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Articles and Statements

The Adaptation Process to Education among University Students with Various Psychotype and Physical Activity Level

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Abstract

The Problem of Research: In the educational process many students experience the stress, which manifests itself in the form of headaches, fatigue, depression, and in decreasing of academic performance. A little physical activity allows them to get out of this state.

Participants and Methods: There were investigated 100 students (educational directions: “Physical culture”, “Music”, “General Medicine”) (age 19-24) from Kazakhstan, Russia, Turkey with various psychotype and physical activity level in the process of their adaptation to educational process. It was used theoretical analysis of scientific and methodological literature, analysis of normative documents, pedagogical observations, sociological methods of research (the scale neuropsychic tension, Questionnaire (well-being, activity, and mood), Eysenck Personality Questionnaire (EPQ)), methods of assessing physical activity (timing, Framingham technique), and methods of statistical data processing.

Results: It was shown that students with a reduced level of physical activity expressed significant stress of adaptation mechanisms. For students of the educational direction "Physical Culture" adaptation to the educational process passes more effectively than for students of the educational direction "Music".

Conclusions: It is necessary to take effective measures to reduce the negative impact of stress on life, health and student performance. These measures include: a change in lifestyle, activisation

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of physical activity, harmonization of interpersonal relations of students, reduction of learning loads. It this way necessary to individualize the learning process, based on the types of temperament, psychotype and level of physical activity.

Keywords: adaptation, physical activity, psychotype, stress resistance, university students, educational process.

1. Introduction

The physical and mental health of people is influenced by many factors, such as physical activity, observance of the norms of a healthy lifestyle, communicative norms in society, type of person's temperament (Kondo et al., 2008; Füzéki, Banzer, 2013; Dore et al., 2016; Dinh-Van Phan et al, 2018).

The problem, which we will discuss in our investigation, occupies humanity for more than 25 centuries. Interest in this is due to the individual differences between people. The psychology of each person is different. It is unique in every people due to their different biological and physiological formation and development of the organism. When we talk about temperament, we mean many mental and psychological differences between people's, differences may be there emotional stability, temper, energy of action, thinking power, mental life, behavior and other activity. Temperament is the speed and strength of the processes of excitation and inhibition in the cerebral cortex. It defines not only emotionality and sensitivity, but also the style of study activity, the way of reaction and behavior (Rothbart, Derryberry, 1981; Rothbart, Bates, 2006; Evans et al., 2007; Rothbart, 2007; Gozde Ersoz et al., 2017).

Nowadays, the problem of insufficient physical activity of the population has been noted. This is due to the unprecedented success in many areas of science and the production of material goods. As a result, most of our contemporaries do not satisfy their natural need for physical activity, and thus the effective functioning of human life systems is not ensured. Many studies paid attention to the worldwide decline in physical activity (PA) and increase the sedentary persons and obesity among human. The inactivity at different ages it is a major problem for most countries, approximately 20 % of adults worldwide report persistent fatigue. However, few studies have addressed the dissemination of effective physical activity interventions. Both community settings and healthcare settings are important locations for dissemination of evidence-based programs and policies with benefits in terms of both prevention and management of chronic disease and injury (Proper et al., 2006; Puetz, 2006; Rabin et al., 2006; Kagotho, 2011; Futornyi, 2013; Fagaras et al., 2015).

In this regard, great attention is paid to improving the status of the population by adopting a healthy lifestyle. The formation of a healthy lifestyle is effectively promoted by physical culture and sports, regular exercise, and various health practices (Kharissova et al. 2015**;** Graciela Chaves et al., 2015).

The stressors (mental or physical) have a major influence upon mood, our sense of well-being, behavior, and health. Acute stress responses in young, healthy individuals may be adaptive and typically do not impose a health burden. However, if the threat is unremitting, particularly in older or unhealthy individuals, the long-term effects of stressors can damage health. During physical and mental stress, under cognitive load occur changes in respiration, and influence of respiration patterns on activity of cardiovascular system. Many researchers showed in study causes of stress for the people, and gave exit routes of stressful situations (Firth, 1986; Neil Schneiderman et al., 2005; Florina Nechita et al., 2014; Juan Pablo Delfino et al., 2015; Dawit Yikealo et al., 2018).

2. Relevance

The relevance of this study is because due to the modernization of the university system of education in the Russia and Kazakhstan, it became necessary to identify the mechanisms of adaptive behavior of students in the process of their education. For most students, one of the most difficulties is the initial period of study at the university. Different stress factors violate adaptation mechanisms and due to leads to decreasing in physical and mental health (Kharissova et al., 2012; Mindubayeva et al., 2015).

Various psychotype characteristics at person (temperament, structural organization of higher nervous activity and character) determine a different level of adaptive capabilities to rapidly

changing conditions of both internal and external environment. Being divorced from the usual living conditions associated with moving to a new place of residence and moving to a different educational level (secondary school-university), most students experience a state of severe stress, accompanied by a long adaptation period, which can be reduced by various psychophysiological methods (autogenic training, classes sports).

Insufficient physical activity of students leads to their poor adaptation to the changing requirements of higher education. To successfully determine the level of adaptation of students in the learning process, it is necessary to consider the reserve capabilities of the human body as a whole and its different systems.

The purpose of this study was to examine the adaptation process to education among university students in terms of temperament and physical activity level.

3. Materials and methods

3.1. Object of the research, Contingent of students

Object of the research: The adaptation process to the influence of the educational process in groups of students with different psychotype and level of physical activity.

Contingents of Students: Study participants were investigated at Karaganda Medical University (Department Morphology and Physiology) in Kazakhstan; Kostroma State University (Department of Biology and Ecology, Department of Physical Culture and Sports) in Russia; and Gazi University (Turkey). There were exanimated 100 students (testees) (educational directions: “Physical culture”, “Music”, “General Medicine”) of 1, 2 and 3 courses (18-24 years).

There are 3 groups: **First (I) group students** of Faculty Musicians of Kostroma State University (KSU) (25 students). **Second (II) group students** of Faculty Physical Culture of Kostroma State University (KSU) (35 students). **Third (III) group students** of International Faculty of General Medicine of Karaganda Medical University (KMU) and Gazi University (GU) (45 students). Among them were 37 % of female, 63 % of male. In addition, according to their physical activity, the students were divided into the following groups: non-athletes (non-sportsmens) (**subgroup 1**) and athletes (sportsmens) (**subgroup 2**). Subgroup 1 has exercising less than 30 minutes per day and not exercising at study (25 students); Subgroup 2 has exercising more than 30 minutes daily, engaging in sports at study 2–3 times/week and meeting, physical standards (75 students).

Informed consent (Ethical approval): The work was carried out in compliance with the basic bioethical rules and requirements with the scientific justification of the planned studies, analysis of possible risks and discomforts, description of the research for non-specialists and obtaining informed consent from the participants of the investigation.

3.2. Research Methodology

There were used theoretical analysis of scientific and methodological literature, analysis of normative documents, pedagogical observations, sociological methods of research (the scale neuropsychic tension, Questionnaire (well-being, activity, mood), Eysenck Personality Questionnaire (EPQ)), methods of assessing physical activity (timing, Framingham technique), methods of statistical data processing.

We used determination of temperament according test Eysenck. Using such methods, we can determine extraversion (the orientation of the personality to the outside world) and neuroticism (the result of unbalance of the processes of excitation and inhibition) properties underlying temperament. That method has 57 questions. Students should be answered "Yes" or "No". The obtained results are compared with the key, which has three scales: extroversion – introversion; neuroticism, the lie scale. Belonging to the type of temperament is detected by using a coordinate system where the results are marked on a scale of "neuroticism" and the scale "extraversion”. The study of memory was carried out according to the methods described in the methodological recommendations of N.M. Kharissova.

3.3. Method for determining the level of anxiety

1. The scale neuropsychic tension. The Perceived Stress Scale (PSS) is the most widely used psychological instrument for measuring the perception of stress. It is a measure of the degree to which situations in one’s life are appraised as stressful. Items were designed to tap how

unpredictable, uncontrollable, and overloaded respondents find their lives. The scale also includes several direct queries about current levels of experienced stress. The PSS was designed for use in community samples with at least a junior high school education. The items are easy to understand, and the response alternatives are simple to grasp. Moreover, the questions are of a general nature and hence are relatively free of content specific to any subpopulation group. The questions in the PSS ask about feelings and thoughts during the last month. In each case, respondents are asked how often they felt a certain way. The measurement of anxiety as a personality trait is particularly important, since this property largely determines the behavior of the subject. A certain level of anxiety is a natural and obligatory feature of an active person. Each person has his own optimum, or desired level of anxiety - this is the so-called useful anxiety. Man's assessment of his condition in this respect is for him an essential component of self-control and self-education. For definition anxiety we used Teilor's Manifest Anxiety Scale (Questionnaire assessment of neuro-emotional stress). The Taylor's Manifest Anxiety Scale is designed to measure anxiety manifestations. The considered scale consists of 50 statements, to which the subject must answer "yes" or "no." Assertions were selected from a set of statements from the Minnesota Multidimensional Personality Questionnaire (MMPQ). Testing lasts 15-30 minutes. For ease of use, each statement is offered to the subject on a separate card.

2. Questionnaire (well-being, activity, mood). The test is designed to quickly assess the state of health, activity and mood (according to the first letters of these functional states, the questionnaire is named). Students are asked to correlate their state with a range of signs on a multistage scale. The scale consists of indices (3 2 1 0 1 2 3) and is located between thirty pairs of words of opposite meaning, reflecting mobility, speed and rate of performing of functions (activity), strength, health, fatigue (well-being), and characteristics of the emotional state (mood). The subject must select and mark the number that most accurately reflects his state at the time of the survey **(Spielberger-Anfimov Questionnaire WAM (Well-being, Activity, Mood)).**

3. Eysenck Personality Questionnaire (**EPQ**). In psychology, Eysenck Personality Questionnaire (EPQ) is a questionnaire to assess the personality traits of a person; this is not the same questionnaire as the Eysenck's personality Inventory or EPI which was an earlier instrument also produced by Hans Eysenck. Hans Eysenck's theory is based primarily on physiology and genetics. Although he was a behaviorist who considered learned habits of great importance, he believed that personality differences grow out of our genetic inheritance. He is, therefore, primarily interested in what is usually called temperament. Temperament is that aspect of our personalities that is genetically based, and present from birth or even before. In devising a temperament-based theory Eysenck did not exclude the possibility that some aspects of personality are learned but left the consideration of these to other researchers. Extraversion is manifested in a friendly, talkative, energetic behavior, while introversion is manifested in a more closed and lonely behavior. Extraversion and introversion are usually considered as a single measurement space; therefore high indicators of one characteristic imply low indicators of another.

3.4. Methods of Statistical Data Processing

Data processing was performed using mathematical statistics methods; reliability was determined by Student's t-test, Fisher's F-criterion.

4. Discussion

Stress Data Analysis among students. Survey was gathered by emailing the survey to all the selected students in the University in order to get their responses. Questionnaires were sent to all students in the Russian groups and International groups in English. Russian part of the questionnaire would be translated to English for easy understanding. After which comparison will be drawn and interpreted to know how the students perceive stress impact in their academic work.

According to a survey, 49 % of men and 55 % of women experience stress. Factors contributing stress are poor performance in examinations (87.5 %), difficulty in understanding the subject (68.3 %), lack of recognition to work done (44.2 %), lack of time to revise (95.2 %), and large content to be learnt (99.1 %).

Before the exam, the students 'condition can be described as tense – almost all indicators are indicative of nervousness and anxiety, self-doubt and discomfort. As for these indicators in a period of relative rest, anxiety and self-doubt, stiffness is also present, but to a much lesser extent, the

remaining indicators of this period in comparison have significant differences. It is worth noting that during regular learning, students feel much calmer and more confident than during the examination session.

During the examination session, and during ongoing training, freshmen students try to avoid difficulties and critical situations, for the most part they have high spirits and feel happy, feel a surge of strength and have a desire to work, and they feel calm, collected and calm. During the session, the blues were noted, emotionality and frustration due to trifles were increased, but the desire to be successful, i.e. it can be concluded that the emotional mood of most of the tested students during the examination session, despite anxiety and tension, still remains positive, as in the intersessional period.

In general, it can be noted with confidence that, although the examination session is undoubtedly stressful for freshmen, overall indicators of emotional assessment are elevated, but they do not radically differ from indicators at rest, which gives us the right to conclude that freshmen have relative stress tolerance.

As an important vegetative indicator, blood pressure and pulse clearly characterize the degree of anxiety and the functional state of freshmen. In the study of these indicators, it was found that the values of blood pressure and heart rate during the examination session are also outside the norm for freshmen: resting pressure was 122/66 mm Hg, and before the exam 143/85 mm Hg., which can be called quite high for their age, this clearly shows what degree of excitement they experienced. As for the pulse, then its indicators exceed the norm both at rest and before the exam - 83 beats / min and 94 beats / min.

An increase in pulse and blood pressure data indicates a malfunction of the cardiovascular system, which, if these indicators are stored for a long time, can lead to various diseases of this system and the body as a whole. During the study, heart rate indicators gradually increased; due to this we can conclude that the dynamics of the pulse rate growth reflects the activation of the sympathetic nervous system. In general, the dynamics of growth in heart rate values was observed in all students.

Analysis of the results of the study showed that among the students there were 56.5 % extroverts and 43.4 % introverts. In the group of the extroverts were dominated choleric (50.9 %) and sanguine (41.2 %). Among the introverts were mostly melancholic (86.7 %). Visual memory (57.3 %) and motor memory (38.8 %) were dominated most in the students. Choleric people are more successful in the learning process than sanguine and melancholic. They are capable of completely giving themselves to study, spending all their energy on it.

For successful academic activity of students, the teacher uses different methods, tasks, and style of teaching, corresponding to the student's temperament.

In all, data were collected from students who were from the international and Russian groups, regarding four main factors of stress which were: Relationship, Academic, Environmental and personal factors. Each had sub factors that caused stress and base on the results, working with new people was the highest factor in both groups of people who answered the questionnaire Relationship as source of stress. With regards to academic issues, class load was the highest. Future worry under environmental factors was the main cause of stress to students and financial difficulty came up under personal factors that cause stress. The results show that stress affects the overall school activities of students as well as their social well-being (Figure 1). The results presented in Figure 2 reflect data on the scales of personal anxiety during stress.

Stress is the insistent outcome caused by various stable and strain routine tasks of every part of our life. The changeover from adolescence to adulthood is a complicated journey in academic life of college students. In this stage, college students face fast physical, social and mental changes along with they may experience unsuitability and adaptableness. College students constantly have more multifaceted inconvenience due to academic pressure, adaption to new environment, fear of failure; struggle to create uniqueness, inferiority, attaining social familiarity, etc. The transition from secondary school to university is often accompanied by unhealthy behaviour changes such as decreasing physical activity and increasing sedentary behaviour. The concept of 'Freshman 15' is a popular term that describes dramatic weight gain of college students (Pariat et al., 2014; Crombie et al. 2009; Vella-Zarb et al., 2009; Mohammad Reza Sharif et al., 2018).

"Students reported that both physical and sedentary activities were influenced by individual factors (e.g. perceived enjoyment, self-discipline, time and convenience), their social networks

(e.g. (lack of) parental control, modelling, social support), physical environment (e.g. availability and accessibility, travel time/distance, prices), and macro environment (e.g. media and advertising)" (Deliens et al., 2015).

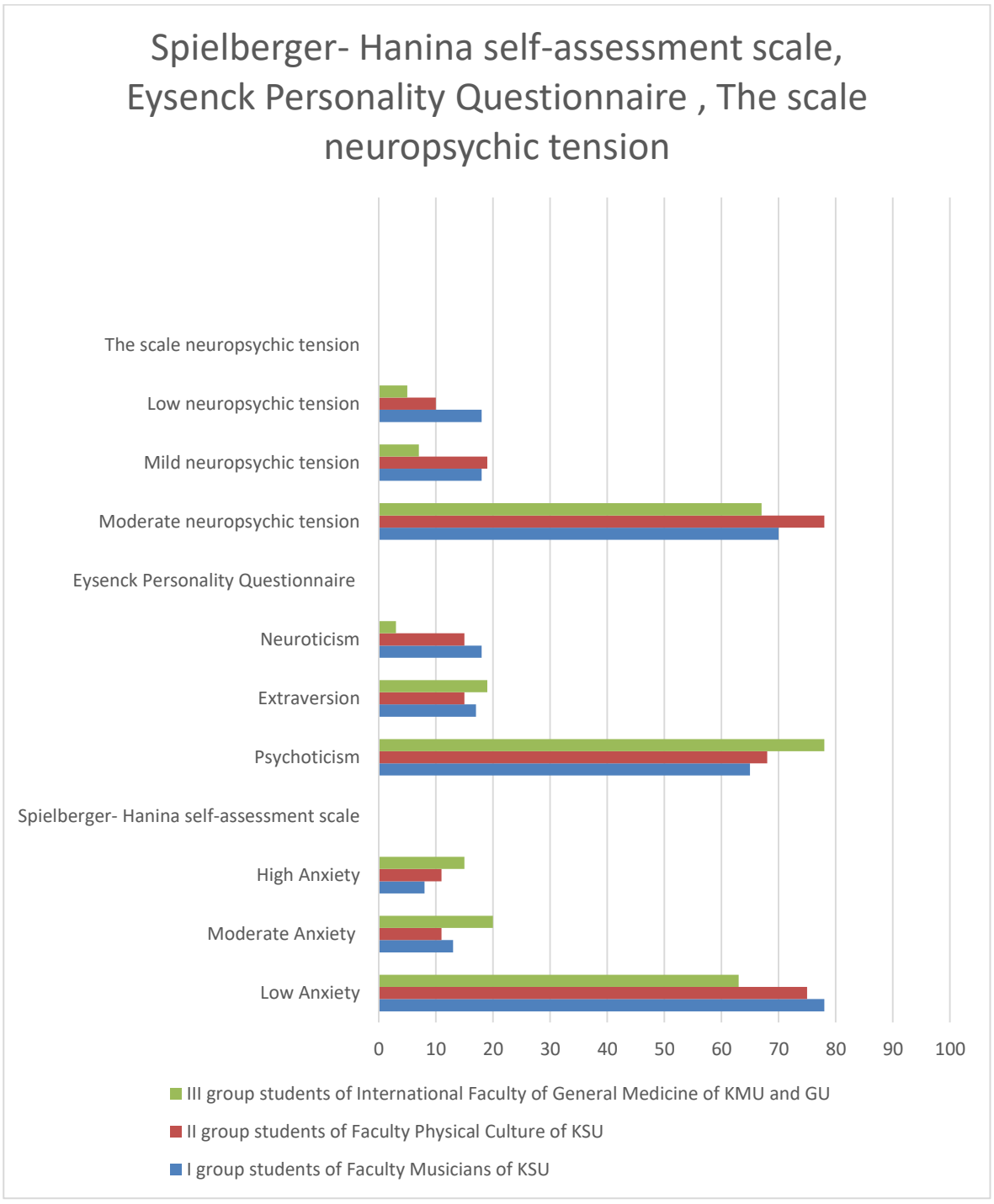

Fig. 1. Spielberger- Hanina self-assessment scale, Eysenck Personality Questionnaire, The scale neuropsychic tension

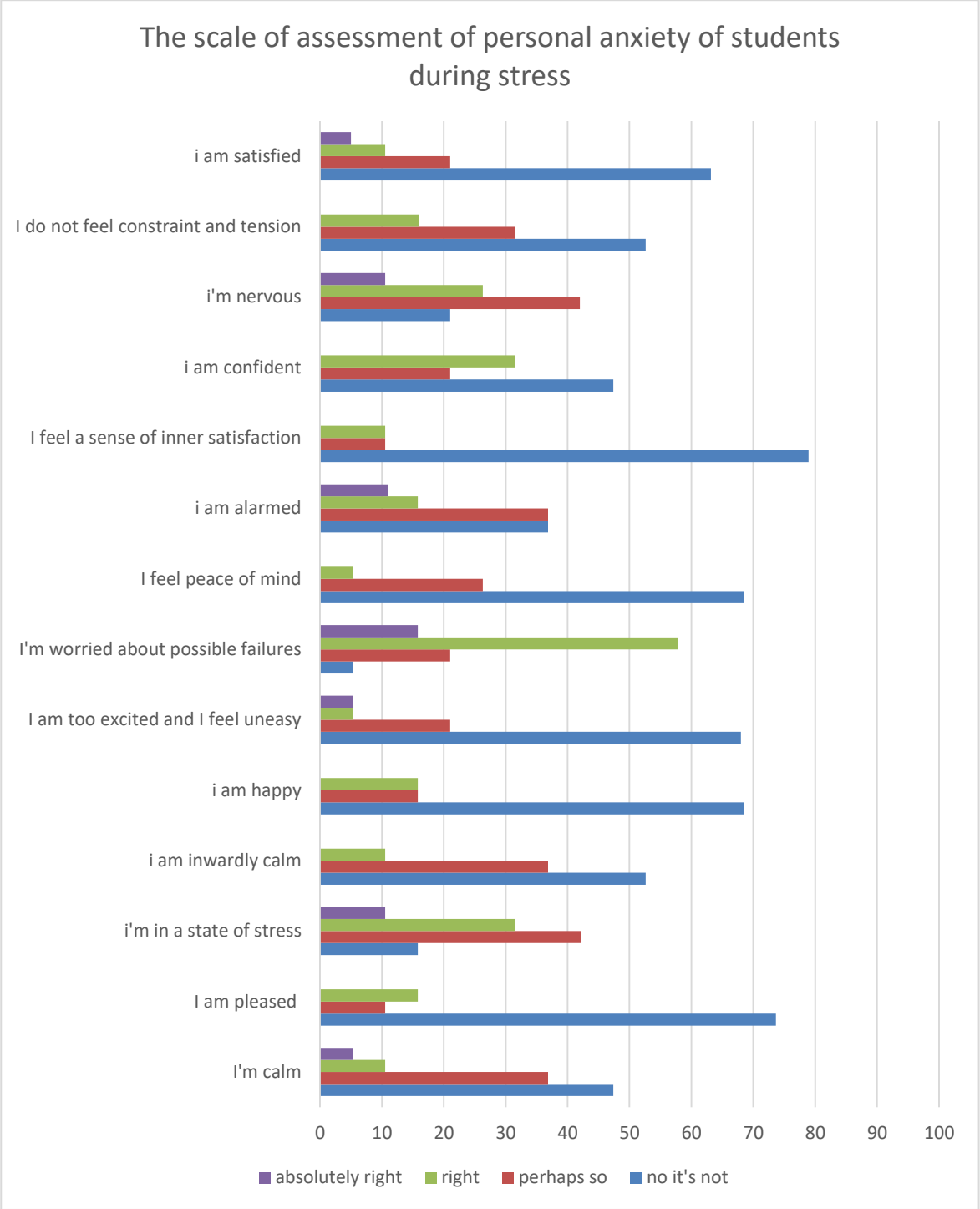

Fig. 2. The scale of assessment of personal anxiety of students during stress

"During the past decade, numerous intervention studies have been published on the effectiveness of programs to promote active living" (Rabin B, et al., 2006). "It is feasible to successfully promote physical activity to groups of people in diverse places, with benefits in terms of both prevention and management of chronic disease and injury" (Proper et al., 2006). "The deficit of motor activity by the students it is advisable to include educational and daily activities of this category of students of various forms of physical education classes of various kinds" (Futornyi, 2013).

"One of such rehabilitation programs is employment by physical exercises and sports. Today there is no necessity to prove huge value of regular employment by physical exercises for strengthening of health, the prevention of diseases, increase of stability and resistibility of an organism. The health

problem has special value for sports. Sports make direct impact on preservation correct integrative reactions of an organism to physical activities" (Kharissova et al., 2012).

"Adaptation to physical activity is a dynamic process, which is based on the formation of a new program of physical development and health. This ability to adapt to the conditions of a regular training activity depends not only on the existing constitutional reserves, but also on the volume of training loads of students involved in cyclic sports, the adequacy, efficiency and stress of regulation mechanisms of the body of students" (Konkabaeva et al., 2016).

To mitigate the stressful situation of the transition of students from the school system of education to the university system and the intensification of their adaptation mechanisms, we recommend the use of preventive teaching methods in the initial courses of the university (increasing the hours in the educational programs devoted to physical education and sports; holding various thematic evenings about active lifestyle; scheduling classes taking according to biorhythms of students; providing a zone of psychological comfort by increasing student appeal for practical psychologists and more time staying in the rooms of students of psycho-emotional discharge). The preventive methods proposed by us will contribute the creation of a general positive emotional background among students during their studies at the university.

5. Conclusion

Based on the results obtained and their interpretation, we can conclude:

- Due to the negative impact of stress on the student's life, such as poor learning, poor academic performance and poor general health, effective measures must be taken. This is done by identifying the underlying causes of stress, which includes changes in lifestyle, less workload, better interpersonal relationships. We hope that; based on the analysis, this thesis will be very useful for helping students in their lives.
- The study revealed that academic problems were greater sources of stress in the first-year medical students when com-pared with nonacademic problems.
- Distress among students may influence professional development and adversely impact academic performance contributing to academic dishonesty and substance abuse. Addressing these issues by the institution using professional help would go a long way in ameliorating their stress levels and in making their learning a pleasant affair.
- These conditions direct the mobility, activity and ability to focus on the educational activities of the sanguine person. For the choleric it is necessary to create conditions that helped to overcome excitability, to concentrate attention, to realize the importance of the question for him. It is necessary to shift attention to the forthcoming activity and concentrate on studying the topic in the phlegmatic. For the melancholic must create a situation of success, distract from negative emotions, anxiety, and educate self-reliance. So, for the best organization of the lesson, the teacher must consider the temperament of the students, what will be beneficial for the health of students.
- It can be assumed that the choleric students have good adaptive abilities to the educational process. Students with a sanguine temperament adapt more quickly to the social environment, and melancholy students, whose performance indicators and ability to communicate have improved after physical education and sports, are most difficult to adapt to the rapidly changing living conditions and social environment.

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References

Konkabaeva, et al., 2016 – *Konkabaeva, A.E., Maral, Rasol* (2016). The Functional State of the Cardiovascular System of Students with Different Levels of Physical Fitness. *European Journal of Physical Education and Sport*. 11(1): 10-16. DOI: 10.13187/ejpe.2016.11.10

Crombie et al., 2009 – *Crombie, A.P., Ilich, J.Z., Dutton, G.R., Panton, L.B., Abood, D.A.* (2009). The freshman weight gain phenomenon revisited. *J. Nutr Rev*. 67(2): 83-94. DOI: 10.1111/j.1753-4887.2008.00143.x

Dawit Yikealo et al., 2018 – *Dawit, Yikealo, Bereket, Yemane, Ikali, Karvinen* (2018). The Level of Academic and Environmental Stress among College Students: A Case in the College of Education. *Open Journal of Social Sciences,* 6(11): 40-57.

Deliens et al., 2015 – *Deliens, T., Deforche, B., De Bourdeaudhuij, I., Clarys, P.* (2015). Determinants of physical activity and sedentary behaviour in university students: a qualitative study using focus group discussions. *BMC Public Health,* 15(201): 4-9. DOI: 10.1186/s12889-015-1553-4

Dinh-Van Phan et al., 2018 – *Dinh-Van, Phan, Chien-Lung, Chan, Ren-Hao, Pan, Nan-Ping, Yang, Hsiu-hen, Hsu, Hsien-Wei, Ting, K. Robert, Lai* **(**2018). A Study of the Effects of Daily Physical Activity on Memory and Attention Capacities in College Students. *Journal of Healthcare Engineering Volume*. Article ID 2942930, 9 p. DOI: https://doi.org/10.1155/2018/2942930

Dore et al., 2016 – *Dore, I., O'Loughlin, J.L., Beauchamp, G., Martineau, M., Fournier, L.* (2016). Volume and social context of physical activity in association with mental health, anxiety and depression among youth. *J. Preventive Medicine*. 91: 344-350.

Dosimov et al., 2014 – *Dosimov, Zh.B., Sisenova, A.T., Dosimov, A.Zh., Zhumaliyeva, G.S.* (2014). Sostoyaniye trevozhnosti v strukture psikhologicheskogo statusa podrostkov [State of anxiety in the structure of the psychological status of adolescents]. *J. Vestnik Almatinskogo gosudarstvennogo instituta usovershenstvovaniya vrachey*. (4): 14-16. [In Russian]

Evans et al., 2007 – *Evans, D., Rothbart, M.K.* (2007). Developing a model for adult temperament. *Journal of Research in Personality*. 41: 868-888.

Firth, 1986 – *Firth, J.* (1986). Levels and sources of stress in medical students. *Br. Med. J. (Clin. Res. Ed.)*. 292(6529): 1177-1180. DOI: 10.1136/bmj.292.6529.1177

Florina Nechita et al., 2014 – *Florina, Nechita, Dan, Nechita, Mihail-Cristian, Pîrlog, Ion, Rogoveanu* (2014). Stress in medical students. *Rom J. Morphol Embryol*. 55(3): 1263-1266.

Futornyi, 2013 – *Futornyi, S.M.* (2013). Problem of shortage of motor activity students. *J. Physical education of students*. 17(3): 75-79. DOI: 10.6084/m9.figshare.663631

Füzéki et al., 2013 – *Füzéki, E., Banzer, W.* (2013). Activities of daily living and health. *J. Public Health Forum*. 21(2).

Gozde Ersoz et al., 2017 – *Gozde, Ersoz, Ece, Altındağ, Özlem, Abbak, Yakup, Albayrak* (2017). Temperament and Character Traits of University Students with Regard to Physical Activity Level. *Yeni Symposium* [Electronic resource]. URL: www.yenisymposium.com. DOI: 10.5455/NYS.20170801020754

Graciela Chaves et al., 2015 – *Graciela, Chaves, Nidia, Britez, Judith, Munzinger, Lorenz Uhlmann, Graciela, Gonzalez, Guillermo, Oviedo, Victoria, Chaparro, Oscar, Achon, Thomas Bruckner, Meinhard, Kieser, Hugo, A. Katus, Derliz, Mereles* (2015). Education to a Healthy Lifestyle Improves Symptoms and Cardiovascular Risk Factors. *AsuRiesgo Study Arq Bras Cardiol*. 104(5): 347-355. DOI: 10.5935/abc.20150021

Juan Pablo Delfino et al., 2015 – *Pablo Delfino, Juan, Inés Barragan, Elena, Botella, Cristina, Braun, Silke, Bridler, René, Camussi, Elisabetta, Chafrat, Verónica, Lott, Petra, Mohr, Christine, Moragrega, Inés, Papagno, Costanza, Sánchez, S., Seifritz, Erich, Soler, Carla, Stassen, Hans H.* (2015). Quantifying Insufficient Coping Behavior under Chronic Stress: A Cross-Cultural Study of 1,303 Students from Italy, Spain and Argentina. *J. Psychopathology*. 48(4): 230-239. DOI: 10.1159/000381400

Kagotho, 2011 – *Kagotho, N.A.* (2011). Longitudinal Analysis of Physical Activity among Foreign-born Individuals. *Journal of Human Behavior in the Social Environment*. 21(5): 540-554. DOI: 10.1080/10911359.2011.580243

Kharissova et al., 2012 – *Kharissova, N.M., Abushakhmanova, A.H., Krekesheva, T.I., Mindubaeva, F.A.* (2012). Medical-social estimation and monitoring of foreign students health status studying in the Republic of Kazakhstan. *J. Vestnik Karagandinskogo universiteta*. 1(65): 37-43.

Kharissova, et al., 2015 – *Kharissova, N., Kharissova, L., Smirnov, I., Kosibaeva, A., Mindubaeva, F.A.* (2015). Physical culture as the basis of students' healthy lifestyle. *J. Georgian medical news*. 4(241): 68-73.

Kondo et al., 2008 – *Kondo, N., Kazama, M., Suzuki, K., Yamagata, Z.* (2008). Impact of mental health on daily living activities of Japanese elderly. *J. Preventive Medicine*. 46(5): 457-462.

Rothbart, 2007 – *Rothbart Mary K.* (2007). Temperament, Development, and Personality. *J. Current directions in psychological science.* 16(4): 207-212. DOI: https://doi.org/10.1111/j.1467-8721.2007.00505.x

Mindubaeva et al., 2015 – *Mindubaeva, F.A., Shukurov, F.A., Salikhova, Y.Y., Niyazova Y.I., Ramazanov, A.Kh.* (2015). On mechanism of functional changes in the organism of teenagers at different levels of locomotor activity. *J. Georgian Medical News.* 2(239): 75-81. PMID: 25802454

Mohammad Reza Sharif et al., 2018 – *Mohammad, Reza Sharif, Mansour, Sayyah* (2018). Assessing Physical and Demographic Conditions of Freshman "15" Male Medical Students. *J. Sport Stud Hlth.* 1(1): e67421. DOI: 10.5812/intjssh.67421

Neil Schneiderman et al., 2005 – *Neil, Schneiderman, Gail, Ironson, Scott, D. Siegel* (2005). Stress and Health: Psychological, Behavioral, and Biological Determinants. *Annu Rev Clin Psychol.* 1: 607-628. DOI: 10.1146/annurev.clinpsy.1.102803.144141

Pariat et al., 2014 – *Pariat, L., Rynjah, A., Kharjana, M.G.* (2014). Stress Levels of College Students: Interrelationship between Stressors and Coping Strategies. *Journal of Humanities and Social Science.* (IOSR-JHSS) 19: 40-46.

Proper et al., 2006 – *Proper, K, Heymans, M., Paw, M., van Sluijs, E., van Poppel, M., van Mechelen, W.* (2006). Promoting physical activity with people in different places-A Dutch perspective. *Journal of Science and Medicine in Sport.* 9(5): 371-377. DOI: http://dx.doi.org/10.1016/j.jsams.2006.06.014

Puetz, 2006 – *Puetz, T.W.* (2006). Physical activity and feelings of energy and fatigue: Epidemiological evidence. *Sports Medicine* – Auckland. 36 (9): 767-780. DOI: 10.2165/00007256-200636090-00004

Rabin et al., 2006 – *Rabin, B., Brownson, R., Kerner, J., Glasgow, R.* (2006). Methodologic challenges in disseminating evidence-based interventions to promote physical activity. *American Journal of Preventive Medicine.* 31 (4 suppl): 24-34. DOI: 10.1016/j.amepre.2006.06.009

Rothbart et al., 2006 – *Rothbart, M.K., Bates, J.E.* (2006). Temperament. In W. Damon, R. Lerner, & N. Eisenberg (Eds.). Handbook of child psychology: Vol. 3 Social, emotional, and personality development (6th ed., pp. 99-166). New York: Wiley.

Rothbart et al., 1981 – *Rothbart, M.K., Derryberry, D.* (1981). Development of individual differences in temperament. In *M.E. Lamb & A. Brown (Eds.), Advances in developmental psychology (*Vol. 1, pp. 37–86). Hills-dale, NJ: Erlbaum.

Vella-Zarb et al., 2009 – *Vella-Zarb, R.A., Elgar, F.J.* (2009). The 'freshman 5': a meta-analysis of weight gain in the freshman year of college. *J. Am Coll Heal.* 58(2): 161-166.

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Processing Determinants of Formation of Pedagogical Technology of Test Control in the Physical Education of Students with Chronic Health Conditions

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Abstract

The implementation of recreational functions requires an effective control system of physical training of students with chronic health conditions. The paper discusses the problems of test control in the physical education of students with chronic health conditions. Is a relevance of the research in this area to the steady increase of the following students. The pedagogical technology is a basis for the construction of the educational process of physical education, its content, form and means aimed at the implementation of its objectives and ensure effective progress of the process at the university. Purpose – the procedural determinants of formation of pedagogical technologies of test control concept in physical training of students with chronic health conditions to identify. Based on the theoretical analysis and compilation of scientific-methodical and special literature with results of previous studies of formation of pedagogical technology of its implementation the identified and systematized procedural determinants. Among identified: the methodological questions, the definition of the indispensable components. requirements of the principles of designing educational technologies; definition of teaching methods of implementing these principles, the pedagogical conditions that ensure the realization of the excellent content of technology in practice. That their use will systemic nature of this process it has been established. The effectiveness of the practical implementation of the directives of the system that ensure the achievement of the goal of the test monitoring of students with disabilities in health, for the effective implementation of the objectives of physical education this will ensure. In incarnation revealed procedural determinants of formation of pedagogical technologies of test control in physical education of students with chronic health conditions do carry out this process specifically to provide high probability of achieving the end result.

Keywords: student, physical education, chronic health conditions, educational technology, procedural determinants.

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1. Introduction

Considering the annual increase in the number of students with chronic health conditions for physical education classes (Blavt, 2016; Koryahin et al., 2019), the state of modern physical education at universities is now a very topical issue. In the context of these issues, the issue of the effectiveness of physical education of students with health disorders is of particular importance (Ayers, 2004; Overton, 2016).

The analysis of the current progress of events in this direction, convincingly prove the importance and point out the necessity and urgency of the work aimed at ensuring a high level of efficiency of physical education of students with chronic health conditions in universities, in accordance with modern educational standards of higher education.

2. Reviews of related literature

The appeal to the theoretical evidence shows that the implementation of the health function of physical education of students with chronic health conditions requires an effective control system (Geoffrey, at al., 2012; Overton, et al., 2016). Leading industry experts (Baghurst et al., 2004; Koryahin et al., 2019) focus on the peculiarities of controlling students with health disabilities. According to the analysis of the available scientific and methodological literature, there are very few recommendations to date for the scientific substantiation and practical implementation of the test control of students with chronic health conditions, both in theoretical and practical perspective. Therefore, despite the accumulation of a considerable amount of theoretical and empirical material on control in physical education (Bassett, 2000; Dinucci et al., 1990; Macleod et al., 2009), its aspects of students with chronic health conditions remain unaddressed by scientists. To date, there is virtually no research on test monitoring of students with health disabilities: there is essentially no reference in the literature to specific scientific intelligence that would highlight perspectives on these issues.

Improved quality control of students with chronic health conditions in physical education, according to reputable scientists, is to make full use of technological potential, which implies qualitative changes in its process (Baghurst et al., 2015; Dinucci et al., 1990; Koryahin et al., 2019). Aspects of the formation of pedagogical technologies are now receiving increasing attention in scientific works (Alfrey et al., 2014; Ayers, 2004; Macleod et al., 2009; Overton et al., 2016). According to scientific intelligence, technology has a strictly defined system of directives that guarantee the achievement of the goal (Cohen et al., 2007). Thus, the introduction of technology provides a reduction in the share of impromptu professionals, aimed at achieving the intended result (Baghurst et al., 2015). The latter was a major factor in conducting research in a specific area.

3. Methods and organization of the research

General Background of Research – is to identify the procedural determinants of the formation of pedagogical technology for the implementation of the concept of test control in the physical education of students with chronic health conditions.

Research methods. The following methods of the theoretical level were used: analysis, synthesis, comparison, abstraction, induction, generalization and systematization for obtaining theoretical and empirical materials, results of ascertaining and forming experiments (Blavt, 2016) and provisions of designing pedagogical technologies (Cohen, et al., 2007).

4. Results

Pedagogical technology for the implementation of test control is an integrated process, with clearly defined ideas and methods of its organization (Blavt, 2016; Cohen et al., 2007). The process of its formation is determined by the action of determinants. Based on these, test control in the physical education of students with chronic health conditions is organized to facilitate the productive realization of its potential.

First of all, there is no clear interpretation of the definition of "pedagogical technology" in pedagogical theory and practice today. Therefore, this concept is a meaningful generalization of the essence of definitions of different sources. Pedagogical technology of test control on the one hand forms the most rational ways of its implementation, on the other – acts as a system of methods, principles and methods used in the monitoring process. However, it is unambiguous that it is the basis for building a model of educational process of physical education in an educational

institution, its content, forms and means, which are reflected in pedagogical methods of physical education aimed at fulfilling its tasks and which provide the most efficient course of this process (Koryahin et al., 2019).

It is believed that any pedagogical technology is a synthesis of the achievements of pedagogical science and practice, the combination of traditional elements and innovative innovations. The latter may also cover specialized technologies used in other fields of science and practice. In particular, new information technologies, educational, valeological, etc. In general, the monitoring process becomes a technology of test control only when it has been predicted, the final results and ways of their achievement are determined, the conditions for implementation and control are given, and the result obtained is as much as possible expected to be diagnosed. The formation of pedagogical technology for the implementation of test control in the physical education of students with chronic health conditions provides an indicative algorithm that determines the necessary steps in its development and is limited to a number of determinants.

The methodological basis for the formation of test control technology is scientific provisions based on the strongest positions of test theory. Therefore, the following methodological queries should be satisfied in this process:

– conceptualism: the concept of test control is at the heart of pedagogical technology;

– systematic: the presence in the pedagogical technology of all features of the system: the logic of the process, the interconnection of all its parts, integrity;

– controllability, which implies the possibility of variation by means and methods of technology to correct the results;

– effectiveness: pedagogical test-control technology must guarantee the achievement of the intended result of the concept;

– reproducibility, which implies the possibility of applying pedagogical technology in other educational institutions.

The next determinants of the formation of pedagogical technology for the implementation of test control in the physical education of students with chronic health conditions are the determination of its indispensable components. Among the latter: the goal, tasks, architectonics, principles, pedagogical conditions for its practical implementation and the end result. In the structure of architectonics distinguish the following main components:

– conceptual, which reflects the main principles of pedagogical technology;

– meaningful, reflecting the purpose, content of control, methods, forms and means of its implementation;

– procedural, which contain provisions that ensure reproduction of the designed pedagogical technology.

The formation of pedagogical technology for the implementation of test control in the physical education of students with chronic health conditions provides for the mandatory fulfillment of the requirements of the design principles. As the main guiding norms of action, they ensure its effective implementation: the principle of expediency of goal-setting, the principle of integrity of technology of the test process, the principle of reproducibility of technology in a specific pedagogical environment to achieve the goals, the presence of the content of the test process with the initial parameters of students' psychophysical state and the principle of establishing the process of orientation as a set of diagnostic expediency and objectivity of control over its results; the principle adapt to the testing process features a contingent of students with chronic health conditions. The formulated principles of design are fundamental provisions in the development of a model of pedagogical technology for the implementation of test control in physical education of students with chronic health conditions.

To form a pedagogical technology for implementing the content of the concept of test control in the physical education of students with chronic health conditions to ensure the implementation of the provisions of certain principles, methodical methods of their implementation are needed. Thus, the requirements of the principle of feasibility of goal setting give test control a certain content and order of action that should contribute to the achievement of goals. This is reflected in the purpose and objectives as a tool to ensure the implementation of the concept. The appropriate test control objectives should be realistic, specific, and achievable for students, taking into account all the limiting factors of their health.

The principle of the integrity of the technology of the test process involves the unity of its structural and semantic parts. The realization of the requirements of this principle means that during the development of the project of the system of test control of students with chronic health conditions it is necessary to achieve interaction of all its elements. These were ensured by the unity and interconnection of all components of the testing process (organizational, methodological, substantive, evaluative), which is generally a didactic system.

The principle of reproducibility of technology in a specific pedagogical environment in order to achieve the set goals is interpreted as the basis for the invariance of the technological algorithm for the implementation of test control when working with students with chronic health conditions in any educational institution.

The principle of the content of the test process with the initial parameters of the students' psychophysical state and the principle of establishing the orientation of the test process as a set of diagnostic expediency and objectivity of control over its results were implemented forming the content of the forms of test control and parameters that characterize the level of psychophysical state of students with chronic health conditions.

The fulfillment of the requirements of the technology tool principle was reflected in the detailed planning of the content of the test control for each nosological group of students with chronic health conditions. This principle also involves the use of innovative technical controls to ensure the accuracy of monitoring information.

The principle of adaptation of the testing process to the characteristics of the students with chronic health conditions contingent was implemented in the formation of the content of the test control system, which involved the development of a complex of test tests and their evaluation systems for individual nosological groups.

Therefore, the formation of pedagogical technology for the implementation of test control in the physical education of students with chronic health conditions, which is termed by methodical methods of implementation of the provisions of the concept. However, the amount of methodological techniques outlined is not subject to strict accounting and regulation, but they largely determine the effectiveness of controls:

– reasonable techniques for determining the strategic goal of technology and its objectives to ensure the achievement of the goal;

– organizational techniques, determine the procedure and sequence of operations of test monitoring;

– techniques that determine the educational and methodological support of the process of test monitoring.

The main features of the formation of pedagogical technology, which determine the effectiveness of its implementation in the practical activity of physical education of students with chronic health conditions, are pedagogical protepsies. Pedagogical protepsy in the context of our study is defined as a system that provides a complete reproductive process of test monitoring, the effectiveness of the organization of control of physical education of students with chronic health conditions in general and its optimal functioning. In fact, they reflect the coherence of the components of pedagogical technology, hierarchical links between its content blocks (Ayers, 2004). Selected pedagogical protepsies are defined as optimal:

– procedural, which are aimed at the optimal choice of means of test control;

– corrective ones, which provide for the implementation of the principles of differentiated approach, accessibility and individualization in the process of test control and evaluation of its results;

– meaningful, for realization of conceptual idea of integrated approach of estimation of investigated parameters in the process of test control;

– variants, which form an invariant content component of the test control system, and implementation of the principles of optimality and optimization;

– a professional, which requires qualified personnel to implement the conceptual idea of improving the quality of staffing;

– orderly, for realization of the basic idea of the concept of improvement of material and technical support of physical education in educational institutions and the principle of dynamism.

Defined pedagogical propsy allow to ensure continuity and consistency of the concept of test control, and therefore bring it to a new level.

5. Discussion

We fully support the scientific approaches of specialists engaged in finding the ways of optimization of physical education results (Alfrey at al., 2014; Ayers, 2004; Baghurst at al., 2015; Dalen et al., 2017; Di Tore et al., 2016; Keating et al., 2009; Macleod et al., 2009). In this context, we are joining the idea that the efficiency of this process can be greatly enhanced by adjusting the control system (Blavt, 2016; Geoffrey et al., 2012; Koryahin et al., 2019).

We agree to our research that an objective estimation of a degree of physical development and of physical fitness has special importance during conducting physical education classes with students of the university's (Alfrey et al., 2014; Baghurst et al., 2004; Bassett, 2000; Cohen et al., 2007; Silverman et al., 2006). Educational assessment of test measurement results of students with chronic health conditions is a leader in ensuring the effectiveness of the physical education (Mercier et al., 2013; Overton et al., 2016).

The obtained results supplement and deepen the information on the control of the physical education students with chronic health conditions university (Blavt, 2016; Koryahin et al., 2019; Macleod et al., 2009; Overton et al., 2016).

6. Conclusion

Effective implementation of the content of test control in the physical education of students with chronic health conditions is provided by the appropriate pedagogical technology, which is presented as a design, strategy, algorithm of the specialist's actions. The formation of pedagogical technology for the implementation of test control in the physical education of students with chronic health conditions is limited by the action of a number of procedural determinants. Among the identified: methodological inquiries, determination of indispensable components, meeting the requirements of the principles of pedagogical technology design; outlined methodical methods of implementation of these principles, pedagogical protepsies, which will ensure excellent implementation of the content of technology in practice. The implementation of the identified procedural determinants of the formation of pedagogical technology for the implementation of test control in the physical education of students with chronic health conditions make it possible to carry out this process purposefully to ensure a high probability of achieving the end result.

Further researches are directed on formation of pedagogical technology of realization of the concept of test control in physical education of students with chronic health conditions.

References

Alfrey et al., 2014 – *Alfrey, L., Gard, M.* (2014). A crack where the light gets in: a study of Health and Physical Education teachers' perspectives on fitness testing as a context for learning about health. *Asia-Pacific Journal of Health, Sport and Physical Education*. 5(1): 3-18. DOI: https://doi.org/10.1080/18377122.2014.867790

Ayers, 2004 – *Ayers, S.F.* (2004). High School Students' Physical Education Conceptual Knowledge. *Research Quarterly for Exercise and Sport*. 75(3): 272-287. DOI: https://doi.org/10.1080/02701367.2004.10609160

Baghurst et al., 2004 – *Baghurst, T., Mwavita, M.* (2014). Evaluation, rationale, and perceptions regarding fitness testing in physical education teacher education programs. *The Global Journal of Health and Physical Education Pedagogy*. 3: 348-364.

Baghurst et al., 2015 – *Baghurst, T., Richard, K., Mwavita, M., Ramos, N., Cheng, M. (Reviewing Editor)* (2015). Procedures and reasoning for skill proficiency testing in physical education teacher education programs. *Cogent Education*. 2(1): 1111716. DOI: https://doi.org/10.1080/2331186X.2015.1111716

Bassett, 2000 – *Bassett, D.R.* (2000). Validity and reliability issues in objective monitoring of physical activity. *Research Quarterly for Exercise and Sport*. 71: 30-36.

Blavt, 2016 – *Blavt O.* (2016). System of control in physical education of students of special medical groups. Lviv Polytechnic Publishing House, 512.

Cohen et al., 2007 – *Cohen, L., Manion, L., Morrison, K.* (2007). Research methods in education (7th Ed.). London: Routledge, 455 p.

Dalen et al., 2017 – *Dalen, T., Ingvaldsen, R.P., Roaas, T.V., Pedersen, A.V., Steen, I., Aune, European T.K.* (2017). The impact of physical growth and relative age effect on assessment in physical education. *Journal of Sport Science*. 17(4): 482-487. DOI: https://doi.org/10.1080/17461391.2016.1268651

De Corby et al., 2005 – *De Corby, K., Halas, J., Dixon, S., Wintrup, L., Janzen, H.* (2005). Classroom teachers and the challenges of delivering quality physical education. *Journal of Education Research*. 98(4): 208-220.

Dinucci et al., 1990 – *Dinucci, J., McCune, D., Shows, D.* (1990). Reliability of a Modification of the Health-Related Physical Fitness Test for Use with Physical Education. *Majors Research Quarterly for Exercise and Sport*. 61(1): 20-25. DOI: https://doi.org/10.1080/02701367.1990.10607474

Di Tore et al., 2016 – *Di Tore, P.A., Schiavo, R., D'isanto, T.* (2016). Physical education, motor control and motor learning: theoretical paradigms and teaching practices from kindergarten to high school. *Journal of Physical Education and Sport*. 16(4): 1293-1297. DOI: 10.7752/jpes.2016.04205

Geoffrey et al., 2012 – *Geoffrey, A., Power, G., Handrigan, A., Basset, F.A.* (2012). Ventilatory response during an incremental exercise test: A mode of testing effect. *Pedagogy*. 12(6): 491-498. DOI: https://doi.org/10.1080/17461391.2011.573580

Keating et al., 2009 – *Keating, X.D., Silverman,, S.* (2009). Determinants of teacher implementation of youth fitness tests in school-basedphysical education programs. *Physical Education & Sport Pedagogy*. 14(2): 209-225. DOI: https://doi.org/10.1080/17408980801974945

Koryahin et al., 2019 – *Koryahin, V., Blavt, O., Stetsyak, O.* (2019). Monitoring and Evaluation Component of Test Control System in Physical Education of Students with Chronic Health Conditions. *European Journal of Physical Education and Sport*. 7(1): 11-17. DOI: https://doi.org/: 10.13187/ejpe.2019.1.11

Macleod et al., 2009 – *Macleod, G., Cebula, K.R. (*2009). Experiences of disabled students in initial teacher education. *Cambridge Journal of Education*. 39(4): 457-472. DOI: https://doi.org/:10.1080/03057640903352465

Mercier et al., 2013 – *Mercier, K., Doolittle, S.* (2013). Assessing Student Achievement in Physical Education for Teacher Evaluation. *Journal of Physical Education, Recreation & Dance*. 84(3): 38-42. DOI: https://doi.org/10.1080/07303084.2013.767721

Overton et al., 2016 – *Overton, H., Wrench, A., Garrett, R. (*2016). Pedagogies for inclusion of junior primary students with disabilities in physical education. *Physical Education and Sport Pedagogy*. 22(4): 414-426. DOI: https://doi.org/:10.1080/17408989.2016.1176134

Plowman et al., 2014 – *Plowman, S.A.* (2014). Top 10 Research Questions Related to Musculoskeletal Physical Fitness Testing in Children and Adolescents. *Journal Research Quarterly for Exercise and Sport*. 85(2): 174-187. DOI: https://doi.org/10.1080/02701367.2014.899857

Silverman et al., 2006 – *Silverman, S., Keating, X.D., Phillips, S.R.* (2008). A lasting impression: A pedagogical perspective on youth fitness testing. *Measurement in Physical Education and Exercise Science*. 12: 146-166. DOI: https://doi.org/:10.1080/10913670802216122

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High-Intensity Interval Training for Hypertensive Power Sports Athletes: A Randomized Controlled Trial

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Abstract

Hypertension is a common diagnosis in power sports athletes.

Objective. Evaluate the effect of high-intensity aerobic work on blood pressure, oxidative capacity, hypertrophy and strength of working muscles in power sports athletes.

Methods. 55 representatives of power sports (powerlifting), heavy weight categories were involved in the research. Athletes were randomized into two groups: the main group (n = 35) and the control group (n = 20). All athletes were subjected to a comprehensive examination before and after the beginning of the research, including: survey, examination, three-time measurement of blood pressure, bioimpedance analysis and calculations of body composition indices, gas analysis, measurement of the oxygenation level of muscle tissue, ultrasonographic measurements of anatomical cross-sectional area of quadriceps muscle of thigh, estimation of maximum arbitrary power of quadriceps muscle of thigh and methods of mathematical statistics.

The athletes of the main group trained 60 days (3 times a week) on a bicycle ergometer according to the high-intensity interval protocol, and the participants of the control group trained 60 days (3 times a week) according to their traditional power protocol.

Results. After 60 days of training, there was a decrease in oxygenation by 72 %, an increase in power and working time at the level of maximum oxygen consumption and an increase in the cross-sectional area of quadriceps muscle of thigh in athletes of the main group. Athletes of the main group experienced a significant decrease in arterial blood pressure: systolic arterial pressure by 4.7 %, diastolic arterial pressure by 5.6 %.

Conclusion. The physical rehabilitation protocol we developed allows athletes of power sports to effectively and safely influence hypertrophy, as well as the oxidizing abilities of working muscles and arterial blood pressure.

Keywords: arterial hypertension, physical rehabilitation, powerlifting, aerobic work, interval method.

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1. Introduction

Hypertension is the most common abnormal diagnosis during pre-screening of the cardiovascular system (CVS) of athletes (Berge et al., 2015; De Matos et al., 2011; Schleich et al., 2016). Although the world's largest scientific communities on arterial hypertension in Europe, America, Canada, Great Britain, Australia and Russia have published recommendations for the detection, assessment and treatment of high arterial blood pressure (ABP) in the last 5 years (Table 1), it is still a question of where to start medical treatment of patients and especially athletes (Alper et al., 2019).

Table 1. Arterial blood pressure limits for diagnosis and initiation of treatment

ABP	ESC/ESH 2018 (Williams et al., 2018)	ACC/AHA 2017 (Whelton et al., 2017)	Canada 2018 (Nerenberg et al., 2018)	Australia 2016 (National Heart Foundation of Australia, 2016)	NICE 2019 (National Institute for Health and Care Excellence, 2019)	Russia 2019 (Chazova, Gernakova, 2019)
Definition of the hypertension's diagnosis						
SAP (mmHg)	≥140	≥130	≥140	≥140	≥140	≥140
DAP (mmHg)	≥90	≥80	≥90	≥90	≥90	≥90
Beginning of antihypertensive therapy						
SAP (mmHg)	≥140	≥140	≥160	≥160	≥140	≥140
DAP (mmHg)	≥90	≥90	≥100	≥100	≥90	≥90

Notes: SAP – systolic arterial pressure; DAP – diastolic arterial pressure; ESC – European Society of Cardiology; ESH – European Society of Hypertension; ACC – American College of Cardiology; AHA – American Heart Association; NICE – National Institute for Health and Care Excellence.

The greatest percent of prevalence of the hypertension (H) is fixed in such sports as weightlifting, American soccer and baseball where athletes reach the body weight of ≥136 kg (Weiner et al., 2013). Also, the burden of H from 55.4 % to 83 % is noted in a subgroup of athletes of power sports of heavy weight category (Chobanian et al., 2003; Guo et al., 2013). Physical exercise is a cornerstone in non-pharmacological hypertension therapy. In total, 17 meta-analyses and one systematic review (594.129 adult ≥ 18 years) gave the convincing proofs demonstrating that: 1) there is inverse relation a dose answer between aerobic work and the arising hypertension at adults with normal ABP; 2) aerobic work reduces the risk of cardiovascular disease (CVD) progression among adults with arterial hypertension (AH); 3) aerobic work reduces ABP in adults with normal arterial blood pressure, pre-hypertension, and AH; And 4) the amount of ABP response to aerobic training varies depending on the ABP at rest, and adults with pre-hypertension have more advantages than normal ABP (Pescatello et al., 2019). It is well documented in scientific periodicals that regular physical activity of aerobic character reduces ABP and is an effective strategy for prevention and treatment of hypertension (Börjesson et al., 2016). However, many experts argue that aerobic work compromises the growth of muscle mass and power caused by power training (Baar, 2014; Murach, Bagley, 2016), and it causes concern of aerobic work using in rehabilitation programs of power sports athletes. The purpose of research was formulated on the basis of problem situation's analysis, data of modern scientific literature and requests of sports doctors, trainers and power sports athletes.

The aim of research: to estimate the influence of high-intensity aerobic work on arterial blood pressure, oxidative abilities, hypertrophy and the strength of working muscles in power sports athletes.

2. Methods and organization of research

Research took place on the basis of the sports medicine department at Russian State University of Physical Education, Sport, Youth and Tourism. 55 representatives of power sports (powerlifting), having sports qualification Candidate for Master of Sports and Master of Sports and heavy weight categories (body weight – 101, 4 ± 5.3 kg) participated in research. Athletes were randomized into two groups: main group (n = 35) and control group (n = 20). The average age of men-athletes was 31, 0 ± 7.3 years. According to ethical standards of scientific research in sports and physical activity of 2020 all participants gave voluntary informed consent to participate in the research (Harriss et al., 2019). All athletes had a comprehensive examination before and after the research including: survey, inspection, three-time ABP measurement, bioimpedansometry and body composition index calculations, gas analysis (determination of anaerobic threshold (AnT) and heart rate's (HR) at this level, maximum oxygen consumption (MOC) and pedaling power on MOC), measurement of oxygenation level (measurements of hemoglobin and myoglobin saturation) in muscle tissue, ultrasonographic measurements of anatomical cross-sectional area (CSA) of quadriceps muscle of thigh, estimation of maximum arbitrary power of quadriceps muscle of thigh.

Bioimpedansometry and indexes calculations of body's composition. Bioimpedance analysis was performed on the "Medass-ABC-02" apparatus (Russia), where the percentage of muscle and fat tissue was estimated, and after there were calculated the body mass index (BMI), fat mass index (FMI), fat free mass index (FFMI) and fat-to-muscle ratio (FMR). The FMI index allows for taking into account the amount of body fat mass in kilograms divided by the growth square. The FMI index was calculated by the formula: FMI = D/H2, (kg/m2) (VanItallie et al., 1990), where D is the fat weight (kg); H is the body length (m). The FFMI index takes into account the amount of defatted body weight in kilograms divided by the growth square. The FFMI index was calculated by the formula: FFMI = FFM/H2, (kg/m2) (VanItallie et al., 1990). The FMR was determined as the ratio of fat mass to defatted body muscle mass. FMR was calculated by the formula FMR = D/FFM, where: D is fat mass (kg); FFM – degreased body weight (kg) (Park, Kim, 2016). The defatted body weight (FFM (Fat Free Mass)) was calculated by the formula W * [1- (D/100)], where W is body weight (kg); D – weight of fat (%) (Kouri et al., 1995).

Gas-metric analysis. The step test was performed on a cycle ergometer "MONARK 839 E" (Monark AB, Sweden), the starting load was set from 20 W with 20 W added every 2 minutes. The gas-metric analysis was carried out using a "CORTEX" gas analyzer (Meta Control 3000, Germany) measuring oxygen consumption and carbon dioxide release from inhalation to inhalation. The heart rate and R-R intervals were fixed by the monitor of heart rhythm "POLAR RS800" (Finland). The test was carried out at the speed of 75 rpm before definition of MOC, the AnT, by HR at the level of the AnT and the pedaling power on MOC (Pallarés et al., 2016).

The "Moxy Monitor" system (USA) was used for measuring of oxygenation level on the lateral head of quadriceps muscle of thigh. The "Moxy" infrared sensor was attached to the lateral head of quadriceps muscle of thigh at the nerve entry point. This method allows measuring the hemoglobin and myoglobin levels in working muscle capillaries.

Ultrasonographic measurements. All participants had ultrasonographic measurements of the anatomical cross-sectional area of quadriceps muscle of thigh before the introduction of the training protocol, and two more control measurements were taken at intervals of 30 days. Measurements were carried out 5-6 days after the last training to prevent swelling affect on muscle size. The CSA of quadriceps muscle of thigh was evaluated at rest using B-mode ultrasonic imaging with a 1.6-5.0 MHz linear sensor, a scanning surface length of 65 mm, and a width of 17 mm (Vivid 7 Dimension/Vivid 7 PRO, General Electric). For better acoustic adhesion, the scanning surface of the sensor and the skin surface of the muscle were coated with a special gel, and the sensor was oriented along the mid-sagittal axis of the muscle. It was carried out an echography of all four heads of a muscle. A zone of arrangement of the sensor for echolocation was at distance of 25 cm proximally from the patella basis on the front, anterointernal and anteroexternal thigh surface of a thigh. All measurements were taken on the right leg after examinees were in supine position within 20 min for providing a possibility of liquid shift. According to researches of echograms digital values of all four portions it was determined degree of hypertrophy expressiveness by the quadriceps muscle of thigh.

Assessment of the arbitrary power's maximum of quadriceps muscle of thigh. The assessment of the arbitrary power's maximum of quadriceps muscle of thigh was performed by one-repeat maximum (1RM) test, using monoarticular exercise of lower leg' extension while sitting in a simulator (HOIST RS-1401, USA). All test sessions were conducted in the morning, at the same time of day. Participants did the exercise at a given 2 second pace for both concentric and eccentric phases. Participants were advised to avoid tiring exercises and sports for 48 hours before each test. An important aspect of burden testing was that performed approaches were prior to muscle failure, defined as an inability to perform a concentric phase of muscle contraction. During the first day of testing, after 5-minute warm-up on a cycling ergometer and demonstration of the correct exercise technique, tests were conducted for the maximum number of repeats measured for a certain load, followed by using a prognostic equation to calculate 1RM Brzycki M: 1RM (kg) = Burden weight (kg)/(1.0278-0.0278 number of repeats (kg)) (Brzycki, 1993). In the second procedure after warm-up the load intensity was set at 90 % of the calculated 1RM and increased for 2.5-5.0 % after each successful lift, until the subject was unable to perform a concentric phase in full motion amplitude. Rest periods between approaches were 2-3 minutes, in the present research 1RM during lower leg extension was usually achieved within 3-4 attempts in all participants. The repetition was valid if the subject could perform it in control without help. All measurements were performed on the right leg and all test procedures were carried out by the same researcher.

Arterial blood pressure measurements. According to clinical recommendations developed by experts of the Russian Medical Society on arterial hypertension and approved at the meeting of the plenary on November 28, 2013 and the profile commission on cardiology on November 29, 2013 the method of self-control SCBD was used for independent ABP measurements (Chazova et al., 2015). Traditional automatic certified tonometers for home use were used in accordance with SCBD. BD measurements were carried out in the morning (from 7:00 to 8:00 am). Measurements were performed 3 times with an interval of at least 1 min on the left hand, all three BD values were recorded in the table and average values were recorded in the archive protocol.

Protocols of physical activity. Athletes of the main group trained for 60 days (3 times a week) according to the following protocol: aerobic work on cycling ergometer with 7 high-intensity intervals (at pedaling power 100 % of MOC) for 2 minutes and low-intensity intervals with HR at the level of 85 % of AnT for 2 minutes were added to traditional power work. Training session time was 28 minutes. Athletes of control group trained for 60 days (3 times a week) according to the traditional power protocol.

3. Results and discussions

It is well known that the percentage of subcutaneous adipose tissue (SAT) is a better predictor of H and CVS diseases (Wang et al., 2015) than BMI, so in 1990 VanItallie TB and co-authors (VanItallie et al., 1990) proposed to use the FMI and FFMI indices for more detailed anthropometric measurements. Later Rao KM and co-authors showed that FMI≥6.6 kg/sq.m well correlated at men with H (Rao et al., 2011). In 2016 Park J. and co-authors proposed the use of the FMR index, which determined as the ratio of fat mass to defatted body muscle mass also for better correlating with ABP and metabolic syndrome components (Park, Kim, 2016). Later a large population observational research (34,182 men and 32,647 women aged 20 and over) showed that FMR correlated well with H (Chen et al., 2019). Anthropometric measurements of power sports athletes of heavy weight categories showed that athletes have rather high indicators of muscle mass. Also "Powerlifting sports" athletes of heavy weight categories which participated in the research have rather high percentage of SAT. For comparison, athletes of the specified sports have the following percent of SAT: wrestlers (≤13 %), sumo wrestlers (24.1-29.6 %), football players (≤15 %), judokas (17.4 %), water-polo players (18.1 %), and climbers (7.8-11.3 %) (Jonnalagadda et al., 2004). It is well known that athletes with increased fat weight may be more prone to metabolic diseases, weight-related injuries than other sports groups and the general population and it leads to a reduction in life expectancy by 10 years (Saito et al., 2003). Several meta-analyses have shown that high intensity aerobic training (HIAT) can be an effective component of body composition management programs (Keating et al., 2017; Wewege et al., 2017). Moreover, the meta-analysis of Viana and co-authors showed that interval training provided by 28.5 % more reduction of total absolute fat mass (kg) than uniform aerobic training (Viana et al., 2019). 60 days of intervention

were reliably reduced SAT in the main group by 2.6 %, BMI by 0.7kg/m2, and FMI by 1.0 kg/m2. Changes in these values were not statistically significant in the control group (Table 2).

Table 2. Anthropometric characteristics of hypertensive power sports athletes of heavy weight categories

Group (N=55)	SAT (%)		BMI (kg/m²)		FMI (kg/m²)	
	0 days	60 days	0 days	60 days	0 days	60 days
main (n=35)	32,0±3,1	29,6±3,0*	34,6±1,5	33,8±1,5*	11,0±1,0	10,0±1,0*
control (n=20)	33,3±4,5	33,5±4,5**	35,0±2,2	35,3±2,1**	11,1±1,2	11,0±1,2**
Note: the statistically significant differences of the compared indicators are marked on the right by asterisk * – p <0,05; *– p>0,05; **						

It is well known that high BMI is associated with CVD and increasing of premature mortality, and also 30 % higher risk of all-cause mortality for each 5 kg/m2 increase in BMI (Whitlock et al., 2009). Accordingly, any reduction in BMI will lead to the prevention of CVD and an increase in life expectancy. Also, Ortega and co-authors (Ortega et al., 2016) researched various body composition indicators and its relations to CVD mortality and all-cause mortality. The results showed that excess fat mass was significantly connected with mortality from CVD and mortality from all causes. It is interesting that FFM connected with a 20 % increased probability of CVD mortality. Later Colpitts and co-authors (Colpitts et al., 2019) indicated that: 1) BMI is a strong predictor of metabolic syndrome and diabetes; 2) attention should be paid to muscle quality (increasing oxidative abilities) but not greater FFM for prevention further cardio-metabolic risk factors. After 60 days of the research there was an increase of FFMI in the main group by 0.3 kg/m2 and in the control group by 0.4 kg/m2, but these data were not statistically significant (Table 3). Also, in the main group there was a significant decrease in the ratio of fat weight to defatted body muscle mass (FMR) by 0.1 and in the control group this ratio remained unchanged.

Table 3. Anthropometric characteristics of hypertensive power sports athletes of heavy weight categories

Group (N=55)	FFMI (kg/m²)		FMR	
	0 days	60 days	0 days	60 days
main (n=35)	23,5±1,6	23,8±1,6**	0,5±0,1	0,4±0,1*
control (n=20)	23,7±1,5	24,1±1,5**	0,5±0,1	0,5±0,1**
Note: the statistically significant differences of the compared indicators are marked on the right by asterisk * – p <0,05; *– p>0,05; **				

Aerobic efficiency is very often characterized by MOC. MOC is defined as the highest rate of oxygen consumption and using by the body during intense exercise. MOC is used for both sports and medical purposes as a determinant of physical efficiency or as a risk indicator of health and longevity (Kodama et al., 2009). Many researchers noted that high intensity work of aerobic character (despite of short muscle stimulus) causes recruitment of all muscle fibers in the working muscle that leads to convincing changes in mitochondrial content of all active muscle and growth of oxidative abilities of working muscles (Gibala, Little, 2019; MacInnis, Gibala, 2016). After 60 days of trainings reliably athletes of the main group increased AnT work capacity and oxygen consumption by 22.7 and 14.5 % respectively (Tables 4 and 5). Also, the work capacity and oxygen consumption at the MOC level increased by 18.5 and 13.6 %, respectively. In the control group of athletes there were no reliable changes in oxidative abilities of muscles.

Table 4. Indicators of gas-metric testing of power sports athletes

Group (N=55)	Capacity on AnT (W/kg)			OC on AnT (ml/kg)		
	0 days	60 days	Δ	0 days	60 days	Δ
main (n=35)	2,2±0,3	2,7± 0,3	0,5*	26,9± 2,5	30,8±1,8	3,9*
control (n=20)	2,3±0,2	2,2±0,3	0,1**	26,3± 3,2	25,8± 3,0	0,5**
Note: the statistically significant differences of the compared indicators are marked on the right by asterisk * – p <0,05; *– p>0,05; **						

Table 5. Indicators of gas-metric testing of power sports athletes

Group (N=55)	Capacity on AnT (W/kg)			OC on AnT (ml/kg)		
	0 days	60 days	Δ	0 days	60 days	Δ
main (n=35)	2,7 ± 0,2	3,2 ± 0,2	0,5*	31,5±2,5	35,8±1,2	4,3*
control (n=20)	2,8± 0,2	2,7± 0,3	0,1**	30,9±2,8	31,3±2,9	0,4**
Note: the statistically significant differences of the compared indicators are marked on the right by asterisk * – p <0,05; *– p>0,05; **						

During the first testing at the end there was a decrease of oxygenation in the lateral head of quadriceps muscle of thigh in the main group from 59.4 % to 41.3 % and in the control group from 57.6 % to 43.8 % (Table 6). After 60 days of training the main group showed a significant decrease of oxygenation from 59.8 % to 28.7 % (31.1 % compared to 18.1 % at the beginning), while the control group had a decrease of oxygenation from 58.3 % to 41.9 % (16.4 % compared to 13.8 % at the beginning of the research) which was not statistically significant. According to the results of the research it is possible to note not only a 72 % decrease of oxygenation, but also an increase in the work capacity at the level of MOC and the time of work for the participants of the main group. This indicates an increase in the oxidative capacity of high threshold muscle fibers (MF) of the working muscles because it has been able to work longer and more efficiently and this is possible only by increasing the mitochondrial apparatus and capillarization the high threshold MF.

Table 6. Indicators of oxygenation in the lateral head of quadriceps muscle of thigh of power sports athletes

Group (N=55)	Before research			After research			Δ, %
	SmO2 beginning	SmO2 ending	Δ, %	SmO2 beginning	SmO2 ending	Δ, %	
Main (n=35)	59,4±13,1	41,3±12,3	18,1	59,8±9,6	28,7±8,3	31,1	72*
Control (n=20)	57,6±10,2	43,8±11,7	13,8	58,3±12,5	41,9±10,6	16,4	19**
Note: the statistically significant differences of the compared indicators are marked on the right by asterisk * – p <0,05; *– p>0,05; **							

In fact, mitochondrial adaptation to aggravated training marks opposite results. Although the stimulus triggered by such training caused large changes in levels of myofibrillar protein and muscle fiber hypertrophy, original researching has shown little change in mitochondrial content was observed, resulting in "dilution" of mitochondrial content in the growing fiber. This adaptation is physiologically disadvantageous because of mitochondrial content's dilution increases the diffusion distance between the capillary and the mitochondrial location that can lead to

deterioration of endurance and operability (Groennebaek et al., 2017). In some researching, it has been reported that the MOC (Bishop et al., 1999) values were unchanged, as well as unchanged (Green et al., 1999) or lower mitochondrial density, oxidative enzyme activity, and capillary density in hypertrophic muscles, were unchanged after the burdened training (Tesch et al., 1989).

After 60 days of physical rehabilitation, there was an increase of CSA of the quadriceps muscle of thigh, which was statistically significant at a distance of 25 cm from the base of the patella in the control and main group (Tables 7 and 8). The difference in hypertrophy of the quadriceps muscle of thigh was not reliable between groups.

Table 7. Cross-sectional area of quadriceps muscle of thigh at the athletes of the main grou

Muscle name	Before researching (cm^2)	60 days (cm^2)	Δ
Musculus rectus femoris	18,95±1,52	24,58±1,28	+5,62*
Musculus vastus medialis	9,37±1,53	16,5±1,43	+7,12*
Musculus vastus lateralis	42,77±3,5	55,54±3,49	+12,76*
Musculus vastus intermedius	23,41±2,44	28,53±2,43	+5,12*
Note: the statistically significant differences of the indicators from the baseline are marked on the right by asterisk * – p <0,05; *			

Table 8. Cross-sectional area of quadriceps muscle of thigh at the athletes of the control group

Muscle name	Before researching (cm^2)	60 days (cm^2)	Δ
Musculus rectus femoris	21,32±1,37	27,44±1,35	+6,12*
Musculus vastus medialis	9,92±1,41	16,33±1,38	+6,41*
Musculus vastus lateralis	41,65±3,8	54,88±3,6	+13,23*
Musculus vastus intermedius	20,89±3,18	27,43±3,06	+6,54*
Note: the statistically significant differences of the indicators from the baseline are marked on the right by asterisk * – p < 0,05; *			

It is well known that development of muscle strength is supported by a combination of morphological and nerve factors including cross-sectional area and muscle architecture, muscle hardness, set of motor units, speed coding, synchronization of motor units and neuromuscular braking (Suchomel et al., 2018).

Respectively, regular and periodic practice / training of 1RM nullifies or at least reduces the difference in power caused by any power training (heavier or with easy loading) and it indicates that the most part of differences in power is connected with practice of 1PM which improves neuromuscular adaptation (Morton et al., 2016). However meta-analysis of Androulakis-Korakakis P and his colleagues showed that performing one approach of 6-12 repeats with loads in the range of 70-85 % of 1RM, 2-3 times a week before achieving a will or short-term muscle failure within 8-12 weeks can lead to a significant power increase in bench press and squats in men (Androulakis-Korakakis et al., 2019). Participants of the main group trained at pedaling power of 100 % of MOC, it corresponds to the range of 80-85 % of 1RM. Reliably there was an increase in muscle strength extending the right lower leg by 6.5 % in the main group and in the control group by 7.1 % after 60 days of training exposure. The difference was not statistically significant between the groups (Table 9).

Table 9. Assessment of the maximum arbitrary power in the quadriceps muscle of thigh of the right leg at the participants of the research

Group (N=55)	Before researching (kg)	After researching (kg)	Δ
Main (n=35)	119,6±15,5	127,4±15,0	+7,8*
Control (n=20)	125,2±10,7	134,1±9,5	+8,9*
Note: the statistically significant differences of the indicators from the baseline are marked on the right by asterisk * – p <0,05; *			

Recent systematic reviews and meta-analyses (Costa et al., 2018; Way et al., 2018) have shown that: 1) HIAT and uniform aerobic training (UAT) provided a comparable decrease of ABP at rest in adults with pre-set H; 2) HIAT was associated with a greater increase of MOC compared to UAT; 3) HIAT results to significant decrease of night DAP compared to UAT; 4) was found almost a significant greater decrease of daily ABP at HIAT compared to UAT. After 60 days of HIAT on a cycle ergometer there was a reliable decrease of ABP at athletes of the main group: SAP by 4.7 %, DAP by 5.6 %. In the control group the ABP changes was not statistically significant (Table 10). It is well known that a reduction in DAP of 5 mmHg within 5 years decreases the risk of stroke by 34% and the risk of coronary heart disease (CHD) by 21 %. Decrease by 7.5 mmHg and by 10 mmHg reduces by 46 % and 56 % the incidence of stroke and by 29 % and 37 % the incidence of CHD (Chazova et al., 2015).

Table 10. Comparative analysis of arterial blood pressure in power sports athletes

Группа (N=55)	SAP (mmHg)			DAP (mmHg)		
	0 days	60 days	Δ	0 days	60 days	Δ
Main (n=35)	159,1±5,8	151,7±4,9	-7,4*	93,3±7,3	85,9±6,7	-7,3*
Control (n=20)	158,0±6,1	156,1±6,0	-1,7**	92,7±5,1	94,1±6,0	+1,4**
Note: the statistically significant differences of the compared indicators are marked on the right by asterisk * – p <0,05; *– p>0,05; **						

4. Conclusion

Analyzing and summarizing the sources of modern scientific literature has prevented us from answering key questions as to whether HIAT can create primary stimulus for skeletal muscle hypertrophy and whether muscles are able to increase their size and become stronger while maintaining oxidative abilities. Our thesis regarding the ability of cyclic training above AnT to cause working muscle hypertrophy is confirmed by a number of researches (Harber et al., 2012; Hudelmaier et al., 2010; Nuell et al., 2019), but the simultaneous growth of oxidative abilities and the reaction of ABP to such training has not been sufficiently explored. It is necessary to include HIAT for prevention and treatment of CVD to power sports athletes because high-intensity aerobic training recruit's similar high threshold muscle fibers that both power training and both physical activities offer the same incentives to create chronic physiological adaptations to muscles as well as for cardiorespiratory efficiency and for strength growth and muscle hypertrophy (Steele et al., 2018). Our research shows that physical rehabilitation over 60 days demonstrated an increase in the oxidative ability growth of the working muscles (MOC increased by 13.6 %) and this increase was accompanied by a rise quadriceps muscle of a thigh and a decrease in ABP. The training protocol of aerobic work developed by us and built based on metabolic variables, will allow athletes to effectively and safely influence to oxidative abilities of working muscles without losing basic power indicators. A further priority area is to carry out pedagogical work among power sports athletes for inclusion of aerobic cycling ergometric sessions in training protocols.

5. Conflict of interests

The authors declare that there is no conflict of interest.

References

Alper et al., 2019 – *Alper, B.S., Price, A., van Zuuren, E.J., Fedorowicz, Z., Shaughnessy, A.F., Oettgen, P., Mayer, M.* (2019). Consistency of Recommendations for Evaluation and Management of Hypertension. *JAMA Network Open*. 2(11): e1915975. DOI:10.1001/jamanetworkopen.2019.15975

Androulakis-Korakakis et al., 2019 – *Androulakis-Korakakis, P, Fisher, J.P., Steele, J.* (2019). The Minimum Effective Training Dose Required to Increase 1RM Strength in Resistance-Trained Men: A Systematic Review and Meta-Analysis. *Sports Med*. 3: 1-15. DOI: 10.1007/s40279-019-01236-0

Baar, 2014 – *Baar, K.* (2014). Using Molecular Biology to Maximize Concurrent Training. *Sports Medicine*. 44(S2): 117–125. DOI: 10.1007/s40279-014-0252-0

Berge et al., 2015 – *Berge, H.M., Isern, C.B., Berge, E.* (2015). Blood pressure and hypertension in athletes: a systematic review. *British Journal of Sports Medicine*. 49(11): 716-723. DOI: 10.1136/bjsports-2014-093976

Bishop et al., 1999 – *Bishop, D., Jenkins, D.G., Mackinnon, L.T., McEniery, M., Carey, M.F.* (1999). The effects of strength training on endurance performance and muscle characteristics. *Med Sci Sports Exerc*. 31: 886-891. DOI: 10.1097/00005768-199906000-00018

Börjesson et al., 2016 – *Börjesson M., Onerup A., Lundqvist S., Dahlöf B.* (2016). Physical activity and exercise lower blood pressure in individuals with hypertension: narrative review of 27 RCTs. *British Journal of Sports Medicine*. 50(6): 356-361. DOI: 10.1136/bjsports-2015-095786

Brzycki, 1993 – *Brzycki, M.* (1993). Strength Testing—Predicting a One-Rep Max from Reps-to-Fatigue. *Journal of Physical Education, Recreation & Dance*. 64(1): 88-90. doi:10.1080/07303084.1993.10606684

Chazova et al., 2015 – *Chazova, I.E., Oschepkova, E.V., Gernakova, U.V. et al.* (2015). Clinical recommendations. Diagnosis and treatment of arterial hypertension. *Journal «Kardiologicheskij Vestnik»*. 10(1): 3-30.

Chazova, Gernakova, 2019 – *Chazova I.E., Gernakova U.V.* (2019). On behalf of experts. Clinical recommendations. Diagnosis and treatment of arterial hypertension. *Systemic hypertensions*. 16(1): 6-31. DOI:10.26442/2075082X.2019.1.190179

Chen et al., 2019 – *Chen, Y.Y., Fang, W.H., Wang, C.C., Kao, T.W., Yang, H.F., Wu, C.J., Chen, W.L.* (2019). Fat-to-muscle ratio is a useful index for cardiometabolic risks: A population-based observational study. *PLOS ONE*. 14(4): e0214994. DOI: 10.1371/journal.pone.0214994

Chobanian et al., 2003 – *Chobanian, A.V., Bakris, G.L., Black, H.R., Cushman, W.C., Green, L.A., Izzo, J.L.* (2003). Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertension*. 42(6): 1206-1252. DOI: 10.1161/01.hyp.0000107251. 49515.c2

Colpitts et al., 2019 – *Colpitts, B.H., Bouchard, D.R., Keshavarz, M., Boudreau, J., Sénéchal, M.* (2019). Does Lean Body Mass Equal Health Despite Body Mass Index? *Scandinavian Journal of Medicine & Science in Sports*. DOI: 10.1111/sms.13605

Costa et al., 2018 – *Costa, E.C., Hay, J.L., Kehler, D.S., Boreskie, K.F., Arora, R.C., Umpierre, D., Duhamel, T.A.* (2018). Effects of High-Intensity Interval Training Versus Moderate-Intensity Continuous Training on Blood Pressure in Adults with Pre- to Established Hypertension: A Systematic Review and Meta-Analysis of Randomized Trials. *Sports Medicine*. 48(9): 2127-2142. DOI: 10.1007/s40279-018-0944-y

De Matos et al., 2011 – *De Matos, L.D., Caldeira, N.A., Perlingeiro, P.S.* (2011). Cardiovascular risk and clinical factors in athletes: 10 years of evaluation. *Med Sci Sports Exerc*. 43: 943-950. DOI: 10.1249/mss.0b013e318203d5cb

Gibala, Little, 2019 – Gibala, MJ, Little, JP. (2019). Physiological basis of brief vigorous exercise to improve health. J Physiol, 6: 1-22. DOI: 10.1113/jp276849

Green et al., 1999 – *Green, H., Goreham, C., Ouyang, J., Ball-Burnett, M., Ranney, D.* (1999). Regulation of fiber size, oxidative potential, and capillarization in human muscle by resistance exercise. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*. 276(2): 591-596. DOI: 10.1152/ajpregu.1999.276.2.r591

Groennebaek et al., 2017 – *Groennebaek, T, Vissing, K.* (2017). Impact of resistance training on skeletal muscle mitochondrial biogenesis, content, and function. *Front Physiol.* 15(8): 713. 1-7. DOI: 10.3389/fphys.2017.00713

Guo et al., 2013 – *Guo, J., Zhang, X., Wang, L., Guo, Y., Xie, M.* (2013). Prevalence of Metabolic Syndrome and Its Components among Chinese Professional Athletes of Strength Sports with Different Body Weight Categories. *PLoS ONE.* 8(11): e79758. DOI: 10.1371/journal.pone.0079758

Harber et al., 2012 – *Harber, M.P., Konopka, A.R., Undem, M.K., Hinkley, J.M., Minchev, K., Kaminsky, L.A., Trappe, S.* (2012). Aerobic exercise training induces skeletal muscle hypertrophy and age-dependent adaptations in myofiber function in young and older men. *Journal of Applied Physiology*. 113(9): 1495-1504. DOI: 10.1152/japplphysiol.00786.2012

Harriss et al., 2019 – *Harriss, D.J., MacSween, A., Atkinson, G.* (2019). Ethical Standards in Sport and Exercise Science Research: 2020 Update. *Int J Sports Med*. 40(13): 813-817. DOI: 10.1055/a-1015-3123

Hudelmaier et al., 2010 – *Hudelmaier, M., Wirth, W., Himmer, M., Ring-Dimitriou, S., Sänger, A., Eckstein, F.* (2010). Effect of exercise intervention on thigh muscle volume and anatomical cross-sectional areas-Quantitative assessment using MRI. M*agnetic Resonance in Medicine*. 64(6): 1713-1720. DOI: 10.1002/mrm.22550

Jonnalagadda et al., 2004 – *Jonnalagadda, S.S., Skinner, R., Moore, L.* (2004). Overweight Athlete. *Current Sports Medicine Reports*. 3(4): 198-205. DOI: 10.1249/00149619-200408000-00005

Keating et al., 2017 – *Keating, S.E., Johnson, N.A., Mielke, G.I., Coombes, J.S.* (2017). A systematic review and meta-analysis of interval training versus moderate-intensity continuous training on body adiposity. *Obesity Reviews*. 18(8), 943-964. DOI: 10.1111/obr.12536

Kodama et al., 2009 – *Kodama, S, Saito, K., Tanaka, S., Maki, M., Yachi, Y., Asumi, M, Sugawara, A., Totsuka, K., Shimano, H., Ohashi, Y., Yamada, N., Sone, H.* (2009). Cardiorespiratory Fitness as a Quantitative Predictor of All-Cause Mortality and Cardiovascular Events in Healthy Men and Women. *JAMA*. 301(19): 2024. DOI: 10.1001/jama.2009.681

Kouri et al., 1995 – *Kouri, E.M., Pope, H.G., Katz, D.L., Oliva, P.* (1995). Fat-Free Mass Index in Users and Nonusers of Anabolic-Androgenic Steroids. *Clinical Journal of Sport Medicine*. 5(4): 223-228. DOI: 10.1097/00042752-199510000-00003

MacInnis, Gibala, 2016 – *MacInnis, M.J., Gibala, M.J.* (2016). Physiological adaptations to interval training and the role of exercise intensity. *The Journal of Physiology*. 595(9): 2915-2930. DOI: 10.1113/jp273196

Morton et al., 2016 – *Morton, R.W., Oikawa, S.Y., Wavell, C.G., Mazara, N., McGlory, C., Quadrilatero, J., ... Phillips, S.M.* (2016). Neither load nor systemic hormones determine resistance training-mediated hypertrophy or strength gains in resistance-trained young men. *Journal of Applied Physiology*. 121(1): 129-138. DOI:10.1152/japplphysiol.00154.2016

Murach, Bagley, 2016 – *Murach, K.A., Bagley, J.R.* (2016). Skeletal Muscle Hypertrophy with Concurrent Exercise Training: Contrary Evidence for an Interference Effect. *Sports Medicine*. 46(8): 1029-1039. DOI: 10.1007/s40279-016-0496-y

National Heart Foundation of Australia, 2016 – National Heart Foundation of Australia. (2016). Guideline for the diagnosis and management of hypertension in adults. Melbourne.

National Institute for Health and Care Excellence, 2019 – National Institute for Health and Care Excellence. (2019). Hypertension in adults: diagnosis and management. NICE Guideline 136. [Electronic resource]. URL: https://www.nice.org.uk/guidance/ng136

Nerenberg et al., 2018 – *Nerenberg, K.A., Zarnke, K.B., Leung, A.A., Dasgupta, K., Butalia, S., McBrien, K., ... Gelfer, M.* (2018). Hypertension Canada's 2018 Guidelines for Diagnosis, Risk Assessment, Prevention, and Treatment of Hypertension in Adults and Children. *Canadian Journal of Cardiology*. 34(5): 506-525. DOI: 10.1016/j.cjca.2018.02.022

Nuell et al., 2019 – *Nuell, S., Illera-Domínguez, V., Carmona, G., Alomar, X., Padullés, J.M., Lloret, M., Cadefau, J.A.* (2019). Hypertrophic muscle changes and sprint performance enhancement during a sprint-based training macrocycle in national-level sprinters. *European Journal of Sport Science*. 1-34. DOI: 10.1080/17461391.2019.1668063

Ortega et al., 2016 – *Ortega, F.B., Sui, X., Lavie, C.J., Blair, S.N.* (2016). Body Mass Index, the Most Widely Used But Also Widely Criticized Index. *Mayo Clinic Proceedings*. 91(4), 443-455. DOI: 10.1016/j.mayocp.2016.01.008

Pallarés et al., 2016 – *Pallarés, J.G., Morán-Navarro, R., Ortega, J.F., Fernández-Elías, V.E., Mora-Rodriguez, R.* (2016). Validity and Reliability of Ventilatory and Blood Lactate Thresholds in Well-Trained Cyclists. *PLOS ONE*. 11(9): e0163389. DOI: 10.1371/journal.pone. 0163389

Park, Kim, 2016 – *Park, J., Kim, S.* (2016). Validity of muscle-to-fat ratio as a predictor of adult metabolic syndrome. *Journal of Physical Therapy Science*. 28(3): 1036–1045. DOI: 10.1589/jpts.28.1036

Pescatello et al., 2019 – *Pescatello, L.S., Buchner, D.M., Jakicic, J.M., Powell, K.E., Kraus, W.E., Bloodgood, B., … Piercy, K.L.* (2019). Physical Activity to Prevent and Treat Hypertension. *Medicine & Science in Sports & Exercise*. 51(6), 1314-1323. DOI: 10.1249/mss.00000 00000001943

Rao et al., 2011 – *Rao, K.M., Arlappa, N., Radhika, M.S., BalaKrishna, N., Laxmaiah, A., Brahmam, G.N.V.* (2011). Correlation of Fat Mass Index and Fat-Free Mass Index with percentage body fat and their association with hypertension among urban South Indian adult men and women. *Annals of Human Biology*. 39(1): 54-58. DOI: 10.3109/03014460.2011.637513

Saito et al., 2003 – *Saito, K., Nakaji, S., Umeda, T., Shimoyama, T., Sugawara, K., Yamamoto, Y.* (2003). Development of predictive equations for body density of sumo wrestlers using B-mode ultrasound for the determination of subcutaneous fat thickness. *British Journal of Sports Medicine*. 37(2): 144-148. DOI: 10.1136/bjsm.37.2.144

Schleich et al., 2016 – *Schleich, K.T., Smoot, M.K., Ernst, M.E.* (2016). Hypertension in Athletes and Active Populations. *Current Hypertension Reports*. 18(11). DOI: 10.1007/s11906-016-0685-y

Steele et al., 2018 – *Steele, J., Butler, A., Comerford, Z., Dyer, J., Lloyd, N., Ward, J., Fisher, J., Gentil, P., Scott, C., Ozaki, H.* (2018). Similar acute physiological responses from effort and duration matched leg press and recumbent cycling tasks. *Peer J*. 28(6): 1-28. DOI: 10.7717/peerj.4403

Suchomel et al., 2018 – *Suchomel, T.J., Nimphius, S., Bellon, C.R., Stone, M.H.* (2018). The Importance of Muscular Strength: Training Considerations. *Sports Medicine*. 48(4), 765-785. DOI: 10.1007/s40279-018-0862-z

Tesch et al., 1989 – *Tesch, P.A., Thorsson, A., Essen-Gustavsson, B.* (1989). Enzyme activities of FT and ST muscle fibers in heavy-resistance trained athletes. *Journal of Applied Physiology*. 67(1): 83-87. DOI: 10.1152/jappl.1989.67.1.83

VanItallie et al., 1990 – *VanItallie, T.B., Yang, M.U., Heymsfield, S.B., Funk, R.C., Boileau, R.A.* (1990). Height-normalized indices of the body's fat-free mass and fat mass: potentially useful indicators of nutritional status. *The American Journal of Clinical Nutrition*. 52(6): 953-959. DOI: 10.1093/ajcn/52.6.953

Viana et al., 2019 – *Viana, R.B., Naves, J.P.A., Coswig, V.S., de Lira, C.A.B., Steele, J., Fisher, J.P., Gentil, P.* (2019). Is interval training the magic bullet for fat loss? A systematic review and meta-analysis comparing moderate-intensity continuous training with high-intensity interval training (HIIT). *British Journal of Sports Medicine*. bjsports–2018–099928. DOI: 10.1136/bjsports-2018-099928

Wang et al., 2015 – *Wang, Z., Zeng, X., Chen, Z., Wang, X., Zhang, L., Zhu, M., Yi, D.* (2015). Association of visceral and total body fat with hypertension and prehypertension in a middle-aged Chinese population. *Journal of Hypertension*. 33(8), 1555-1562. DOI:10.1097/hjh.000000 0000000602

Way et al., 2018 – *Way, K.L., Sultana, R.N., Sabag, A., Baker, M.K., Johnson, N.A.* (2018). The effect of high-intensity interval training versus moderate intensity continuous training on arterial stiffness and 24 h blood pressure responses: A systematic review and meta-analysis. *Journal of Science and Medicine in Sport*. DOI: 10.1016/j.jsams.2018.09.228

Weiner et al., 2013 – *Weiner, R.B., Wang, F., Isaacs, S.K., Malhotra, R., Berkstresser, B., Kim, J.H., … Baggish, A.L.* (2013). Blood Pressure and Left Ventricular Hypertrophy During American-Style Football Participation. *Circulation*. 128(5), 524-531. DOI: 10.1161/circulat ionaha.113.003522

Wewege et al., 2017 – *Wewege, M., van den Berg, R., Ward, R.E., Keech, A.* (2017). The effects of high-intensity interval training vs. moderate-intensity continuous training on body composition in overweight and obese adults: a systematic review and meta-analysis. *Obesity Reviews*. 18(6): 635-646. DOI: 10.1111/obr.12532

Whelton et al., 2017 – *Whelton, P.K., Carey, R.M., Aronow, W.S., Casey, D.E., Collins, K.J., Dennison Himmelfarb, C., … Wright, J.T.* (2017). 2017 ACC/AHA/AAPA/ABC/ACPM/ AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension*. 71(6): 1269–1324. DOI: 10.1161/hyp.0000000000000066

Whitlock et al., 2009 – *Whitlock, G., Lewington, S., Sherliker, P., Clarke, R., Emberson, J., Halsey, J., Qizilbash, N., Collins, R., Peto, R.* (2009). Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. *The Lancet*. 373(9669): 1083-1096. DOI: 10.1016/s0140-6736(09)60318-4

Williams et al., 2018 – *Williams, B., Mancia, G., Spiering, W., Agabiti Rosei, E., Azizi, M., Burnier, M., … Desormais, I.* (2018). 2018 ESC/ESH Guidelines for the management of arterial hypertension. *Journal of Hypertension*. 36(10): 1953–2041. DOI: 10.1097/hjh.0000000000001940

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Factors Affecting the Teachers' Use of Motivational Strategies in the Physical Education Class

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Abstract

The purpose of the current study is to examine the factors influencing Physical Education (PE) teachers' use of motivational strategies in the PE classes. Using Self-Determination Theory (SDT; Deci, Ryan, 1985a) as a theoretical framework, this study determines if teachers' autonomous causality orientation, perceived job pressure and perceptions of student self-determined motivation, need satisfaction and self-determined motivation predict PE teachers' use of the motivational strategies that facilitate competence, autonomy and relatedness. A total of 101 PE teachers took part in the study. The results of the hierarchical multiple regression found that teachers' autonomous causality orientation, their perceptions of student self-determined motivation, need satisfaction and self-determined motivation, were positive and significant predictors of teachers' use of motivational strategies the PE classroom. The perceptions of job pressure did not predict the use of motivational strategies among the PE teachers in Singapore. Overall, the results showed the three step regression models predicted a total of 38 % variance in teachers' use of motivational strategies in the PE classroom. Therefore, it is important to take into consideration the provision of a working environment for PE teachers where their needs of autonomy, competence and relatedness are facilitated.

Keywords: autonomous causality orientations, self-determined motivation, need satisfaction, use of motivational strategies

1. Introduction

Given the emphasis on nurturing students to be self-directed learners through Singapore's education system (Ministry of Education, 2015) in recent years, it is vital to understand how students' motivation and interest for learning can be enhanced. Since teachers bear the responsibility of contributing significantly to the development of students, it is imperative to understand how student motivation can be nurtured from a teachers' perspective. Studies have shown that Physical Education (PE) teachers' utilisation of motivational strategies does have a

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positive impact on students' motivation in PE (e.g., Papaioannou et al., 2004; Taylor et al., 2008). A wealth of research thus far has applied self-determination theory (SDT) by Deci and Ryan (1985a) in understanding motivation in educational, sports and healthcare settings. The purpose of this study was to examine the personal and contextual factors that could influence the use of motivational strategies by teachers in a PE class using the SDT framework.

2. Theoretical Framework

SDT (Deci, Ryan, 2000; Ryan, Deci, 2017) postulates that an individual has three inherent psychological needs namely autonomy, competence and relatedness, and the satisfaction of these three needs is essential for optimal human functioning and development. Autonomy refers to the need to experience free will or control over one's actions (Deci, Ryan, 2000; deCharms, 1968). Competence refers to the need to experience mastery and generate intended effects (Deci, Ryan, 2000; White, 1959). Relatedness refers to the need to feel affiliated towards others (Deci, Ryan, 2000; Baumeister, Leary, 1995). Fulfilment of these three needs would facilitate intrinsic motivation.

In addition, SDT places motivation along a continuum with amotivation at one end, followed by extrinsic motivation and finally the ideal state of intrinsic motivation is at the opposite end of the continuum. The sequence for the different types of motivation stems from the degree to which the motivation for one's action emerges from oneself (Ryan, Deci, 2000). Amotivation, which is the absence of motivation, refers to one's inadequate desire to participate in an activity. Extrinsic motivation can be further broken down into external regulation, introjected regulation, identified regulation and integrated regulation. Firstly, external regulation refers to the motivation to act so as to fulfil an external mode of contingency such as threats, rewards or deadlines. Secondly, introjected regulation refers to incorporation in which one accepts a value or regulatory process but does not personally identify or acknowledge it as one's own (Deci et al., 1994). Thirdly, identified regulation refers to actions that are executed when one consciously values a behavioural goal, where one acknowledges or deems it as personally significant. Fourthly, integrated regulation refers to one who has completely assimilated the regulatory process and has accepted it as one's values after deliberation. Finally, intrinsic motivation refers to the inherent enjoyment and gratification gained from participating in an activity (Ryan, Deci, 2000; 2017).

Past research have reported that fulfilment of the fundamental needs of autonomy, competence and relatedness would result in intrinsic motivation and intrinsic motivation in turn facilitates more productive learning (Ryan, Deci, 2000; 2017). In a study done by Spray and Wang (2001), it was revealed that students with greater autonomy-related intentions for being engaged in PE class had higher levels of perceived competence and were predisposed towards contrasting their performance with normative expectations in contrary to their friends. In addition, Chatzisarantis, Biddle and Meek (1997) found that autonomous motives in contrast to controlling ones, significantly predicted subsequent behaviour in a physical activity setting. Because intrinsic motivation is integral in enhancing learning and teachers play the vital role of nurturing students, it is essential to understand how students' motivation can be developed from a teachers' perspective.

Studies have highlighted the positive impact of teachers' use of motivational strategies on students' motivation in PE. In a study done by Papaioannou et al. (2004), it was reported that adaptive motivational strategies employed by physical educators led to positive motivation-related experiences for students. In addition, in a study done by Taylor and Ntoumanis (2007), students reported that their autonomous motivation in PE was positively predicted by their perceptions of teachers' employment of autonomy support, structural and involvement motivational strategies. In Taylor et al.'s study (2008), it was reported that teachers' autonomous causality orientation, perceived job pressure and perceptions of student self-determined motivation predicted teachers' need satisfaction. In turn, when teachers' needs were fulfilled, they were self-determined and hence they engaged in motivational strategies such as gain understanding of students, provide instrumental help and support and provide a meaningful rationale for students. In addition, studies have shown that the type of motivational strategy used by teachers does have significant consequences on students (Wang et al., 2019).

The purpose of the current study was to replicate and extent Taylor et al.'s study (2008) in Singapore setting. Specifically, this study examined the influence of teachers' autonomous causality

orientation, perceived job pressure, perceptions of student self-determined motivation, need satisfaction and self-determined motivation on the use of motivational strategies in PE classroom.

3. Methods

Participants

A total of 101 PE teachers (64 males, 36 females, 1 missing) with a mean age of 38.46 years (*SD* = 7.78) volunteered to participate in this study. PE teachers were sampled from primary and secondary schools in Singapore. The teachers had a mean teaching experience of 11.54 years (*SD* = 7.61). They are all qualified PE teachers who gone through their teacher training programme at the National Institute of Education, Singapore.

Procedures

Following the ethics approval by the university's Institutional Review Board, a multi-section questionnaire and assent forms were given to the teachers. In the assent forms, purpose of study, no foreseeable risk involved, voluntary participation and anonymity were stated and guaranteed. Participants were instructed to return the signed assent form and completed questionnaire to the researcher and to keep a duplicate copy of the assent form for their reference. The participants took about 25 minutes to complete the questionnaire in a quiet meeting room.

Measures

Perceived Job Pressure. We used the 10-item questionnaire by Taylor and his colleagues (Taylor et al., 2008) to assess three work-related types of pressure (time constraints, school authorities, and evaluation based on students' performance) that physical education teachers have reported as affecting their choice of motivational strategies. There were four items measuring perceived time constraints (e.g. "I wish there was more time in PE lessons"), three items for evaluation based on students' performance (e.g. "If student don't perform, it looks bad on my record") and three items for pressure from school authorities (e.g. "My teaching methods are dictated by school policy"). Participants indicated their responses on a 7-point scale with a range of 1 (not at all true) to 7 (completely true).

Autonomous Causality Orientation. The General Causality Orientations Scale (GCOS) by Deci and Ryan (1985b) was adopted to evaluate the autonomous causality orientation in teachers. The actual GCOS inventory comprises of 12 scenarios and 36 questions. Each scenario illustrates a conventional social or achievement circumstance in which the participant responds with three kinds of answers namely, autonomous (i.e. degree to which one "is oriented towards things in the environment"), controlled (i.e. degree to which one "feels controlled by external factors") and impersonal (i.e. degree to which one "experiences behaviour as out of his or her control"). An example of a scenario includes, "You are embarking on a new career and the most important consideration is likely to be how interested you are in that kind of work" (i.e. autonomous response). Only 8 scenarios and teachers' autonomous responses were used for this study. Answers ranged from 1 (very unlikely) to 7 (very likely) on a 7-point scale.

Teachers' Perceptions of Student Self-Determination. The perceived locus of causality scale (PLOC; Goudas, Biddle & Fox, 1994) was used to assess and quantify teachers' perceptions of students' motivations. The 14-item questionnaire measures external regulation (4 items; e.g. "Because they will get into trouble if they don't), introjected regulation (4 items; e.g. "Because they want me to think that they are good students"), identified regulation (3 items; e.g. "Because it is important for them to do well in PE") and intrinsic motivation (3 items; e.g. "Because they enjoy learning new things in PE"). Answers were indicated on a 7-point scale from 1 (strongly disagree) to 7 (strongly agree). First, the mean score of each motivational regulation were calculated. A Relative Autonomy Index (RAI; Grolnick & Ryan, 1989) was calculated based on a weighted score of intrinsic motivation* (2), identified regulation*(1), introjected regulation* (-1) and external regulation* (-2). The RAI reflects the degree of self-determination of the students in PE with positive scores indicating more autonomous regulation and negative scores more controlling regulation.

Psychological Need Satisfaction. The Basic Need Satisfaction at Work Scale (BNSAW; Deci et al., 2001) was used to evaluate the extent of fulfilment of the three basic needs namely autonomy (3 items; e.g. "I am free to express my ideas and opinions on the job"), competence (3 items; e.g. "People at work tell me I am good at what I do") and relatedness (3 items; e.g. "I

really like the people I work with") in teachers. Answers ranged from 1 (not at all true) to 7 (completely true) on a 7-point scale. Negative statements were reverse-scored before data analysis.

Teachers' Self-Determination. The Work Motivation Inventory (WMI; Blais, Lachance, Vallerand, Brière & Riddle, 1993) was utilized to assess the self-determination of teachers. Questions were asked from the basis of "Why do I teach?" and followed by 16 items where there are 4 items for the four different categories of motivational regulations from SDT such as external regulation (e.g. "For the income it provides me"), introjected regulation (e.g. "Because my work is my life, I don't want to fail"), identified regulation (e.g. "Because I want to pursue my career in teaching PE"), and intrinsic motivation (e.g. "For the intense moments of pleasure teaching gives me"). Answers ranged from 1 (does not correspond at all) to 7 (corresponds completely) on a 7-point scale. Using the same formula in calculating teachers' perception of students' self-determination, RAI was calculated to reflect teachers' self-determination towards teaching.

Teachers' Use of Motivational Strategies. The teacher version of the Teacher as Social Context Questionnaire (TASCQ; Wellborn, Connell, Skinner & Pierson, 1988) was adapted to assess the extent of the teachers' usage of the three types of motivational strategies. Teachers answered 10 questions that measured their provision of instrumental help and support (3 items; e.g. "I show my students different ways to complete tasks"), provision of a meaningful rationale (3 items; e.g. "I encourage my students to think about how what I teach can be useful to them") and gaining an understanding of students (4 items; e.g. "I know my students well"). Answers ranged from 1 (not at all true) to 7 (completely true) on a 7-point scale.

4. Data Analysis

In the preliminary analysis, a series of Confirmatory Factor Analysis (CFA) was conducted based on all the measures using EQS for Windows 6.3 (Bentler, 2006). Subsequently, IBM SPSS Version 25 was used for the main analysis. Descriptive statistics, Cronbach's Alpha coefficients, Pearson's product-moment correlation coefficient were computed for the main variables. Finally, stepwise hierarchal multiple regression was conducted to examine the factors predicting the use of motivational strategies in PE classes.

In the evaluation of model fit to the data, the typical fit indices were used: Bentler-Bonett normed fit index (NFI), the comparative fit index (CFI); Bollen's Fit Index (IFI) and the mean square error of approximation (RMSEA). For the NFI, CFI, and IFI, the conventional cut-off values of close to 0.90 were used (Hu, Bentler, 1999). For RMSEA, we used the value close to .08 as the cut-off. The chi-square statistic and the degree of freedom are also presented for reference.

5. Results

Descriptive Statistics

The results of the Confirmatory Factory Analysis (CFA) of all the measures are shown in Table 1. All the measurement models showed acceptable fit, except with the use of motivational strategies (three-factor model). It was found that a higher order whereby the three first order factors load on a higher order factor (motivational strategies) would fit the data better (see Table 1). In subsequent analysis, we used the higher-order factor and named it as "use of motivational strategies".

Table 1. Fit indices for CFA models

Model	χ^2	df	SBχ^2/df	NNFI	CFI	IFI	RMSEA (90% CI)
Perceived Job Pressure	45.68	32	1.43	.922	.944	.947	.066 (.000, .106)
Autonomous Orientation	20.87	20	1.04	.992	.995	.995	.021 (.000, .090)
Perception of Student Self-determined Motivation	88.88	67	1.32	.927	.946	.949	.058 (.014, .088)
Need Satisfaction	31.98	24	1.33	.958	.972	.973	.058 (.000, .106)
Teachers' self-determination	119.46	93	1.28	.938	.952	.954	.054 (.016, .079)

Use of Motivational Strategies (3-factor model)	69.49	24	2.89	.769	.846	.852	.138 (.100, .175)
Use of Motivational Strategies (higher order factor)	22.33	20	1.12	.986	.992	.993	.034 (.000, .095)

Note. NNFI = Non-Normed Fit Index; CFI = robust Comparative Fit Index; IFI = Bollen's Fit Index; RMSEA (90 % CI) = robust Root Mean Square Error of Approximation (90 % confidence interval).

The descriptive statistics including internal reliabilities, range, means, standard and deviation of all the variables are presented in Table 2. The internal consistency of all subscales demonstrated acceptable internal reliability ranging from .66 to .84, except for perceived pressure from evaluation based on their students' performance (α = .48). Caution is required when interpreting the results.

Table 2. Descriptive Statistics of the Main Variables

Variable	α	Range	*M*	*SD*
Pressure from time constraints	.81	1 to 7	4.06	1.37
Pressure from evaluation	.48	1 to 7	3.80	1.11
Pressure from school authority	.74	1 to 7	3.14	1.34
Autonomous causality orientation	.77	1 to 7	5.98	.64
Perceptions of student self-determined motivation	.72 - .77	-18 to 18	6.54	4.56
Need satisfaction	.72 - .81	1 to 7	5.36	.83
Teachers' self-determined motivation	.64 - .74	-18 to 18	3.75	3.03
Use of motivational strategies	.82	1 to 7	5.70	.62

Teachers reported moderate perceived pressure from time constraints and school authorities. Additionally, teachers also revealed a high autonomous orientation and moderate perceptions of student self-determined motivation. In addition, teachers revealed a high need satisfaction and moderate level of autonomy. Finally, teachers reported a high utilisation of motivational strategies in their PE classes (see Table 2).

From Table 3, the correlation shows that teachers' autonomous causality orientation was negatively correlated with pressure from school authority, but positively correlated with the need satisfaction, self-determined motivation and the use of motivational strategies. There were positive correlations between teachers' perceptions of student's self-determined motivation, need satisfaction and teachers' self-determined motivation, and the use of motivational strategies.

Table 3. Correlations of Main Variables

Variable	1	2	3	4	5	6	7	8
1. Pressure from time constraints	--							
2. Pressure from evaluation	.04	--						
3. Pressure from school authority	.28**	.36**	--					
4. Autonomous causality orientation	-.16	.08	-.22**	--				
5. Perceptions of student self-determined motivation	-.10	.03	-.21*	.21*	--			
6. Need satisfaction	-.33**	-.12	-.36**	.27**	.31**	--		

7. Self-determined motivation	.05	-.03	.06	.28**	.35**	.16	--
8. Use of motivational strategies	-.12	.06	-.18	.40**	.45**	.40**	.39** --

Note: **$p < .01$, *$p < .05$.

Hierarchical Multiple Regression

A hierarchal multiple regression was conducted to predict teachers' usage of the motivational strategy (see Table 4). In the first step, the predictor variables entered were namely, pressure from time constraints, evaluation, pressure associated with school authorities, autonomous causality orientation and perceptions of students' self-determined motivation. In the second step, teachers' basic need satisfaction was entered. In the third step, teachers' self-determined motivation was entered.

The first step of analysis revealed that teachers' autonomous causality orientation ($\beta = .31$, $t = 3.40$, $p < .01$) and teachers' perceptions of students' self-determined motivation ($\beta = .37$, $t = 4.18$, $p < .01$) were significant positive predictors of teachers' use of motivational strategies. The model predicted 31 % of variance in teachers' use of motivational strategies. In the second step, after controlling for the first four variables, teachers' basic need satisfaction accounted for additional 4 % of variance ($\beta = .25$, $t = 2.54$, $p < .01$, $\Delta R^2 = .04$). Similarly, in the third step, teachers' self-determined motivation was a significant positive predictor of teachers' use of motivational strategies ($\beta = .20$, $t = 2.19$, $p < .01$, $\Delta R^2 = .03$), with additional 3 % variance. Overall, the results showed the three models predicted a total of 38 % variance in teachers' use of motivational strategies in the PE classroom.

Table 4. Prediction of the Use of Motivational Strategies

Step	Variable	*β*	*t*	R^2	R^2_{adj}	ΔR^2
1						
	Pressure from time constraints	-.03	-.31	.31**	.27**	
	Evaluation	.03	.36			
	Pressure from school	-.04	-.37			
	Autonomous causality orientation	.31	3.40**			
	Perceptions of student self-determined motivation	.37	4.18**			
2						
	Pressure from time constraints	.03	.32	.35**	.31**	.04
	Evaluation	.05	.53			
	Pressure from school authorities	.01	.12			
	Autonomous causality orientation	.27	3.05**			
	Perceptions of student self-determined motivation	.32	3.60**			
	Need satisfaction	.25	2.54**			
3						
	Pressure from time constraints	.01	.06	.38**	.33**	.03
	Evaluation	.03	.72			
	Pressure from school authorities	-.01	-.05			
	Autonomous causality orientation	.22	2.47*			
	Perceptions of student self-determined motivation	.26	2.80**			
	Need satisfaction	.24	2.48**			
	Self-determined motivation	.20	2.19**			

Note: **$p < .01$, *$p < .05$.

6. Discussion

The aim of this study is to investigate the personal and contextual factors mentioned in Taylor et al.'s model (2008), in predicting the use of motivational strategies by PE teachers in Singapore. Overall, the results revealed some insights into the antecedents of teachers' use of motivational strategies in the PE classroom.

In general, Singapore PE teachers displayed high autonomous causality orientation, need satisfaction, and self-determined regulation. This is consistent with a recent study with teachers from other subject areas from Singapore (Liu et al., in press). This further supports the high degree of autonomy-support provided to the teachers in Singapore schools from the system perspective.

The results of the hierarchical multiple regression found that teachers' autonomous causality orientation, their perceptions of student self-determined motivation, need satisfaction and self-determined motivation, were positive and significant predictors of teachers' use of motivational strategies the PE classroom. These findings are critical as autonomy supportive and interpersonal involvement teaching strategies have been proven to positively impact students by enhancing intrinsic motivation (Ntoumanis, 2005), promoting self-esteem (Deci et al., 1981), experiencing competence (Connell, Wellborn, 1991) and encouraging engagement behaviours (Skinner, Belmont, 1993).

There are a few interesting results from the current study compared to an earlier study with teachers from other subject areas (Liu et al., in press). Firstly, none of the perceived job pressure factors play a significant role in determining teachers' use of motivational strategies. This could be the fact that PE is a non-examination subject in Singapore schools and therefore evaluation based on student performance, time constraints or school authority did not have an impact on teachers' motivation or need satisfaction. However, Taylor et al. (2008) did find that perceived job pressure was a significant predictor of PE teachers' use of motivational strategies through need satisfaction and teacher autonomy in the UK sample. This could be due to the fact that PE is examination subject in the UK system as an option.

Secondly, the results revealed that a teacher's autonomous causality orientation is crucial as it is a significant predictor of the use of motivational strategies. This is in line with previous studies (Liu et al., in press; Taylor et al., 2008). This is supported by literature where pre-service teachers with high autonomous orientations rather than controlling personal dispositions, exhibited more autonomy supportive behaviours (Reeve et al., 1999).

Thirdly, the findings that a teacher's perception of student self-determined motivation predicted the use of motivational strategies support Liu et al. (in press). Teachers who perceive students as high in self-determined motivation are more inclined to employ autonomy supportive and interpersonal involvement motivational strategies in a PE class. On the other hand, if teachers perceive their students to be low in self-determined motivation, they are less inclined to use these adaptive motivational strategies. This is in line with literature where past research reported that teachers who identified their students as being more involved and interested in class provided more autonomy support, structure and involvement in their teaching for these students (Skinner, Belmont, 1993). Likewise, in another study, teachers used more autonomy supportive teaching when they perceived their students as intrinsically motivated (Pelletier, Vallerand, 1996). This reaffirms the fact that teachers' motivation to teach is affected by students' motivation to learn and vice versa (Liu et al., in press).

Fourthly, this study also revealed that teachers' psychological need satisfaction and self-determined motivation are significant and positive predictor of teachers' use of motivational strategies. This implies that when teachers' fundamental needs of autonomy, competence and relatedness are fulfilled, they are more inclined to use autonomy supportive strategies in a PE class. This is consistent with one of the sub theory of self-determination theory, which is the basic psychological needs theory (Ryan, Deci, 2017). Therefore, school authorities should consider the provision of a working environment for teachers where their basic psychological needs (competence, autonomy, and relatedness) are met.

Apart from the five variables studied in this study, it is possible that other variables have influenced the prediction of teachers' use of these motivational strategies in Singapore's PE setting. Specifically, future studies may consider other factors such as PE teachers' knowledge of adaptive motivational strategies, their experience in applying motivational strategies in class and their mood or

emotional condition on the day of teaching. Hence, more studies on teachers' application of motivational strategies in Singapore's PE context are required to support the findings from this study.

There are a few limitations of this study need to be highlighted. Firstly, the sample size is relatively small in the current study. Having a larger sample size could facilitate a more accurate depiction and understanding of the perceptions of the general population of Primary and Secondary PE teachers in Singapore. Secondly, a more specific sample size could generate more accurate results as well. For example, future studies could focus entirely on one level of PE teachers (e.g. Primary school PE teachers only) as the difference in curriculum and nature of students in the Primary and Secondary context could generate unforeseen complications in the results and hence affect the authenticity of the conclusions in the study. Thirdly, this study was based on teachers' self-reported use of motivational strategies, future studies could be use other methods to eliminate the potential bias from teachers' self-accounts. Finally, another extension of this study is to include the perspective from the students, in terms of students' motivation and associated outcomes. By doing so, multilevel analysis could be conducted to examine the effects of teachers' variables on students' variables.

In summary, the findings from this study revealed that teachers' autonomous causality orientation, teachers' perceptions of student self-determined motivation are key predictors of teachers' use of motivational strategies in the PE classroom through needs satisfaction and teachers' self-determined motivation. Therefore, it is important to take into consideration the provision of a working environment for PE teachers where their needs of autonomy, competence and relatedness are facilitated.

References

Baumeister, Leary, 1995 – *Baumeister, R.F., Leary, M.R.* (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*. 117, 497-529.

Bentler, 2006 – *Bentler, P.M.* (2006). EQS for Windows (Version 6.1). Encino, CA: Multivariate Software.

Blais et al., 1993 – *Blais, M.R., Lachance, L., Vallerand, R.J., Brière, N.M., Riddle, A.S.* (1993). L'inventaire des motivations au travail de Blais (The work motivation inventory). *Reveu Québécoise de Psychologie*. *14*: 185-215.

Chatzisarantis et al., 1997 – *Chatzisarantis, N.L.D., Biddle, S.J.H., Meek, G.A.* (1997). A self-determination theory approach to the study of intentions and the intention-behaviour relationship in children's physical activity. *British Journal of Health Psychology*. 2: 343-360.

Connell, Wellborn, 1991 – *Connell, J.P., Wellborn, J.G.* (1991). Competence, autonomy, and relatedness: A motivational analysis of self-system processes. *Minnesota Symposia on Child Psychology*. 23: 43-77.

deCharms, 1968 – *deCharms, R.* (1968). Personal causation. New York: Academic.

Deci et al., 1994 – *Deci, E.L., Eghrari, H., Patrick, B.C., Leone, D.R.* (1994). Facilitating internalization: The self-determination theory perspective. *Journal of Personality & Social Psychology*. 62(1): 119-142.

Deci et al., 1981 – *Deci, E.L., Nezlek, J., Sheinman, L.* (1981). Characteristics of the rewarder and intrinsic motivation of the rewardee. *Journal of Personality and Social Psychology*. 40: 1-10.

Deci et al., 2001 – *Deci, E.L., Ryan, R.M., Gagne, M., Leone, D.R., Usunov, J., Kornazheva, B.P.* (2001). Need satisfaction, motivation, and well-being in the work organizations of a former eastern bloc country: A cross-cultural study of self-determination. *Personality and Social Psychology Bulletin*. 27: 930-942.

Deci, Ryan, 2000 – *Deci, E.L., Ryan, R.M.* (2000). The 'what' and 'why' of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*. 11: 227-268.

Deci, Ryan, 1985a – *Deci, E.L., Ryan, R.M.* (1985). Intrinsic motivation and self-determination in human behavior. New York: Plenum.

Deci, Ryan, 1985b – *Deci, E.L., Ryan, R.M.* (1985). The general causality orientations scale: Self-determination in personality. *Journal of Research in Personality*. 19: 109-134.

Goudas et al., 1994 – *Goudas, M., Biddle, S., Fox, K.* (1994). Perceived locus of causality, goal orientations, and perceived competence in school physical education classes. *British Journal of Educational Psychology*. 64: 453-463.

Grolnick, Ryan, 1989 – *Grolnick, W.S., Ryan, R.M.* (1989). Parent style associated with children's self-regulation and competence in school. *Journal of Educational Psychology*. 81: 143-154.

Hu, Bentler, 1999 – Hu, L., Bentler, P.M. (1999). Curoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*. 6(1): 1-55.

Liu et al. – *Liu, W.C., Wang, C.K.J., Reeve, J., Kee, Y.H., Chian, L.K.* (In press). What determines teachers' use of motivational strategies in the classroom? A self-determination theory perspective. *Journal of Education*.

Ministry of Education, 2015 – Ministry of Education (2015). 21st Century Competencies [Electronic resource]. URL: https://www.moe.gov.sg/education/education-system/21st-century-competencies

Ntoumanis, 2005 – *Ntoumanis, N.* (2005). A prospective study of participation in optional school physical education based on self-determination theory. *Journal of Educational Psychology*. 97: 444-453.

Papaioannou et al., 2004 – *Papaioannou, A., Marsh, H. W., Theodorakis, Y.* (2004). A multilevel approach to motivational climate in physical education and sport settings: An individual or a group level construct? *Journal of Sport and Exercise Psychology*. 26: 90-118.

Pelletier, Vallerand, 1996 – *Pelletier, L.G., Vallerand, R.J.* (1996). Supervisors' beliefs and subordinates' intrinsic motivation: A behavioral confirmation analysis. *Journal of Personality and Social Psychology*. 71: 331–340.

Reeve et al., 1999 – *Reeve, J., Bolt, E., Cai, Y.* (1999). Autonomy-supportive teachers: How they teach and motivate students. *Journal of Educational Psychology*. 91: 537-548.

Ryan, Deci, 2000 – *Ryan, R.M., Deci, E.L.* (2000). Intrinsic and extrinsic motivations: Classic efinitions and new directions. *Contemporary educational psychology*. 25(1): 54-67.

Ryan, Deci, 2017 – *Ryan, R.M., Deci, E.L.* (2017). Self-deteremination theory: Basic psychological needs in motivation, development, and wellness. New York: The Guilford Press.

Skinner, Belmont, 1993 – *Skinner, E.A., Belmont, M.J.* (1993). Motivation in the classroom: Reciprocal effects of teacher behavior and student engagement across the school year. *Journal of Educational Psychology*. 85: 571-581.

Spray, Wang, 2001 – *Spray, C.M., Wang, C.K.J.* (2001). Goal orientations, self-determination and pupils' discipline in physical education. *Journal of Sports Sciences. 19*: 903-913.

Taylor et al., 2008 – *Taylor, I.M., Ntoumanis, N., Standage, M.* (2008). A self-determination theory approach to understanding the antecedents of teachers' motivational strategies in physical education. *Journal of Sport and Exercise Psychology*. 30(1): 75-94.

Taylor, Ntoumanis, 2007 – *Taylor, I., Ntoumanis, N.* (2007). Teacher motivational strategies and student self-determination in physical education. *Journal of Educational Psychology*. 99: 747-60.

Wellborn et al., 1988 – *Wellborn, J., Connell, J., Skinner, E. A., Pierson, L.H.* (1988). Teacher as social context: A measure of teacher provision of teacher involvement, structure and autonomy support. (Tech. Rep. No. 102). Rochester. NY: University of Rochester.

White, 1959 – *White, R.W.* (1959). Motivation reconsidered: The concept of competence. *Psychological Review*. 66: 297-333.

Wang, 2016 – *Wang, C.K.J.* (2016). Maximizing student motivation in physical education: A self-determination theory perspective. In C. D. Ennis, K. Armour, A. Chen, A. Garn, E. Mauerberg-deCastro, S. S. D. Penney, M. A. Solmon, & R. Tinning (Eds.), Routledge Handbook of Physical Education Pedagogy (pp. 594-606). New York: Routledge.

Wang et al., 2019 - *Wang, C.K.J., Liu, W.C., Kee, Y.H., Chian, L.K.* (2019). Competence, autonomy, and relatedness in the classroom: Understanding students' motivational processes using the self-determination theory. *Heliyon. 5*(7): e1983. DOI:10.1016/j.heliyon.2019.e1983

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Understanding the Role of the Talent Development Environment in Fostering Sporting Excellence: A Review

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Abstract

With increasing competitiveness in professional sport, countries and sports organizations are seeking to optimize their athletes' sports performance. The talent development environment is an important factor contributing to athletic success. This review aims to synthesize existing literature pertaining to the talent development environment. The results of this review provided a contemporary understanding of the essential components of talent development environment (e.g., long-term development and support network), as well as their differential and holistic role in fostering talent development. The influence of talent development environments on athletic success was explored through the lens of achievement goal theory and self-determination theory. Constructs of these two theories were found to relate to the components of the talent development environment. Despite the growing literature aimed at understanding the talent development environment, issues and gaps in the existing literature were identified. Future research directions were proposed to advance this critical research area.

Keywords: talent development, environmental factors, research synthesis, motivation, sport.

1. Introduction

With increasing competitiveness in professional sport, countries and organizations seeking to optimize performance of their athletes have increasingly adopted talent identification and development programs (Li et al., 2014, 2016; Wang et al., 2016; Wang et al., 2011). Talent identification refers to spotting those with potential or innate abilities for attaining elite-level performance, while talent development concerns the handling of "talent", nurturing them within a conducive environment, towards world-class aptitude (Li et al., 2014). Talent identification and development programs, if successful, may promote sustainable and quality performance at the international level (Martindale et al., 2007; Wang et al., 2011).

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The emerging consensus around interaction between innate and environmental influence in the nature-nurture debate underlies the importance of both talent identification and talent development towards fostering athletic excellence (Abbott et al., 2002). The intuitive claim that innate ability cannot instantly translate into a world-class performance standard has been argued by many in academia (Gagné, 2004; Li et al., 2015; Vaeyens et al., 2008, Lenoir et al., 2008) and supported by empirical evidence. For instance, evidence has been found for plasticity in joint flexibility and strength in measures predictive of success in competitive swimming (Bloomfield et al., 1990). In fact, Bloomfield and colleagues (1990) found no differences in the flexibility of adolescent swimmers and non-swimmers, suggesting differentiation that grows with training. Thus, where talent identification is important in differentiating those who can and cannot attain excellence (Gagné, 2004), talent development can alter the value of physical factors predictive of sporting success (Abbott et al., 2002).

Some, however, suggest that talent identification initiatives are affected by inherent problems. While supporting the importance of interaction between talent identification and talent development, the multidimensionality of sport performance (e.g., technical skills and physical ability) also confounds the effectiveness of talent identification programs, which face difficulties in early and accurate identification of future top performers (Abbott et al., 2002; Abbott, Collins, 2004; Vaeyens et al., 2008). Furthermore, an overemphasis on "selecting" talented individuals arguably creates ethical problems (Abbott et al., 2002). These issues, alongside sparse scientific grounding for talent identification programs, has prompted a shifting emphasis towards talent development (Martindale et al., 2010; Vaeyens et al., 2008; Wang et al., 2016). The relative importance of talent development in the emergence of top talent should not be discounted. After all, expertise grows from an interaction between an individual, however gifted, and his or her environment (Barab, Plucker, 2002). As such, the talent development environment is a key factor towards successful performance among world-class athletes, who stand to benefit from well-structured, holistic programs aimed at maximizing their potential (Martindale et al., 2005).

The purpose of this research is to review and synthesize the literature pertaining to talent development environment. The practical importance and growing literature in talent development environment warrants review, condensing existing work towards an updated collective understanding on the topic. In addition, this paper will examine emerging attempts to understand the underlying operation of the talent development environment in enabling sporting achievement through psychological perspectives, which may have implications on the development of effective talent development programs. Finally, it will address limitations in current research and opportunities for progress in the field.

2. Discussion and results

Essentials of Talent Development Environment

Though generally understood as "all aspects of the coaching situation" (Martindale et al., 2005), scholars have sought to identify specific aspects of talent development environments. One approach involved the development of the Talent Development Environment Questionnaire (TDEQ), which serves the dual purpose of understanding constituent aspects of the TDE and providing a tool to evaluate these aspects in given environments (Li et al., 2015; Martindale et al., 2010). Beginning with a review and content analysis of relevant research, Martindale and colleagues (2010) generated their initial ideas and items in consultation with coaches, athletes and sports psychologists. Factor analysis then identified seven factors (long-term development focus, quality preparation, communication, understanding the athlete, support network, challenging and supportive environment and long-term developmental fundamentals) contributing to effective talent development environments. While the TDEQ enabled professionals with a practical yet evidence-based tool to improve their talent development programs across different sports, the measure experienced issues with conceptual overlaps between factors and low internal reliability within some of them (Li et al., 2015; Wang et al., 2011, 2016). Further validation of the TDEQ yielded a five factor model, the TDEQ-5 (long-term development, support network, holistic quality preparation, communication and alignment of expectations; Li et al., 2015; Li et al., 2018). Our review pertaining to talent development environment is therefore organized on the basis of the five factor framework and the review results are summarized in Table 1.

Table 1. Essentials of Talent Development Environment

Components	Features
Long-Term Development	- Allow mistakes - Emphasize fundaments - Reap the gains of diversification - Delay specialization - Identify late bloomers
Support Network	- Seek continual familial support - Extent support network to friends and peers - Give permission to maintain or development support network - Avoid intra-team conflict
Holistic Quality Preparation	- Employ deliberate practice - Individualize programs with sports science support - Balance training and recovery/school - Create a sporting culture
Communication	- Provide immediate informative feedback - Build positive coach-athlete relationship - Set clear performance plan that emphasizes on progression - Use both formal and informal communication channels
Alignment of Expectations	- Set expectations with appropriately difficult challenges - Align expectations with the long-term development goals - Involve significant others in adjusting expectations

Long-term Development

Champions are not born in a day. This saying, calling for an emphasis on long-term development over short-term performance, receives support by the vast majority of talent development literature (Martindale et al., 2010). Ericsson, Krampe and Tesch-Römer (1993) for instance, argue that many skills are "the result of intense practice extended for a minimum of 10 years". Similarly, Bloom's (1985) Model of Staged Development, crafted through interviews with world-class athletes and other non-sports talents, proposes a stage based model for the development of expertise over time. Individuals' transition from the stage of initiation towards development and eventually, perfection, only moving on to the next stage with the acquisition of requisite skills, mentalities and relationships.

In view of the long-term nature of the emergence of elite performance, well-designed long-term development programs are better poised to tackle issues in the talent development process. Retaining the flexibility to forgo short-term success to emphasize activities important for future development, these programs are more able to allow mistakes, emphasize fundamentals and reap the gains of diversification and delayed specialization (Johnson et al., 2006; Li et al., 2014; Martindale et al., 2010). Baker, Cobley and Fraser-Thomas (2009) noted several physical and psychosocial costs of early specialization such as increased risk of injury, slower maturation and diminished social development that more short-term focused programs may leave their athletes prone to. Furthermore, long-term programs, in prioritizing future success over immediate rewards, are more likely to be equipped to appropriately anticipate, discount and manage performance level fluctuations over one's athletic development emerging from various mental and physical impediments (Martindale et al., 2010).

The importance of long-term development as a factor of the talent development environment stresses the need for integration of talent development initiatives with their talent identification counterparts, such that potential athletes are, at the earliest possible opportunity, incorporated into a long-term system dedicated to maximizing their potential (Li et al., 2014). However, an emphasis on long-term development should also be structured to allow identification of late bloomers (Li et al., 2014). Vaeyens and colleagues (2008) argues that talent identification and talent development programs should be interconnected, considering maturity and long-term potential to avoid excluding prospective stars.

Support Network

A social support network readily available to athletes contributes to the success of the talent development environment (Li et al., 2015). Qualitative studies of top athletes and their families found that family members play an important role in supporting athletes psychologically and logistically throughout their development from amateurs to professionals (Côté, 1999; Durand-Bush, Salmela, 2002; Henriksen et al., 2010; Holt, Morley, 2004). The importance of support networks have been reinforced through quantitative approaches. Lafferty and Dorrell (2006) uncovered an association between perceived parental support and coping strategies in junior age group swimmers. Low perceived parental support was linked to self-blame and venting emotion, whereas high-perceived parental support was associated with coping through training. In a study involving tennis players, belonging, appraisal and overall social support predicted several components of tennis performance (Rees et al., 1999).

Aside from familial support, friends form another important aspect of athletes' support network (Li et al., 2014). Patrick and colleagues (1999) reported that when adolescent talents viewed talent development programs as impeding their social life, motivation and enjoyment in their talent was undermined. Thankfully, the professional sporting environment creates a fertile opportunity for friendship, and most of athletes' friends are from sporting circles (Carlson, 2011; Henriksen et al., 2010; Patrick et al., 1999). Interviews with adolescent athletes revealed that these peer relationships among athletes were important to maintaining their long-term commitment to sporting, and were often regarded as more intimate than regular friendships (Patrick et al., 1999). The shared expertise of athletes uniquely places them in a position to provide professional support to one another as friends, in addition to more conventional forms of peer support (Durand-Bush, Salmela, 2002; Henriksen et al., 2010; Li et al., 2014; Morgan, Giacobbi, 2006).

Conversely, negative social support serves as a threat in TDEs. World-class and developing athletes alike reported that parental expectations for performance fostered pressure that undermined performance (Durand-Bush, Salmela, 2002; Holt, Dunn, 2004). Other studies show that the development of a performance climate (competition for relative superiority instead of focus on skill development) and intra-team conflict (where teammates put one another down) are related to negative outcomes such as anxiety and reduced enjoyment (Keegan et al., 2010; Vazou et al., 2005).

Given the importance of a positive support network, effective talent development environments should encompass solid, contingent social support for athletes. However, talent development programs are limited in their ability to foster support networks, having to ensure conducive training environments at the same time. Interview studies show that growing athletic commitment often accompanies social sacrifices (Henriksen et al., 2010; Holt, Dunn, 2004; Holt, Morley, 2004). Furthermore, for professional programs to force social support as a contributor to professional accomplishment is an ethically problematic issue (Rees et al., 1999), and will likely detract from the growth of an organic, contingent support structure. Talent development practitioners may be confined to allowing athletes to build and maintain their own support networks, ensuring that as far as possible, talent development programs facilitate rather than impede the natural development of good social support (Rees et al., 1999).

Holistic Quality Preparation

Holistic quality preparation refers to the strength of intervention programs both within and outside the formal talent development situation (Li et al., 2015). The multidimensional nature of talent, encompassing physiological, psychological and technical aspects, suggests that effective talent development environments concentrate on more than merely technical skills and physical ability (Abbott, Collins, 2004; Li et al., 2014; Martindale et al., 2007). Successful development requires more generic skills such as sporting fundamentals, effective decision-making and life skills (Martindale et al., 2007), pointing towards a more multidimensional yet integrated approach to talent development.

The importance of a holistic approach does not detract from the core aim of athletic achievement; high quality practice is indispensable for success in professional sporting. Ericsson's theory of deliberate practice (Ericsson et al., 1993) notes several requisites for effective learning. While deliberate practice encompasses task engagement, learners also stand to benefit from an appropriate task that accounts for the existing knowledge, as well as informative feedback of their performance. Extended and repeated access to the contingent task and feedback is necessary to

improve performance. In addition to the formal coaching situation, the talent development environment is enriched by support staff members that provide specialist knowledge in the talent development process beyond the technical expertise of the coach (Durand-Bush, Salmela, 2002). Of the world-class athletes studied by Durand-Bush and Salmela (2002), many worked with more than just their head coaches. Psychologists, physiologists, nutritionists and other support staff contributed to their attainment and maintenance of success. Importantly, individualized approaches should be considered to ensure that talent development programs are tailored to the individual athlete as approaches that work for one athlete may not work for another (Carlson, 2011; Johnson et al., 2006, 2008).

Training should incorporate recovery in tandem with exertion. Aside from the obvious physical strain from high level practice, the intensity of effective training, though necessary for excellence, may lead to "staleness", "overtraining" and "burnout" (Ericsson et al., 1993). Involving physical and emotional fatigue, poorer performance and devaluation of the sport (Ericsson et al., 1993; Gustafsson et al., 2011; Raedeke, 1997), burnout may lead to withdrawal, long-term impaired performance as well as negative physiological consequences (Gustafsson et al., 2011). Successful teams often take breaks, tapering as competitions approached, differentiating them from unsuccessful teams that were typically over trained (Durand-Bush, Salmela, 2002). Well-designed talent development programs should therefore include physical rest, as well as help athletes combat psychological stress (Abbott et al., 2002; Martindale et al., 2007).

Finally, holistic quality encompasses components external to the formal talent development setting. Schools often play an important role in developing athletic talent, and the school environment can also potentially complement formal talent development programs, with many accomplished athletes still in, and enjoying, school (Durand-Bush, Salmela, 2002; Li et al., 2014; Li, Wang, Pyun, 2017a). While academic and athletic development often occur concurrently, successful athletes balance the demands of both (Côté, 1999; Durand-Bush & Salmela, 2002; Li et al., 2017a). Cultural factors also form a part of the talent development environment. The culture of a sport in a country arguably contributes to sporting success among its citizens, such as with Canada's strength in ice hockey and South American nations' prowess in soccer (Baker, Horton, 2004; Côté et al., 2006). Others also suggest that the intimacy and informality of talent development environments in smaller cities are more conducive for athletic success, given the greater satisfaction children gain from sport in these environments (Côté et al., 2006; Li et al., 2014).

Communication

Li and colleagues (2015) also identified communication, the ability of coaches to communicate effectively with the athlete formally and informally, as an important aspect of the talent development environment. This includes feedback, goal setting, development planning and emphasis on progression (Li et al., 2015; Martindale et al., 2010). The importance of the coach-athlete relationship has been highlighted by many (Baker, Horton, 2004; Bloom, 1985; Carlson, 2011; Côté et al., 2006; Durand-Bush, Salmela, 2002; Gould et al., 2002; Li et al., 2014; Martindale et al., 2007; Morgan, Giacobbi, 2006), seeming to suggest that a mix of formal, high level coaching, emotional support and tangible help are important towards coaching success (Morgan, Giacobbi, 2006).

A survey involving all athletes who participated in the 1996 Summer and 1998 Winter Olympics (Gould et al., 2002) found that many formal and informal aspects of coaching affected performance. In formal coaching, immediate informative feedback followed by repeated performance of the task is a key aspect of deliberate practice (Ericsson et al., 1993). Yet, successful coaching involves more nuance than mere informational support. In the formal coaching situation, Gould and colleagues (2002) found that over-coaching, an inability to deal with crises, make fair decisions and communicate effectively were all believed by Olympic athletes to negatively impact their ability to varying degrees. On the other hand, a clear performance plan implemented by the coach bolstered performance.

Martindale and colleagues (2007) argues that the informal facet of the coach-athlete relationship is a "vital extra" to the formal coaching situation. Relaxed meetings between coaches and athletes build trust and rapport, while providing an avenue for important informational exchange that may help to augment coaching quality and athletic performance (Martindale et al., 2007). The importance of the coach-athlete relationship is understandable, given the non-linear

pathway to world-class achievement and its consequent implications on the effectiveness of a talent development environment (see holistic quality preparation). Athletes surveyed in Gould and colleagues' (2002) study of 1996 and 1998 Olympians indicated that trust in their coach's ability and commitment to their success aided their performance, showing how trust built in informal settings contributes to athletic success. While informal settings may build athletes' trust in coaches' ability, they may also allow coaches to understand athletes better. Athletes who felt that their coaches did not know them or were attuned to their needs also believed that this had a negative impact on their performance (Gould et al., 2002). This included coaches' expectations of athletic performance; athletes believed that coaches' unrealistic expectations hurt their performance.

Alignment of Expectations

Referring to how targets are set and aligned in talent development programs (Li et al., 2015), alignment of expectations is highly related to the other factors. As noted, a good coach-athlete relationship encompasses realistic expectations of performance (Gould et al., 2002). This carries implications on the tailoring of an individualized training program well suited to the athlete (Carlson, 2011; Johnson et al., 2008, 2006), an important aspect of a quality talent development environment. Within individual coaching encounters for instance, well set expectations facilitate the development of appropriately difficult challenges that allow deliberate practice and subsequent learning (Ericsson et al., 1993). The continued utility of deliberate practice also involves the appropriate adjustment of expectations based on achievement, in order to ensure continued contingency of challenges.

In a talent development program focused on long-term development, athletes' expectations likely also need to be adjusted to align with the program's emphasis on a long-term benchmark; individuals unable to work towards long-term goals are often those who fail to perform or dropout (Abbott, Collins, 2004). Given the importance of athletes' self-motivation to the survival and success of a long-term program, athletes should be involved in decisions regarding their development and availability of opportunities (Martindale et al., 2010). This can be achieved with the aid of parents, sport psychologists and other support staff. The relationships between the different factors, despite their individual importance, stress the importance of an integrated yet multi-factorial approach to understanding talent development environments.

Towards a Theoretical Basis for the Talent Development Environment

Indeed, all components of talent development interact with each other in manners unique to the individual (Gagné, 2010). The ability of the talent development environment to effect changes on psychological factors of talent development forms a component of the operation and effectiveness of talent development programs (Li et al., 2017b; Wang et al., 2011, 2016). This section attempts to present an understanding of the influence of talent development environments on athletic performance through theoretical frameworks. Forming a theoretical understanding of the influence of environmental factors on athletic success may guide the structuring of future interventions aimed at cultivating athletic achievement. To date, self-determination theory (Deci, Ryan, 1985, 2000; Ryan, Deci, 2000) and achievement goal theory (Dweck, Leggett, 1988; Dweck, 1986; Elliott, Dweck, 1988; Nicholls, 1984) are the two theoretical frameworks that have been used to understand the impact of talent development environments on athletes' outcomes in particular to their motivation.

Achievement Goal Theory

One approach that has received particular attention in the literature on motivation is achievement goal theory (see Elliot, 2005 for review), which has seen application in the talent development literature (Wang et al., 2011, 2016). Dweck and colleagues (Dweck, Leggett, 1988; Dweck, 1986; Elliott, Dweck, 1988) first formulated this theory with reference to a central distinction between learning and performance goals. As individual competence goals, learning goals related to increasing task competence, while performance goals concerned the seeking of favorable judgements of competence (Dweck, Leggett, 1988). This approach was conceptually similar to those developed by others at the time (Ames, Archer, 1988; Elliot, 2005), such as Nicholls (1984), who referred to a distinction between task and ego involvement, and Ames and Archer (1987, 1988), who distinguished between mastery and performance goals.

Early formulations of achievement goal theory drew a relationship between implicit theories of intelligence, achievement goals and behavioral tendencies (Dweck, Leggett, 1988; Elliott, Dweck, 1988). Based on her research with school children (Diener, Dweck, 1978, 1980), Dweck sought to

explain why differences emerged among some children, classified as "helpless", and others, referred to as "mastery-oriented". Despite similarities in performance prior to failure, "mastery-oriented" children sought challenges and persisted through failure, finding solutions to overcome them. Children characterized by the "helpless" pattern avoided challenging situations and gave up easily, attributing failure to lack of ability (Diener, Dweck, 1978, 1980; Dweck, 1986). By fostering learning and performance goals experimentally, Elliot and Dweck (1988) found that those with performance goals tended to respond in a helpless manner, while those with learning goals were inclined to respond in a mastery-oriented fashion. Tendency to adopt performance or learning goals were also found to be dependent on individuals' implicit theories of intelligence; those who held an entity theory (that intelligence is a fixed trait) tended to adopt performance goals, while those believing in an incremental theory of intelligence (that intelligence is malleable) were more likely to adopt learning goals (Dweck, Leggett, 1988).

Elliot (1999) later proposed adding an approach-avoidance (valence) dimension to the achievement goal approach, arguing that this framework better accounted for existing findings within the achievement goal literature. This eventually led to a formulation involving four achievement goals: mastery-approach (focused on task-based competence), mastery-avoidance (focused on task-based incompetence), performance-approach (focused on normative competence) and performance-avoidance (focused on normative incompetence). In particular, the addition of a valence dimension addressed issues of mixed results, where performance goals were tied to adaptive rather than maladaptive behavior (Elliot, 1999). Despite the addition of more goals, Elliot (1999) suggested that multiple goals could be pursued simultaneously. Within the sporting context and other areas, this 2×2 framework was later supported by confirmatory factor analyses (Elliot, 2005; Wang et al., 2007). Empirical research using Elliot's 2×2 framework found that in general, widespread positive effects were associated with mastery-approach goals, while performance-approach goals were linked to positive but truncated effects (Elliot, 2005). Most of the negative effects of performance goals uncovered in earlier literature were associated with performance-avoidance goals, highlighting the importance of the valence dimension (Elliot, 2005).

Self-Determination Theory

As the predominant approach to understanding achievement motivation (Elliot, 2005), achievement goal theory remains a useful construct in understanding the influence of talent development environment on athletic achievement through its impact on athletes' psyche. However, such an analysis may be insufficient. Self-determination theory (Deci, Ryan, 1985, 2000; Ryan, Deci, 2000) presents a more holistic approach, in which perceived *competence*, central to achievement goal theory, is but one of three basic psychological needs integral to self-determination of behavior alongside *autonomy* (referring to the experience of choice) and *relatedness* (a sense of connectedness to those concerned with the goal).

Various studies have shown that generally, greater satisfaction of these three needs has led to greater intrinsic motivation, where actions are performed due to their inherent draw, as opposed to extrinsic motivation, where actions are performed in view of outcomes separate from the activity (Deci, Ryan, 2000; Ryan, Deci, 2000). In these studies, intrinsic motivation was usually measured through questionnaire measures or a "free choice period" where subjects are given the freedom to engage with or ignore a target task (see Deci, Ryan, 1985 for review). Intrinsic motivation is better understood in view of the *locus of causality*, another concept important to self-determination theory (Ryan, Connell, 1989). Derived as a simplex model, perceptions of an action's locus of causality can range from an *external locus of causality*, where an action is performed entirely for reasons external to the self, to an *internal locus of causality*, where it is performed for reasons inherent to the self (Ryan, Connell, 1989). Where intrinsically motivated behaviors carry an internal locus of causality, extrinsically motivated behaviors have a more external locus of causality (Ryan, Deci, 2000). In terms of motivating desired behaviors, intrinsic motivation is favored due to its ability, by definition, to regulate and motivate desired behaviors without the need for external influences, inspiring high quality learning (Deci, Ryan, 1985; Ryan, Deci, 2000). A third motivational state, *amotivation*, describes an unregulated activity that one consequently has no motivation to pursue (Deci, Ryan, 1985).

Relation between Constructs

Due to achievement goal theory's concern with conceptions of competence, some proposed that elements of the talent development environment could predict athletes' achievement goals.

This was investigated by Wang and colleagues (Wang et al., 2011) in a questionnaire study involving 374 athletes in a Singaporean sports school. Using the TDEQ and the Achievement Goal in Sport Questionnaire, the investigators found that the TDEQ measures accounted for 10-27 % of the variance in the four achievement goals. Notably, long-term developmental focus, long-term developmental fundamentals (both largely condensed to long-term development in the TDEQ-5), support network and communication predicted the adoption of mastery-approach goals. Long-term developmental focus and fundamentals also positively predicted the adoption of performance-approach and performance-avoidance goals.

A further study involving Korean and Singaporean adolescent athletes (Wang et al., 2016) suggested that perceived competence moderates the relationship between the TDE and achievement goal adoption. For instance, long-term development focus predicted mastery-avoidance in those with low perceived competence, though failing to predict it in high perceived competence individuals. Also, those higher in competence reported higher goal adoption regardless of valence. These findings suggest that the talent development environment is important towards encouraging positive achievement goal formation that may lead to adaptive, mastery-oriented training behavior (Wang et al., 2011). In particular then, successful talent development programs should foster an environment that eventually promotes mastery-oriented behavior and emphasizes long-term development with assistance of other talent development environmental factors such as communication, support network and holistic quality preparation (Wang et al., 2016).

Studies involving self-determination theory have also highlighted the need to consider the talent development in athletic motivation. In addition to investigating the talent development environment's relationship with achievement goal constructs, Wang and colleagues' (2011) also sought to understand links between the talent development environment and motivational styles. The relationships between the talent development environment (long-term development and fundamentals, support network) and athletes' motivation reflect one mechanism through which the talent development environment influences athletic success. This emphasizes the need to consider the talent development environment in continuing to promote intrinsic goals where possible and developing a successful talent development program, especially given the link between intrinsic goal pursuit and mastery-approach goals that are associated with positive outcomes. Later studies investigating athlete burnout further supported an association between the talent development and the satisfaction of the three basic psychological needs, while providing evidence that athletic burnout was negatively related to needs satisfaction (Li et al., 2017a, 2017b).

Limitations and Future Research Directions

The research reviewed thus far has supported the importance of considering the talent development environment in fostering athletic success, provided an understanding of its constituent elements and presented a preliminary theoretical understanding of one way the talent development environment influences athletic achievement. However, issues in existing research and gaps in the literature provide room for further study. Given the relatively recent development of the TDEQ-5 (Li et al., 2015), many studies investigating the talent development environment have used the TDEQ, providing a less than ideal measure of the talent development environmental factors. The *challenging and supportive environment* factor in the TDEQ has been plagued by poor internal reliability (Li et al., 2015; Wang et al., 2011, 2016). A revised TDEQ developed by Wang and colleagues (2011) removing this factor was similarly flawed; it was tested in only one sample and yielded low internal reliability ($\alpha = .62$) in *quality preparation* (Li et al., 2015). Several factors of the original TDEQ also face problems of conceptual overlap. Where supportive environment and support network both concern support external to the formal coaching situation, *long-term development focus* and *long-term development fundamentals* both emphasize long-term development (Li et al., 2015). Given issues with the TDEQ, more studies should be conducted using the refined TDEQ-5 to validate and extend the existing literature. The TDEQ-5 also requires further work; developed based on results from Singaporean schools and Chinese sports institutions, cross-cultural replication is required to ensure the generalizability of the scale (Li et al., 2015, 2018). The ecological validity of the TDEQ-5 may also have been threatened by the removal of some items from the original TDEQ, prompting the need for further refinement of the TDEQ-5 (Li et al., 2015).

Another issue with the TDEQ and the TDEQ-5 is their role as generic scales evaluating talent development environments (Li et al., 2015; Martindale et al., 2010; Wang et al., 2011). On one hand, studies are required to confirm the invariance of the measures across different sports (Wang

et al., 2011). On another, their generic nature ignores context-specific requirements of a given talent development situation (Martindale et al., 2010). This is particularly important given the uniqueness of each sport that increasingly dominates later stages of professional athletic development (Abbott et al., 2002; Abbott, Collins, 2004; Côté, 1999). Through interviews with 15 athletes and their families, Coté (1999) found that as athletes progressed, they dedicated decreasing amounts of time to extraneous activities, channeling more time towards a few sports, and eventually a single sport. Abbott and Collins (2004) similarly noted that while transferrable elements dominated early sporting development, sport-specific factors gained greater importance in later stages. The importance of considering sport-specific elements in understanding the talent development environment has been acknowledged by Martindale and colleagues (2010), who in developing the TDEQ called for exploration of these issues in view of potential extensions of context-specific instruments from the generic TDEQ. Durand-Bush and Salmela (2002) likewise indicated the need for more sport-specific research in the role of support networks in athletic development.

Many earlier studies investigating the talent development environment have also relied heavily on qualitative approaches involving athletes, their families and sporting professionals. Though useful for exploratory understandings of the talent development environment, quantitative research is required for a more rigorous conception of the elements and influence of talent development environment on athletic accomplishment. Where quantitative research has been employed, most did not track the influence of the talent development environment on sporting development, or relied on cross-sectional approaches, hampering ability to draw causal inferences. Recent papers have acknowledged this issue, calling for longitudinal and experimental studies that lend themselves to causal analyses (Li et al., 2017b). Finally, while theoretical approaches such as achievement goal theory and self-determination theory have proven useful lenses to understanding the influence of the talent development environment on athletes and their development, more work is required to improve academic understanding of the influence of talent development environments on athletic success, as well as to refine theoretical perspectives to account for domain-specific elements.

3. Conclusion

This review provided a contemporary understanding of the environment's elements, as well as their differential and holistic role in fostering talent development. Its approach made particular reference to the factors identified in the development of the TDEQ-5, namely *long-term development*, *holistic quality preparation*, *support network*, *communication*, and *alignment of expectations* (Li et al., 2015). The influence of talent development environment on athletic success was also explored through the lens of psychological motivation with appeal to key theoretical perspectives: achievement goal theory (Dweck, Leggett, 1988; Elliot, 1999, 2005; Nicholls, 1984) and self-determination theory (Deci, Ryan, 1985, 2000; Ryan, Deci, 2000). This was performed with the aim of understanding the operation of the talent development environment as a mechanism towards talent development on the intrapersonal level that could inform future development and refining of talent development processes. Work involving these theories provided evidence that constituent components of the talent development environment, achievement goal orientations and basic psychological needs are related concepts.

Despite the growing literature aimed at understanding the talent development environment, this area may still benefit from further research. Ultimately, academic understanding of talent development needs to be channeled towards professional practice in both powerhouses and ascendant nations, among world champions and underdogs alike. Maintaining the privilege of witnessing "Faster, Higher, Stronger" feats of human ability year on year is contingent on amassing greater knowledge of what underpins human excellence, and how to put that knowledge to work.

References

Abbott, Collins, 2004 – *Abbott, A., Collins, D.* (2004). Eliminating the dichotomy between theory and practice in talent identification and development: considering the role of psychology. *Journal of Sports Sciences*. 22(5): 395-408.

Abbott et al., 2002 – *Abbott, A., Collins, D., Martindale, R.J.J., Sowerby, K.* (2002). Talent identification and development: An academic review. Edinburgh, UK: sportscotland.

Ames, Archer, 1987 – *Ames, C., Archer, J.* (1987). Mothers' beliefs about the role of ability and effort in school learning. *Journal of Educational Psychology*. 79(4): 409-414.

Ames, Archer, 1988 – *Ames, C., Archer, J.* (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of Educational Psychology*. 80(3): 260-267.

Baker et al., 2009 – *Baker, J., Cobley, S., Fraser-Thomas, J.* (2009). What do we know about early sport specialization? Not much! *High Ability Studies*. 20(1): 77-89.

Baker, Horton, 2004 – *Baker, J., Horton, S.* (2004). A review of primary and secondary influences on sport expertise. *High Ability Studies*. 15(2): 211-228.

Barab, Plucker, 2002 – *Barab, S.A., Plucker, J.A.* (2002). Smart people or smart contexts? Cognition, ability, and talent development in an age of situated approaches to knowing and learning. *Educational Psychologist*. 37(3): 165-182.

Bloom, 1985 – *Bloom, B.S.* (1985). Developing Talent in Young People. New York, NY: Ballantine Books.

Carlson, 2011 – *Carlson, R.* (2011). Talent detection and competitive progress in biathlon – A national example. *Polish Journal of Sport and Tourism*. 18(4): 290-295.

Côté, 1999 – *Côté, J.* (1999). The influence of the family in the development of talent in sport. *The Sport Psychologist*. 13(4): 395-417.

Côté et al., 2006 – *Côté, J., Macdonald, D. J., Baker, J., Abernethy, B.* (2006). When "where" is more important than "when": Birthplace and birthdate effects on the achievement of sporting expertise. *Journal of Sports Sciences*. 24(10): 1065-1073.

Deci, Ryan, 1985 – *Deci, E.L., Ryan, R.M.* (1985). Intrinsic motivation and self-determination in human behavior. New York, NY: Plenum.

Deci, Ryan, 2000 – *Deci, E.L., Ryan, R.M.* (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*. 11(4): 227-268.

Diener, Dweck, 1978 – *Diener, C.I., Dweck, C.S.* (1978). An analysis of learned helplessness: Continuous changes in performance, strategy, and achievement cognitions following failure. *Journal of Personality and Social Psychology*. 36(5): 451-462.

Diener, Dweck, 1980 – *Diener, C.I., Dweck, C.S.* (1980). An analysis of learned helplessness: II. The processing of success. *Journal of Personality and Social Psychology*. 39(5): 940-952.

Durand-Bush, Salmela, 2002 – *Durand-Bush, N., Salmela, J.H.* (2002). The development and maintenance of expert athletic performance: Perceptions of world and olympic champions. *Journal of Applied Sport Psychology*. 14(3): 154-171.

Dweck, 1986 – *Dweck, C.S.* (1986). Motivational processes affecting learning. *American Psychologist*. 41(10): 1040-1048.

Dweck, Leggett, 1988 – *Dweck, C.S., Leggett, E.L.* (1988). A social-cognitive approach to motivation and personality. *Psychological Review*. 95(2): 256-273.

Elliot, 1999 – *Elliot, A.J.* (1999). Approach and avoidance motivation and achievement goals. Educational Psychologist, 34(3): 169-189.

Elliot, 2005 – *Elliot, A.J.* (2005). A conceptual history of the achievement goal construct. In A.J. Elliot & C.S. Dweck (Eds.). Handbook of competence and motivation (Vol. 16, pp. 52-72). New York, NY: Guilford Press.

Elliott, Dweck, 1988 – *Elliott, E.S., Dweck, C.S.* (1988). Goals: An approach to motivation and achievement. *Journal of Personality and Social Psychology*. 54(1), 5-12.

Ericsson et al., 1993 – *Ericsson, K.A., Krampe, R.T., Tesch-Römer, C.* (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*. 100(3), 363-406.

Gagné, 2010 – *Gagné, F.* (2010). Motivation within the DMGT 2.0 framework. *High Ability Studies*. 21(2): 81-99.

Gould et al., 2002 – *Gould, D., Greenleaf, C., Chung, Y., Guinan, D.* (2002). A survey of U.S. Atlanta and Nagano Olympians: Variables perceived to influence performance. *Research Quarterly for Exercise and Sport*. 73(2): 175-186.

Gustafsson et al., 2011 – *Gustafsson, H., Kenttä, G., & Hassmén, P.* (2011). Athlete burnout: An integrated model and future research directions. *International Review of Sport and Exercise Psychology*. 4(1), 3-24.

Henriksen et al., 2010 – *Henriksen, K., Stambulova, N., Roessler, K.K.* (2010). Holistic approach to athletic talent development environments: A successful sailing milieu. *Psychology of Sport and Exercise*. 11(3), 212-222.

Holt, Dunn, 2004 – *Holt, N.L., Dunn, J.G.H.* (2004). Toward a grounded theory of the psychosocial competencies and environmental conditions associated with soccer success. *Journal of Applied Sport Psychology*. 16(3), 199-219.

Holt, Morley, 2004 – *Holt, N.L., Morley, D.* (2004). Gender differences in psychosocial factors associated with athletic success during childhood. *Sport Psychologist*. 18(2): 138-153.

Johnson et al., 2008 – *Johnson, M.B., Castillo, Y., Sacks, D.N., Cavazos, J., Edmonds, W.A., Tenenbaum, G.* (2008). "Hard work beats talent until talent decides to work hard": Coaches' perspectives regarding differentiating elite and non-elite swimmers. *International Journal of Sports Science & Coaching*. 3(3): 417-430.

Johnson et al., 2006 – *Johnson, M.B., Tenenbaum, G., Edmonds, W.A.* (2006). Adaptation to physically and emotionally demanding conditions: The role of deliberate practice. *High Ability Studies*. 17(1): 117-136.

Keegan et al., 2010 – *Keegan, R., Spray, C., Harwood, C., Lavallee, D.* (2010). The motivational atmosphere in youth sport: Coach, parent, and peer influences on motivation in specializing sport participants. *Journal of Applied Sport Psychology*. 22(1): 87-105.

Lafferty, Dorrell, 2006 – *Lafferty, M.E., Dorrell, K.* (2006). Coping strategies and the influence of perceived parental support in junior national age swimmers. *Journal of Sports Sciences*. 24(3): 253-259.

Li et al., 2018 – *Li, C., Martindale, R., Wu, Y., Si, G.* (2018). Psychometric properties of the Talent Development Environment Questionnaire with Chinese talented athletes. *Journal of Sports Sciences*. 36(1): 79-85.

Li et al., 2017a – *Li, C., Wang, C.K.J., Pyun, D.Y.* (2017). The roles of the talent development environment on athlete burnout: A qualitative study. *International Journal of Sport Psychology*. 48(2): 143-164.

Li et al., 2017b – *Li, C., Wang, C.K.J., Pyun, D.Y.* (2017). Impacts of talent development environments on athlete burnout: A self-determination perspective. *Journal of Sports Sciences*. 35(18): 1838-1845.

Li et al., 2014 – Li, C., Wang, C. K.J., Pyun, D.Y. (2014). Talent development environmental factors in sport: A review and taxonomic classification. *Quest*. 66(4): 433-447.

Li et al., 2015 – *Li, C., Wang, C.K.J., Pyun, D.Y., Martindale, R.* (2015). Further development of the talent development environment questionnaire for sport. *Journal of Sports Sciences*. 33(17): 1831-1843.

Martindale et al., 2005 – *Martindale, R.J., Collins, D., Daubney, J.* (2005). Talent development: A guide for practice and research within sport. *Quest*. 57(4): 353-375.

Martindale et al., 2007 – *Martindale, R.J.J., Collins, D., Abraham, A.* (2007). Effective talent development: The elite coach perspective in UK sport. *Journal of Applied Sport Psychology*. 19(2): 187-206.

Martindale et al., 2010 – *Martindale, R.J.J., Collins, D., Wang, J.C.K., McNeill, M., Lee, K.S., Sproule, J., Westbury, T.* (2010). Development of the Talent Development Environment Questionnaire for Sport. *Journal of Sports Sciences*. 28(11): 1209-1221.

Morgan, Giacobbi, 2006 – *Morgan, T.K., Giacobbi, P.R.* (2006). Toward two grounded theories of the talent development and social support process of highly successful collegiate athletes. *Sport Psychologist*. 20(3): 295-313.

Nicholls, 1984 – *Nicholls, J.G.* (1984). Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. *Psychological Review*. 91(3): 328-346.

Patrick et al., 1999 – *Patrick, H., Ryan, A.M., Alfeld-Liro, C., Fredricks, J. A., Hruda, L.Z., Eccles, J. S.* (1999). Adolescents' commitment to developing talent: The role of peers in continuing motivation for sports and the arts. *Journal of Youth and Adolescence*. 28(6), 741-763.

Raedeke, 1997 – *Raedeke, T.D.* (1997). Is athlete burnout more than just stress? A sport commitment perspective. *Journal of Sport & Exercise Psychology*. 19(4): 396-41.

Rees et al., 1999 – *Rees, T., Ingledew, D.K., Hardy, L.* (1999). Social support dimensions and components of performance in tennis. *Journal of Sports Sciences*. 17(5): 421-429.

Ryan, Connell, 1989 – *Ryan, R.M., Connell, J.P.* (1989). Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and Social Psychology*. 57(5): 749-761.

Ryan, Deci, 2000 – *Ryan, R.M., Deci, E.L.* (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*. 25(1): 54-67.

Vaeyens et al., 2008 – *Vaeyens, R., Lenoir, M., Williams, A.M., Philippaerts, R.M.* (2008). Talent identification and development programmes in sport. *Sports Medicine*. 38(9): 703-714.

Vazou, 2005 – *Vazou, S., Ntoumanis, N., Duda, J.L.* (2005). Peer motivational climate in youth sport: A qualitative inquiry. *Psychology of Sport and Exercise*. 6(5): 497-516.

Wang et al., 2007 – *Wang, C.K.J., Biddle, S.J.H., Elliot, A.J.* (2007). The 2×2 achievement goal framework in a physical education context. *Psychology of Sport and Exercise*. 8(2): 147-168.

Wang et al., 2016 – *Wang, C.K.J., Pyun, D.Y., Li, C., Lee, M.S.* (2016). Talent development environment and achievement goal adoption among Korean and Singaporean athletes: Does perceived competence matter? *International Journal of Sports Science & Coaching*. 11(4): 496-504.

Wang et al., 2011 – *Wang, C.K.J., Sproule, J., McNeill, M., Martindale, R. J. J., Lee, K.S.* (2011). Impact of the talent development environment on achievement goals and life aspirations in Singapore. *Journal of Applied Sport Psychology*. 23(3): 263-276.