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- ABSTRACT -

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Relationships between effort parameters and dynamics of heart rate in fitness for all weight training

Key word:
weight training, effort parameters, heart rate, dynamic, fitness, physical activity, leisure.

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Introduction

To emphasize the importance of weight training good practice by population is necessary to accurately establish the relationships between effort parameters and dynamics of heart rate (HR) in fitness for all weight training. This compliance, if properly understood and applied, will improve the practice of this physical activity, protecting weight training practitioners.

The benefits of weight training are the result of the workout planning. 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 proper planning is essential to anticipate a beneficial finality for every workout (American College of Sports Medicine, 2007).

Our research aims to fill current knowledge related to effective weight training practice by population. We aim for our solutions to improve theoretical and practical models in this area. The research topic is of great importance for the population since more people are turning to weight training as leisure physical activity. Although it is an area of great interest, weight training for population is not investigated enough in terms of methodological approaches that practitioners use in the gyms and in term of decisions that influence the dynamics of heart rate.

The starting point of our research is the general conception about the physiological effects of physical activity and sports and custom concepts about weight training, addressed from the first principles of Weider to present conceptualizations attributed both to contemporary authors (Bompa, Costill, Poliquin, Sandler, Sbenghe, Wilmore etc.) and to worldwide organizations which issue regulations in this area (American College of Sports Medicine, International Fitness Association, American Heart Association etc.).

PART I

The level of knowledge about fitness for all weight training

Chapter 1. The prospect of training with weights in personal fitness

This chapter covers aspects of knowledge reflected in the literature on the concept of health as a whole, on the concept of physical fitness as part of the personal health and the muscle component as decisive part in the individual management in order to keep high levels of health.

1.1. General aspects of health concept

The perception of health has evolved from its comparison with that state of fact when illness is missing to a positive concept that, in acceptance of US Department of Health and Human Services (1996), includes the physically, the socially and the emotionally wellbeing.

It is accepted nowadays that the health of a person is based on several components. The level of expression of all health components, their interaction and relationship is expressed through a person's wellbeing, as claimed by Greenberg, Dintiman, & Oakes (1998). We present in the next section, health components as Greenber and his collaborators agree with (Greenberg, Dintiman, & Oakes, 2004, p. 7):

- Physical health (cardiovascular fitness, muscular strength and endurance, flexibility and body composition);
- Social health (ability to interact well with people and with the environment and to have satisfying personal relationships);
- Mental health (ability to learn and develop intellectually);
- Emotional health (ability to control your emotions so that you feel comfortable when you speak and the ability to express them properly);
- Spiritual health (a spiritual belief in a unifying force).

1.2. The concept of physical fitness

Physical fitness, according to American College of medicine (ACSM) (2005), is a multidimensional concept represented by a set of attributes that the individual possesses or earns and which are related to the ability to perform physical activity. We have so many definitions of physical fitness, being far from uniform understand, especially in our country, as states Sbenghe (2005). We agree with a definition of Caspersen, Powell & Christenson (1985, cited by Garber et al, 2011, p. 1337) that we believe it is representative for physical fitness: "The ability to carry out daily tasks with vigor and alertness, without undue fatigue and with ample energy to enjoy [leisure] pursuits and to meet unforeseen emergencies".

According to Nieman (1998) physical fitness has two major components, one named general fitness and one named specific fitness. Ratamess (2012) includes in general fitness components related to the physical health of the body and in specific fitness components needed to perform various physical activities.

The specific fitness, according to Plowman & Smith (2002, p. 12), "is directed toward optimizing athletic performance". It is about not only for physical skills necessary for sports performance, but also about those physical skills needed to be applied in everyday life, the specific fitness components being support for daily activities, as advocated Ratamess (2012).

General physical fitness, according to Greenberg, Dintiman & Oakes (1998), helps you to obtain high levels of personal wealth. They are the result of physical exercise practiced regularly, a balanced diet and a good rest directed to recover the functional capacity of the body due to everyday stress.

1.3. Recommendations on muscular component

It is gratifying that people of all ages turn to exercise to improve physical fitness components. There is increasing evidence, McLatchie admited (1993), which suggests that a balanced long-term training program should include sufficient flexibility exercises, a minimum of weight training exercises and sufficient time for relaxation and recovery.

Muscle component is very important in individual strategy as supports the ACSM. This component "directly impact on activities of daily living (ADLs) because daily living activity requires a given percentage of one's muscular capacity to perform common tasks" (American College of Sports Medicine, 2005, p. 154). Improving the functioning of muscle, weight training brings to practitioner many benefits in terms of personal health (American College of Sports Medicine, 2005) and help the individual to maintain functional independence throughout life.

ACSM (2009) recommendation for adults is that they should perform activities that maintain or increase muscular strength and endurance at least two days a week. Garber and his colleagues (2011) also argue that adults should practice exercises with weights for large muscle groups at least two to three days a week.

A guide with rules regarding weight training was established initially in 1998 by ACSM, says Ratamess (2012). The same author shows that, since then, "ACSM has expanded these initial guidelines by providing progression recommendations for strength, power, hypertrophy, and endurance training in healthy young and older individuals" (Ratamess, 2012, p. 192).

Chapter 2. Weight training for population

This chapter presents the beneficial perspectives of weight training practice by the population and explains the specifics of weight training for a deeper understanding of methodical and physiological point of view, in terms of heart rate dynamics.

2.1. Benefical perspectives

The human body becomes more efficient as it reaches adequate levels of fitness. Engaging in regular exercise combined with good nutrition decreases the time required for recovery and reconstruction of all tissues (Bushman, Clark-Young, & American College of Sports Medicine, 2005).

The type of activities that people practice lifelong determines their functional capacity that they will keep for their own musculoskeletal system, with important implications for the entire body. ACSM (2013) states that the practice of weight training plays an important role in delaying and reducing the negative effects that aging has on the human body.

Daily activities are dependent on the strength and integrity of the locomotor muscles, thus maintaining and improving the functionality of the locomotor system or at least maintaining muscle strength should play an important role in our lives.

Humphries (2001) argues that the ideal lifestyles which maintaines and developes muscular system, the skeletal system and the hormonal system should include weight training. From weight training benefit bones, tendons, ligaments and cardiovascular system, this type of training, practiced regularly, is reducing the risk of injury and illness, shows Westcott (1996). „Currently, RT (resistance training) is a modality of exercise recommended for virtually everyone because it has been shown to enhance health, well-being, and performance" (Ratamess, 2012, p. 9). Many people, sais Ratamess (2012), participate to weight training in order to increase endurance or muscle strength, others want muscular hypertrophy, and part of the population benefit from weight training as a form of rehabilitation.

2.2. Specific aspects

Training is a complex process with specific characteristics depending on the field of use. Specific to weight training are many exercises addressed primarily to physical development, many apparatus and specific accessories and some principles and training methods developed by scientific research and by many results otained through practice over the years.

A comprehensive definition of weight training is presented by Ratamess (2012, p. 195): "The RT program is a composite of several variables that include muscle actions used, intensity, volume, exercises selected and workout structure, the sequence of exercise performance, rest intervals between sets, repetition velocity, and training frequency".

The effort into weight training is a consequence of how the parameters of effort are combined in each workout. As we know, the human body will always try to maintain a state of homeostasis (Kory-Mercea, 2003). Training is, in simple terms, a game between the stress

applied on the body and its adaptive responses developed in order to maintain homeostasis, as expressed concisely by Gambetta (2007).

2.3. Weight training workout

Workout is the smallest unit of planning. In oredr to be efficient the workout is divided theoretically and practically in several parts succeeding logical by its objectives and physiological approach.

Regardless of the models of structure, longer or shorter, presented by diffrent authors, the proposal and application of weight training structure must be consistent with the goals of the practitioner and regularities that govern the physiology of the human body. Training chaotic or practicing without knowing what you do and how you have to do it is like searching for treasure without the map, says David Sandler (2003).

Regarding weight training in fitness for all, we believe that a workout should be composed of three distinct parts:

- warm-up;
- the main or fundamental part;
- cool-down.

Each part has specific objectives that aim characteristic physiological responses of the body and specific means for achieving the objectives.

2.4. The dynamics of heart rate in weight training

2.4.1. General aspects of heart rate

A basic condition for any normal activity is, as Suciu (2007) stated, regulation of cardiac activity made by heart's ability to alter its activity widely. "The cardiovascular system is one of the basic apparatus of immediate or long-term adaptation to effort" (Derevenco, 1998, p. 40).

Ratamess (2012) argues that physical exercise causes an increased need for oxygen and nutrients at the cellular level, resulting in increased body temperature and "waste" in tissues. All these changes require an effective response from the cardiovascular system. In response to changes with the onset of exercise the heart rate is accelerating at a rate directly proportional to the intensity of effort (Wilmore & Costill, 1993). Whyte & Sharma (2010) argue that the heart rate increases linearly with exercise intensity to its maximum value.

Measuring heart rate we can follow the cardiac profile of a physical activity (Derevenco, 1998) and we can use heart rate as a guide to plan our exercise intensity because it is in a linear relationship directly with oxygen consumption (American College of Sports Medicine, 2005).

2.4.2. Dynamics of heart rate in a workout

HR is influenced, obviously, by the structure and content of the workout. At the beginning of physical activity we have a very important part of preparing the body for the effort, in which HR is increasing. In the next part, the fundamental one, HR will reach a higher value, says Ratamess (2012). In cool-down faze HR will decrease.

In weight training exercise periods are short and they alternate with periods of rest. HR dynamics in weight training is characterized by multiple ascents and descents, which are conditioned by the structure and content of the training session.

To illustrate the dynamics of HR in weight training we present the Figure 2. HR data were processed with the program SportTracks (Zone Five Software LLC, 2013). The image generated below was exported from the same program.

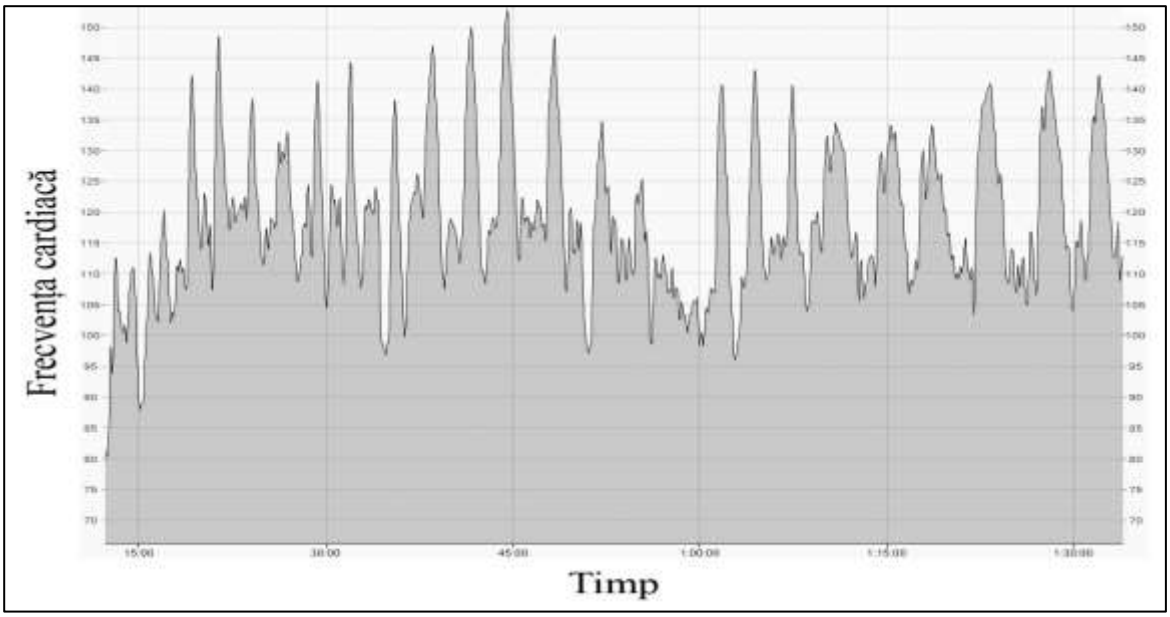

Fig. 2 - HR dynamics in a weight training workout

We present a chart with the means of HR for exercises included in a weight training workout (see Chart 1).

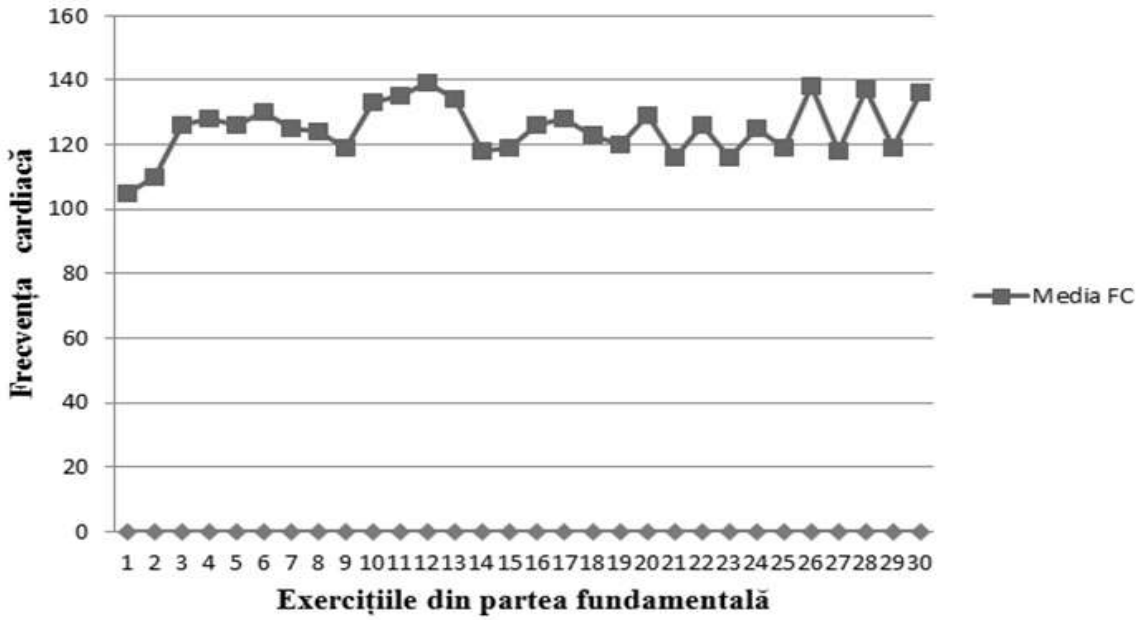

Chart 1 - Means of HR for exercises included in a workout

Chapter 3. Specific parameters of effort in weight training

This chapter details the specific parameters of weight training effort in order to facilitate their interpretation in a custom approach, required for scientific investigation.

Building an effective training program for a given individual can be a difficult task due to the large amount of existing information on weight training, sais Chetlin (2002). Some information in this area is wrong or insufficiently verified by science, therefore, we agree with the statement promoted by ACSM (2005, p. 136): "The art of exercise prescription is the successful integration of exercise science with behavioral techniques".

Scientific support is very important for practitioners protection. Not everyone needs the same level of personal fitness development. Sharkey (1988, p. 5) captures very well this aspect: "Top fitness is mandatory for shaping the heart of a future champion but not the heart of a future octogenarian".

A weight training program should take into account the variables that may change even during workout, such as ambience or environment in the training gym. We believe that the success of the exercise is influenced by the presence of a personal trainer who can provide guidance and important tips during training. Personal coach, as Plowman and Smith (2002) acknowledge, can also act as a motivator. The authors present a weight training experiment which included two groups of people, one group received assistance from personal trainers. The conclusion was that "these results clearly show that personal training (one-on-one supervision) can affect the strength gains achieved by participants" (Mazetti et al, 2000, cited by Plowman and Smith, 2002, p. 554).

PART II

Preliminary research for protocols and equipment verification

Chapter 4. The protocol verification for the study of weight training workout approach by population in gyms of Cluj-Napoca

The purpose of this research was to simulate training sessions similar to those used by the population in fitness gyms. These training sessions were used to verify data collection protocols and the methods required to record specific information. We tested the equipment proposed to be used for registration and, where necessary, we have been adapted them in order to achieve our study objectives.

4.1. Objectives

To verify the working protocol we have decided for the following objectives:

- HR recording system verification;
- Peripheral oxygen saturation recording system verification;
- Verification for data transfer compatibility from Google Android platform (used for recording data in fitness gym) to Microsoft Windows platform (used for processing and analysis the date collected).

4.2. Methodology

This stage of the research took place from 15 to 25 July 2013, in the gym of Faculty of Physical Education and Sports, the Babeș-Bolyai University, Cluj-Napoca. At this stage were recorded five weight training sessions. The duration of these sessions was between 68 minutes and 98 minutes, a total of 459 minutes being recorded.

Data recording system used to record HR is composed of a Bluetooth transmitter that is applied to a sensor elastic belt (belt snaps on the chest), Polar brand, and a phone (smartphone) with Bluetooth capability. For reception and data analysis were used two specific software, one for proper reception of data on smartphone and one for analysis and interpretation of HR data, installed on computer.

Specifically, our system is composed of:

Mai exact, sistemul nostru este compus din:

- Polar WearLink® + transmitter with Bluetooth® (Polar Electro, fără an);
- smartphone Samsung GalaxyNote 2, N7100 (Samsung Electronics Co. Ltd., fără an);
- software for Android phone (Google Inc., fără an), SportsTracker Pro (SportsTrackLive, fără an);
- softwares on Windows 7 operating system (Microsoft Corporation, fără an), SportTracks (Zone Five Software LLC, fără an);

For periphery oxygen saturation recording it had been used the Pulseoximeter CMS 50DL.

To record data in fitness gym were used, at the beginning, two models of observation sheet, one with column for oxygen saturation and one without this data (Annex 1 and Annex 2).

For collaborating with research subjects we used a participation agreement accepted by Doctoral commission. This participation agreement can be found in Annex 4.

4.5. Conclusions

All goals of this phase have been completed and we successfully built the necessary recording sheets for research conducted in fitness gyms of Cluj-Napoca.

We have successfully built the system needed for HR dynamics data collection (Văidăhăzan, Hanţiu, Pop, & Patrascu, 2015) and we built an effective protocol for collecting and analyzing HR data.

We managed, also, to establish an efficient protocol for transferring data from Android platform on Microsoft Windows platform.

During this phase of research, following the analysis of sampling data on peripheral oxygen saturation, it was decided to abandon the record for this functional parameter.

It has been successfully verified the recording sheet needed for observations during the workout in fitness gyms.

Chapter 5. The protocol verification for the study of relationships between effort parameters and dynamics of heart rate in fitness for all weight training

At this stage of research it was verified the proper protocol for HR record applied specific on structure and content of sessions necessary for the experiment conducted in the last part of our research.

5.1. Objectives

The objectives for this stage were:

- specific warm-up content verification in order to accomplish the methodological and physiological conditions proposed in our model (Annex 17);
- specific cool-down content verification in order to accomplish the methodological and physiological conditions proposed in our model (Annex 18);
- verification of testing sessions;
- verification of tempo specific sessions needed for experiment.

5.2. Methodology

This stage of the research took place from 17 January to 5 February 2015, in the gym of Faculty of Physical Education and Sports, the Babeș-Bolyai University, Cluj-Napoca. At this stage were recorded 17 weight training sessions. The duration of these sessions was between 22 minutes and 87 minutes, a total of 831 minutes being recorded.

HR was recorded with the system described before (Văidăhăzan, Hanţiu, Pop, & Patrascu, 2015). Other materials used at this stage of research were: timer, scales, tape measure and two colored cones. To achieve the proposed tempo for training sessions we used a sound system connected to a digital metronome (Easy Metronome).

All training sessions were conducted by a researcher helped by one or two assistants, depending on the specific of training. As guidelines for research activity we used observation sheets specific to each session.

Research sessions proposed to be checked were:

- session 1, RAST test (Running-based Anaerobic Sprint Test) (Annex 6);
- session 2, 1RM (one repetition maximum) test for latissimus dorsi (Annex 7);
- session 3, 1RM test for pectoralis major (Annex 7);
- session 4, Training session for speed execution used in research, with 60% of 1RM (Annex 8);
- session 5, Experiment session with 1010 tempo (60% of 1RM) (Annex 9);
- session 6, Experiment session with 3030 tempo (60% of 1RM) (Annex 10);
- session 7, Experiment session with 6060 tempo (60% of 1RM) (Annex 11).

It has been used in relation to subjects included in the study a Participation agreement (Annex 5).

5.5. Conclusions

Dynamics of effort in warm-up and cool-down is consistent with the objectives proposed.

The rest proposed into research sessions were chosen accordingly so as to allow adequate recovery of energy reserves before the experiment sets.

The structures proposed for the execution of exercises on experimental tempo were conducted properly, all subjects managing to keep the tempo required in the main sessions, after they participated in the training session.

PART III

Personal contributions of research on weight training

Chapter 6. Study I - Study of weight training workout approach by population in gyms of Cluj-Napoca (ascertaining investigation)

To mark the importance of good practice in weight training for population is necessary to establish as accurately as we can the relationships between effort parameters and dynamics of HR in this type of physical activity. These relationships, if properly understood and applied, will improve practice in this type of physical activity and will protect the people involved in this type of leisure activity. Starting from this premise, we proposed this observational investigation in order to identify and decipher the mechanisms which will represent starting point for future research.

We need new directions for research and action in this area, new ways which need to build a scientifically approach for safety attendance with maximum benefit to weight training in fitness gyms. Therefore, through our work, we intend to fill a gap in the literature and in the practice of this area. We want that solutions which will be adopted to improve theoretical models and the practice of weight training.

6.1. Objectives

Research is one of extensive and intensive type, aiming at enlarging the inventory of knowledge in the field concerned, respectively deepening understanding by explaining. The objectives of this investigation are methodical and physiological. Therefore, by solving our research objectives, we intend to build the weight training practitioner profile.

The objectives of this study are:

- Methodical analysis of workout from the perspective of training session parts (warm-up, main part and cool-down);
- Analysis of practitioners knowledge about how they identify muscle groups involved in training sessions;
- Methodical and physiological analysis of warm-up, included in weight training workout for every subject;
- Methodical and physiological analysis of cool-down, included in weight training workout for every subject;
- Analysis of load models used by practitioners during workout;

- Analysis of exercise duration and rest duration in every workout;
- Effort density analysis in terms of number of exercises and sets relative to workout duration and rest periods;
- HR dynamics analysis by interpretation of HR increases after each set carried out in weight training workout;
- Building a workout design to allow for optimum effort parameters quantifying that will realize the best possible progression for a long-term evolution of the practitioner.

6.2. Hypothesis

Based on the experience gained from previous research we have built for this study the following assumptions:

1. Weight training workouts attended by the population in Cluj-Napoca's fitness gyms are improperly methodically planned.

2. The warm-up and the cool-down built by weight training practitioners don't have a relevant structure.

3. Practitioners of weight training in gyms of Cluj-Napoca do not comply with HR dynamics recommended by literature.

6.3. Subjects and Methods

This study was conducted during August 14, 2013 - August 20, 2014, in fitness gyms of Cluj-Napoca. The subjects are practitioners from all weight training gyms in which we have been granted access (Appendix 13), between 4 and 6 practitioners from every gym.

A number of 155 practitioners were interviewed. A percentage of 47.74% refused participation in the study, and 52.26% have given their consent. We also have to note that a practitioner among those included in the study did not use exercises with weights in his workout in the day we recorded him. The total number of subjects recorded was 81. Fot our selection non-random sampling was used because the likelihood of a member of the population to be selected in the sample could not be determined.

They were accepted into the study only those practitioners who have previously completed an attendance agreement (Annex 4).

6.6. Conclusions

From methodical analisys many practitioners shows defective weight training in fitness gyms. In very many workouts warm-up is performed improperly. The problems were even greater when we analised the cool-down phase. This part of workout is missing in almost all workouts that we recorded.

Knowing the main muscle groups that are included in weight training sessions, a prerequisite for conscious and active participation, it's not a basic necessity for practitioners of weight training, unfortunately.

Practitioners of weight training don't relate to HR dynamics when they build the warm-up and the cool-down phase.

The models for loading and unloading the weight are varied but the reference to the theoretical maximum intensity proposed in the literature is missing for nearly all practitioners.

Most practitioners have an adequate approach to workout duration but when they had to respect the rest between exercises almost all practitioners couldn't do it. The main reason this happened, we believe, is because they don't use any means for recording the rest during weight training workouts.

HR dynamics in weight training recorded are on a wide range. Practitioners used different approaches and the lack of research in this area requires for us to be reserved in our assertions for definitive conclusions on this issue. We can say, however, that depending on several factors (work intensity, physical condition practitioner, execution technique, body position during and after exercise, etc.), increases in HR recorded after exercise should be points of interest for several studies in this area because they may pose certain risks for cardiovascular practitioners.

Following the above we can say that all research hypotheses proposed for this study are admitted.

Chapter 7. Study II - Study of relationships between effort parameters and dynamics of heart rate in fitness for all weight training

We believe it is important to gain a better understanding of the relationships between effort parameters and the influence they have on HR dynamics. We name only few conditions, already demonstrated: HR maximum during an exercise in weight training is different depending on the speed of execution for repetitions (Buitrago, Wirtz, Yue, Kleinoder, & Mester, 2011); maximum weight obtained at different speed is also different, being dependent by the speed of repetitions (Ide et al, 2011); speed execution influences the perception of fatigue (Diniz, Martins-Costa, Machado, Lima, & Chagas, 2014).

7.1. Objectives

For this study we proposed a total of five goals. The main objectives of the research:

- The first objective of the research was to record the maximum values of HR at various speeds of execution and analysis their distribution pattern on three different tempo execution.
- The next objective of the research was to record the maximum number of repetitions that the subjects could carry out at various speeds of execution.
- The third objective of the research was to record the time under tension obtained at different speeds of execution.
- The fourth objective of the study was to analyze the growth trend of HR at various speeds of execution for repetitions.

As a secondary objective, we proposed to check if there is any correlation between fatigue index, calculated as a result of applying RAST test, and time under tension for the muscle tested, obtained from subjects when they performed maximal repetitions.

7.2. Hypothesis

Changing the speed of execution for repetitions is valued differently by practitioners of weight training, issue that we have discussed with many of the practitioners involved in the first study that we conducted. Following the analysis conducted for the first study, we concluded that changing the speed of execution causes changes in other factors involved in workouts.

Thus, the following hypothesis for current research was proposed: changing the speed of execution for repetitions, in weight training, influence the maximum number of repetitions, the time under tension for muscle trained and the dynamics of HR.

7.3. Subjects and Methods

This study was conducted during February 9 to April 19, 2015, in the gym of Faculty of Physical Education and Sports, the Babeș-Bolyai University, Cluj-Napoca.

For the construction of experiment group were interviewed 24 students of the Faculty of Physical Education and Sports. All of them volunteered to participate in our research. Depending on the availability of each one, and after a practice session with proposed tempo, we selected 12 students.

One subject participated only in the first 3 sessions of research but after that he was excluded from the study due to an oldest injury that limited his amplitude of motion for pectoralis major. At the end, the final number of subjects for this research was 11.

The muscles included in the survey were:

- Latissimus dorsi with the exercise "back lat-pull downs";
- Pectoralis major with the exercise "bench presses".

The tempo used in the experiment was as follows:

- 1010 (1 second on eccentric, zero seconds on isometric after the eccentric, 1 second on concentric, zero seconds on isometric after concentric);
- 3030 (3 second on eccentric, zero seconds on isometric after the eccentric, 3 second on concentric, zero seconds on isometric after concentric);
- 6060 (6 second on eccentric, zero seconds on isometric after the eccentric, 6 second on concentric, zero seconds on isometric after concentric).

The weight used in research for all experimental sets was 60% of 1RM, tested on both muscle groups for each subject.

HR was recorded with the system described before (Văidăhăzan, Hanţiu, Pop, & Patrascu, 2015). There were a total of 44 training sessions, totaling just over 38 hours of recordings (ie, 2310 minutes of recording). For analyzing and extracting HR values of each record was used, on the Windows 7 platform, the program SportTracks 3 (Zone Five Software LLC, 2013).

To participate in the research subjects were asked to complete a Participation agreement (Annex 5).

After enrollment, each subject participated in seven sessions interspersed with days of rest. Sessions included in the survey were:

- session 1, RAST test (Running-based Anaerobic Sprint Test) (Annex 6);
- session 2, 1RM (one repetition maximum) test for latissimus dorsi (Annex 7);
- session 3, 1RM test for pectoralis major (Annex 7);
- session 4, Training session for speed execution used in research, with 60% of 1RM (Annex 8);
- session 5, Experiment session with 1010 tempo (60% of 1RM) (Annex 9);
- session 6, Experiment session with 3030 tempo (60% of 1RM) (Annex 10);
- session 7, Experiment session with 6060 tempo (60% of 1RM) (Annex 11);

7.6. Conclusions

The peaks recorded for HR don't have the same dynamic model for all subjects. Therefore, we can not say that maximum HR during exercise is specific to speed of execution. The mean distribution pattern analysis indicates a difference between the two muscles included in the research.

The maximum number of repetitions decrease at the same workload as the execution speed decreases. Analyzing the mean of repetitions it can be observed a difference between muscles studied.

Time under tension for muscle presents values inversely proportional to the speed of execution. Being conditioned by the number of repetitions, time under tension obtained for the pectoralis major is lower than time under tension obtained for latissimus dorsi on all 3 tempo included in the research.

The biggest growth trend of HR was recorded at two-second execution speed (tempo 1010) for both muscles. Comparing the growth trends between these two muscles, on tempo of 1010, it was observed that the latissimus dorsi trend growth is higher than the pectoralis major.

RAST fatigue index did not correlate with time under tension obtained by our subjects.

In conclusion, the hypothesis proposed at the beginning of the research is confirmed, revealing at the same time critical information for practicing in this area and for the research that we want to achieve in future with weight training.

General conclusions and recommendations

The practice of weight training by population in gyms of Cluj-Napoca is deficient both methodically and physiologically. This paper shows the practitioner profile for this leisure activity and identifies the problematical issues in order to improve both the practice and the theory in this field. Through this research it has been emphasized the importance of the link between knowledge existing in theory and the practice of weight training.

Is an urgent need to disseminate accurate information in order to modify the methodical behavior of practitioners. We have to plan more carefully the parts of the workout if we want to achieve proper physiological responses for people who engage in the practice of weight training in fitness gyms. We should, also, continue the research on specific physiological aspects of weight training in fitness to reduce the risk of injury and the exposure to cardiovascular system diseases that may occur due to wrong physical effort planning.

Since time under tension, as we have seen, is a variable that influences the cardiovascular response to stress, we believe that we need a more comprehensive approach to weight training. Practitioners of weight training, coaches and trainers, must learn to work with the concept of tempo and time under tension.

Regarding exercise intensity we recommend to use the 1RM reports or the zone of maximum repetitions. We recommend, also, for all practitioners to work with maximum repetitions for every set in order to be able to assess more easily stress on the body.

Duration of effort it is advisable to be selected primarily based on personal program of each practitioner and it has to be adjusted according to specific physiological response between workouts.

In order to properly adjust the density of effort in weight training, we recommend to use the density index values and the set/exercise index when planning a major training cycle.

Complexity of effort needs to be addressed in terms of biomechanical characteristics of exercises introduced into workout, and taking into account the other parameters of effort.

Regarding the aspects of the HR dynamics, we recommend to follow the three important rules (which we used in our research) when performing the warm-up and the cool-down. We recommend to record the HR during every workout and to assess it using the values offered by literature.

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