STUDIA UBB EDUCATIO ARTIS GYMN., LXII, 1, 2017, pp. 19 - 28
(RECOMMENDED CITATION)
DOI:10.24193/subbeag.62(1).02

REPETITION SPEED INFLUENCE ON INCREASING TENDENCY FOR HEART RATE IN WEIGHT TRAINING

REMUS-CRISTIAN VĂIDĂHĂZAN[1*], IACOB HANȚIU[1]

ABSTRACT. The benefits of weight training are consequences of the workout. A weight training program is a composite of several variables that can be combined in a multitude of options to achieve the desired effects (Ratamess, 2012). Identifying these variables and their correct planning is essential to anticipate a beneficial purpose of weight training program (American College of Sports Medicine, 2007). Our research took place between February 9 and April 19, 2015, in the gym of the Faculty of Physical Education and Sports of the Babeș-Bolyai University of Cluj-Napoca. The research objective was to analyse the trend of increase in heart rate (HR) at different speeds of execution for repetitions of the weight training exercises. The results obtained suggest that the tempo of execution influence the increasing tendency for heart rate in weight training. In general, we noticed that as the speed of execution decreases the growing trend of HR is lower. But those conditions apply only at specific speed of execution for repetitions and they are influenced by the specific of muscle involved in exercise.

Key words: *weight training, tempo, heart rate, increasing tendency.*

REZUMAT. Influența vitezei de execuție a repetărilor asupra tendinței de creștere a frecvenței cardiace în antrenamentul cu greutăți. Beneficiile antrenamentului cu greutăți sunt consecințe ale programului de antrenament. Un program de antrenament cu greutăți este un compozit de mai multe variabile care pot fi combinate într-o multitudine de variante pentru a obține efectele scontate (Ratamess, 2012). Identificarea acestor variabile, precum și planificarea corectă a lor, este esențială pentru a anticipa o finalitate benefică a programului de antrenament cu greutăți (American College of Sports Medicine, 2007). Cercetarea s-a desfășurat în perioada 9 februarie - 19 aprilie 2015, în sala de fitness a Facultății de Educație Fizică și Sport din cadrul Universității

[1] Babeș-Bolyai University, Cluj-Napoca, Faculty of Psychology and Science of Education, Romania
** Corresponding author: vaidahazan@gmail.com*

Babeş-Bolyai Cluj-Napoca. Obiectivul cercetării a constat în analiza tendinţei de creştere a frecvenţei cardiace la diferite viteze de execuţie a repetărilor din cadrul exerciţiului. Rezultatele obţinute sugerează că tempoul de execuţie al repetărilor influenţează tendinţa de creştere a FC. În general, am observat că pe măsură ce viteza de execuţie scade tendinţa de creştere a FC este mai mică. Dar aceste condiţionări nu se aplică tot timpul şi sunt influenţate de specificul grupei musculare implicate în exerciţiu.

Cuvinte cheie: *antrenament cu greutăți, viteză de execuție, frecvență cardiacă, tendință de creștere.*

Objective

The research objective was to analyse the trend of increase in heart rate (HR) at different speeds of execution for repetitions of the weight training exercises.

Material and methods

The research took place between February 9 and April 19, 2015, in the gym of Faculty of Physical Education and Sports of the Babeş-Bolyai University of Cluj-Napoca.

The research was applied to 11 subjects, students of Physical Education and Sports Faculty of the Babeş-Bolyai University. All subjects enrolled in the study were male, with a minimum of 6 months experience in weight training. Age of participants was between 19 and 25 years (for details see Table 1).

Muscle groups included in our research were:

- Latissimus Dorsi with the exercise “Back Lat Pull-Downs”;
- Pectoralis Major with the exercise “Horizontal Bench Press”.

Tempo of execution used in our research was:

- 1010 (1 second for eccentric, 0 seconds for isometric after eccentric, 1 second for concentric, 0 seconds for isometric after concentric);
- 3030 (3 seconds for eccentric, 0 seconds for isometric after eccentric, 3 seconds for concentric, 0 seconds for isometric after concentric);
- 6060 (6 seconds for eccentric, 0 seconds for isometric after eccentric, 6 seconds for concentric, 0 seconds for isometric after concentric).

Table 1. Details of subjects included in research

№	Code	Age (years)	Bodyweight (kg)	Height (m)	Body mass index IMC
1	005	22	78	1.80	24.07
2	006	21	80	1.85	23.37
3	007	21	74	1.75	24.16
4	008	22	80	1.76	25.83
5	009	21	67	1.77	21.39
6	011	22	69	1.72	23.46
7	012	20	82.6	1.75	26.97
8	013	19	83.5	1.79	26.06
9	014	21	67.8	1.72	22.92
10	015	25	83.2	1.80	25.68
11	016	19	64.9	1.69	22.72

The workload used in our experiment was 60% of one repetition maximum (1RM). Heart rate was recorded using our own protocol (Văidăhăzan, Hanțiu, Pop, & Pătrașcu, 2015). Heart rate values were analyzed and extracted from each record with SportTracks 3 (Zone Five Software LLC, 2013).

Each subject participated at 6 sessions interspersed with days of rest. Sessions included in the research were:

- Session 1, 1RM test for Latissimus Dorsi;
- Session 2, 1RM test for Pectoralis Major;
- Session 3, training session with 3 particular tempo (60% of 1RM);
- Session 4, research session with tempo 1010 (60% of 1RM);
- Session 5, research session with tempo 3030 (60% of 1RM);
- Session 6, research session with tempo 6060 (60% of 1RM).

The sequence of research sessions was conducted according to the following design:

- 1RM testing session for Latissimus Dorsi;
- 1RM testing session for Pectoralis Major;
- Rest day;
- One session with execution of 3 tempo;
- Rest day;

- Research session for 1010 tempo;
- Rest day;
- Research session for 3030 tempo;
- Rest day;
- Research session for 6060 tempo.

1RM testing protocol is different between researchers. There are many proposed programs that comply with some main rules regarding the length of the pause between test sets but there is no standardized model. Thus, our protocol was built based on several papers (Kraemer, Fleck, & Deschenes, 2012; Ratamess, 2012; Schwellnus, 2008).

The 1RM session, used by us, was as follows:

- Warm-up;
- Rest for 1 minute;
- Set No. 1 with 50% of predicted 1RM (10 repetitions);
- Rest for 3 minutes;
- Set No. 2 with 70% of predicted 1RM (5 repetitions);
- Rest for 5 minutes;
- Set No. 3 with 100% of predicted 1RM (1 repetition);
- Rest for 5 minutes;
- Set No. 4 with 100% of predicted 1RM (1 repetition);
- Rest for 5 minutes;
- Set No. 5 (if necessary) with 100% of predicted 1RM (1 repetition);
- Rest for 1 minute;
- Cool-down.

All research sessions were led by a scientist helped by an assistant. The exercises included in our research were recorded on camera to analyse the form of repetitions. In order to achieve the desired tempo we used an audio system connected to a digital metronome (Paul Girsas, n.d.). Centralization of data was performed with Microsoft Excel.

Encodings used for research sessions are:

- Research session with 1010 tempo, MD_T1 codes (for Latissimus Dorsi) and PM_T1 (for Pectoralis Major);

- Research session with 3030 tempo, MD_T2 codes (for Latissimus Dorsi) and PM_T2 (for Pectoralis Major);

- Research session with 6060 tempo, MD_T3 codes (for Latissimus Dorsi) and PM_T3 (for Pectoralis Major).

Centralization of data was done with Microsoft Excel and statistical analysis was performed with SPSS Statistics using linear regression to calculate the upward trend in HR. The growth trend for HR was analysed by growth step, expressed in beats / minute. A paired-samples t-test was conducted to compare the dynamic of HR between tempos of execution.

Results

The increasing tendency for HR, for every exercise recorded, is presented in Table 2.

Table 2. Increasing tendency for HR for exercises recorded

№	Code	Increasing tendency (beats/min.) MD_T1	Increasing tendency (beats/min.) MD_T2	Increasing tendency (beats/min.) MD_T3	Increasing tendency (beats/min.) PM_T1	Increasing tendency (beats/min.) PM_T2	Increasing tendency (beats/min.) PM_T3
1	005	0.914	1.125	0.571	0.877	0.858	0.839
2	006	1.495	0.557	0.657	1.265	0.861	0.961
3	007	2.421	0.626	0.766	1.807	0.659	0.385
4	008	0.829	0.506	0.141	0.696	0.223	0.367
5	009	1.630	0.739	0.544	0.495	0.424	0.636
6	011	1.121	0.257	0.434	0.506	0.094 *	0.116
7	012	0.801	0.815	0.446	0.929	0.440	0.195
8	013	1.022	0.736	0.291	1.209	0.656	1.429
9	014	0.668	0.245	0.161	0.590	0.291	0.350
10	015	0.763	0.246	0.143	0.618	0.162 *	0.344
11	016	1.626	0.417	0.483	1.051	0.358	0.289

* Data recorded for these sets are not statistically significant and they haven't been used in our analysis.

The statistical index of HR increase, for Latissimus Dorsi, on the 3 tempo included in our research are found in Table 3.

There was a significant difference in the scores for increasing tendency of heart rate for MD_T1 (M=1.21, SD=0.53) and increasing tendency of heart rate for MD_T2 (M=0.57, SD=0.28); t(10)= 3.69, p=0.05. These results suggest that tempo of execution has an influence on HR tendency growth. In particular, our data shows that as the speed of execution decreases the growing trend of HR is lower.

Table 3. Statistical index of HR increase for Latissimus Dorsi

Pair	Tempo	Mean	N	Std. Deviation	Std. Error Mean
Pair 1	MD_T1	1.20818	11	0.532359	0.160512
	MD_T2	0.56991	11	0.276324	0.083315
Pair 2	MD_T1	1.20818	11	0.532359	0.160512
	MD_T3	0.42155	11	0.213815	0.064468
Pair 3	MD_T2	0.56991	11	0.276324	0.083315
	MD_T3	0.42155	11	0.213815	0.064468

A significant difference we observed, also, in the scores for increasing tendency of heart rate for MD_T1 (M=1.21, SD=0.53) and increasing tendency of heart rate for MD_T3 (M=0.42, SD=0.21); t(10)= 6.77, p=0.05. These results suggest that the tempo of execution has an influence on HR tendency growth. In particular, our data shows that as the speed of execution decreases the growing trend of HR is lower.

There was no difference in the scores for increasing tendency of heart rate for MD_T2 and increasing tendency of heart rate for MD_T3, p=0.05.

Table 4. Paired Samples Test for Latissimus Dorsi

Pair	Tempo	Pairde Differences			t	df	p
		Mean	Std. Deviation	Std. Error Mean			
Pair 1	MD_T1 - MD_T2	0.638273	0.574428	0.173197	3.685	10	0.004
Pair 2	MD_T1 - MD_T3	0.786636	0.385376	0.116195	6.770	10	0.000
Pair 3	MD_T2 - MD_T3	0.148364	0.255572	0.077058	1.925	10	0.083

The statistical index of HR increase, for Pectoralis Major, on the 3 tempo included in our research are found in Table 5.

Table 5. Statistical index of HR increase for Pectoralis Major

Pair	Tempo	Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PM_T1	0.99100	9	0.403537	0.134512
	PM_T2	0.53000	9	0.237158	0.079053
Pair 2	PM_T1	0.91300	11	0.401269	0.120987
	PM_T3	0.53736	11	0.394509	0.118949
Pair 3	PM_T2	0.53000	9	0.237158	0.079053
	PM_T3	0.60567	9	0.403028	0.134343

There was a significant difference in the scores for increasing tendency of heart rate for PM_T1 (M=0.99, SD=0.40) and increasing tendency of heart rate for PM _T2 (M=0.53, SD=0.24); t(8)=4.10, p=0.05. These results suggest that tempo of execution has an influence on HR tendency growth. In particular, our data shows that as the speed of execution decreases the growing trend of HR is lower.

A significant difference we observed, also, in the scores for increasing tendency of heart rate for PM_T1 (M=0.91, SD=0.40) and increasing tendency of heart rate for PM_T3 (M=0.54, SD=0.39); t(10)= 2.69, p=0.05. These results suggest that the tempo of execution has an influence on HR tendency growth. In particular, our data shows that as the speed of execution decreases the growing trend of HR is lower.

There was no difference in the scores for increasing tendency of heart rate for PM_T2 and increasing tendency of heart rate for PM_T3, p=0.05.

Table 6. Paired Samples Test for Pectoralis Major

Pair	Tempo	Pairde Differences			t	df	p
		Mean	Std. Deviation	Std. Error Mean			
Pair 1	PM_T1 - PM_T2	0.461000	0.337665	0.112555	4.096	8	0.003
Pair 2	PM_T1 - PM_T3	0.375636	0.463089	0.139627	2.690	10	0.023
Pair 3	PM_T2 - PM_T3	-0.075667	0.309311	0.103104	-0.734	8	0.484

Statistical index of HR increase for both muscles included in our research are found in Table 7.

Table 7. Statistical index of HR increase for Latissimus Dorsi and Pectoralis Major

Pair	Tempo	Mean	N	Std. Deviation	Std. Error Mean
Pair 1	MD_T1	1.20818	11	0.532359	0.160512
	PM_T1	0.91300	11	0.401269	0.120987
Pair 2	MD_T2	0.64067	9	0.253884	0.084628
	PM_T2	0.53000	9	0.237158	0.079053
Pair 3	MD_T3	0.42155	11	0.213815	0.064468
	PM_T3	0.53736	11	0.394509	0.118949

In Table 8 we observe a significant difference in the scores for increasing tendency of heart rate for MD_T1 (M=1.21, SD=0.53) and increasing tendency of heart rate for PM _T1 (M=0.91, SD=0.40); t(10)=2.47, p=0.05. These

results suggest that muscle specificity influence the growing trend of HR. In particular, our data show that the increasing tendency of heart rate differs depending on the muscle group involved, on 1010 tempo.

There was no difference in the scores for increasing tendency of heart rate for MD _T2 and increasing tendency of heart rate for PM_T2, p=0.05. We have seen no difference, also, in the scores for increasing tendency of heart rate for MD_T3 and increasing tendency of heart rate for PM_T3, p=0.05. These results suggest that muscle group involved in exercise does not influence the increasing tendency of heart rate for 3030 and 6060 tempo.

Table 8. Paired Samples Test for both muscles, on all 3 tempo of execution

Pair	Tempo	Pairde Differences			t	df	p
		Mean	Std. Deviation	Std. Error Mean			
Pair 1	MD_T1 - PM_T1	0.295182	0.395732	0.119318	2.474	10	0.033
Pair 2	MD_T2 - PM_T2	0.110667	0.219803	0.073268	1.510	8	0.169
Pair 3	MD_T3 - PM_T3	-0.115818	0.423594	0.127718	-0.907	10	0.386

Discussions

The biggest increasing tendency for heart rate was recorded for Latissimus Dorsi on the 1010 tempo. Compared with this, the trend of growth on 3030 tempo had lower values. The increasing tendency for heart rate for 6060 tempo was lower than 1010 tempo, also. As a result, we can say that as the speed of execution for repetitions decreases the tendency to increase of HR is lower.

The same model of response regarding the growth trend of HR we observed with Pectoralis Major. The increasing tendencies for HR recorded on 3030 and 6060 tempo are lower when compared to 1010 tempo.

A comparison between muscles shows that HR increasing tendency is lower for Pectoralis Major than Latissimus Dorsi, on 1010 tempo. But on 3030 and 6060 tempo this difference is uncertain because the data did not show statistical significance. We can only assume that as we execute our reps with lower speed the differences in growth trend for HR is cancelled by physiological factors.

Since the growth trends of HR are lower at lower speeds of execution, we recommend using lower speeds execution (almost 6 seconds) for beginners' workouts. The results obtained by us support ACSM recommendations that

suggest for beginners moderate speeds of about 3 seconds on the eccentric contraction and 3 seconds on the concentric contraction (American College of Sports Medicine, 2005).

Conclusions

The biggest increasing tendency for heart rate was recorded at two-second execution speed (1010 tempo) for both muscles, the Latissimus Dorsi and Pectoralis Major. Comparing the growth trends between the two muscles at 1010 tempo, we observed that the Latissimus Dorsi trend growth is higher than the Pectoralis Major.

For 3030 and 6060 tempo we didn't find significantly differences between the two muscles regarding the increasing tendency for heart rate.

Acknowledgment

The content of this article is part of the PhD research conducted in Sport Science.

REFERENCES

American College of Sports Medicine. (2005). *ACSM's Guidelines for Exercise Testing and Prescription - Seventh Edition.* Statele Unite ale Americii: Lippincott Williams & Wilkins.

American College of Sports Medicine. (2007). *ACSM's Resources for the Personal Trainer - Second Edition.* Statele Unite ale Americii: Lippincott Williams & Wilkins.

Buitrago, S., Wirtz, N., Yue, Z., Kleinoder, H., & Mester, J. (2011). Effects of load and training modes on physiological and metabolic responses in resistance exercise. *Eur J Appl Physiol, 112*(7), 2739-2748. doi:10.1007/s00421-011-2249-9.

Coulson, M., & Archer, D. (2009). *Practical fitness testing.* Marea Britanie: A. & C. Black.

Diniz, R.C., Martins-Costa, H.C., Machado, S.C., Lima, F.V., & Chagas, M.H. (2014). Repetition duration influences ratings of perceived exertion. *Perceptual and Motor Skills, 118*(1), 261-273.

Honeybourne, J., Hill, M., & Moors, H. (2004). *Advanced PE & sport.* Marea Britanie: Nelson Thornes.

Ide, B.N., Leme, T.C., Lopes, C.R., Moreira, A., Dechechi, C.J., Sarraipa, M.F., ... Macedo, D.V. (2011). Time Course of Strength and Power Recovery After Resistance Training With Different Movement Velocities. *Journal of Strength and Conditioning Research, 25*(7), 2025-2033. doi:10.1519/jsc.0b013e3181e7393f.

Kraemer, W. J., Fleck, S. J., & Deschenes, M. R. (2012). *Exercise physiology.* Statele Unite ale Americii: Wolters Kluwer Health/Lippincott Williams & Wilkins.

Paul Girsas. (no date). *Easy Metronome*. Retrieved from play.google.com: *https://play.google.com/store/apps/details?id=girsas.metronome*.

Ratamess Jr., N. (2012). *ACSM's Foundations of Strength Training and Conditioning.* Statele Unite ale Americii: Lippincott Williams & Wilkins.

Schwellnus, M. (2008). *The Olympic textbook of medicine in sport.* Marea Britanie: Wiley-Blackwell.

Văidăhăzan, R.-C., Hanțiu, I., Pop, N.H., & Pătrașcu, A. (2015). Heart rate recording system for participants to weight training in Cluj-Napoca's fitness gyms (compatibilities between Android and Windows 7). *Studia Universitatis Babeș-Bolyai, Educatio Artis Gymnasticae, 60*(1), 29-40.

Zone Five Software LLC. (2013, February 12). *SportTracks*. Retrieved from zonefivesoftware.com: *http://www.zonefivesoftware.com/sporttracks/*