (BG) between UNI and BI RT. Quantitative research method was used, RT (UNI versus BI training) as the independent variables whereas BG set as the dependent variable. In order to measure training effects following a single bout of different training intervention (UNI versus BI), a crossover experimental pre and post test design was implemented. A total of sixteen (n = 16) trained women with mean age of 23 (SD = 1.35) years old went through a single bout of RT involved a total body exercise using major muscles group with 80% of 1RM for each protocols (UNI and BI) for 10 repetitions to maximal effort (for 3 sets). Crossover design would be more accurate in exposing different training protocol to a similar characteristic of individuals as compared using different individuals. The results revealed that blood glucose (BG) were statistically changed (p < .001) across times (between PRE to IP, between PRE and 15P as well as between PRE and 30P), and finding shows there is no difference between training protocols (p = .39). Thus, similar responses of UNI and BI RT on BG concentration provides wide selection of exercise method to practitioners specifically to trained women. Future research on UNI versus BI RT could venture onto other types of hormones analysis including insulin, growth hormone and cortisol can be included. Besides, future research should consider a long run study that involve chronic adaptation of RT on human body in order to prevent and alleviate disease.

Keywords: Acute response; weight training; exercise protocol; blood sugar

ABSTRAK

Reka bentuk program yang sesuai adalah kunci kejayaan, dan pemilihan senaman berkenaan adalah salah satu faktor kritikal. Pemilihan senaman akan mendedahkan rangsangan yang berbeza seperti di dalam prinsip kekhususan; prinsip penyesuaian khusus kepada beban yang dikenakan. Pemilihan latihan sama ada dua anggota badan (BI) atau satu anggota badan (UNI) adalah penting dalam melaksanakan pembinaan mana-mana program latihan bebanan (RT). Kajian ini bertujuan untuk mengkaji tindak balas fisiologi diantara latihan bebanan UNI dengan latihan bebanan BI ke atas glukosa darah (BG). Kajian ini menggunakan kaedah penyelidikan kuantitatif di mana pembolehubah bebas adalah jenis RT (UNI berbanding latihan BI) manakala pemboleh ubah bergantung adalah BG. Reka bentuk pra dan pasca ujian silang digunakan untuk mengukur kesan latihan ke atas satu sesi latihan bebanan bagi setiap protokol (UNI berbanding dengan BI). Enam belas (n = 16) wanita telah dilatih dengan usia min minimum 23 (SD = 1.35) tahun menjalani sesi senaman keseluruhan badan untuk setiap protokol UNI dan BI yang kedua-duanya terdiri daripada kumpulan otot utama untuk 80% 1RM, 10 pengulangan usaha maksimal untuk 3 set. Pemilihan reka bentuk silang akan memberi tindak balas yang lebih tepat dalam mendedahkan perbezaan protokol latihan kepada ciri-ciri individu yang sama jika dibandingkan dengan menggunakan individu yang berbeza. Keputusan menunjukkan bahawa glukosa darah (BG) berubah secara signifikan (p <.001) mengikut masa (antara PRE dan IP, antara PRE dan 15P dan juga diantara PRE dan 30P), dan mendapati tiada perbezaan antara protokol latihan (p = .39). Oleh itu, kesamaan respon UNI dan BI RT terhadap kepekatan BG menghasilkan pemilihan kaedah senaman yang pelbagai dan meluas khususnya kepada wanita terlatih. Berdasarkan hasil yang diperoleh, adalah sangat menarik untuk memerhatikan glukosa darah dan / atau metabolisme tenaga antara UNI dan BI RT semasa latihan, selain mengkaji hubungan antara BG dan penggunaan kalori semasa latihan. Kajian masa depan mengenai UNI berbanding BI RT boleh dilaksanakan ke analisis hormon

yang lain termasuklah insulin, hormon tumbesaran dan kortisol boleh diambilkira. Selain itu, kajian masa depan perlu mempertimbangkan kajian jangka panjang yang melibatkan penyesuaian kronik RT ke atas tubuh manusia khususnya demi mencegah dan mengurangkan risiko pelbagai penyakit.

Kata kunci: Tindak balas fisiologi; latihan bebanan; protokol latihan; glukosa darah

INTRODUCTION

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

Miller, Cheatham and Patel (2010) defined RT as a method of physical conditioning of complex programming (which include progressive and various training techniques) in order to achieve desired training goals. RT exercises can be executed in unilateral (UNI) or bilateral (BI). Loading on one limb (leg or arm) at one particular exercise referred as unilateral exercise. According to Mccurdy et al. (2005); Waller and Whitall (2001) UNI exercise often used as a variation for BI exercise. Beachle and Earle (2008) define BI exercise as the combination of efforts from both limbs to exert force against a load.

Previous studies (Lauder & Lake 2008; Makaruk et al. 2011) mentioned that in the RT programme, the exercise selection of BI or UNI RT need be prioritized because different exercise may exposes different stimulation to the body.

Due to the principle of specific adaptation imposed demand (SAID), previous studies (Lauder & Lake 2008; Makaruk et al. 2011) suggested that exercise selection will expose different stimulation. SAID principle claimed that altering exercises variables for instance types of exercise including traditional or functional exercise, as well as UNI and BI RT may stipulate unique stimulation to physiological parameters. Hence, varying exercise stimulus is need to be distinct to provide better understanding (Kraemer 1988). Exercises with specific movement may direct to energy metabolism. Thus, RT session probably altering BG concentration. Thompson et al. (2001) which studied on different exercise intensity on BG among healthy and diabetic population proposed that an equivalent total body exercise may provide similar absolute amounts of glycogen depletion, in spite of different intensity used in RT. To the extent of researcher knowledge, although UNI RT has been emphasized to be as important as BI RT (Mullican & Nijem 2016), there is limited number of studies on the specific response of exercise selection (including between unilateral and bilateral RT) (Jones et al. 2012) on BG metabolism specifically.

MATERIAL AND METHODS

SAMPLING

The present study was participated by sixteen (n=16) trained female students. The effect size of the present study was set at 0.8 (large) (Cohen 1988). Based on Migiano et al. (2010) a minimum number of 8 participants would be appropriate with the intention to establish sample with large effect size. In order to overcome the risk of dropout, the researcher recruited 16 participants for the present study.

The inclusion criteria of the present study set for age between 19 to 26 years old, healthy females. In order to ensure the safety and accuracy of data collected, participants need to had at least six months of experiences in RT, understood and performed correct biomechanical exercise techniques as well as free from any injuries. According to Cadore et al. (2008), trained population may need a higher training volume in order to create optimum stimulation and response, thus 80% training intensity was adopted to the present study. The present study excluded participants with known medical conditions as well as participants whom has been taking any supplements that would enhance performance. Apart from that, the study also excluded any participants with spinal injuries or severe musculoskeletal injuries within 6 months prior to the study.

The study was approved by the University's Research Ethic Committee. The testing procedures and possible risks involved in the study informed to the participants and required inform consent been read, sign and completed by every and each participants. The participants were asked to avoiding heavy physical activity or exercise before each RT session. Based on Stokes et al. (2013), all participants were asked to fast 10 hours before each exercise interventions.

INSTRUMENTATION

Participant's height and weight was measured with measuring machine (Pro Series, Health-o-meter). PAR-Q and ECG test (Omron, HCG-801) were used as the qualifying screening test. Participant's details (including name, age, height, body weight, training status

and history of supplementation used) was recorded. Resistance training details and physiological results was also recorded in the score sheet. The total exercise time and continuous repeated physiological tests for selected time on BG during interventions was measured with stopwatch (Casio, Japan). A metronome (Yamaha, Japan) with 60 b.min-[1] was used to paced the exercises tempo during the intervention.

Finger prick method was performed by the appointed qualified Medical Assistance. In order to evaluate BG, 30 µL(microliter) of blood was drawn for each BG test across the intervention. Blood analyzer machine (Reflotron Plus) was used to analyzed BG sample (mmol/l). During every protocol, blood was drawn before a bout of RT session (PRE), immediately after RT session (IP), 15 minutes after RT session (15P) and 30 minutes after RT session (30P). Previous studies (Nur Khairunisa & Zulkifli, 2018; Shaner et al., 2014; Rahimi et al. 2010; Bottaro et al. 2009) was using the similar procedure. BG concentration examined the availability of BG in the blood. It indicated the glucose metabolism from the provided acute RT.

PROCEDURES

A crossover research design implemented to evaluate the response of BG following one session of RT programme (which comparing UNI and BI training protocol). As suggested by Migiano et al. (2010), each of the exercise protocol involved a total body major muscles groups to allow an optimum responses created from metabolic demand.

In the present study, participants required to do a total of four sessions. 1st session and 2nd session developed for familiarization phase and measured each participant's 1RM strength. 3rd session aimed for BI RT exercise intervention in which participants perform a bout of total body BI RT protocol (7 exercises, 80% of 1RM, 10 repetitions for each exercises, total of 3 sets with 60 to 90 seconds of rest in between exercises and sets (Bompa & Haff 1999). 4th session whereas focused on total body, seven exercises of 80% 1RM UNI RT exercise intervention with the same procedure used in the 3rd session, unilaterally. Drop set was used in the present study in which, participant need to completed 10 repetitions in total for each exercises, however the load was adjusted lower if participants failed to complete due to fatigue on any sets. Participants were highly advised to do each of the exercise until failure so that a 100 percent muscle recruitment could be achieved in the present study. Metronome (Yamaha, Japan) was set at 60 b.min-[1] throughout RT intervention to pace the (identical) exercise tempo. The similar procedure was used by Nur Khairunisa & Zulkifli (2018).

Study was set by similar knowledgeable and well-prepared data collectors throughout the data collection process, and adopted single-blind method to avoid biases. Prior to 1st session and 2nd session, the rest in between sessions was set approximately 72 to 92 hours. This method was used by Nur Khairunisa et al. (2018) and Jones et al. (2012). Apart from that, based on previous studies (Goto et al. 2005; Shaner et al. 2014) participant was set to rest for 7 days in between 3rd and 4th session in order to avoid contamination of test results. Finger prick method was used to drawn the blood during 3rd and 4th RT session throughout the selected time (which includes PRE, IP, 15P and 30P).

STATISTICAL ANALYSES

Statistical Package of Social Sciences (SPSS) software version 22.0 was used to analyze the acquired data. Descriptive statistic was used to analyze the demographic data (including age, weight and height of participants) and described into mean and standard deviation. Repeated Measure Analysis of Variance was performed to compare the response of BG between UNI and BI RT on multiple time measurements (PRE, IP, 15P and 30P). Significant value set at .05.

RESULTS

The results from Shapiro Wilk normality test (p=.09) indicated that the data are all normally distributed (p>.05). The present study involved a total of 16 trained women with mean age of 23 (SD = 1.35) years old, mean height of 157.03 (SD = 6.15) cm, while mean weight of 58.63 (SD = 9.11) kg.

Figure 1 shown mean and standard deviation of BG across multiple time measurements (PRE, IP, 15P and 30P) following UNI and BI RT exercise protocol among 16 trained women. Based on the results obtained, BG in both exercise protocols were increased rapidly from PRE to IP, followed by a gradually increased from IP to 15P. However, both UNI and BI exercise protocol then showed a decline pattern in BG from 15P to 30P.

The effect of difference exercise interventions (UNI and BI RT) was analyzed using Repeated Measure Analysis of Variance suggested BG shown significant change across the multiple time measurement (p= .50). Hence, this conclude that there was a significant change in BG across times. Further analysis showed in Table 1 was used to evaluate the data in detailed examining the significant point on BG concentration. Post hoc analyses with Bonferroni correction spotted significant change (p<.05) on BG were

between PRE and IP, between PRE and 15P as well as between PRE and 30P.

The effect of two exercise protocols (UNI and BI RT) on BG was analyzed with Repeated Measure Analysis of Variance concluded a non-significant interaction ($p = .39$) between the two different protocols.

DISCUSSION

The present study thus conclude that RT intervention was affecting BG concentration across the repeated time measurement (PRE and IP, PRE and 15P, as well as PRE and 30P). On the other hand, there was no significant change on BG between IP to 15P, between IP to 30P and as well as between 15P to 30P. BG concentration shown a constant increment from PRE to IP followed by to 15P, and subsequently declined at 30P in both protocols.

UNI and BI RT protocols, BG concentration experienced a sudden rise from PRE to IP. It is probably due to fasting BG measured at PRE, followed by food consumption prior to exercise. With participants consuming food, BG concentration would be elevated. Stokes et al. (2013) claims that during a submaximal exercise, insulin was decrease due to the elevation of catecholamine concentration, in order for the body to preserves adequate amount of glycogen to maintain function beyond the demands of the exercise. This suggest that glucose was release in the blood to supply the demands of glucose needed in both protocols. Hence, glucose is use in energy metabolism. A constant rise of BG between IP to 15P in both protocols perhaps suggesting a constant release of glucose in the blood to provide a continuous energy. At relative intensities of exercise above 60% of maximal oxygen uptake, muscle glycogen became an increasingly important energy substrate; the entire glycogen content of some muscle cells can be depleted during exercise (Beachle & Earle 2008).

In contrast, BG concentration shown a significant decrement from 15P to 30P. It was suggesting the reaction of insulin to the body demands; resting or skeletal muscle inactivity does not require an energy metabolism thus the release of glucose in the blood lower as compared to higher skeletal muscle activity. Hence, movement specific exercises lead to energy metabolism. BG concentration was not significantly change from IP to 15P, between IP and 30P as well as from 15P to 30P. Thus this claimed that

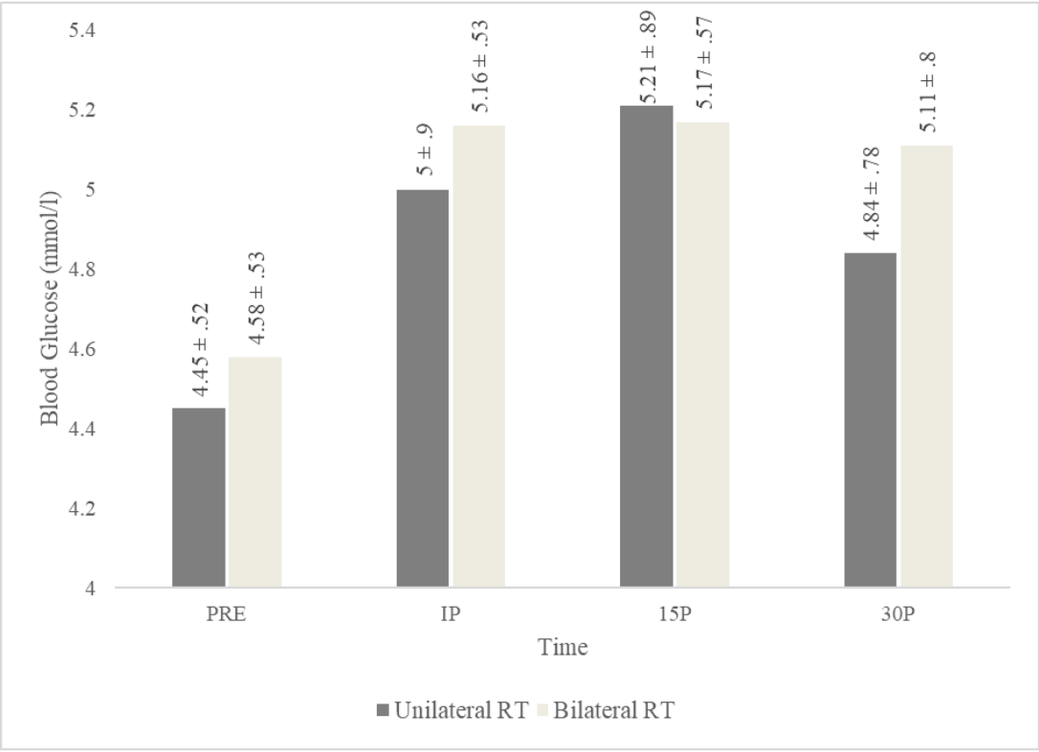

FIGURE 1. Mean and standard deviation of BG across the repeated time measurement following UNI and BI RT protocol. At PRE, the mean BG for UNI RT protocol was 4.45 (*SD* = .52) mmol/l, mean BG at IP was 5.0 (*SD* = .90) mmol/l, men BG at 15P was 5.21 (*SD* = .89) mmol/l, last but not least mean BG at 30P was 4.84 (*SD* = .78) mmol/l. On the other hand, mean BG reported during BI RT for PRE was 4.58 (*SD* = .53) mmol/l, mean BG at IP was 5.16 (*SD* = .53) mmol/l, while mean BG at 15P was 5.17 (*SD* = .57) mmol/l, last but not least mean BG for BI RT at 30P was 5.11 (*SD* = .80) mmol/l

TABLE 1. Post hoc analyses for employing Bonferroni correction on BG concentration across repeated time measurement

(I) Time	(J) Time	Mean Difference(I-J)	Std. Error	*p*
PRE	IP	-.57*	.14	<.05*
	15P	-.68*	.13	<.001*
	30P	-.46*	.13	<.05*
IP	15P	-.11	.11	1.00
	30P	.10	.12	1.00
15P	30P	.21	.09	.13

the concentration BG in between recovery period were not significantly change.

The present study concluded that there was no significant difference in BG concentration between UNI and BI RT protocols. Thus, this proposed that glucose metabolism between UNI and BI RT was similar, hence amount of glucose used between two protocol was approximately equal. This results is parallel to Thompson et al. (2001) and supported by Beachle and Earle (2008) in which proposed that an equivalent total body exercise may provide similar absolute amounts of glycogen depletion. UNI and BI RT protocols used in the present study was using a similar exercises performed with unilaterally and bilaterally. Besides, the time of completion between both of the exercise protocols was approximately same.

Last but not least, the training status of participants could be another factor for the insignificant difference. Thompson et al. (2001) suggested that even during an intense exercise, the BG among healthy individuals are well maintained. Therefore, due to adaptation of the previous training trained population might responded lesser to two exercise protocols used in the present study as compared to other population such as sedentary and untrained population. Apart from that, future researches shall investigate onto specific population including diabetes or insulin resistance patients. With the used of insulin resistance individuals as the participants, might make the results become more visible, because their glucose metabolism is more sensitive as compared to healthy population.

The insignificant difference on BG between two RT protocols (UNI and BI) used present study perhaps due to the similar intensity used and approximately equal total exercise time in both protocols. Exercise intensity and exercise volume does affect the physiologic functions contributing to glucose regulation (Black, Swan & Alvar 2010). This is also supported by McArdle, Katch and Katch (2010) which claimed that a very high-intensity, intermittent exercise, such as RT, might cause substantial depletion of muscle glycogen (decreases 20% to 60%) with relatively few sets (low total workloads). While, greater energy demands incurred by higher volumes require more blood glucose and muscle glycogen usage for fuel resulting in greater overall muscle glycogen depletion (Black et al. 2010). Thus, one of the factor of an insignificant difference shown between UNI and BI RT could be due to the identical RT intensity used between two protocols. This results suggesting a similar energy metabolism used in UNI and BI RT.

CONCLUSION

The study concluded that BG was significantly change across the repeated time measured (including from PRE to IP, between PRE and 15P as well as between PRE and 30P). There were no significant change on BG concentration from IP to 15P, between IP and 30P and from 15P to 30P. Last but not least, UNI and BI RT may provide similar responses on BG concentration among trained women.

RECOMMENDATION

It would be fascinating for the future study to measure BG to relate on energy metabolism between UNI versus BI RT during exercise as well as to investigate the relationship between BG and calories expenditure.

Apart from that, future study should investigate on chronic adaptation following UNI and BI RT, and perhaps investigate the relationship between physiological response and chronic adaptation on physical performance indicator (such as muscle hypertrophy, body composition and strength). This may enhance further knowledge on physiological responds and adaptation of the body and how it affects performance. Besides, future study could include other hormones analysis including insulin, growth hormone and cortisol to be correlate with BG concentration.

Future research on the topic of UNI versus BI RT could venture onto other populations such as the untrained women, men population, elderly and specific population such as diabetic population. It is also recommended to investigate different training method, intensity and/or volume as specific adaptation may imposed demand.

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