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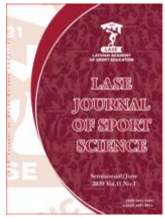

ORIGINAL RESEARCH PAPER

CONTENT VALIDITY AND RELIABILITY OF TEACHER VALUE ORIENTATION INVENTORY IN PHYSICAL EDUCATION

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Abstract

In professional specialization, a PE teacher cognizes behavioural models, social norms, values and desired development perspectives necessary for the teacher's successful performance in this professional role. Value orientation reflects the views of PE teachers on the educational process, what students should learn, how they should be involved in the learning process, and how learning should be evaluated. PE teachers have diverse and varied opinions, thus, reliable and valid inventory is needed to define them. The continuous development of teacher value orientation inventory strengthens the provision of professional socialization of PE teachers. However, the adaptation of the surveys used in practice and research requires a careful evaluation of the cultural environment context, where content validity and reliability play an essential role in survey translation procedures and verification. The aim of this research is to assess content validity and reliability of the Latvian version of the Teacher Value Orientation Inventory in Physical Education Short Form (VOI-SF-PE). Research methods: scientific literature review and analysis, Value Orientation Inventory Short Form (VOI-SF-PE) (Chen, Ennis, & Loftus, 1997) – Latvian version, expert opinion method, mathematical statistics. Research participants: 107 PE teachers aged 40±13 years, 49 – men, 58 – women. Research results show that the VOI-SF-PE version translated into Latvian measures PE teacher value orientation, it has an adequate content validity and reliability, and it can be used in the Latvian environment, as *well as to conduct comparative research with various countries and cultures.*

Key words: *physical education, teacher value orientation, validity, reliability*

Introduction

Within physical education internationally, there continues to be a renewed interest – both philosophically and empirically - in teacher beliefs and their impact on curriculum decision-making and subsequently on student learning (Chen, Zhang, Wells, Schweighardt, & Ennis, 2017; Drouet, Route, Boulley, Pasco, & Lentillon-Kaestner, 2021). As a subject, physical education (PE) possesses a wide range of possible aims and objectives. For example, general consensus purports that the aims and objectives of physical education include: (i) the development of knowledge, principles and strategies related to games, movement and physical activity, (ii) the development of competence in a range of motor skills and movement patterns, (iii) the recognition of value in physical activity engagement, (iv) the development of knowledge and skills leading to the pursuit of lifelong physical activity engagement, and (v) the development of social skills and affective characteristics, including respect for self and others (SHAPE, 2022; ACARA, 2022).

In Latvia, the regulation of the Cabinet of Ministers No. 747 "Regulations Regarding the State Basic Education Standard and Model Basic Education Programmes" (2018, Section 2) establishes that "the objective of the implementation of the basic education content is a comprehensively developed and competent student who is interested in his or her intellectual, socio-emotional, and physical development, is living healthily and safely, studies with pleasure and interest, participates in public events in a socially responsible manner and undertakes initiative, is a patriot of Latvia", while the results to be achieved by the pupil in the field of study of health and physical activity (2018, Section 7.7.): "the pupil understands and practices habits of a healthy lifestyle, recognizes risks in different situations, including extreme situations, and makes decisions for safe and active action, engages skilfully, responsibly and with interest in diverse physical activities, which promote mental and physical abilities, participates in team building, plans, divides work tasks, helps and supports others". Furthermore, the regulation of the Cabinet of Ministers No. 416 "Regulations Regarding the State General Secondary Education Standard and Model General Secondary Education Programmes" (2019, Section 2) states that "the objective of the implementation of the general secondary education content is a competent pupil who is aware of his or her personal capacities and interests for the purposeful creation of personal and professional future, who respects himself or herself and others, deepens knowledge, understanding, skills and continues to strengthen values and virtues according to his or her own future objectives, acts responsibly, innovatively and productively in the creation of himself or herself, family, welfare and sustainable state of Latvia and the world", whereas the results to be achieved by the pupil are complex in the field of study of health, security and physical activity (2019, Section 7.7.) – "the pupil acts intentionally in his or her everyday life according to the habits of a healthy lifestyle, independently and responsibly chooses physical activities and engages in them, defines and implements objectives for the growth of movement skills and physical preparedness of significance for him or her, uses and assesses the most efficient tactical solutions and strategies in individual and team physical activities, is able to identify danger and risks in different environments and situations, including in the case of danger to the national security, understands his or her obligations, rights and possible action within the context of comprehensive national protection, takes preventive safety measures, identifies steps for safe action, selecting the most appropriate strategies for problem solving".

Subsequently, an important question for researchers and PE teachers is "what knowledge and skills are most valuable for my students in this school setting?" (Ennis, 2017a). One approach to answering this question is to examine the knowledge, beliefs and attitudes of PE teachers, given that teacher value orientations have a powerful influence on curriculum and instruction decisions (Ennis, 1992a), and that "curriculum innovation is not complete until a teacher decides to teach it" (Capel, 2016, p. 168). Within health and physical education, there exists a rich body of research that has revealed and confirmed five fundamental value orientations: disciplinary mastery, learning process, self-actualization, social reconstruction, and ecological integration (Ennis & Chen, 1995; Ennis, Chen, & Ross, 1992), with "social responsibility" added as the sixth value orientation by Ennis and colleagues in the early 1990s. Each value orientation serves as a philosophical foundation or a belief system guiding physical educators' curricular choices, instructional decisions, and teaching behaviours in the instructional practice of physical education (Zhu & Chen, 2018).

Curriculum scholars argue that value orientations are important to examine and understand. It is paramount to uncover teacher value orientations as a range of factors that may contribute to values and beliefs, including their study programme at university (e.g., overt focus on socio-cultural or biophysical sub-disciplines), the impact of jurisdictional curricula documents and support materials where curriculum intent challenges traditional norms of enactment and discourses from schools where different forms of student learning may impact teachers' beliefs and attitudes provides a lens or useful heuristic for understanding the practices that teachers may interpret and enact in their classes.

A value orientation developed from one or a combination of two or three curriculum sources, namely subject-matter content, socio-cultural objectives or individual development, is considered important in the curriculum development process for physical education (Jewett, Bain, & Ennis, 1995). To put it briefly, discipline mastery is most related to the development of subject matter content, namely fundamental movement skills, sport skills, health-related exercise and kinesiological subdisciplines. The value orientation of the learning process highlights the principles or processes of learning content related to physical education by adding new knowledge to prior learning - thus linked to constructivist approaches. Self-actualisation puts attention on the individual student and their capacity to become self-directed, responsible and independent, developing autonomy and responsibility for their own learning. The fourth value orientation includes ecological integration. This value orientation emphasises holistic approaches where balance must exist between student needs, subject matter, the context of learning and social concerns. Social reconstruction gives priority to values that align with socio-cultural objectives. Here, teachers view schooling as a process through which culture and society can be achieved and improved. Social responsibility exists as an amalgam of individual development and socio-cultural objectives. Focus is on teaching cooperative behaviours and respect and understanding of others. This sixth orientation replaced social reconstruction in the re-development of VOI-2.

Research studies using VO in physical education

Extensive research has been conducted in the United States, from its inception in the late 80s through present day. In reflecting on the seminal work conducted by the late Catherine Ennis (and colleagues), Curtner-Smith, Baxter & May (2018) have highlighted that value orientation research could fall under three main areas: descriptions and comparisons, influence of value orientations on pedagogy, and interventions/interactions. Readers are encouraged to engage with this paper as word limitations prohibit us from examining these areas in detail. The area of descriptions and comparisons has examined a wide range of characteristics including teachers' gender, race, nationality and physical activity background. Others have also looked at teachers' experience and their qualification levels to see if this influences their value orientations. With regard to experience, findings are equivocal and likely dependent on local context (e.g., curricula, other education contexts) (Banville, Desrosiers, & Genet-Volet, 2002; Ennis

& Chen, 1995; Liu & Silvernman, 2006). Similarly, no differences in priorities were found between the academic programme types (four year undergraduate programme versus one-year postgraduate programme) undertaken by pre-service teachers and their value orientations (Capel, 2016).

It appears from a wide variety of research work amongst pre-service teachers and in-service teachers that value orientations do impact the curriculum content and pedagogical activities delivered in physical education to meet their and their programme objectives – thus highlighting the importance of value orientations on pedagogy. For example, teachers who favour DM and LP VOs tend to teach FMS and games/sport through direct and indirect teaching styles. Their objectives are to be able to perform a variety of skills linked to the curriculum (Ennis, 1992a), with Gillespie (2011) stating that these teachers saw themselves as "knowledge deliverers" (p. 63). Conversely, teachers that favoured SA, SR, and EI were focussed on pedagogies considered to implement affective objectives (Gillespie, 2011). Interestingly, an opportunity for future research is how some teachers value different orientations yet utilise competing pedagogical styles and approaches, thus struggling to reach their objectives (Ennis, 1992b).

The final area highlighted by Curtner-Smith, Baxter and May (2018) is that of impact of interventions and interactions. Several studies have examined teachers' VO as it relates to national curriculum development processes. The main congruence existed between teachers' VOs and the country's national curriculum (see Capel, 2016 and Meek & Curtner-Smith, 2004) for the United Kingdom). One interesting study conducted by Chen and colleagues (2017) examined teachers VO against an externally developed, health-related learning curriculum. Their findings suggested that student learning was not compromised when incongruent VO profiles occurred in teachers delivering the intervention.

Broadening the VOI research

As highlighted by Curtner-Smith, Baxter and May (2018) ongoing work is required to be undertaken in more countries where culture and educational systems differ. Ongoing and developing research has been undertaken around the world. For example, the VOI has been translated into different languages for studies in non-English speaking countries such as in French speaking Canada (Banville, Desorsiers, & Genet-Volet, 2002), Chinese (Chen, Liu, & Ennis, 1997), Flemish (Behets & Vergauwen, 2004) and Taiwanese (Liu & Silverman 2006). It continues to be refined, and further development and validation is occurring, using principles suggested by Zhu & Chen (2018) such that Drouet and team (2021) are developing the French version, OVEPS. Their work considered the five value orientations

and collapsed them to form three value orientations as part of their development of two French versions of the VO questionnaire (OVEPS). The three value orientations included a motor skills VO (collapsing DM and LP), a self-awareness VO (collapsing ecological integration and self-actualisation) and a social knowledge VO, including student social development and the social responsibility VO.
The aim of this research is to assess content validity and reliability of the Latvian version of the Teacher Value Orientation Inventory in Physical Education Short Form (VOI-SF-PE).

Material and Methods

In order to determine the reliability and validity of the Latvian version of the Teacher Value Orientation Inventory in Physical Education Short Form (VOI-SF-PE), the research involved 107 PE teachers, age (40.06 ± 13.05 years, 49 – men, and 58 – women). The following research methods were used in the research: scientific literature review and analysis, Teacher Value Orientation Inventory in Physical Education Short Form (VOI-SF-PE) (Chen, Ennis, & Loftus, 1997) – Latvian version, expert opinion method, mathematical statistics. The study has been approved by the Ethics commission of the Latvian Academy of Sport Education. The questionnaire survey and collection of respondents' data took place anonymously, in accordance with the Vienna Convention on Human Rights.

Teacher Value Orientation Inventory in Physical Education Short Form (VOI-SF-PE) (Chen, Ennis, & Loftus, 1997) consisting of 50 statements is organized into 10 five-statement sets and 5 dimensions (factorial structure): disciplinary mastery (DM), learning process (LP), self-actualization (SA), social responsibility (SR), and ecological integration (EI). VIO-SF is based on the forced-choice format – 10 five-statement sets of forced choice scales. Forced-choice questionnaires consist of multiple "blocks" presenting two or more items simultaneously, and the participants are asked to indicate their preferences for the items within each block. The unlabelled items are randomly arranged in each set. Participants should rank each of the five items in each set according to their priorities, ranging from 5 (highest priority) to 1 (lowest priority). By doing so, the composite scores from each value orientation range from 50 to 10, reflecting a priority for items in one of the value orientations.

The adaptation of the questionnaire survey took place in several stages (Zhu & Chen, 2018; International Test Commission, 2017). The forward-backward translation of the questionnaire survey was provided by professional English and Latvian philology specialists specializing in sport science. The apparent and content validity was determined. Five experts were invited to determine the content validity. The following content validity approaches were used: a content validity index (CVI) is estimated for individual items (Lynn, 1986) and Cronbach's Alpha coefficient to quantify agreement of item relevance by three or more experts (Waltz, Strickland, & Lenz, 2005).

The expert group consisted of 3 scholars, 1 practitioner, and 1 end user. Five experts validated the content of each questionnaire survey item. A 4-point scale (Lynn, 1986) was used: 1-irrelevant, 2-partially irrelevant, 3-almost relevant, 4-fully relevant. The CVI for each scale item is the proportion of experts who rate the item as a 3 or a 4 on a 4-point scale. Example: 3 of 5 content experts rated an item as relevant (3 or 4), the CVI would be: 3/5= .60. This item would not meet the required .80 level (Polit & Beck, 2006). The CVI for the entire scale is the proportion of the total number of items deemed content valid.

The following mathematical statistics methods were used in the research: descriptive statistics, Cronbach's Alpha coefficient - to determine internal consistency of the questionnaire survey and its subscales. Data were processed with SPSS software 28.0.

Results

In the next stage of the research after the forward-backward translation of the questionnaire survey, the experts determined the content validity of the questionnaire survey. All five experts anonymously evaluated the item content validity of the Latvian version of the VOI-SF-PE questionnaire survey. After evaluation, a content validity index (CVI) was determined for each item. The research found that all questionnaire survey items have a valid CVI index indicator, from 0.80 to 1.00. CVI was 0.80 only for 6 items: "1. I teach students to try new activities to find ones they enjoy (EI)", "10. I teach students games, sports and fitness activities so they can participate with others (DM)", "11. I require that students spend class time practicing games, skills, and fitness tasks emphasised in my daily objectives (DM)", "26. I teach students to use knowledge or skills learned in class to help their group or team be successful", "27. I teach students about the positive uses of exercise and healthy eating for their bodies (DM)" and "50. I teach students how to learn new knowledge and skills (LP)", while the other 44 items had CVI of 1.00. Therefore, it can be concluded that the content of the Latvian version of the VOI-SF-PE questionnaire survey corresponds to the original version of the questionnaire survey as the CVI index is appropriate.

In turn, when determining the Cronbach's Alpha coefficient to quantify agreement of item relevance by five experts, it was found that the Latvian version of the VOI-SF-PE questionnaire survey has a Cronbach's Alpha coefficient of 0.89. The translated version of the questionnaire survey has a relatively high item relevance, because if the Cronbach's Alpha coefficient is below 0.70, then it is considered the lowest scientifically acceptable value, while a value above 0.80 is considered good (Ahmad, Zulkurnain, & Khairushalimi, 2016). However, the average indicators of individual items of the questionnaire survey are from 3.00 – 4.00, where the experts evaluated each statement on a 4-point scale; the determined average indicators show that the translated version of the questionnaire survey has adequate content validity.

In the next stage of the research, 107 PE teachers fille out the Latvian version of the VOI-SF-PE questionnaire survey. At this stage of the research, the descriptive statistics of the Latvian version of the VOI-SF-PE questionnaire survey and the Cronbach's Alpha coefficient for the questionnaire survey as a whole and for each scale of the questionnaire survey was determined. The average indicators of each scale of the questionnaire survey and the standard deviation is shown in Table 1.

Table 1

Descriptive Statistics Indicators of the Teacher Value Orientation Inventory in Physical Education Short Form Translated into Latvian (*n*=107)

VOI-SF-PE	DM	LP	SA	SR	EI
X±Σ* (*n*=107, inventory translated into Latvian)	36.37±7.19	35.48±7.16	35.47±7.38	34.62±8.86	34.11±7.31

**X – arithmetic mean; Σ – standard deviation*
DM=Disciplinary Mastery; SR=Social Responsibility; LP=Learning Process; SA=Self-Actualization; EI=Ecological Integration

The highest arithmetic mean indicator is in the DM scale (36.37±7.19), which indicates that knowing the curriculum content during a PE class is very important for teachers and that they pay more attention to the acquisition of skills and knowledge related to performance in sport. Pupil learning experience will be mainly focused on skill development, competence in sport, fitness and knowledge to improve performance. In turn, the lowest arithmetic mean indicator is in the EI scale (34.11±7.31), which indicates that the teacher is able to maintain a balance between the needs of the pupil and the group, and by integrating the content of the study subject, the personal development of pupils and the achievement of identifiable socio-cultural goals. The teacher encourages pupils to find personal meaning by participating in various physical activities, learning about movements and improving understanding about the environment in which they live. Furthermore, the average indicators of individual items of each scale exceeded 3.0 on a 5-grade scale: in the DM scale from 3.24 – 4.12 (for instance, see Table 2); in the LP scale from 3.09 – 3.93; in the SA scale from 3.37 – 4.14; in the SR scale from 3.27 – 3.73, and in the EI scale from 3.07 – 3.74.

Table 2

Item Statistics of the scale DM of the Teacher Value Orientation Inventory in Physical Education Short Form Translated into Latvian (*n*=107)

DM scale items	Mean	Std. Deviation
4. Es plānoju tā, lai skolēni praktizētu prasmes, spēles vai fitnesa uzdevumus. *[4. I plan so that students are practicing skills, games, or fitness tasks]*	3.36	1.269
10. Es mācu skolēniem spēles, sporta un fitnesa aktivitātes, lai viņi varētu piedalīties tajās kopā ar citiem. *[10. I teach students games, sports and fitness activities so they can participate with others.]*	3.62	1.343
11. Es prasu, lai skolēni laiku stundās pavadītu, vingrinoties spēlēs, prasmēs un fitnesa uzdevumos, kas akcentēti manos ikdienas mērķos. *[11. I require that students spend class time practicing games, skills, and fitness tasks emphasised in my daily objectives.]*	3.24	1.393
16. Es plānoju tā, lai skolēni vingrinātos optimālā biežumā, intensitātē un ilgumā, lai uzlabotu savu fizisko sagatavotību. *[16. I plan so that students exercise at optimal frequency, intensity, and duration levels to improve their fitness]*	3.86	1.217
21. Es mācu skolēniem pareizi izpildīt prasmes vingrinājumos un kustību pamatus. *[21.I teach students to perform exercise skills and movement fundamentals correctly]*	4.12	1.130
27. Es mācu skolēniem par vingrinājumu un veselīgā uztura pozitīvo ietekmi uz viņu ķermeni. *[27. I teach students about the positive uses of exercise and healthy eating for their bodies]*	3.82	1.196
31. Es mācu skolēniem zināšanas un prasmes, lai viņiem patiktu sportot un spēlēt spēles. *[31. I teach students knowledge and skills so they will enjoy playing sports and games]*	3.88	1.286
39. Es mudinu skolēnus izbaudīt mācīšanās prasmes, spēles un fitnesa aktivitātes. *[39. I encourage students to enjoy learning skills, games, and fitness activities]*	3.71	1.166
43. Es mācu skolēniem visefektīvāko veidu, kā pielietot zināšanas un veikt specifiskus pienākumus. *[43. I teach students the most effective way to apply knowledge and perform specific duties]*	3.40	1.196
48. Es mācu skolēniem kļūt zinošiem, prasmīgiem un sagatavotiem. *[48. I teach students to become knowledgeable, skilled and fit]*	3.36	1.312

A statement with an average value below 3.0 on a 5-grade scale is considered as weak in the value orientation content and is excludedregardless of its ranking position (Chen, Ennis, Loftus, 1997). In the Latvian version of the VOI-SF-PE questionnaire survey, there was no statement with an average value below 3.00 on a 5-grade scale, so the content of the statements corresponds to the content of the scale dimensions.

The Cronbach's Alpha coefficient for each of the scales ranges from 0.766 to 0.867 (see Table 3): in the DM scale – 0.774; in the LP scale – 0.810; in the SA scale – 0.766; in the SR scale – 0.867, and in the EI scale – 0.772. All questionnaire survey scales have acceptable internal consistency and reliable questionnaire survey results in three (DM, SA, EI) out of five questionnaire survey scales 0.70 – 0.79 (Cohen, Manion, & Morrison, 2007), while highly reliable questionnaire survey results are in two (LP, SR) scales 0.80 – 0.90 (Cohen, et al., 2007).

Looking at the Corrected Item-Total Correlation for each item, the results show that none of the questionnaire survey items have negative values, which would indicate that any of the items are measuring something else. None of the items are in doubt and there is no need to decide whether an item should be removed from the analysis.

Table 3

Cronbach's Alpha coefficient of the Teacher Value Orientation Inventory in Physical Education Short Form Translated into Latvian (*n*=107)

VOI-SF-PE	DM	LP	SA	SR	EI
Cronbach's Alpha coefficient	0.774	0.810	0.766	0.867	0.772

DM=Disciplinary Mastery; SR=Social Responsibility; LP=Learning Process; SA=Self-Actualization; EI=Ecological Integration

The Cronbach's Alpha coefficient of all scales of the Latvian version of the VOI-SF-PE questionnaire survey is 0.94, which indicates a high alpha value (> 0.90) (Cohen, et al., 2007; Tavakol, & Dennick, 2011) and a form appropriate for the Latvian language and the Latvian cultural environment.

Discussion

There are researchers who believe that an alpha value of 0.90 is the maximum recommended (Tavakol & Dennick, 2011), and if this value is exceeded, it may indicate that the questionnaire survey should be shortened, but there are also studies that state that it would not be desirable for the Cronbach's Alpha value to exceed 0.95 (DeVellis, 2003). The Cronbach's Alpha coefficient of the Latvian version of the VOI-SF-PE questionnaire survey is 0.94, none of the average indicators of individual items was lower than 3.0 and the results of the Corrected Item-Total Correlation for each item show that none of the questionnaire survey items has a negative value;

herefore, it can be concluded that the questionnaire survey does not need to be shortened. Thus, the Latvia version of the Teacher Value Orientation Inventory in Physical Education Short Form has an appropriate structure. The Latvian version of the VOI-SF-PE questionnaire survey is valid for use in the Latvian environment, as well as for comparing the obtained results with scientific research conducted around the world, in which such an inventory is used.

If we compare the average indicators of each scale of the questionnaire survey included in this research (n=107) with the results of other recent research (Chen, et al., 2017; Vieira & Carreiro da Costa, 2017), where a variant of the VOI-SF-PE questionnaire survey was used (see Figure 1), then the DM scale in all research has the highest average indicators from 33 to 44, which shows that curriculum content approach is dominant for PE teachers.

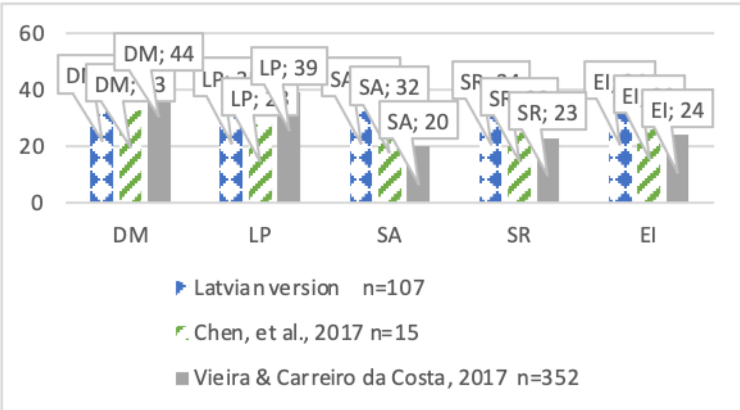

Figure 1. Comparison of Average Indicators of Each Scale of the VOI-SF-PE Questionnaire Survey in Various Research

Teachers believe that passing on knowledge and skills to each generation of pupils through repeated practice is the best way to achieve competence. For these teachers, the goal of PE is the pupils' ability to understand basic knowledge and be able to demonstrate skills in the PE context. Latvian PE teachers also have the highest average indicator in this scale compared to other scales.

In turn, the lowest average indicators are in the SR scale from 23 to 34, which indicates the desire of teachers to give priority to interpersonal interaction, cooperation and teamwork in and outside the learning environment. Learning tasks in the classroom of a SR-oriented PE teacher can focus on character development, raising pupils' responsibility for self and society. In physical education, SR learning results will focus on pupils showing respect and cooperation, as well as valuing teamwork during physical activities and not only as a member of a group. Therefore, active participation becomes an integral part of social responsibility. Teachers with this value orientation use a group-based learning approach so that pupils experience cooperation, group dynamics and teamwork, and to emphasize collective goals. However, compared to the results of other research, Latvian PE teachers have the highest average results of the SR scale of 34. If we look at the average results of the scales of this research as a whole, it can be concluded that Latvian PE teachers have assigned a relatively equal priority to each of the scales, as the average indicators are between 34 and 36.

The limitations of this research are related to the existing COVID-19 restrictions in the country, which affected the participation of a larger number of respondents in the research. PE teachers had difficulty setting priorities in the five-statement sets, because they believed that all aspects of the dimension are important.

In the future, this questionnaire survey can be used in the Latvian environment, both for comparing the value orientation and pedagogical approach of PE teachers of different levels of education, and the survey can also be used for researching the value orientation of future PE teachers in the study process, further promoting professional specialization in the course of studies, in which the future PE teacher learns what behaviour and development perspectives are desirable in this professional role. The possible further application of this version in international comparative research is very important in order to study the common and different aspects of PE teacher value orientation, to understand the peculiarities of global changes, as well as to develop recommendations for improving professional specialization.

Conclusions

The research results indicate that the Latvian version of the VOI-SF-PE questionnaire survey measures PE teacher value orientation, is has an appropriate reliability (Cronbach's Alpha coefficient is 0.94) and an adequate content validity (CVI index indicator from 0.80 to 1.00) and it can be used in the Latvian environment, as well as to conduct comparative research with various countries and cultures.

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ORIGINAL RESEARCH PAPER

STROKE PARAMETER ANALYSIS DURING A COMPETITION DISTANCE (200M) IN CANOE SPRINT ON AN ERGOMETER AND ON WATER

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Abstract

Canoe sprint is a specific type of sport (under natural conditions, it takes place on water); therefore, a large part of research is carried out under laboratory conditions, when the load is performed on various special exercise machines (ergometers) that try to simulate natural conditions as closely as possible. Thus, one of the fields of research in canoe sprint is the mutual correlation of various indicators – kinematic, physiological and biomechanical – under natural conditions of the sport and under laboratory conditions. Although research have been carried out in the relevant direction, they did not consider specific direct differences in the power of a stroke and stroke parameters when paddling on an ergometer compared to paddling on water. A precise comparison of these differences would provide an opportunity to describe the differences in the characteristics of a full stroke and brace (water phase) when paddling on water and on an ergometer in canoe sprint, simulating a 200m competition distance. The research subject was a European and World championships medallist, – 25 years of age, height – 191.4cm, weight – 99.1kg. In order to obtain stroke parameters during a 200 m competition distance under natural conditions on water and under laboratory conditions while paddling on an ergometer, two experiments were carried out – a field experiment and a laboratory experiment (the two experiments included pulsometry, blood biochemical analysis and dynamometry). There were large percentage differences found among the time parameters of a stroke: when paddling on water, the duration of the unsupported phase was 44.8% shorter (0.08s), and when paddling on an ergometer, the duration of the brace phase was 29.8%

longer (0.1s). The total duration of a stroke on water was on average 5% longer (0.02s). This indicates the different nature of the load, as the time in which muscles must be able to perform the maximum transfer of force and power per unit of time is 1/10 longer on water; this, in turn, suggests that coaches need to take these differences into account when preparing athletes; - in athletic training, the parameters of a stroke performed on water should be taken as the basis for the duration of muscle work.

Key words: *Canoe sprint, kayak ergometer, on water measurements, stroke parameters, stroke phases, power.*

Introduction

Modern canoe sprint is characterized by high intensity, a tight competition schedule (from April to August) and specialization in a specific discipline. By specialization we understand the adaptation of athlete training to a specific distance and boat class. If before the Beijing Olympic Games in 2008 an athlete often competed in several disciplines and boat classes, then with the next Olympic cycle this trend has changed, and athletes specialize in a specific distance and a specific boat class. This is due to the changes in the competition programme, which make it difficult to compete in several disciplines. Such specialization forces the sport to develop, – to perform scientific measurements in order to use them in methodical preparation. Since canoe sprint is a specific type of sport (under natural conditions, it takes place on water), a large part of measurements and research takes place under laboratory conditions, when the load is performed on various special exercise machines (ergometers) that try to simulate natural conditions as closely as possible (Van Someren & Olivier, 2002; Begon & Colloud, 2007; Borges et al., 2017). Thus, one of the fields of research in canoe sprint is the mutual correlation of various indicators – kinematic, physiological and biomechanical – under natural conditions of the sport and under laboratory conditions.

Due to the latest technological advances in biomechanical measurements in canoe sprint (Sturm et al., 2010; Sturm, 2012; Gomes et al., 2011; Gomes et al., 2015; Hogan, 2019; Bonaiuto et al., 2020; Winchcombe, 2020; Kong et al., 2020), it is possible to analyse them under natural conditions. Currently, obtaining biomechanical measurements has become possible due to commercially available devices that provide the opportunity to perform such measurements. Research show significant differences in kinematic indicators, – the technical performance, muscle activity, stroke frequency (Klitgaard et al., 2020; Fleming et al., 2012 a,b). Differences in physiological indicators are also noted, - in the maximum oxygen consumption (Matzka et al., 2021). Furthermore, research have been conducted on the calculation of load intensity, using various biomechanical and physiological indicators, such as heart rate (Van Someren & Olivier, 2002; Bishop 2004; Borges et al., 2014). In general, the aim of the research is to adjust the load intensity in training work on water. In studies where measurements were made on water, it was found that power indicators are most effectively used in load planning (Hogan, 2019; Winchcombe, 2020).

Summarizing the analysed sources of literature, it was concluded that the types of biomechanical measurements in canoe sprint are divided into three basic categories: competition analysis, kinematic analysis and force measurements on water. The third type is the one of interest in our research; according to the author Lok, 2013, it is the most important when paddling on water, - and also the most difficult, as it must be taken into account that the devices that perform these measurements must meet specific requirements. The authors Aitken and Neal (1992), and Stothart et al. (1986) have already developed separate guidelines to consider: water endurance, lightness, mobility, a robust provider of signal energy and data recording capacity, adaptability to the paddle of the subject, real-time reflection of an action from more than one subject (team boats).

In general, these guidelines have been taken into account and researchers in canoe sprint have progressed greatly with the development of such devices. Researchers Baker (1998), and Sperlich and Baker (2002) have already published force indicators of a stroke, – measured in newtons (N). Furthermore, a system of measuring devices was developed – "Fpaddle", which has been used in various research (Gomes et al., 2011; Gomes et al., 2015). In 2010, authors Sturm, Yousaf and Eriksson published a study on a device, – "Kayak XL System", – that measures not only the force applied to the paddle, but also leg force – the force that the athlete exerts against the leg support of the boat through the feet during a canoe sprint stroke movement (Sturm et al., 2010). Recently, another device has appeared, with the help of which it is possible to perform these measurements – "E-Kayak system". Authors Bonaiuto et al. (2020) have reviewed the possibilities of this device in their study. It is a multi-channel digital reception system tailored specifically for canoe sprint. Unfortunately, there is no information about the above-mentioned devices regarding their commercial availability; the opposite is the case with the device – "Kayak Power meter", – manufactured by the New Zealand company "One Giant Leap", which is a commercially available product that allows to measure the force and power indicators of a stroke on water; the device has been validated (Macdermid & Fink, 2017) and several studies have already been conducted with it in canoe sprint (Hogan, 2019; Winchcombe, 2020; Kong et al., 2020).

The most important stroke parameters that can be obtained by using these devices are:

- stroke frequency or pace (the number of strokes performed per minute);
- brace length (the distance from the water contact of a paddle blade until its removal from water);
- brace duration (the time from the water contact of a paddle blade until its removal from water);
- stroke length (the distance travelled from the start of a brace with one hand to the start of the next brace with the other hand);
- stroke duration (the time from the beginning of a brace with one hand to the start of the next brace with the other hand);
- air phase time (the part of the stroke time in which the paddle blade is out of the water);
- brace length (the distance travelled by the boat only during the brace phase);
- stroke force variables (the maximum achieved force, average force, force ratio, rate/frequency of force increase, impulse and impulse frequency);
- stroke power variables (the maximum power achieved/peak power in a stroke, average power, power ratio and work performed).

Although studies have been conducted in the discussed direction, they did not cover specific direct differences in stroke power and stroke parameter indicators when paddling on an ergometer compared to paddling on water. A precise comparison of these differences would provide an opportunity to describe the differences in the characteristics of a full stroke and brace (water phase) when paddling on water and on an ergometer in canoe sprint, simulating a 200m competition distance.

Material and Methods

The research subject was a European and World championships medallist, – 25 years of age, height – 191.4cm, weight – 99.1kg. The permission of the Ethics Commission of the Latvian Academy of Sport Education was received for this study.

In order to obtain the stroke parameters of a high-performance kayaker during a 200m competition distance under natural conditions on water and under laboratory conditions on a kayak ergometer, two experiments had to be performed, – a field experiment and a laboratory experiment.

The **field experiment** was conducted in a competition distance, – in Limbaži, at the paddling base of SIA “Olimpiskais Centrs Limbaži”, ten days after the final race of the World championship. Within its framework, the athlete performed a 200m distance at maximum effort in a competition distance, and the following methods were used to obtain data: pulsometry (to obtain HR recovery indicators); blood biochemical analysis (to obtain lactate recovery indicators); dynamometry (to obtain indicators of power and force applied to the paddle), using a specialized device – a kayak power meter (*One Giant Leap, Nelson, New Zealand*).

Pulsometry was provided by a Garmin pulsometer (model: Forerunner 935) combined with a heart rate belt (model: HRM-Tri™ monitor). The pulsometer was placed on the boat, wrapped around a special watch holder and placed in clear sight of the athlete so that he could see the information displayed on it.

For an informative comparison of the physiological orientation of load between the two experiments, blood biochemical analysis was performed, and lactate value was measured before the load, in the 4th minute immediately after the load and in the 25th minute of recovery. Lactate measurement was performed with a portable test strip analyser Accutrend® Plus. Based on the scientific literature on portable lactate devices in sport, it is one of the most commercially available (Baldari et al., 2009, and Tanner, Fuller & Ross, 2010).

A special device – a kayak power meter (*One Giant Leap, Nelson, New Zealand*) – was used to measure the force and power of the stroke. The validity of the device ranges from 0.12% to 1.4% (Macdermid and Fink, 2017). In order to prepare the device for work, an online application must be used with a *Bluetooth* connection, the operation of which is ensured through adaptive network technology – ANT+™.

Data are recorded using a Windows desktop application or a paired compatible ANT+™ device running in bicycle mode (as power display is required). The device was used in high-speed data mode – HSD. The competition distance covered was recorded by a power meter at a frequency of 50hertz (Hz); each value of power (W) and applied (upper and lower arm) force (N) was recorded every 0.01s. The device stored the fire in its internal memory, and it was then possible to analyse the data by using an internet connection and accessing the manufacturer's data reflection application. Furthermore, the data were downloaded in a *Microsfot Excel* application format. A total of 27834 cells were filled with data as the device was operated in high-speed data recording mode for approximately five minutes and recorded all force and power values applied by the subject to the strokes every 0.005s. Furthermore, data filtering was performed, and only the data reflecting the power and force values during a competitive distance (200m) on water were extracted (3814cells). Next, data comparison was made in the MS Excel application and the online application, as it was important to mark the beginning and the end of the strokes, as well as to separate brace phases to further record and analyse the average values of these indicators. Also, a recording and summarization of the stroke and brace duration was performed. These actions were performed for each of the 87 strokes performed by the athlete in the 200m distance on water. The power meter recorded six different values in high-speed data mode every 0.01 s: upper arm force applied to the paddle shaft (left stroke), lower arm force applied to the paddle shaft (left stroke), upper arm force applied to the paddle shaft (right stroke), lower arm force applied to the paddle shaft (right stroke), power (left stroke), power (right stroke). Thus, during the performance of each stroke (right or left), there were changes in the indicators of the relevant active side, for instance, when the athlete performed a left stroke, there were changes (an increase) in the values of upper and lower arm force of the left stroke and the power values of the left stroke.

One of the next parameters that was calculated was the duration (s) of the unsupported phase of a stroke, which was calculated by expressing the unknown value of (1) equation: the duration of a brace was subtracted from the duration of a stroke.

The **laboratory experiment** took place exactly 2 weeks after the field experiment, in the sports laboratory of the Latvian Olympic Unit, with the subject completing a 200m distance on a kayak ergometer at maximum effort. The following experimental methods were used during the laboratory experiment: ergometry; pulsometry; blood biochemical analysis (lactate measurement during the load). The load was performed on a kayak and canoe ergometer „Dansprint", Dansprint ApS, Hvidovre, Denmark. It is one of the kayak ergometers that is also used in official races and also one of the most commercially available kayak ergometers (Borges et al., 2017). When paddling on a kayak ergometer, using the „Dansprint" application "Dansprint Analyser – USB – ver.1.61", initially 13 indicators were recorded: number of consecutive strokes; total distance (m); speed (km/h); length of the stroke (m); power of the stroke (W); work (J); pace (strokes/min); water time (%); stroke time (s); length of the stroke in water (m); unsupported phase (s); total work done (J); the time spent in the distance (s).

A more in-depth analysis of the stroke parameters on an ergometer required the calculation of additional indicators. Within the framework of the study, the stroke time in water (water connection) or brace time (s) was calculated:

$$brace\ time\ (s) = stroke\ time\ (s) - unsupported\ phase\ (s)$$

In each of these phases, specific technical actions of the athlete are manifested, and the division of such phases is also expressed by researchers in canoe sprint (Plagenhoef, 1979; Krauksts, 1997; Szanto 2010; McDonnell et al., 2012).

As part of the study, the brace force was also calculated according to this equation (N):

$$Force = \frac{P\ x\ t}{d\ \ 0} \qquad (2)$$

In the equation, P is the power of the stroke (W), t is stroke time (m) and d is the stroke length (m).

In addition, the relative power was also calculated, and it was expressed by the following equation:

$$Average\ relative\ power\ (W/kg) = \frac{Average\ power\ of\ the\ stroke\ (W)}{Weight\ of\ the\ athlete\ (kg)} \qquad (3)$$

The average correlations and changes in stroke parameters when paddling on a kayak ergometer were summarized and presented in a table (see Table 1).

Table 1

Comparison of Various Indicators Between an Ergometer and Paddling on Water

Indicator	Ergometer	Water	Percentage difference (%)	p value
Number of strokes	89.33	87.00	-2.6	p > 0.05
Speed (km/h)	19.42	18.95	-2.4	p > 0.05
Stroke length (m)	2.24	2.30	2.6	p > 0.05
Brace power (W)	941.4	1071.1	**12.1**	**p < 0.05**
Stroke power (W)	539.9	862.6	**37.4**	**p < 0.05**
Stroke force (N)	100.5	395.8	**74.6**	**p < 0.05**
Brace force (N)	174.6	456.2	**61.7**	**p < 0.05**
Work (J)	224.0	366.3	**38.9**	**p < 0.05**
Pace (stroke/min)	144.7	137.0	**-5.3**	**p < 0.05**
Water time (%)	57.5	78.0	**26.3**	**p < 0.05**
Stroke time (sec)	0.42	0.44	**5.0**	**p < 0.05**
Brace time (s)	0.24	0.34	**29.8**	**p < 0.05**
Unsupported phase (s)	0.18	0.10	**-44.8**	**p < 0.05**
Total work (J)	20083.00	31868.1	**37.0**	**p < 0.05**
Total time (s)	37.57	38.1	1.4	p > 0.05

Results

A total of 15 different indicators were compared, 11 of which are related to the nature of the stroke in canoe sprint.

There was a -2.6% difference between the number of strokes performed on the ergometer and on water; the difference is not significant ($p>0.05$).

There was a -2.6% difference between the average speed presented in the distance on the ergometer and on water, the difference is not significant ($p>0.05$).

There was a 2.4% difference between the average stroke length on the ergometer and on water, the difference is not significant ($p>0.05$).

There was a 12.1% difference between the average power of the brace on the ergometer and on water (see Figure 1), which is considered significant ($p<0.05$). The correlation on the ergometer is not reliable $r|<r\ 0.05;n$. The correlation on water is reliable $|r|\geq r\ 0.05;n$ and considered weak $0.2<|r|< 0.49$.

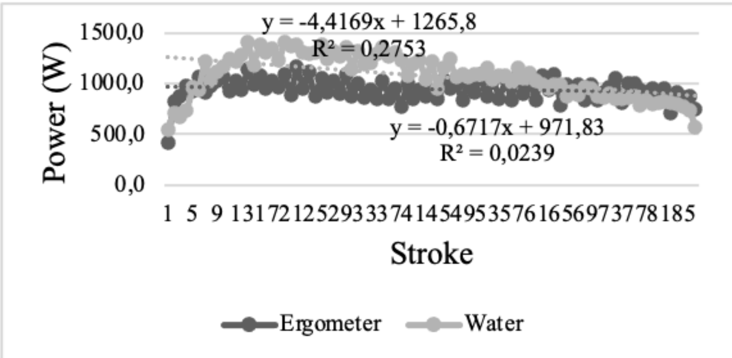

Figure 1. Brace Power (on Ergometer and on Water)

There was a 37.4% difference between the average power of the stroke on the ergometer and on water (see Figure 2), which is considered significant ($p<0.05$). The correlation both on the ergometer and on water is reliable $|r| \geq r\ 0.05;n$ and in both cases it is considered weak $0.2<|r|<0.49$.

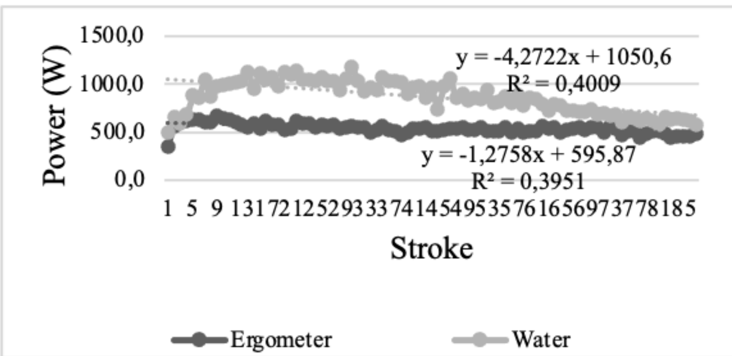

Figure 2. Stroke Power (on Ergometer and on Water)

There was a 74.6% difference between the average force of the stroke on the ergometer and on water (see Figure 3), which is considered significant ($p<0.05$). The correlation both on the ergometer and on water is reliable $|r|\geq r$ 0.05;n. In the case of the ergometer, it is on average $0.5<|r|<0.69$. On water, the correlation is rated as close $0.7<|r|< 0.99$.

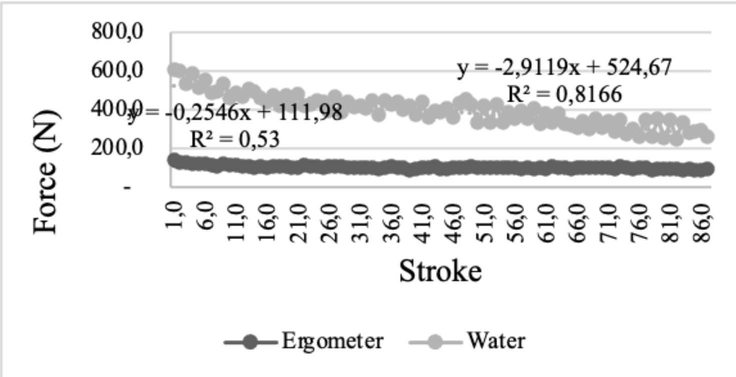

Figure 3. **Stroke Force (on Ergometer and on Water)**

There was a 61.7% difference between the average brace force on the ergometer and on water (see Figure 4), which is considered significant ($p<0.05$). The correlation on the ergometer is not reliable $r|<r$ 0.05;n. The correlation on water is reliable $|r|\geq r$ 0.05;n and considered close $0.7<|r|<0.99$.

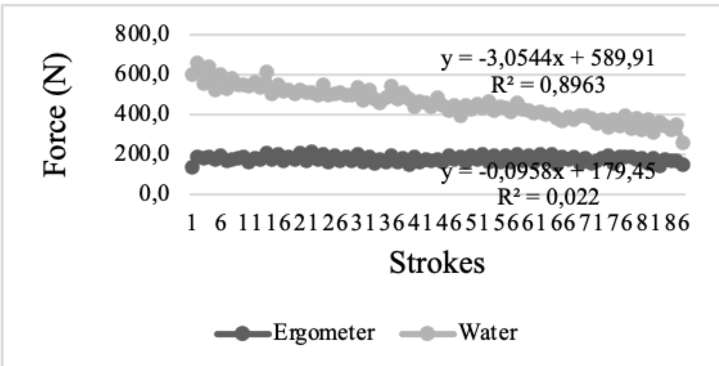

Figure 4. Brace Force (on Ergometer and on Water)

There was a 38.9% difference between the average stroke/brace work on the ergometer and on water, which is considered significant ($p<0.05$).

There was a -5.3% difference between the average shown pace when paddling on the ergometer and on water, which is considered significant ($p<0.05$).

There was a 26.3% difference between the average (%) water contact when paddling on the ergometer and on water, which is considered significant ($p<0.05$).

There was a 5% difference between the average stroke time when paddling on the ergometer and on water (see Figure 5), which is considered significant ($p<0.05$). The changes in the stroke duration values are considered significant $p<0.05$, but the correlation in both cases is not reliable $|r|<r_{0.05;n}$.

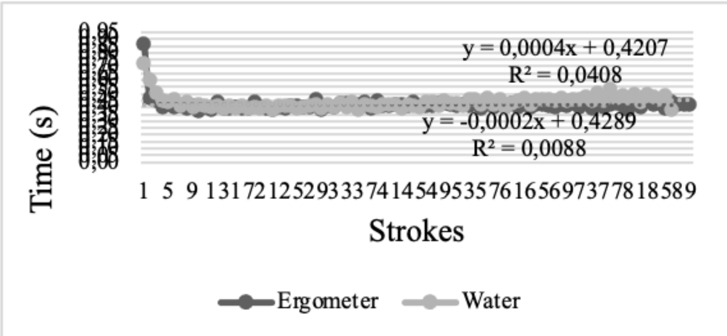

Figure 5. Stroke Duration (on Ergometer and on Water)

There was a 29.8% difference between the average brace time when paddling on the ergometer and on water (see Figure 6), which is considered significant ($p<0.05$), and the changes in the brace duration values are considered significant $p<0.05$, but the correlation in both cases is not reliable $|r|<r_{0.05;n}$.

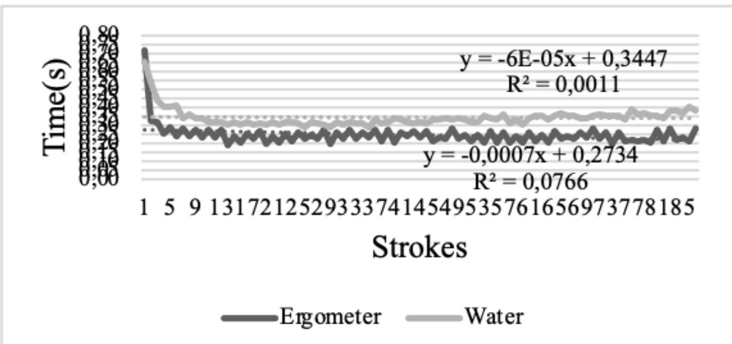

Figure 6. Brace Duration (on Ergometer and on Water)

There was a -44.8% difference between the average time of the unsupported phase when paddling on the ergometer and on water (see Figure 7), which is considered significant ($p<0.05$). The correlation both on the ergometer and on water is reliable |r|≥r 0.05;n and in both cases it is considered weak 0.2<|r|<0.49.

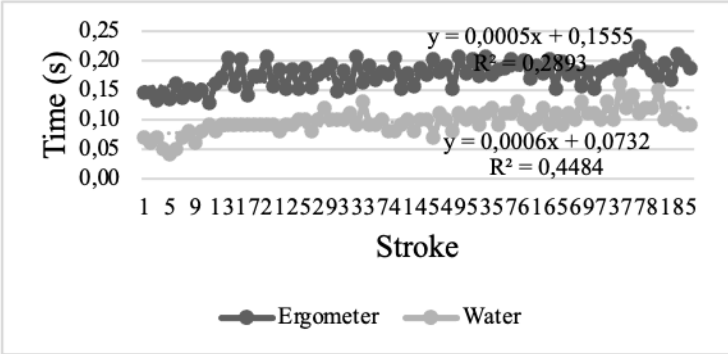

Figure 7. Unsupported Phase Duration of a Stroke (on Ergometer and on Water)

There was a 37.0% difference between the total work done on the ergometer and on water, which is considered significant ($p<0.05$).

There was a 1.4% difference between the total distance time on the ergometer and on water, which is not considered significant ($p>0.05$).

In general, the indicators differed, as well as the degrees of their difference appeared to vary. In order to be able to assess the significance of these differences, the percentage difference for each indicator was calculated between their values on the ergometer and on water. In 4 out of 15 cases, the difference was less than 5%. In 11 cases, this difference was >5% (from 5 to 74.6%). The smallest percentage differences were found between the number of strokes, the average speed shown over the distance, the stroke length and the total time spent on the distance. The largest percentage differences were found between the force values applied in the stroke and its brace phrase (61.7% and 74.6% respectively). There were also large percentage differences between stroke time parameters: when paddling on water, the duration of the unsupported phase was 44.8% shorter (0.08 s), while when paddling on the ergometer, the brace phase time was 29.8% longer (0.1s). The total stroke duration on water was on average 5% longer (0.02s).

Discussion

The aim of the research was to compare stroke parameters during a 200 m competition distance simulation on an ergometer and on water. The obtained results indicate differences in such indicators as stroke power, brace power, stroke force and brace force. Basically, the differences in these indicators can be explained by the fact that different devices were used, each of which measures these indicators differently. A group of researchers from Australia also faced the same issue (Winchcombe et al., 2019), so they state that in the future it is necessary to study the possibility of determining power indicators in the same way both on an ergometer and on water.

Previously Sturm (2010) has had similar achievements with a team as they compared the developed "Kayak XL System" device and whether the power displayed by the device correlates with the power of the ergometer (in this case, the "Dansprint" ergometer was used). It was found that the maximum force values applied to the paddle correlate well (93.6%) with the force device continued, various trials took place, during which the desired nuances were improved and the second version of the device was developed (Sturm, 2012). However, there is currently no information on the commercial availability of this device and other studies involving it. Therefore, it is currently still relevant to find out the average differences in stroke parameters, performing as equal load as possible on an ergometer and on water; thus, the author's study also looked at physiological indicators – heart rate and biochemical lactate analysis.

In the study, the average differences of the HR value per second during a 200m competition distance simulation showed a difference of 3.49% between paddling on water and paddling on the ergometer (it was higher when paddling on water). Looking at the lactate values – before and after the load they were 1.0 and 1.5mmol/l respectively, and in the 4th minute after the load (the maximum La value) 19.5 and 13mmol/l on the ergometer and on water. Taking into account the presented maximum HR and La values, it can be concluded that the subject performed a maximum load. We conclude that the following differences in the stroke force and power indicators can be observed when performing a maximum load between an ergometer and water, in favour of water, – the brace power is 9.9% higher; the stroke power is 35.4% higher; the brace force is 60.4% higher; the stroke force is 73.8% larger.

Author Van Someren et al. (2000) states that an ergometer is capable of physiologically stimulating the functioning of the body's systems in short-term intensive work in a similar way as on water, and our study also confirms this. However, while analysing the HR and La recovery speed of the research subject, it was concluded that it was faster after the work on water. Here the reasons can be various – one of them is that the ergometer test was performed later than the water test. The load on water was performed on the 10th day after the World championship, and then it was done on the ergometer two weeks after the water performance (24 days after the World championship). Therefore, according to the authors Иссурин & Люстиг (2004), there is a possible effect of maintaining the training effect. In this case, it can be observed that the body's buffer system is no longer able to utilize lactate as quickly after the load on the ergometer. Also, the recovery rates of La and HR could be affected by the fact that the load on the ergometer differs kinematically – different technical performance and activation of different muscles can be observed (Klitgaard et al., 2020; Fleming, 2012a,b; Bishop, 2004; Borges et al., 2014).

The performed study provides an insight into the nature of a stroke, as looking at the measurements obtained from both experiments, we find that initially the power values of a brace are higher when paddling on the ergometer than when paddling on water. This is due to the fact that the boat has to be moved from place along with its mass in the first strokes on water. In contrast, this initial part of the distance is not provided for on the ergometer. When reaching a high movement speed on water, the power values of a brace increase rapidly and are held at a high level until the 40th stroke when the brace power starts to decrease. On the ergometer, the trend is different; initially, optimal values of brace power are reached, then a slight drop is observed from the 28th to the 40th stroke, followed by stabilization where the values slightly increase and are maintained almost until the end.

The above-mentioned characterization of stroke differences is confirmed by the obtained numerical parameters of stroke phases, which show that the average stroke time on water was 0.44s against 0.42s on the ergometer; by dividing the stroke phases according to McDonnell et al., 2012, the brace time or water contact phase (0.34s on water against 0.24s on the ergometer) and the unsupported stroke phase time (0.10s on water against 0.18s on the ergometer) was obtained; therefore, the differences in the kinematic indicators between performing a similar load on the ergometer and on water are related to the fact that the duration of the active stroke phase on the ergometer is significantly shorter.

Conclusions

Stroke force and power parameters indicate that under natural conditions force and power values demonstrated by athlete are significantly ($p < 0.05$) higher, – a difference of 12.1% between the average brace power, a difference of 37.4% between average stroke power, a difference of 61.7% between average stroke force and a difference of 74.6% between the average brace force in favour of natural conditions were reported

Stroke time parameters, including the water time part (%), indicate that under natural conditions the time against the stroke is 29.8% higher when the paddle blade has been in the active phase, in which force is applied. This indicates the different nature of the load, since the time in which the muscles must be able to perform the maximum force and power transition into a unit of time is 1/10 of a second longer on water; in turn, this suggests that coaches need to take these differences into account when preparing athletes; – in athletic training, the parameters of the stroke performed on water should be taken as the basis for muscle work duration. Furthermore, the overuse of a kayak ergometer may hinder the force conversion phase.

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ORIGINAL RESEARCH PAPER

CHANGES IN THE PERFORMANCE INDICATORS OF BASKETBALL PLAYERS IN IMPROVING MENTAL TOUGHNESS AND SELF-EFFICACY

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Abstract

The mental toughness and self-efficacy of athletes are some of the most important factors that directly influence and predict an athlete's performance. The aim of this research is to evaluate the impact of improving basketball players' mental toughness and self-efficacy on increasing performance indicators. Material and methods: research participants – U-16 basketball players (n=15), the Psychological Performance Inventory Alternative version (PPI–A), the Sports Mental Toughness Questionnaire (SMTQ) and the General Self-Efficacy Scale (GSE) questionnaires, the control exercise method was applied before and after the determining experiment, as well as mathematical statistics. Three measuring instruments adapted to the Latvian environment – PPI-A, SMTQ, GSE (Astaficevs, Vazne & Fernate, 2020) – were used in the research. The results show that the performance indicators of basketball players are affected by the implementation of psychological tasks improving mental toughness and general self-efficacy in sport in two control exercises – midrange jump shots ($p<0.05$) and free throws ($p=0.001$). An increase was also found in the results of other shots, but it was not statistically reliable. Moreover, moderately close correlations were found between mental toughness and self-efficacy improvement ("Self-efficacy and determination"; "Positive cognition and imagery", "Self-belief") after the implementation of psychological tasks in the training process and in individual performance indicators of basketball players ($p<0.05$).

Key words: *improvement of mental toughness, improvement of general self-efficacy, performance indicators of basketball players, basketball, U-16 basketball players*

Introduction

The world we live in today is dominated by the desire to succeed and win. Perhaps the knowledge that you are the best, the strongest or the smartest excites us and makes us persistently strive for victory. High-performing athletes have realized that the winning formula involves much more than just good technical, physical, or tactical preparation. On the way to success, athletes inevitably face various psychological issues. It is often observed that in the event of a poor performance, athletes and their coaches plan to adjust their physical, technical, or tactical preparation routine, perceiving the psychological aspect as less important. However, in order to overcome issues and improve performance, it is necessary to pay attention to the aspect of psychological preparation. The mental toughness and self-efficacy of athletes are some of the most important factors that directly influence and predict an athlete's performance. These factors contribute to athletes' motivation, confidence in their abilities, persistence, and self-control.

The study of mental toughness was mainly implemented in the context of sport, gaining wide resonance among sport researchers. In sport science, the concept of mental toughness is defined differently (Loehr, 1986; Jones et al., 2002; Thelwell, Weston & Greenlees, 2005; Coulter et al., 2010; Weinberg et al., 2011; Gordon & Gucciardi, 2011), but the consensus reached by researchers is that it is a key factor that affects performance regardless of stress or environmental conditions. Mental toughness includes several components: determination, self-belief, positive cognition, visualization, self-confidence, constancy, and self-control. The commitment component is related to athletes' motivation.

Several studies have indicated that the motivation of athletes in general is significantly influenced by the coach's support (Langan, Lonsdale, Blake & Toner, 2015; Ryan & Deci, 2017; Joesaar, Hein & Hagger, 2012; Sheldon & Watson, 2011; Healy, Ntoumanis, Veldhuijzen van Zanten & Paine, 2014; Quested et al., 2013). Self-belief is an optimistic assessment of oneself and one's abilities, an inner feeling of trust that creates confidence within athletes. Various research indicate that self-belief is a prerequisite for athletes to fulfil their athletic potential (Connaughton, Hanton & Jones, 2010). An athlete's self-belief can be influenced by many factors, but several studies point to positive self-talk as a vital aspect of self-belief (Bandura, 1997; Hatzigeorgiadis, Zourbanos, Goltsios &

Theodorakis, 2009; Hatzigeorgiadis, Zourbanos, Mpoumpaki & Theodorakis, 2008; Weinberg, Grove & Jackson, 1992; Zetou et al., 2014; Abdoli et al., 2017; Park, Lim & Lim, 2020). Visualization is described as the process of imagining the desired actions and their results before they happen. Research on the impact of imagery on sport performance indicate that the application of the imagery method to the training and competition process has a significant impact on performance in sport (Eddy & Mellalieu, 2003; Caliari, 2008; Newmark, 2012; Mattie & Munroe-Chandler, 2012). Self-confidence describes athletes' unshakable belief in their ability to succeed. This belief is mainly based on personal experience gained during the training and competition process. Scientific research clearly shows that athletes with a higher level of self-confidence perform better than those with a lower level of self-confidence (Burton 1988; Moritz, Feltz, Mack & Fahrbach, 2000). Constancy as a component of mental toughness is described as athletes' persistence to achieve their goals and the ability to adapt in the face of failure. Research indicate that the definition of constancy used in the context of sport refers to psychological processes in behaviour that protect athletes from experiencing negative stressors, helping them to overcome short-term and long-term setbacks (Rees et al., 2016; Sarkar & Fletcher, 2014; Galli & Gonzales, 2015). Improving the components of mental toughness contributes to the mental toughness of athletes.

General self-efficacy refers to athletes' belief in their abilities to solve new or complex issues. The study of scientific literature indicates that the self-efficacy of athletes greatly influences and is able to predict the result in the context of the present and the future (Maddux, & Lewis, 1995; Singh, Bhardwaj & Bhardwaj, 2009; Hays, Thomas, Maynard & Bawden, 2009; Heazlewood & Burke, 2011).

Research aim – to evaluate the impact of improving basketball players' mental toughness and self-efficacy on increasing performance indicators.

Material and Methods

In order to evaluate the impact of improving basketball players' mental toughness and self-efficacy on increasing performance indicators, the following research methods were used: the Psychological Performance Inventory Alternative version (PPI–A), the Sports Mental Toughness Questionnaire (SMTQ) and the General Self-Efficacy Scale (GSE) questionnaires, the control exercise method for determining performance indicators of basketball players was applied before and after the determining experiment, as well as mathematical statistics. The group of respondents consisted of basketball players (n=15) aged 16, and the experience of team players participating in competitions was on average seven years. The study has been approved by the Academy of Sport Educational Ethics commission.

At the beginning and at the end of the determining experiment, the team players answered the statements of the mental toughness and self-efficacy questionnaires. In order to determine the mental toughness of the players, the Latvian versions of the three questionnaires were used: Psiholoģisko prasmju aptaujas alternatīvā aptauja" (*Psychological Performance Inventory Alternative version*), and, Psihiskās noturības sportā aptauja" (*Sports Mental Toughness Questionnaire*), and "Vispārējās pašefektivitātes aptauja" (*General Self-Efficacy Scale*) (Astaficevs, Vazne, Fernate, 2020). In order to determine the performance indicators of basketball players, control exercises of basketball techniques were performed at the beginning and at the end of the experiment, which consisted of 6 different types of basketball shooting drills, which were evaluated according to the time limit of the task and accuracy indicators (see Fig. 1).

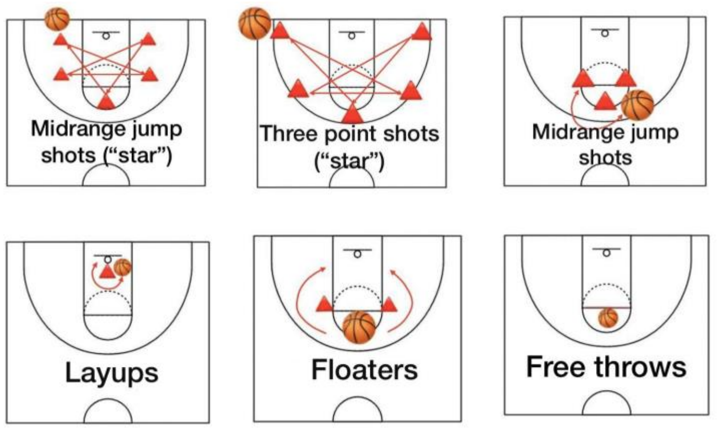

Figure 1. Basketball Technique Control Exercises Used to Determine Performance Indicators of Basketball Players

Based on the structural model of mental toughness and general self-efficacy (Self-efficacy and determination, Self-control, Positive cognition and imagery, Self-belief) and the results of the Psychological Performance Inventory Alternative version (PPI–A), the Sports Mental Toughness Questionnaire (SMTQ) and the General Self Efficacy Scale (GSE) questionnaires, tasks were developed for the improvement of mental toughness and self-efficacy of basketball players. The content of the tasks for the improvement of mental toughness and self-efficacy of basketball players is based on the needs of the players, as well as on a previously developed structural model of mental toughness and general self-efficacy.

The content of classes was implemented in 12 classes, within three months and divided into four parts, improving: *self-efficacy and determination* skills; *self-control* skills; *positive cognition and imagery* skills, as well as *self-belief* skills. Goal-setting strategies, strategies for overcoming anxiety and regulating emotions, improvement of attention management skills were worked on with the basketball players. Furthermore, players were introduced to some basic autogenic training skills, positive self-talk strategies, and various routines before shooting free throws. After the implementation of psychological classes, the determination and analysis of the mental toughness and self-efficacy indicators of basketball players was repeated. After testing the impact of implementing mental toughness and general self-efficacy improvement on the achievements of basketball players, control exercises were developed that combined various basketball shooting techniques (see Fig. 1). The effects of mental toughness and self-efficacy improvement on team players' mental toughness, self-efficacy and performance indicators were experimentally tested. The Wilcoxon signed-ranks test was used to assess the reliability of the increase.

After the determining experiment, a correlation analysis was performed with the aim of checking whether there are correlations between the effects of mental toughness and self-efficacy improvement and the performance of basketball players (shooting accuracy during control exercises) after performing the psychological tasks. The results of the questionnaires and technique control exercises were processed with SPSS software.

Results

By comparing the individual indicators of the participants of the determining experiment group, it can be seen that all basketball players have positive changes in the indicators of all scales of the Psychological Performance Inventory Alternative version (PPI-A) (see Fig. 2). The biggest changes were found for basketball players A1 (51), A12 (53) and A14 (60) with an indicator increase of 8 points. These players have acquired and been able to successfully apply goal-setting strategies, resulting in the improvement of their motivation to develop their skills in order to achieve the self-set goals and imagery techniques.

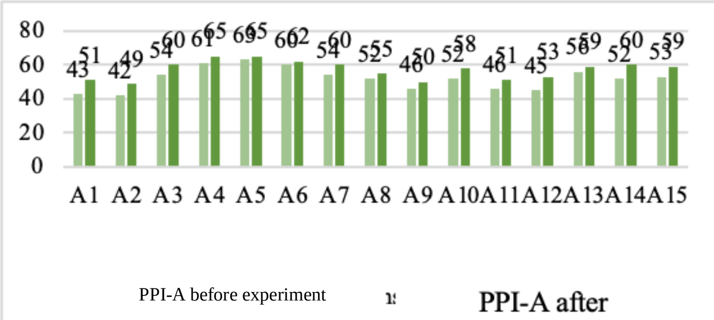

Figure 2. Individual indicators of the Psychological Performance Inventory Alternative Version Recorded in the Group of Basketball Players Before and After the Determining Experiment (*n*=15, *p*<0.05)

Results were improved in the *imagery* scale, which indicates the ability of basketball players to apply different imagery techniques to be able to train basketball techniques in their thoughts and to predict different situations during competitions. For all scales of the PPI-A questionnaire, the test reliability calculated for the group of basketball players is p<0.05, which means that the group has statistically significant differences between the answers to the PPI-A questionnaire before and after the determining experiment. The overall results of the respondents of the Psychological Performance Inventory Alternative version (PPI-A) questionnaire can be evaluated as average (see Fig. 2). All respondents noted difficulties in maintaining positive emotions during competitions in situations where mistakes are made, as well as that their self-talk is often negative. In general, the results of the Psychological Performance Inventory Alternative version in all scales of the respondent group have improved after the implementation of the psychological tasks (*p*<0.05).

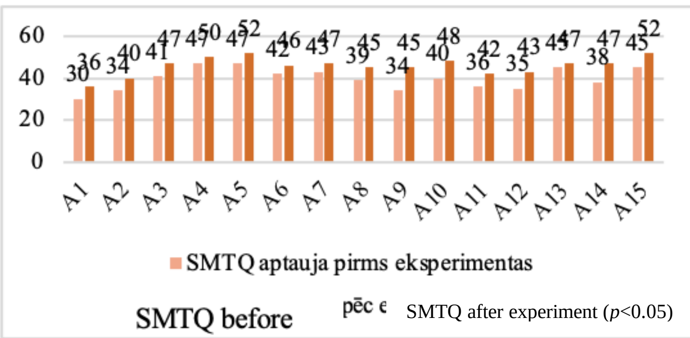

Figure 3. Individual indicators of the Questionnaire on Mental Toughness in Sport Recorded in the Group of Basketball Players Before and After the Determining Experiment (*n*=15, *p*<0.05)

By comparing the individual indicators of the participants of the determining experiment group, it can be seen that all basketball players have positive changes in the indicators of all scales of the mental toughness questionnaire in sport (see Fig. 3). The biggest changes are observed for basketball players A9 (45) – by 11 points, and A14 (47) – by 9 points. The significant improvements in the indicators of the A9 player's self-confidence scale indicate the basketball player's understanding and confidence in his abilities, as well as positive changes in the player's perception of stressful situations and their coping mechanisms. In turn, player A14 significantly improved the indicators of the self-control scale at the end of the experiment, which indicates the basketball player's ability to control his thoughts and emotions when mistakes are made or when it is necessary to deal with unexpected events (p<0.05). The overall results of the respondents of the Sports Mental Toughness Questionnaire (SMTQ) before the experiment are rated as moderately low. The main difficulties often faced by the players of this team are worries about poor performance or failure in the training process and competitions. The players admit that they feel anger and frustration if they have not managed to do what they set out to do. In general, the indicators of the respondent group of the mental toughness questionnaire in sport have improved after the implementation of psychological tasks, and the result of the self-confidence scale after the experiment is rated as high (p<0.05).

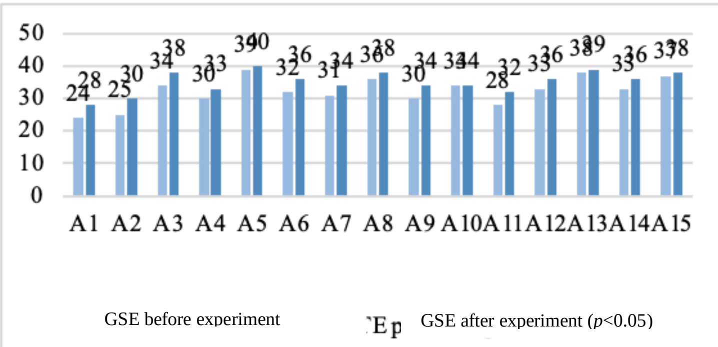

Figure 4. Individual indicators of the General Self-Efficacy Questionnaire Recorded in the Group of Basketball Players Before and After the Determining Experiment (n=15, p<0.05)

By comparing the individual general self-efficacy indicators of the basketball players before and after the experiment, it can be concluded that 14 basketball players have positive changes in the general self-efficacy indicators, but for one player these indicators remained unchanged. The biggest increase in general self-efficacy indicators was observed for basketball player A2 (30) by 5 points. Moreover, there is an increase of 4 points for basketball players A1, A3, A6, A8, A9 and A11. No changes were observed for the basketball player A10 after the experiment. The test reliability calculated for the athlete group of the general self-efficacy questionnaire is p=0.001, which means that the group has statistically significant differences between the answers to the general self-efficacy questionnaire before and after the experiment (see Fig. 4).

The average indicators of the general self-efficacy (GSE) questionnaire recorded among the respondents of the determining experiment before the experiment can be evaluated as average (see Fig. 4). The team players indicate that they are often able to cope with unpredictable situations, and in the face of difficulties the players remain calm and rely on their own abilities. However, it is difficult to stick to their goals and achieve the desired results. This is due to the lack of application of goal-setting strategies. The general self-efficacy indicators of the respondent group have improved after the content implementation and are rated as high. It is interesting to note the trend that the overall increase in results for the leading players of the team is lower than the rest of the players of the team. This can be explained by the different levels of psychological preparation of the players.

In order to experimentally test the effectiveness of the content of the theoretical model of mental toughness components and self-efficacy improvement on the example of the basketball team, a performance assessment (control exercise performance) was conducted at the beginning and at the end of the determining experiment. The control exercises consisted of six different types of shooting techniques in basketball: midrange jump shots (star); three-point shots (star); midrange jump shots; layups; floaters; as well as free throws (see Figure 1). The control exercises were performed two times, and the best result of the two was selected. The limiting factors of the experiment were the number of shots, accuracy, and the time limit.

By applying the strategies of the mental toughness components, basketball players are able to prepare more effectively to perform the necessary techniques (shots into the basket) as accurately as possible. By imagining the technically correct execution of throws, using positive self-talk and various types of pre-start rituals, as well as by controlling the rhythm of breathing, players focus more effectively on the execution of shots. In competition and training conditions, it is often observed that players, in the event of an inaccurate shot, dwell on the experience of the missed shot, which is followed by negative body language, thus losing time and focusing their attention on a past event that can no longer be changed.

In turn, while working on the improvement of general self-efficacy, the players' confidence in their abilities to accurately perform the specific technique was promoted.

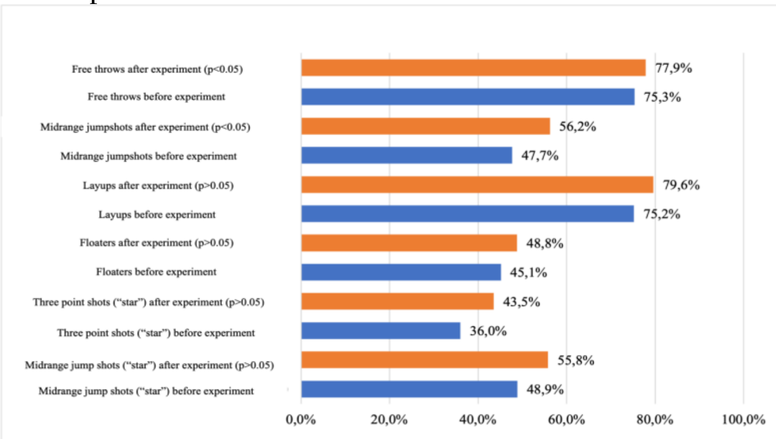

Figure 5. Basketball Player Performance Indicators – the Percentages of Control Exercise Results Before and After the Determining Experiment (*n*=15)

The level of players' self-efficacy varies, so it is necessary to individually evaluate which of the sources of self-efficacy is decisive. Whether the player has gained enough experience in performing the specific technical elements to feel confident in his ability to accurately execute shots in the basket, whether the player gains confidence by seeing how his teammates successfully deal with specific technical elements, whether the player needs verbal support from the coach or teammates to gain more confidence, whether the player's emotional state at a given moment determines his self-efficacy. By evaluating the main sources of self-efficacy of each player, it is possible to predict and promote the player's level of self-efficacy.

By summarizing the overall results of the control exercises before and after the determining experiment, changes in the performance indicators of the basketball players can be observed, and Figure 4 shows the overall changes in the percentages of players' indicators when performing different types of shots at the basket. Overall, the players of the team improved the accuracy of free throws by 2.6% (p=0.001), the accuracy of midrange jump shots was improved by 8.5% (p<0.05), layups were improved by 4.4%, floaters – by 3.7%, three-point shots ("star") were improved by 7.5%, and the accuracy of midrange jump shots ("star") was improved by an average of 6.9%. The reliability of the increase in performance indicators calculated for the group of basketball players according to the Wilcoxon test shows an increase in indicators in all shots, but the increase is statistically reliable only in two control exercises - "midrange jump shots" (*p*>0.05) and free throws (*p*=0.001) (see Fig. 5).

Moderately close, positive correlations were found between performance indicators (results of control exercise performance after the experiment) and the psychological tasks for improving mental toughness and self-efficacy.

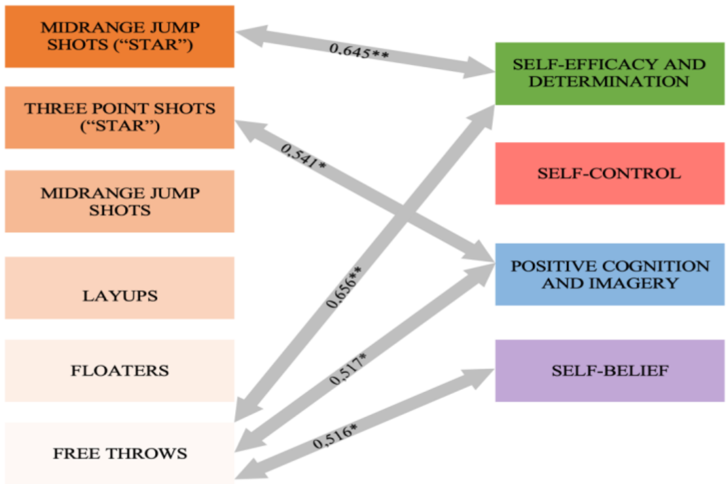

Figure 6. Correlations Between the Factors of the Mental Toughness Components and Self-Efficacy Structural Model and the Performance Indicators (*n*=15)

By conducting a correlation analysis, it was found that there is a positive, moderately close correlation between "Midrange jump shots ("Star")" and "Self-efficacy and determination" (r=0.645, *p*<0.05). There is also a positive, statistically reliable correlation between "Three-point shots ("Star")" and "Positive cognition and imagery" (r=0.541; *p*<0.05). Furthermore, it was found that there is a positive, statistically reliable correlation between „Free throws" and „Self-efficacy and determination" (r=0.656; *p*<0.01), as well as with „Positive cognition and imagery" (r=0.517; *p*<0.05) and „Self-belief" (r=0.516; *p*<0.05). Correlations with "floaters", layups and midrange jump shots were not found (see Fig. 6).

Discussion

The development of mental toughness, along with physical, technical and tactical aspects, is considered the basis for the full development of athletes (Bergeron, et al., 2015). In the context of sports, psychological skills include desirable personal characteristics such as self-efficacy that influence sports performance (Zakula, Tubic & Jovanovic, 2017).

The results obtained during the development of the study indicate that there are correlations between mental toughness, general self-efficacy, and performance. In contrast, psychological techniques encompass methods or processes by which desired levels of personal characteristics can be achieved, such as self-talk and imagery (Ponnusamy et al., 2018). Evidence supports the importance of several psychological skills (Moritz et al., 2000; Woodman & Hardy, 2003) and techniques (Brown & Fletcher, 2017; McCormick, Meijen & Marcora, 2015) for optimizing athletic performance. Naturally, the process of developing psychological skills is the focus of sports science researchers and sports psychologists (Adler et al., 2015). Qualitative (Weinberg et al., 2017), longitudinal (Gucciardi et al., 2015) and experimental studies (Bell, Hardy & Beattie, 2013) indicate that athletes' mental toughness has characteristics that can change from situation to situation, however, can be developed and perfected.

The results of more and more studies point to the importance of mental toughness in promoting high performance (Arthur et al., 2015; Mahoney et al., 2014; Cowden, 2017), as well as contributing to the adaptation mechanism for psychosocial risks such as burnout (Madigan & Nicholls, 2017) anxiety (Schaefer et al., 2016) for prevention, therefore researchers' efforts are focused on understanding the development of mental toughness (Newland et al., 2013; Anthony, Gucciardi & Gordon, 2016; Jin & Wang, 2018; Schild et al., 2020). After analysing the results of the respondents', the main factors affecting performance were identified, which are related to the skills to deal with worries about poor performance and the ability to maintain positive emotions with the help of self-talk. There are statistically reliable improvements in the results shown by the respondents in control exercises after the implementation of the created content ($p<0.05$).

Taking into account the specifics of other sports, the created content for improving mental toughness and self-efficacy indicators and performance is adaptable to athletes of various sports. By experimentally testing the effectiveness of the created content on basketball players, an improvement in performance results was found, which indicates the possibilities of improving mental toughness and general self-efficacy. By carrying out further research on the components of mental toughness and general self-efficacy, it is possible to approbate it on a larger group of respondents, as well as to adapt it to the specifics of other sports. There is a possibility that the developed content can be modified to apply to athletes of a younger age, taking into account the development peculiarities of different age stages.

Conclusions

The indicators of mental toughness and self-efficacy of basketball team players increased after the implementation of the content of the developed psychological task ($p<0.05$).

The performance indicators of the players are statistically reliably affected by the implementation of the psychological tasks for improving mental toughness and general self-efficacy in two control exercises – midrange jump shots ($p<0.05$) and free throws after the experiment ($p=0.001$). There is an increase in the results of other control exercises, but it is not statistically reliable ($p>0.05$).

Moderately close correlations were found between "Self-efficacy and determination" and performance indicators after the experiment: "Midrange jump shots ("Star")" (r=0.645, $p<0.05$) and "Free throws" (r=0.656; $p<0.01$). "Positive cognition and imagery" have moderately close correlations with the result of "Three-point shots ("Star")" (r=0.541; $p<0.05$) and "Free throws" (r=0.517; $p<0.05$). The "Self-belief" content has a moderately close correlation with the result of "Free throws" (r=0.516; $p<0.05$).

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ORIGINAL RESEARCH PAPER

INTERACTION OF PARENTS AND PRIMARY SCHOOL PUPILS (GRADES 1 – 4) IN THE PROCESS OF PHYSICAL ACTIVITIES

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Abstract

Objective of the study: To investigate the physical activity habits and interactions between primary school pupils in grades 1 – 4 and their parents. The methods used in the study: observation, literature analysis. To collect data, a questionnaire was administered through an online survey website visidati.lv. The survey was carried out in autumn 2021 in fifty Latvian schools. 90 primary school pupils in grades 1 – 4 and 90 parents of primary school pupils participated in the survey. Results: A child develops a systematic physical activity routine at an early age. Family physical activity is effective in increasing physical activity in children aged 5 to 12 years. The closest relationship between a parent and their child occurs when the child is eight years old. Parents act as external motivators for their children. Scientific studies have shown that parents can influence their *children's activity in two ways: indirectly as role models for physical activity, through verbal motivation, or directly by participating together in sport or supporting their child's training. The empirical study results show that primary school pupils promote their parents' (77%) willingness to engage in physical activity. 72% of pupils are motivated by their mother, 64% by their father. Pupils (69%) recognise that it would be useful to engage in more physical activity with their parents. Parents engage with their children, influence them positively, and contribute to their motivation through practical (transport – 59%), emotional, and informational (89%) support. Conclusions: A tangible interaction takes place between parents and children during physical activity.*

Keywords: *Children, Pupils, Parents, Physical activity, Interaction, Exercise, Family.*

Introduction

Physical activity (PA) is an innate human need that develops the body, keeps it healthy, and improves performance. Everyday observations in society show that physical activity is on the decline. Adults justify it with busy work, lack of time, and lack of commitment. Observing a negative parental role model in the family, children, who are naturally inclined to be physically active, adopt it, too. PA is also reduced by the sedentary leisure time in virtual and social media environments brought about by the digital age. Physiological, psychosocial, familial, and environmental factors are the potential determinants of physical activity in early childhood and later life, as the child's experiences influence attitudes towards PA and an active lifestyle in general.

In a systematic review published in 2021, the authors found evidence of a relationship between parent-child PA habits and behaviour in primary school children in grades 1 – 4 (age 6 – 12 years). The authors of the study justified this choice of age on the grounds that younger children exhibit a closer relationship with their parents. Most studies found an association between parental involvement and children's PA, but four studies found no association (Matos, 2021).

A 2020 systematic review found a weak correlation between child and parent PA levels. The review recommended examining activity patterns such as sitting, standing, running, and cycling, and investigating the family environment, including siblings' indicators. In the 39 studies summarised in this review, a positive correlation was observed between parent-child physical activities, irrespective of the age of the child or the gender of the parent or child. In most studies, the estimated positive relationship was considered weak, with correlations between parent-child PA ranging from

0.10 to 0.20. Overall, the quality assessment of the included studies indicates that there is a need for qualitative methodologies in this area of research to reduce the risk of bias (Petersen et al., 2020).

Both reviews stated that the methods used to assess associations between child and parent activity were surveys, pedometers, anthropometric measurements, or the use of accelerometers (Petersen et al., 2020; Matos, 2021). It should be noted that this study used an online questionnaire method, as the 2021 COVID-19 pandemic emergency prevented face-to-face data collection.

PA, which includes both high and low intensity, is modifiable in positive behaviour and health, so it is important to identify factors that could promote a person's ability to engage in PA across the lifespan. One of these factors that requires more research is the relationship between parents and their children. Research in this area suggests that adults with children often have lower levels of PA than individuals without children (Bellows-Riecken & Rhodes, 2008), but this is mainly observed in parents of underage children. Importantly, as children grow older, they often influence or even monitor their parents' health behaviours, which may include health-promoting interventions (Thomas et al., 2018).

A 2016 meta-analysis of 47 studies found that family PA was effective in increasing physical activity in children aged 5 to 12 years (Brown et al., 2016). This allows to identify that parental and familial PA role models and active recreation are very important factors that encourage children to participate in sport for recreation.

Regardless of the socio-economic status of the child's family, it is important to encourage parents to cultivate a healthy and physically active lifestyle. Information for parents should include: 1) encouraging sports activities, 2) encouraging children to have breakfast every morning, and 3) reducing the duration of TV and computer use (Fernandez-Alvira et al., 2013). As habits are gradually formed from early childhood (1 – 3 years), parental role modelling is an important factor in a child maintaining a healthy and active lifestyle throughout the child's life. Parental awareness of PA is a key to successfully engaging the younger generation in PA. This requires cooperation between pupils and parents (interpreted from the pedagogical perspective of A. Špona (2006), it is a concerted activity of two or more people, an opportunity for acquiring knowledge, learning skills, and enriching experiences) in which interaction (mutual perception, evaluation, and influence) takes place. This means that the motivation of the pupils is important in their attitude towards PA, which is developed through the interaction between children and parents.

It is important to know that motivation is what psychologists refer to as the set of individual psychological factors or motives that initiate an individual's activity and determine a behaviour or behavioural goal. Two factors are distinguished as constituting motivation: 1) intrinsic motives or psychological triggers of behaviour and 2) extrinsic motives or incentives. Intrinsic motives are driven by a person's needs and their immediate gratification, which is evident in a specific action or behaviour, while extrinsic motivation is generated by the evaluation of consequences. In the case of extrinsic motivation, the stimulus is external to the person and is triggered by external factors, objects and events (Mārtinsone et al., 2015). It should be noted that parents become a factor of extrinsic motivation through setting an example and encouraging children to get participate.

Beet, Cardinal and Alderman (2010) highlight that parents have a determining influence on their children's PA. Parents care for their children's health and determine children's activities, provide resources, and provide access to them. In the context of promoting pupils' general PA, several support mechanisms are available to parents: motivational (providing verbal/non-verbal encouragement to engage in the activity of interest and validating engagement in performance); instrumental (providing material support and/or services); conditional (directly involved in the activity with or around the child); and regulatory (setting performance rules and/or limits). The evidence suggests that physically active parents raise physically active children and act as an important support for their children. However, mothers and fathers influence their children's PA differently. It appears that the relationship between a parent and their child is strongest at the age of eight, gradually diminishing until adolescence. In this case, verbal motivation will be an external factor that parents provide to their child.

Several studies have shown that even when adults are aware of the importance of practicing PA themselves, they do not look for ways to introduce it into their daily lives. Nowadays, there is a general negative trend towards avoiding effort and energy expenditure as people do not perform regular PA, even though this has negative long-term health consequences (Cheval et al., 2018; Lieberman, 2015; Thivel et al., 2018). Evidence from the community shows that such adult habits and role models can adversely affect children's attitudes towards PA.

A study by Lissak (2018) has found that the rapid improvements in technology nowadays quickly enable more and more information to be obtained and accessed almost anywhere and any time. This attracts the attention of children and young people and they spend a lot of time in front of screens, exceeding the recommended two hours a day. Parents should therefore pay attention to their children's screen time, as time spent in a sedentary way could be used for health-promoting PA instead.

An important fact nowadays is that the age of the connectivism paradigm (Siemens, 2005) requires a different approach to information technology. The new generation seizes the opportunity and communicates with each other remotely. Consequently, primary school pupils are increasingly using a variety of digital devices for both leisure and finding information for learning (especially in COVID-19 circumstances).

Of relevance are the results of an Australian study published by Schoeppe et al. in 2020 on how to promote PA with smartphone apps. The app sought to improve PA in both adults and children. The aim of the conducted study was to investigate daily activities using the app and to identify possible short-term effects to increase PA across the family (children, mothers, and fathers). The single-group study was conducted, determining PA before and after the intervention. It was found that after the intervention, PA increased by 58 min/day in children using smart devices (boys: 54min/day, girls: 62min/day; all $p<0.001$). PA increased by 27 min/day in mothers ($p<0.001$) and by 31min/day in fathers ($p<0.001$). The percentage of children meeting the Australian Child PA Guidelines (≥60 PA min/day) increased from 34% to 89% ($p<0.001$). This study concluded that PA indicators in families have improved and the use of the app can increase PA in families.

Children want to belong to a social group – family, school, formal or informal organisation. The real social environment influences personal beliefs, behaviour, actions, and experiences. The influence of the family environment is important at youngest school age. In Latvia, there has been research (Bula-Biteniece, 2011) on the PA of preschool children. The theoretical framework of parental influence on children's PA determined the choice of this study. Based on practical observations at school, in the community, and in theoretical sources (scientific and current review information), this study examined the PA interaction between primary school parents and pupils in grades 1 – 4.

Materials and Methods

The study used a questionnaire approach. The target audience of the study were primary school pupils in grades 1 – 4 and their parents. The electronic survey was carried out in autumn 2021 in fifty Latvian schools. 90 families responded to the survey. The respondents chose to participate voluntarily. 51% of the respondents lived in Riga, 35% in another city or town, 7% in rural areas, and 7% in the Pierīga Region. The questionnaire questions were designed to find out the physical activity (PA) habits, interactions, and the motivation of parents and children to be physically active. The data collection questionnaire for the family consisted of 37 questions.

21 question was aimed at the parents. The questions addressed the parent's sex, age, place of residence and level of education (Q.1), PA at work (Q.2), attitudes towards PA (Q.3,4,5), opportunities to be physically active (Q.7,8), beliefs and habits, and awareness of their child's PA (Q.9,10,11): child's current PA (Q.12), knowledge of average weekly PA activities of a primary school-age child (Q.13), the duration of their child's PA in one day (Q.14), child's favourite physical activities (Q.15), whether the child contributes to parents' PA and parents' enjoyment of joint physical activities with the child (Q.16), how knowledgeable the parent is about PA (Q.18), the parent's duty to be a role model for the child (Q.19), whether parents introduce sports to the child (Q.20), whether parents consider themselves as an extrinsic motivator for the child (Q.21).

16 questions (Q.22-37) addressed the child's (also referred to as the pupil's): sex (Q.22), age (Q.23), grade (Q.24), enjoyment of PA (Q.25); actual PA (Q.26), attendance at school (Q.27) and outside school (Q.28), which sports they like (team, individual, with family)(Q.29); enjoyment of being involved in PA with their parents (Q.30), parents' encouragement to be involved (Q.31); whether the child would like to be involved in PA with his/her parents (Q.32), who in the family encourages PA (Q.33), whether more frequent PA with the parents would contribute to the desire to play sport (Q.34), whether the parents tell the child why he/she should play sport (Q.35), which parent (mother (Q.36) or father (Q.37)) contributes to extrinsic motivation.

Two data processing methods were used to analyse the quantitative data: descriptive and inferential statistics. The descriptive method was used for ordinal data, which in this case was a Likert scale, and it was used for nominal data. The descriptive method was used to visualise the data in percentage plots. The inferential method was used for linear correlations and to measure their correlation strength and degree of significance. For data processing, Microsoft Excel 365 (14.0, 2010) was used to collect, analyse, and visualise the data. In this software, the data were summarised in graphs and calculations were performed. The obtained data were compared and interpreted.

A total of 180 respondents participated in the study: 90 respondents were parents of primary school pupils in grades 1 – 4. Of these, 92% (83 respondents) were female and 8% (7 respondents) were male. The mean age of the respondents was 38.4 years. 90 respondents were primary school pupils in grades 1 – 4. The study questionnaire was completed by 52%

(n=47) of the girls and 48% (n=43) of the boys. The mean age of respondents was 8.5 years. Pupils in grade 3 (42%), grade 2 (27%), grade 1 (21%), and grade 4 (10%) took part in the survey.

Results

50% of the parents surveyed had a sedentary job, 20% were not in paid employment but were housekeepers, and 14% worked on their feet (Q.2).

Considering the self-assessment data of parents (Q.3) and children's PA, the level of parental activity is as follows: 21% had an active lifestyle, 24% a rather active lifestyle, and 34% – a semi-active lifestyle. 16% described their lifestyle as rather sedentary and 4% as sedentary. The parents rated their children's current PA as follows: 34% moderately active, 22 rather active, 21% active, 14% rather sedentary, 6% sedentary. 3% of the parents were not sure. Overall, 77% of children were rated as active and 23% as sedentary.

Attitude of primary school pupils towards PA (Q,25) was as follows: 62% liked engaging in PA, 20% rather liked it, 14% partly liked it, 2% rather disliked it, and 1% completely disliked it. To 41% of the parents regular everyday PA (Q.4) was very important, important to 38%, partly important to 7%. 12% disagreed and 2% completely disagreed with that statement.

19% of the parents strongly agreed with the statement that they perform PA frequently enough, 34% agreed, 6% partly agreed, 11% disagreed with the statement, and 30% disagreed strongly. Factors that hindered being physically active were: 28% lack of time, 19% workload, 16% laziness, 15% health problems. 31% of the pupils rated their level of PA as active, 39% said they were more often active than passive, 27% said PA was rare or occasional, and 3% said they were often not physically active. (Fig. 1).

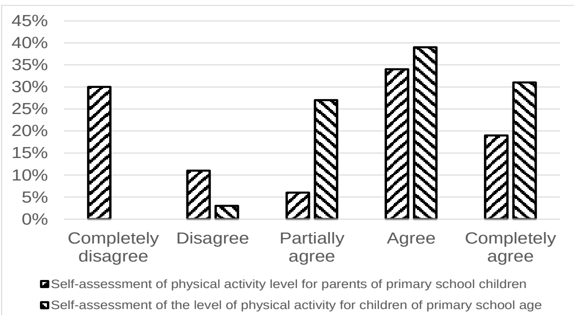

Figure 1. Children's and parents' answers to the statement 'I believe that I do physical activities often enough'

When evaluating the children's responses, we observed that 70% of children were physically active and further 27% had rare or occasional PA=97% of children engaged in PA. This is a positive indicator for primary school age children. (Fig. 1).

A linear correlation was used to see if there was a correlation between the parent's and child's PA self-assessment. The linear correlation coefficient turned out to be r=0.22, which means that the correlation is positive but weak (Fig. 2).

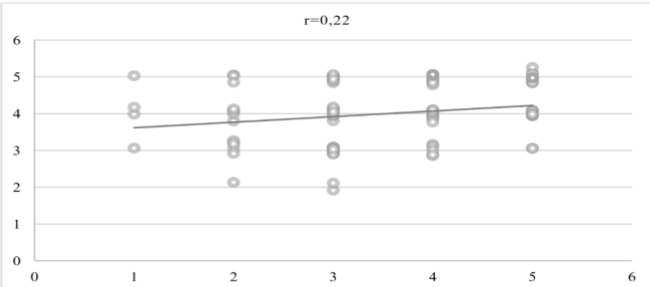

Figure 2. Linear correlation between parents' and children's self-assessment of the physical activity level

The families' daily commuting habits (Q.8) were: 69% of the parents travelled by private transport, 12% by public transport, 17% on foot, and 2% by bicycle. In the children's answers we can see that 53% were taken to their daily appointments by their parents, 16% used public transport, and 24% walked wherever they needed to go. Most of the children saved time and stayed with their parents, but did not walk much. It is a convenient but movement-limiting habit. Children are safe when they are with their parents, and it promotes positive interaction.

Motivation to engage in physical activity

According to the parents, the most recognised sports for children (Q.15) were: 43% team sports and 27% individual sports. 23% of the respondents believed that children liked best to participate in PA together as a family, while 7% admitted that they did not know what their children enjoyed. In contrast, among the children (Q.29), 49% liked team sports best, 37% liked to engage in PA with their family, only 13% liked individual sports best, and 1% did not like to engage in any PA.

28% of the parents were involved in one sport, 26% in two sports, and 46% in three sports. Parents' favourite sports: hiking, walking and Nordic walking – 36%, cycling – 15%, health/fitness – 12%, athletics – 11%. Analysing the data, we found that the parents did sufficiently long sports activities during the week. The most exciting sports at school (Q.28) for 20% of the pupils were dancing, 13% – team sports, and 13% –

swimming lessons. Favourite sports outside school were 16% team sports and 12% swimming.

After school hours, 75% of pupils took part in some PA while 24% did not. 62% of the pupils attended one PA at school, 16% attended two different PA, 7% attended three PA (Total 85%), and 15% did not attend any activity. 71% of the pupils took part in PA outside the school, while 29% did not (Q.28). 82% of the pupils attend one extra-curricular PA, 11% – two PA, and 7% – three different PA.

Parental awareness of the recommended duration of PA for adults and children is an important issue. From the parents' point of view, this is how much moderate intensity PA an adult should have during the week (Q.9): 47% – 3h or more, 17% – 3h, 6% – 2h 30min, 8% – at least 2h, 7% – 1h 30min, 8% – 1h, and 4% – no more than 30min. In total, 70% thought that PA should be between 2h 30min and 3h or more, 27% – 30min to 2h, 3% did not know. In reality, the parents devoted the following time to PA during the week (Q.10): 23% – 3h or more, 7% – 3h, 1% – 2h 30min. 11% – 2h, and 6% – 1h 30min. 22% were physically active for one hour, while 16% did not spend more than 30minutes per week. This means that 54% did not reach the recommended 150min or 2h 30min per week, 31% reached this duration, and 14% did not know how much time they spent on PA.

Parents had the following opinions on how much moderate to high intensity PA a primary school-age child should have in a day (Q.11): 41% – at least 60min, 29% – 40min, 17% – 30min. 3% – at least 1h 30min, but 10% – at least 2h. Thus, 54% of the parents believed that children should be exposed to PA between 60min and 2h daily, while 46% believed that 30 – 40min of PA were sufficient for a child. The latter may have possibly been influenced by the duration of sports activities at school. In the parents' assessment of the actual duration of their child's daily PA (Q.14), 12% of children spent at least 2h, 6% – at least 1h 30min, 28% – 1h, 34% – at least 40min, 13% were active for 30min, and 7% – only for 15min. 46% of the children had 1 – 2h of PA daily; 54% had 15 – 40min of PA daily.

Of all the study participants, 40% of respondents did not reach the minimum recommended amount of physical activity per week, while 18% did. 28% of the parents achieved the recommended weekly amount of PA, while their children did not achieve it. 14% of the parents did not achieve the recommended weekly amount of PA, but their children did (Fig. 3).

Motivation to exercise was evidenced by the parents' responses about their own emotions (enjoyment) from participating in PA with their child (Q.16): 57% of the parents found PA with their child a emotionally positive, 31% said it was rather enjoyable, 7% – neutral, 2% – rather not enjoyable, 1% – not enjoyable.

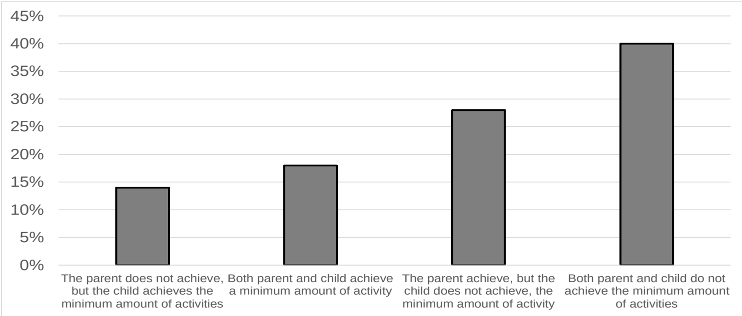

Figure 3. Parent-child physical activity interactions during the week

2% did not practice PA together with their child. Overall, 88% of parents experienced positive emotions from engaging in joint PA with their child. This means that an interaction between parents and children takes place (Fig. 3).

The following figure shows whose opinions in the family were the most important for the child and influenced the children's motivation (Fig. 4.), (Fig. 5).

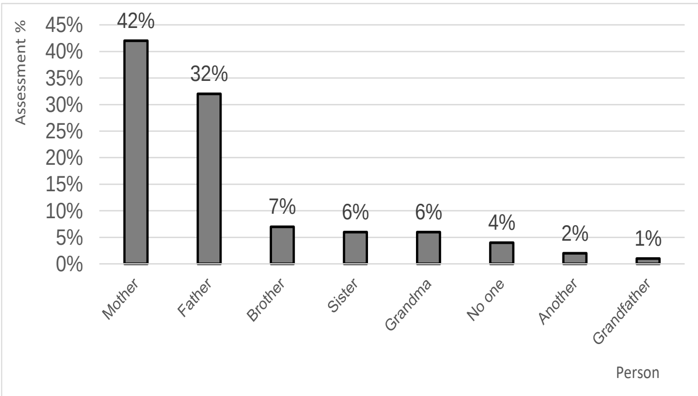

Figure 4. Children's assessment of who most often encouraged sports and physical activities in the family

72% of the pupils considered their mother to be the main source of motivation in their daily life. 64% of the pupils considered their mother to be the main source of motivation in their daily life.

87% of the parents involved in the study considered it their duty to encourage their children to be active. 70% of the parents claimed that they provided their children with the opportunity to try different sports. Such parental involvement has a positive influence on the child's attitude towards physical activity.

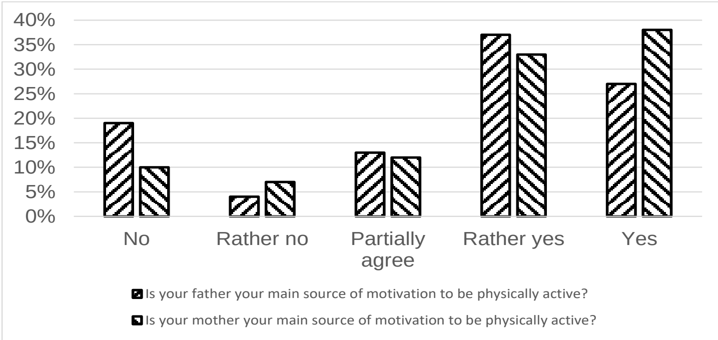

Figure 5. Promoters of extrinsic motivation in the family (father (Q.37) and mother (Q.36))

80% of the parents considered themselves to a greater or lesser extent as contributors to their child's extrinsic motivation. 89% of the children admitted that their parents told them about the positive effects of physical activity on their health.

Desired improvements in physical activity

23% of the pupils said they could agree with the statement that they do more PA in their daily life, spend less time sitting, using a computer, smartphone, etc., 29% somewhat agreed, 18% partly agreed, 22% somewhat disagreed, and 8% disagreed.

30% of the children confirmed that they very often liked to spend time with their parents being physically active, 39% said it happened often, 16% said it happened sometimes (total 85%), 6% – rarely, 1% – never, and 8% said they did not really know (15%). (Fig. 6)

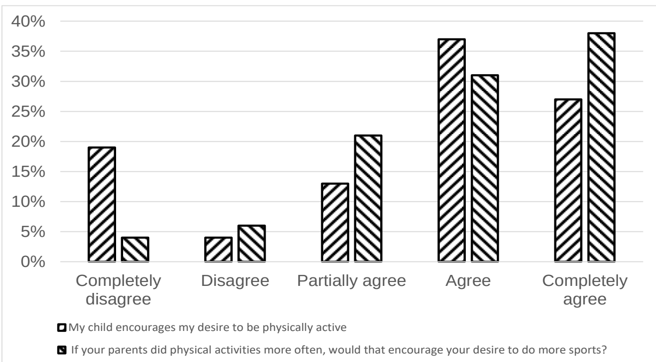

Figure 6. Children's influence on parents' willingness to engage in physical activity

39% of the parents strongly agreed with the statement 'my child contributes to my desire to be physically active', 37% agreed, 3% partially agreed, 17% disagreed, and 4% strongly disagreed (total 79%). 69% of the children said that they would be more likely to take part in sport if their parents were more physically active more often (Fig. 6.).

Mutual influence, motivational example. A linear correlation between parents' responses to the statement 'My child contributes to my desire to be active' and children's responses reflecting their enjoyment of physical activity together with their parent showed a correlation coefficient of r=0.36. This reveals that there is a positive and semi-significant correlation between these indicators. Personal example is the greatest motivator (Fig. 7.).

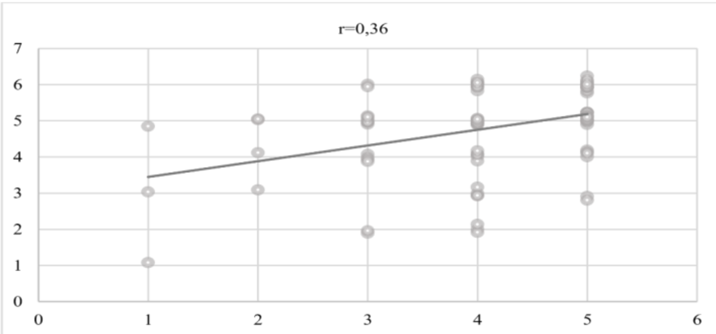

Figure 7. Linear correlation between parent's belief that their child contributed to their desire to be physically active in relation to the child's enjoyment of joint physical activity with the parent

27% of the children wanted to increase their daily PA time together very often, 24% – often, and 30% – sometimes.16% did not know if they would like more of it. 81% of children wanted more PA.

Discussion

The publications of the Latvian Centre for Disease Prevention and Control (SPKC) emphasise that every individual needs PA. The World Health Organisation (WHO) defines PA as any movement of the body that is produced by the muscles of the human skeleton and during which energy is consumed. PA includes not only various exercises and exercise complexes, but also activities that involve movement and activity of the human body, such as walking, cycling, house cleaning, and other activities (SPKC, 2021; Bull et al., 2020). The study results show that both parents and pupils believe that there is a need for PA.

The SPKC guidelines state that for an adult, medium intensity PA is recommended for at least 150 minutes or 2 hours 30 minutes per week or high intensity PA for 75 minutes or 1 hour and 15 minutes, while muscle strengthening PA for as many muscle groups as possible is recommended at least 2 times per week (SPKC, 2021).

Global sedentariness is regarded as major problem with one in four adults (about 28%) not following the WHO aerobic PA recommendation. The WHO considers this to be the fourth highest mortality risk in the world. Lack of exercise negatively affects the heart, lungs, and general musculoskeletal system and increases the risk of injury, therefore individuals who spend most (2/3) of their day sitting should engage in PA to improve their physical and mental health (Matos, 2021; Nooijen et al., 2019). The report of the Expert Council on Health Promotion and Disease Prevention of the Ministry of Health of the Republic of Latvia released on 31 January 2018 calls for a focus on the implementation of health-promoting measures in the work environment (Veselības ministrija, 2018). Data from this study showed that 50% of parents worked sitting down due to the nature of their job.

A systematic review of walking or strolling showed that walking at a pace of 3 – 5mph (5 – 8km/h) consumes enough energy to be classified as moderate intensity (Department of Health, 2011). Only 21% of the parents and 24% of the pupils we surveyed walked regularly.

SPKC guidelines recommend that children and adolescents should be physically active for at least 60 minutes of moderate to high-intensity physical activity daily, with muscle- and bone-strengthening PA required on average 3 times a week (SPKC, 2021). In our study, 46% of the children had PA 60 – 120min; 54% had PA 15 – 40min daily.

Excessive and addictive use of digital devices has been scientifically proven to be associated with adverse physical, psychological, social, and neurological consequences (Lissak, 2018). Only 23% of the pupils in our study engaged in PA more frequently and spent less time sitting, using a computer, smartphone, and other devices. The remaining 77% could not claim to be physically active.

Parents can provide the following for their children: 1) direct support by providing sports equipment, driving to a sports session, or engaging in joint PA; 2) psychological or emotional support by motivating and encouraging them to be physically active; 3) reminding and informing them about the positive effects of these activities on their child's health (Sheridan et al., 2014; Matos, 2021). Our study confirmed that there is a relationship between parent's and child's self-assessment of PA. The linear correlation was r=0.22, the correlation was positive but weak. The correlation coefficient between the parents' statement 'my child contributes to my desire to be active' (77%) and the children's responses that they enjoyed doing PA with their parent (85%) was r=0.36, showing a positive and partially significant correlation between these indicators. 88% of the parents experienced positive emotions from engaging in joint PA with their child.

Children of the primary school age (especially at 8-year-olds) have the closest contact with their parents (Beets et al., 2010). 87% of the parents surveyed considered it their duty to encourage their children's PA. 70% of the parents provided opportunities for their children to try a variety of sports, acting in line with the guideline recommendations to ensure that possible forms of physical activity are enjoyable and age-appropriate as they may increase PA in moderately active and active children. 80% of the parents considered themselves as contributors to their child's extrinsic motivation.

89% of the children received information from their parents about the positive effects of physical activity on their health. 69% of children would enjoying playing sport if their parents were more physically active.

The mother was the main source of motivation in daily life for 72% of the pupils, and the father for 64% of the pupils. These answers show the current interaction patterns within the family. The results of the study support the fact that there is an interaction between parents and physical activity of primary school pupils in grades 1 – 4.

Conclusions

The study confirmed that there was an interaction between parents' and children's physical activity habits and beliefs. The results showed that the parents were aware of the amount of time adults should spend on physical activity. Parents took part in different sports in their daily routine, but this was not a systematic pattern. The results suggest that parents should systematically remind their children of the required amount of physical activity per day (1h). Children considered their physical activity important, attended both school and after-school activities and wanted to do more physical activity with their parents. There was interaction in the area of physical activity between the respondents (58% of the children and parents). The study confirmed a positive correlation between parents' and children's willingness to engage in physical activity together as a family. The results showed that parents influenced their children positively and stimulated them to be physically active through practical, emotional, and informative support.

We can conclude that in view of the connectivism paradigm and the rapidly increasing prevalence of technology in the world today, there is a need to use technology to promote physical activity between parents and children (primary school pupils) through face-to-face and remote contacts.

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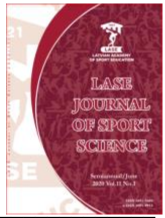

ORIGINAL RESEARCH PAPER

PERCEIVED STRESS LEVELS, HEART RATE VARIABILITY AND AUTOGENIC TRAINING TECHNIQUES FOR 16–17-YEAR-OLD FEMALE VOLLEYBALL PLAYERS

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Abstract

The modern world of information and technology offers a variety of approaches and methods of psychological training of athletes, so a problem arises – which methods and means are the most appropriate and influential. In addition to the various possibilities, the training of athletes on different levels still does not sufficiently use the psychological training potential or it is not included at all in the training process of the athletes. The aim of this study: the compilation of AT techniques, their implementation and evaluation of the effectiveness of autogenic training (AT) techniques based on perceived stress levels (PSL) and heart rate variability (HRV) indicators of female volleyball players. Study participants and methods. The research group was formed from female volleyball players aged 16 – 17 years (n=13). HRV measurements identification of the heart rate variability with the equipment "Omega Medicine" of the research and production company "Dinamika" of St. Petersburg and Survey of Perceived Stress Level (Cohen, et.al., 1983) were conducted. The Statistical Package for the Social Science (SPSS 28.0) was used to analyse the empirical quantitative data. The results of the study did not show statistically significant changes, but a positive developmental dynamic in the HRV indicators and a decrease in the PSL were observed. The obtained indicators were not statistically reliable, *however, there was a positive dynamic of the results after the implementation of AT techniques, but due to a small number of respondents the results cannot be generalized.*

Keywords: *autogenic training techniques, heart rate variability, perceived stress levels, female volleyball players*

Introduction

Stress is an inevitable part of our daily lives, but whether stress will result as a destructive mechanism of action, or whether a new experience will be gained making us stronger, more knowledgeable and smarter, encouraging us to take on new challenges, it depends on our understanding of stress (and surrounding events) and on the ability to manage one's own stress at the physical, emotional, intellectual, and also behavioural level (Vaine, 2019, Zakriževska-Belogrudova, 2021).

One of the current issues in sports, and in everyday life, is coping with stress and self-regulation of emotional states, applying various methods and techniques. Therefore, by developing and perfecting the psychological skills of athletes, it is possible to optimize the negative effects of stress, which are inextricably linked to the internal physiological processes, including biochemical and neurobiological ones, and which have a direct impact on athletes' performance (Vealey, 2007; Molinaet et al., 2018; Weinberg & Gould, 2019).

Psychological preparation is an integral part of the training process. Like comprehensive physical fitness is the basis for the athlete's special, technical, and tactical training, thus comprehensive psychological training is the basis for the athlete's mental toughness both during the training process and during the competitions. For example, a study done by Kaiseler, Polman and Nicholls (2009) shows that regardless of stress factors, the athletes with higher levels of mental resilience more easily overcome the negative effects of stress. The work on psychological resilience must be implemented during the athlete's training process, including the elements of psychological preparation.

When designing psychological training programmes, the athlete's performance in everyday training should be taken into account and it must be objectively based on the athlete's current level of performance. There should be a close cooperation with the coach, who is actively involved in the process, both by improving his/her own and the athlete's performance, as well as by engaging in educational and self-learning processes helping the athlete to see and manage the stress situations and adverse reactions caused by them (FIVB, n.d.). Thus, the philosophy of the athlete's psychological preparation process is to help the athletes to achieve optimal development, experience, and performance; in turn, the coaches are not only as the managers of the sports' training process, but they also provide the spiritual support to the athletes (Vealey, 2007).

The peculiarities of athletes' behavioural responses in the conditions of increased stress in competitions are largely determined by the level of self-regulatory skills. The athletes with elaborated self-regulation skills are characterized by optimal state of readiness in competitions, they are less sensitive to the influence of stress factors. In turn, a low level of self-regulation skills leads to the occurrence of unfavourable pre-start conditions in athletes (pre-start fever, pre-start apathy, pre-start complacency, etc.). Systematic, long-term sports activities promote the natural development of athletes' self-regulation, but they do not ensure a high level of psychological preparedness for all athletes. Targeted learning of psychological techniques allows to successfully develop self-regulatory skills for the athletes of various qualifications (Смоленцева, 2006).

The topical issues of psychological preparation of athletes are in the sight of many researchers. The possibilities of the modern world of information and technologies offer a variety of approaches and methods for the psychological training of athletes, thus creating problems in terms of deciding which methods and means are more appropriate and effective. In addition to the various possibilities, the training of athletes on different levels still does not make sufficient use of psychological training potential or it is not included at all in the training process of the athletes. Therefore, there is also a problem of educating the parties involved in the training process. As studies show, in the training process the athletes develop self-regulatory skills, but this does not ensure a high level of psychological preparedness (Bunszen & Uneståhl, 1997; Nikolaev et al., 2020). A similar problem is also described by Australian sports scientists Keilani et al. (2016), who researched the knowledge of professional athletes and the application of various psychological methods in practice. 96 % of athletes are aware of at least one type of mental training techniques, but it was not sufficiently applied by the athletes.

For psychological preparation of athletes, one of the well tested stress management training methods is autogenic training (AT), which consists of structured self-instruction techniques and positive self-talk formulas (Linden, 2007; Решетников, 2018). In the view of sports psychologists (Razali et al., 2017; Dehghani & Ebrahimi, 2017; Molina et al., 2018; Vesković et al., 2019; Weinberg & Gould, 2019), it is the skills of relaxation, self-enlightenment, emotional self-regulation, and visualization that should be used when psychologically training high-level athletes.

AT is a comprehensive system with a broad philosophical background, the assumptions and goals of which are shared with other methods of relaxation and meditative practices (Peper & Williams, 1980). Schlamann et al. (2010), Esch (2013) point out that such relaxation and meditative experiences are also rooted in neuroscience and neurobiology. It affects not only the functional level of the brain, but also affects structural changes in brain's grey and white matter, especially in those areas and networks of the brain that are related to attention and memory, interception, and sensory processing, as well as self-regulation and automatic regulation.

Therefore, when summarizing the findings of sports scientists (Linden, 2007; Ortigosa-Márquez et al., 2015; Решетников, 2018), it can be said that the benefits of autogenic training are – to stop unwanted emotional states, anxiety, excessive strain, and excessive stress. By systematically practicing AT techniques, one can learn to fully relax, to get a full mental and physical rest that retains its valuable influence long after the end of the training session, to help prevent pain and other unpleasant sensations, to improve memory and attention characteristics, to promote the abandonment of harmful habits, and to increase creativity in sports and everyday life.

In order to evaluate the usefulness of psychological preparation techniques included in the training process, several research instruments are employed, including observations, surveys and functional measurements. One of the world's most widely practiced and proven methods is the determination of heart rate variability (HRV). According to DeWayne et.al. (2015) and McCraty (2015) the HRV serves as an indicator of emotional regulation abilities, especially when negative emotions are expressed unclearly and impulsive. The HRV method is used to evaluate the regulation system of physiological functions of the human body. Another well-known method is the survey, and in the present study it is the Perceived Stress Levels (PSL) questionnaire. Determination of PSL was based on a survey developed by Cohen et al. (1983, 1988), which predicts that perceived stress is an individual's feelings or thoughts about it, as well as it determines how much stress a person has at a given moment or over a given period. The PSL includes feelings about the uncontrollability and unpredictability of one's life, i.e., about how often one has to face difficulties, how much changes take place in one's life, provides insight into an individual's beliefs about the ability to cope with problems or difficulties. The PSL scale developed by scientists (Cohen, et.al.,1983) shows high reliability rates and correlates with the life events, depression and physical manifestations of stress.

The aim of the study was to compile the AT techniques, implement them and conduct the effectiveness impact assessment on self-report PSL and HRV scores of female volleyball players.

Materials and Methods

The research was conducted according to ethical rules, and a research group – volleyball players, 16 – 17 years young women (*n*=13), was established. The parents of the young volleyball players were informed about their participation in the study in accordance with the regulations of the data protection law. All volleyball players had not previously practiced autogenic training techniques, as well as the volleyball players had not previously undergone any psychological training sessions.

For improvement of volleyball players' psychological skills, the classical exercises of AT techniques were collected after J. H. Schultz (Linden, 2007) for improvement of athletes' psychological skills. A total of nine AT training sessions were designed and delivered, including seven AT exercises; the training sessions took place in the period over two months, in September and October 2021, once a week. The principle of the gradual acquisition of AT techniques was followed, thus, a new element was gradually added to each AT technique acquisition session in addition to the two traditional AT parts – calming and activating. An introductory part was added, which included a breathing observation exercise (10 breathing cycles), and only then the first exercise (invoking a sense of warmth in the limbs) was planned. In the first three sessions, the classic AT techniques were included (except for "The heart beats calmly and rhythmically"), a total of five exercises, and one exercise for exiting from the state of relaxation. The given AT techniques develop and perfect the athletes' bodily sensations, concentration abilities, attention retention and relaxation skills, and starting with the fourth session, another exercise was added – the target formula for the improvement of positive self-talk, self-confidence, and self-belief. The first three sessions, taking into account the restrictions of COVID-19, were conducted online, the other six sessions were conducted face-to-face, after the athletes' volleyball practice.

The first research instrument. The heart rate variability (HRV) diagnostic method is used to track the changes in the athlete's functional state during a course of detective experiment. The use of HRV diagnostic method allows to obtain information about the functional status level of athletes, which is one of the objective indicators of stress level.

Omega-M equipment (Система комплексного компьютерного исследования функционального состояния организма человека «Омега – М», 2022), patented by St. Petersburg research and production company Dynamics, was used for diagnostics of athletes' HRV. It is a complex scientific apparatus (Certificate of Conformity of the Russian Federation No. POCC RU.ME01.BO5487) that captures and analyses the heart rate. The analysis of bio-rhythmic processes is based on new information technologies and the latest knowledge in biology, physiology, genetics and clinical medicine. Any changes in the body are reflected in the rhythm of the heart. Responding to the impulses of the central nervous system, the heart rate determines the rhythm of the whole organism, therefore, the dynamics of the HRV shows an objective functional state of the organism, which allows to predict the further possible changes (Михайлов, 2000; Ярилов, 2001; Чуян et al., 2008; Баевский et al., 2009). The HRV analysis can determine the state of the regulatory system of the body, the influence of factors regulating neurohumoral heart rhythm, the balance of the autonomic nervous system, i.e., the balance of the sympathetic and parasympathetic nervous systems. The autonomic nervous system regulates and harmonizes the functioning of all internal organs (American Heart Association, 1996).

The results of obtained measurements were analysed according to Baevsky's (Баевски et al., 2009) interpretation of HRV data, relating it to the general functional state of the organism and the biomedical explanation of the concept of health, which states that health is sufficient adaptation abilities of the organism to maintain homeostasis (Баевский, 2000).

The HRV data are interpreted by distinguishing between five levels of adaptation: optimal level of adaptation (100 – 80%); normal level of adaptation (79 – 60%); medium level of adaptation (59 – 40%), low (39 – 20%) and very low levels of adaptation (19 – 0%). For the study, general parameters of functional diagnostics of the organism were selected, which, based on the HRV, determine the following health qualities of the human body:

(A) parameter indicates the adaptation level of the cardiovascular system.
(B) parameter indicates the regulation of the autonomic vegetative system.
(C) parameter indicates neurohumoral regulation.
(D) parameter indicates the psycho-emotional state.
(H) parameter is the total integral health parameter.

The HRV diagnostics were performed for all volleyball players involved in the study. HRV was measured at rest (while sitting). Special jaws were applied to both forearms of the study participants, which recorded the heart rate over a period of 3 – 5 minutes, and 300 cardio-complexes were recorded.

Second research instrument. A Survey of Perceived Stress Level (Cohen et al., 1983), adapted by Department of Psychology, University of Latvia. Adaptation of the survey to Latvian was done by I. Stokenberga (2008). The questionnaire consists of a total of 10 questions, with five variants for each answer: 0 = never; 1 = almost never; 2 = sometimes; 3 = quite often; 4 = very often. Summing up the responses gives the following results: 0 – 13 points for a low PSL; 14-26 points for a moderate PSL; 27 – 40 points for a high PSL.

Diagnostic measurements were performed before and after the whole AT intervention, not after each session.

Statistical Package for the Social Science (SPSS 28.0) was used for comparative analysis of the empirical quantitative data. Tools used for the analysis of survey and measurement data: descriptive statistics (arithmetic mean, variation or dispersion rates, representation, or standard errors). The mean results for the most significant parameters are expressed as a percentage score; the coefficient of internal coherence (Cronbach's Alpha α); the Kolmogorov-Smirnov test for the determination of the data distribution; a T-test will be used for the comparative analysis of the results of the detective experiment, which determines the differences in the linked sample sets.

Results

For PSL questionnaire, the coefficient of internal coherence was determined (Cronbach's Alpha $\alpha = 0.811$). Summarizing the data of the PSL survey, the following results were obtained: the arithmetic mean of PSL is 16.6 points, SD±4.7; SE±1.3. Summarizing the scores obtained, where 0 – 13 points is low PSL, 14 – 26 moderate PSL, 27 – 40 high PSL, it can be concluded that two (15.4%) of the study participants, have a low PSL and 11 (84.6%) – moderate PSL, but no participants have a high PSL (n=13) (see Table 1).

Table 1.

Volleyball players' PSL indicators before and after acquisition AT

Participants	Age	PSL score before AT	PSL level before AT	PSL after AT	**PSL level before AT**
Number		points		points	
A1	17.5	14	moderate stress	16	moderate stress
A2	17.2	20	moderate stress	21	moderate stress
A3	17.4	19	moderate stress	13	low stress
A4	17.1	23	moderate stress	23	moderate stress
A5	16.7	15	moderate stress	21	moderate stress
A6	16.3	10	low stress	8	low stress
A7	16.5	21	moderate stress	19	moderate stress
A8	16.8	17	moderate stress	15	moderate stress
A9	16.9	24	moderate stress	25	moderate stress
A10	17.7	14	moderate stress	14	moderate stress
A11	16	16	moderate stress	11	low stress
A12	17.3	8	low stress	8	low stress
A13	17.6	15	moderate stress	9	low stress

In a repeated PSL survey, the average score of the group is 15.6 points, SD±5.7; SE±1.6, five athletes (38.5%) have low PSL, eight participants (71.5%) have moderate PSL and there are no young athletes with a high PSL (see Table 1). Compared to the measurement made before acquiring AT techniques, it can be concluded that for three athletes the PSL has decreased from a moderate level to low. Comparison of group data was performed using the T-test based on One-Sample Kolmogorov-Smirnov Test, which shows a normal distribution of data ($p<0.5$). PSL data obtained from the T-test before and after AT acquisition do not show significant changes ($p=0.85$) in PSL of the athletes.

For A, B, C, D, H indicators based on HRV analysis, the coefficient of internal coherence was determined (Cronbach's Alpha $\alpha=0.807$). Analysing the A, B, C, D, H indicators based on HRV analysis obtained before the AT intervention, the following arithmetic mean indicators were obtained: in parameter A – 63.9; SD±20.26; SE±5.6; in parameter B – 67.4; SD±24, SE±6.7; in parameter C – 58.4; SD±15.5; SE±4.5; in parameter D – 60, SD±17; SE±4.7, but in parameter H the arithmetic mean indicator is 62.5; SD±17.9; SE±4. 5.

Summarizing the individual indicators of the volleyball players (see Table 2), in parameter A, the optimal level of adaptation is for 15.4% of athletes; the normal level of adaptation is for 53.8% of athletes; lower than normal, the average level of the regulatory system is for 23% and the very low level of adaptation is for 7.7% of athletes. In Parameter B, the optimal level of adaptation is for 30.8% of athletes; the normal level of adaptation – for 38.5%; lower than normal, the average level of the regulation system is for 23%, and the very low adaptation level is for 7.7% of athletes. In parameter C, the optimal level of adaptation is for 7.7% of athletes, normal level of adaptation –f or 46.2%; lower than normal, average level of regulation system – for 30.8%; but low level of adaptation – for 15.4% of athletes. In parameter D – optimal level of adaptation is for 7.7 % of athletes; normal level of adaptation is for 46.2%; lower than normal, average level of regulation system is for 30.8%; but low level of adaptation is for 15.4% of athletes. The total integral health status parameter (H) characterizes the overall body functional status of athletes – optimal functional status is for 15.4% of athletes, normal functional status is for 53.8% of athletes, lower than normal – for 15.4% of athletes, and 15.4% has a low functional status of body.

Table2

Individual HR scores and A,B,C,D,H indicators based on HRV analysis before and after the AT sessions

Particiants	HR before AT	HR after AT	A before AT	A after AT	B before AT	B after AT	C before AT	C after AT	D before AT	D after AT	H before AT	H after AT
Number	Bpm	Bpm	%	%	%	%	%	%	%	%	%	%
A1	69	71	74	81	85	88	65	63	62	70	72	75
A2	67	77	63	68	71	79	63	75	65	70	66	73
A3	79	76	55	57	63	61	50	52	58	60	57	58
A4	70	72	91	94	95	95	68	68	72	73	82	83
A5	62	67	62	94	72	97	59	70	58	69	63	83
A6	67	73	62	63	96	83	46	63	49	58	63	67
A7	76	67	99	100	100	100	84	91	97	95	95	96
A8	77	78	55	41	69	61	66	58	62	49	63	52
A9	98	98	45	46	36	36	30	29	35	35	35	36
A10	107	106	18	55	18	28	37	63	31	50	26	49
A11	75	74	60	64	52	59	47	50	50	51	52	56
A12	81	89	70	75	68	73	68	71	69	72	69	73
A13	93	90	77	78	51	56	76	78	72	73	69	71

Repeated measurements of A, B, C, D, H indicators based on HRV analysis after acquisition of AT lead to the following data: the arithmetic mean indicator of the group in parameter A is 70.5; SD±18.6; SE±5.2; in parameter B – 70.5, SD±22.8, SE±6.3; in parameter C – 63.9; SD±15.1; SE±4.2; in parameter D – 63.5; SD±15.2; SE±4.1, but in parameter H the arithmetic mean is 67; SD±16.4; SE±4.5.

In parameter A, the optimal level of adaptation is for 30.8% of athletes, the normal level of adaptation – for 38.5%, lower than normal, the average level of the regulation system – for 30.8% of athletes, and no low level of adaptation was found. In parameter B, the optimal level of adaptation is for 38.5% of athletes, the normal level of adaptation – for 30.8%, lower than normal, the average level of the regulation system is for 23%, the low level of adaptation is for 7.7% of research participants. In parameter C, the optimal level of adaptation is for 7.7% of athletes, the normal level of adaptation – for 61.6%, lower than normal, the average level of the regulation system is for 23%, but the low level of adaptation is for 7.7% of athletes. In parameter D, the optimal adaptation level is for 7.7% of athletes, normal adaptation level – for 53.8%, lower than normal, average level of regulation system is for 23%, but low adaptation level is for 15.4% of athletes. In parameter H, the optimal level of adaptation is for 23% of athletes, the normal level of adaptation is for 38.5%, lower than normal, the average level of the regulation system is for 23%, but the low level of adaptation is for 15.4% of athletes.

Comparison of group data was performed using the T-test based on One-Sample Kolmogorov-Smirnov Test, which shows a normal distribution of data ($p<0.5$).

Table 3

Based on HRV data, comparative results of A,B,C,D, H parameters before and after the application of a sessions of AT techniques

Paired Samples Test				
		Paired Differences	t	Sig. (2-tailed)
		95% Confidence Interval of the Difference		
		Upper		
Pair 1	A before AT/A after AT	1.579	-1.755	.105
Pair 2	B before AT/B after AT	2.470	-1.209	.250
Pair 3	C before AT/C after AT	-.091	-2.215	.047
Pair 4	D before AT/D after AT	1.105	-1.652	.125
Pair 5	H before AT/H after AT	.580	-1.935	.077

Analysing the obtained data before and after the acquisition of AT techniques, based on the athletes' HRV data, which determine the adaptation level of (A)cardiovascular system; (B) autonomous vegetative system; (C) central heart rhythm; (D) psycho-emotional state, as well as (H) parameter, which is the total integral parameter of the state of health, no significant changes were observed, except in the measurement C, which shows a statistically significant changes $p\leq .047$ (see Table 3).

Discussion

By studying the available literature on this subject and evaluating the main conclusions of this study, it is possible to compare it with related studies on the impact of "psycho-regulatory" techniques on PSL indicators and stress optimization for the athletes. In recent years in sports science, the research on the application of the HRV biofeedback method has gained popularity, but not so much research is conducted on AT. There are studies that confirm that general self-regulated daily meditations, which include the effects of AT, HRV Biofeedback and influence of physical exercises on HRV, demonstrate equivalent impact to the improvement of the attention control, increasing self-awareness and self-compassion, as well as reducing the stressful feelings (de Bruin et al., 2016).

In an interdisciplinary study of Kemp and Quintana (2013) that analysed the findings of clinical epidemiology, psychophysiology, and molecular neuroscience, it is suggested that the optimization of HRV scores is one of the most important components of mental and physical well-being, concluding that HRV is an available and significant criterion for health and well-being in the future. In addition, for optimization of HRV, it is recommended not only to change the eating habits, abandon harmful habits, but also to engage in physical activity and meditation.

Studies have shown interrelationships between the stress score survey data and HVR, for example, the study of Sommerfeldt et al. (2019) shows the interrelationships between the heart rate and self-observation of stress. Significant correlations were found with psychological well-being scores, reduction of depressive symptoms, lower rates of anxiety as a trait, and higher motivation to manage stress. High indicators of HRV are associated with better general health, allowing the body to better adapt to external environment and internal stimuli. Low HVR rates, on the other hand, are predictors of cardiovascular and metabolic problems and are associated with a higher mortality risk (Morgan & Mora, 2017).

The results of the McGrady (2007) study show that HRV is associated with a mental state and has an adaptive character, so psychological and physical well-being is one of the main determinants. The research data shows that people with panic disorders have a higher heart rate and lower HRV than for control groups without panic disorders. Breathing has a significant effect on HRV. Breathing rate, rhythm, and type are correlated with heart rate fluctuations and this is called heart rate variability (McGrady, 2007). Slower breathing with about six breaths per minute causes greater variability.

There are interrelationships between HRV and other physiological reflexes, such as baroreceptors, and between HRV and diseases. Since HRV has a direct correlation to breathing, it can be improved by mastering breathing exercises. Deep breathing increases HRV and it has a direct effect on the cardiovascular and respiratory systems, especially for the patients with bronchial asthma and hypertension, as the baroreflex mechanism can be improved by acquiring and regularly using various breathing techniques. According to scientists, the understanding of breathing psychophysiology is essential for anyone who wants to manage the effects of stress (McGrady, 2007). Lim and Kim (2014) conducted a study on the impact of AT on HRV and stress reduction for a nursing school student as their stress conditions increase during their internships. Nineteen college students who participated in the study were assigned to the experimental group and underwent an 8-week AT programme, while the remaining 21 were assigned to the control group and were not involved in the AT acquisition process. Stress response was assessed by a questionnaire, and HRV was measured three times, i.e., before the implementation of AT programme, at the end of the programme, and 6 months after the end of the AT programme.

In turn, Kaitlyn (2018), studying the correlations between the HRV and mental health of female hockey players during the entire sports season from September to March, found weak interrelations between the HRV RMSSD (square root of the root mean square difference of successive NN intervals) indicator and psychological resilience of the athletes, explaining such a result with a small sample of an experimental group. The author's study also shows moderately close interrelations between some HRV parameters and the acquisition of AT techniques, which could be one of the elements characterizing the athletes' psychological resilience but does not characterize the athletes' psychological resilience in general.

There are several studies on the impact of AT on athletes' psychometric scores, but they are not linked to the physiometric measurements of HRV. For example, the study of Ortigosa-Márquez, et.al. (2015) was conducted using classic AT techniques, and the aim of the study was to investigate the impact of AT on athletes' competitive anxiety, cognitive anxiety, athletes' self-confidence, self-esteem, and respiratory volume. Athletes completed a personal control record as they learned AT techniques, in which they indicated whether they performed AT, date, time, and their feelings and emotions. Results of the study, in the experimental group, showed statistically significant changes only in self-confidence and self-esteem indicators. As in most of such type of studies, there was a limited experimental sample, and the study was conducted with 18 medium level sprint triathlon athletes. In turn, the study of Vesković et al. (2019) combined AT with guided visualization – an 8-week intervention with an aim to optimize anxiety and self-confidence for high-class karate athletes. The repeated measurements indicated a difference in anxiety levels between the control and the experimental group, and a more detailed data analysis showed a decrease in cognitive anxiety and an increase in self-confidence among the participants of the experimental group. The researchers concluded that the implementation of the psychoregulation skills improvement programme had a positive impact on the optimization of anxiety and self-confidence level for all the best karate athletes.

At the end of the discussion, it can be concluded that the objectives and methodology of the studies analysed are quite different, most of the studies involve a small sample of athletes, and also the results of the studies cannot be objectively compared.

Conclusions

The obtained indicators are not statistically reliable, however, there was a positive dynamic of the results after the implementation of AT techniques, but due to a small number of respondents they cannot be generalized.

Taking into account the data and results obtained in the study, in the future research for the stronger validity of the results, the improvements should be made to research methodology together with expanding the range of respondents and developing a more flexible and young athletes motivating programme of AT techniques.

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ORIGINAL RESEARCH PAPER

PHYSICAL CONDITIONING OF BASKETBALL PLAYERS AGED 14 – 15 IN YEAR 2020/2021

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Abstract

2020/2021 season Latvian youth basketball season started in September and lasted for a month without an audience. The championship's regular season games were stopped for all Youth Basketball League's team. Starting with 2020 October physical preparation workouts were happening in a park and also as 1:1 workout session – a coach and a player. The country issued many regulatory documents for organizing workouts. Starting with the 21st of December 2020, it was prohibited to organize a workout indoors. Coaches and players continued to keep their physical shape in outdoor workouts and hoped that the season will continue. But the competition season was discontinued. When the summer preparation season started, day and 24-hour camps were allowed at sport schools. On the 7th of May 2021, the Latvian Youth Basketball League issued control standards in Physical Conditioning, which the disciples of sport schools had to meet by the 31st of August 2021. The disciples of MT-5 (preparation training group in the fifth year of study) and MT-6 (preparation training group in the sixth year of study) had to perform at least 4 out of 6 physical conditioning control exercises. Control standards: 20m run from a standing position, 60m run from a standing position, skipping on the skipping rope (30 sec.), passes with both hands from the chest for a 2m distance (30 sec.), long jump from place and a long-distance pass with the basketball ball. The results confirm that the disciples of groups MT-5 (aged 14) and MT-6 (aged 15) have very low physical conditioning standards, which does not facilitate improvement in physical conditioning.

Keywords: *physical conditioning, control exercises and tests, Covid-19.*

Introduction

2020/2021 Latvian youth basketball season started in September and lasted for a month without an audience. The championship's regular season games were stopped for all Youth Basketball League's teams. Starting with October 2020, physical preparation workouts were happening in a park and as 1:1 workout session – a coach and a player. From the 17th of October 2020 until the 6th of November 2020 trainings were organized outdoors, individually, or online. In outdoor group trainings, it was prohibited to use locker rooms (Alterations to the Regulations of the Cabinet of Ministers, 2020). Starting with the 21st of December 2020, it was prohibited to organize a workout indoors (Alterations to the Regulations of the Cabinet of Ministers, 2020, Skutane & Avotina, 2022).

The study was conducted in order to develop outdoor trainings: improving physical conditioning in the period when it was not known to which competitions the players were preparing and when the next competitions will take place. It was the time for which no textbook explains how to plan the process of training (Skutane & Avotina, 2022).

COVID-19 restriction measures recommended by the World Health Organization and imposed at global level were applied in different countries by the governments and local authorities, impacting all categories of populations and socio-economic areas (Teodorescu et al., 2021).

The results related to training programming confirmed the hypothesis assuming that the major training process coordinates were significantly impacted by distance coaching.

All restrictions imposed during the pandemic greatly affected the entire training process, starting with the need to change the training objectives (most of the surveyed coaches resorting to this measure) up to restructuring the training content due to improper practice conditions. Wasif et al. (2021) and Giradi et al. (2020) highlighted that interrupting training or changing the effort dynamics caused athletes to lose their sports skills (Washif et al., 2021; Girardi et al., 2020). For athletes, the lockdown became a detraining period, disrupting the established periodization, this being an important negative consequence of home isolation (Jukic et al., 2020).

The aim of the study is to assess the control exercises developed by the Latvian Youth Basketball League for boys of MT-5 and MT-6 groups. The task is to assess the correspondence of the control standards to the training process under COVID–19 circumstances.

The level of physical conditioning and technical preparation is determined by control standards – tests (Ķīsis, 2015). The theory of human conditioning testing is one of the most completely developed theories in the field of sport theory. Information about tests, their modifications, and various factors influencing the testing results has been collected over years. Testing programmes have been developed to describe the physical conditioning of children and teenagers aged 6 – 18, and these programmes are recognized in many countries of the world, including the European Union, the USA, Canada, Russia, Japan, and others (Rudzītis & Lāriņš, 2008).

Testing is a standardized, scientifically founded, widely applied method in sport that is used to determine an athlete's physical development, physical conditioning and the body's functional abilities (Brittenham, 1996; Kīsis, 2018).

Collecting the results of unified tests provides an opportunity to regularly obtain the newest data on the level of physical conditioning of children, youth, and adults, their working capacity and developmental tendencies, which is one of the most important indicators (Ķīsis, 2018, Vispārējās fiziskās sagatavotības normatīvi, 2021).

Standards are developed for a defined group of athletes and are valid for this group only. Currently various scientists of this country have collected much information on how the standards that are valid for, e.g., the teenagers and youths from the countries in northern Europe are not applicable in the countries in southern Europe or in Africa (Rudzītis & Lāriņš, 2008). The Latvian Youth Basketball League (LYBL) has developed general physical conditioning standards for 2020/2021, and the results to be achieved by each age group, and these have been approved by the Cabinet of Ministers (Vispārējās fiziskās sagatavotības normatīvi, 2021). These standards differ from the standards developed for the previous years, and the standards do not match the ones mentioned by various authors (Ķīsis, 2018, Liepiņš, 2000, Rudzītis, 2003, Rudzītis & Lāriņš, 2008).

Conditioning is an athlete's ability to show a certain result in a chosen sport, and it depends on the athlete's technique, tactic, physical, psychological, and intellectual preparation, as well as health condition (Ķīsis, 2018).

Physical conditioning is the results of physical preparation process, which is manifested in the acquisition of movement skills and physical characteristics at a determined level. Physical conditioning is described by physical peculiarities – endurance, strength, speed, agility, and flexibility (Ķīsis, 2018, Liepiņš, 2000).

Various tests are used to measure physical conditioning. Each coach can choose them to depend on his/her concept and available options. It is advisable to include various tests for measuring one physical characteristic to have a more precise and informative assessment. Control exercises must be performed at least twice during a season (at the beginning and at the end of a season), and twice during a training camp. The performance of a control exercise must take the form of a competition (Ķīsis, 2018, Rudzītis, 2003). In order to obtain information about an athlete's potential abilities during a test, it is necessary to analyse the dynamics of testing over a long-term period (several years). If a disciple has always been ranked highly within his/her group or progresses quickly but evenly, it can be considered that he/she has high potential in the tested characteristics (Rudzītis et al., 2008).

The task of testing is to determine the athlete's developmental ability in conditioning (strength, endurance, speed, flexibility, and coordination) and coordination (balance, orienteering, differentiation of movement parameters, sense of rhythm, change of action, vestibular stability, muscle relaxation, and movement coordination) as well as to assess technical and tactical preparation (Brittenham, 1996, Liepiņš, 2000, Rudzītis, 2003, Rudzītis & Lāriņš, 2008). Testing also enables to solve practical tasks: the disciples themselves can assess their physical conditioning and plan the activities necessary for them; to stimulate the disciples to improve their shape further; to know not only the initial indicators but also their changes over a specified period (Rudzītis & Lāriņš, 2008).

Only the exercises meeting certain requirements can be used as tests:

- There should be defined test performance goals.
- Definite, standardized measurement methodology should be developed for tests and their performance procedure.
- The safety and informativity of tests should be clarified.
- Tests results should be possible to enter in the respective assessment system (Brittenham, 1996, Rudzītis & Lāriņš, 2008).

Regular tests of physical characteristics are to be performed in order to:

1. Assess the youth's physical capacity using tests that are close to basketball.
2. Create the athlete's physical profile with strong and weak characteristics.
3. Compare the youth's physical capacities to their peers in Latvia and high-class basketball players elsewhere in the world.
4. Make the necessary corrections in the training plans (for the coach) and to make the work more efficient.
5. Observe the youth's progress in the long run.
6. Motivate the youth, coaches, and sport organisations to put forward new goals and aspire to new heights (Ernšteins & Ikstens, nd.).

However, this material does not include the LYBS tests for COVID-19 training period and does not describe the options for preparing to the tests, as only popular tests performed in various sports are mentioned there.

The authors of a study performed in Latvia suggested testing basketball technique. The participants performed technical-related fitness tests to assess dribbling (control dribble, 20m dribble, two balls of 20m dribble, Illinois agility dribble), shooting (30 free-throw shoots, 1min. shooting, modified medium and long-range shots, close range shots) and defensive movements. The dribbling skills had substantial improvements (7 to 8-years-old: 20m sprint with dribbling, effect size = 1.86; control dribble effect size = 2.18; 9 to 10-year-old: 20m sprint with dribbling, effect size = 1.85; Illinois agility test with dribbling effect size = 1.82). Changes in defensive movement occurred mostly at the 14 – 15 age period. Current results and consequent normative profiles, presented as percentile tables, allow to accurately follow the players' development (Matulaitis et al., 2019). These tests are not used for young basketball players in Latvia.

The aim of a Portuguese study was to estimate the influence of body size and pubertal status on variation in functional capacities and sport-specific skills of 59 youth basketball players aged 14.0 – 15.9 years. Height and mass were measured, and stage of pubic hair was assessed at clinical examination. Six tests of functional capacity were evaluated: squat jump, counter-movement jump, 60s sit-ups, 2kg standing medicine ball throw, hand grip strength, and 20m multi-stage shuttle run. Four basketball skills were tested (shooting, passing, dribbling, and defensive movements). Comparisons between basketball players of different sexual maturity status were performed using analysis of covariance (controlling for chronological age). Functional capacities and basketball skills appeared to be largely independent of pubertal status especially after controlling for variation in body size. Results of multiple linear regressions indicated chronological age as a significant predictor for four items, while maturity status was a significant predictor for only one item. The influence of body mass was negative for two functional indicators (jumping and multi-stage shuttle run) and two basketball skills (dribbling and defensive movements), but positive for two functional tests of upper body strength (hand grip and ball throw). Height was positively correlated with two specific skills (passing and defensive movements), while a combination of tallness and heaviness was associated with a disadvantage on three functional capacities and two sport-specific skills (Coelho et al., 2008).

Basketball is a combined game demanding elevated physical and technical skills, mental characteristics and tactical behaviour. These characteristics cannot be evaluated only by skill tests, which are considered inadequate to record the mental ability of the aged 14 – 15 years old athletes. For the complete evaluation of the athletes' performance observation methods have been proposed, which record all of their efforts during the game. The aim of the present study was to evaluate the athletes' efficacy in passing skill, with two different methods: (a) the skill test and (b) game observation and correlate the results with the total game performance (Sachanidi et al., 2013).

The study made in Ukraine put forward basketball and physical conditioning tests: in order to assess the technical fitness, the following was used: movement in a defensive stance, push-passing the ball in a give-and-go play with two hands and an over-arm pass with one hand within 30s at a distance of 2m from the wall, foul shots, jump shots, a complex exercise in running, passing, catching, driving and throwing the ball into the basket, running for 20m, standing long jump, height of jumping up with pushing of two legs, 3x40s running on the basketball court after 1 minute of rest. All tests meet the basic criteria of the theory of tests. The lack of due attention to the age-old peculiarities of young basketball players and to the distribution of the amount of time for training, and especially technical training, is aggravated by the fact that teams of 12 – 14-year-old basketball players are formed in the Youth Sports School, due to which early specialization begins, which is focused on the formation of players for a certain role and training them to participate in the competition. There is no consistency or full scope in the development of the techniques, skills, or formation of originality in it. Along with the introduction of normative indicators in full concerning physical and technical fitness, rational distribution of time for all types of training by years of training and improvement of the competition system will allow to significantly increase the level of work with young basketball players in terms of their long-term training (Koryahin et al., 2019).

There are simple and complex tests. Simple tests are used to test one ability. Complex tests assess several distinct components of abilities and their indicators (Rudzītis et al., 2008).

Usually, several tests are used to assess the physical conditioning of young athletes. The tests assess each physical characteristic (speed, strength, endurance, etc.) separately and then compare it to other results of the athlete or to previously developed standards.

Physical conditioning tests include:

- Long jumping from place (explosive strength test) (Brittenham, 1996; Ķīsis, 2018; Liepiņš, 2000; Rudzītis, 2003; Rudzītis & Lāriņš, 2008).
- 20m or 30m run with a walking start (maximum speed test) (Brittenham, 1996, Rudzītis & Lāriņš, 2008).
- 30m and 60m run (speed test) (Ķīsis, 2018; Liepiņš, 2000; Rudzītis, 2003; Rudzītis & Lāriņš, 2008).
- 1000m, 1500m, and 3000m run (endurance test) (Ķīsis, 2018).

- And other tests that are not considered in this study but are added the tests developed by the LYBL.

The study considers physical conditioning standards confirmed by the LYBL (Latvian Youth Basketball League) and are mandatory for all sport schools in Latvia. The general physical conditioning standards for 2020/2021 were issued by the LYBL on the 7th of May 2021 (Vispārējās fiziskās sagatavotības normatīvi 2020. /2021, 2021).

For boys aged 14 – 15, in the speed test of 20m run from a standing start the results were recorded using a 10-grade scale with 10 for < 2.92s and 1 for > 3.59s (see Table 1); the results in the long jump of 1.75m and above was considered to be good (Liepiņš, 2000).

Table 1

Assessment of the results of physical conditioning control exercises for basketball players aged 15 (10-grade scale) (Rudzītis, Lāriņš, 2008)

20m run from a standing start (sec)	20m run from a walking start (sec)
10 < 2.92	10 < 2.32
9 = 3.00 – 2.92	9 = 2.38 – 2.32
8 = 3.09 – 3.01	8 = 2.44 – 2.39
7 = 3.18 – 3.10	7 = 2.51 – 2.45
6 = 3.19 – 3.27	6 = 2.58 – 2.52
5 = 3.28 – 3. 35	5 = 2.59 – 2.65
4 = 3.36 – 3.43	4 = 2.66 – 2.71
3 = 3.44 – 3.51	3 = 2.71 – 2.76
2 = 3.52 – 3.59	2 = 2.77 – 2.82
1 > 3.59	1 > 2.82

Prof. A. Rudzītis (Rudzītis, 2003) developed an assessment table of physical conditioning control exercises, where each result in the following exercises: long jump from the sport, 2x40m run, 60m run from a standing start and ball throw (long-distance pass) is expressed in points from 1 to 60.

In the long jump from place in the age group of 14 years old the minimum result is 1.91m (1 point), and the maximum result is 2.50m (60 points); in the age group of 15 years old the minimum result is 2.01m (1 point), and the maximum result is 2.70m (60 points) (Rudzītis, 2003).

In the 60m run in the age group of 14 years old the minimum result is 9.6s (2 points), and the maximum result is 7.7s (59 points). In the age group of 15 years old the minimum result is 9.4s (2 points), and the maximum result is 7.5s (59 points) (Rudzītis, 2003).

In the ball throw (long-distance pass) in the age group of 14 years old the minimum result is 16.20m (1 point), and the maximum result is 28.0m (60 points). In the age group of 15 years old the minimum result is 17.20m (1 point), and the maximum result is 29.0m (60 points) (Rudzītis, 2003). Alternatively, 16-year-olds should show the result of 20m with a normal-sized ball, and 15-year-olds should show the result of 22m (Rudzītis, 2003).

Passes with both hands from the chest at the age of 14:25 passes in 30s, and at the age of 15:24 passes in 30s (Rudzītis, 2003).

The control exercise "skipping with a skipping rope (30s)" has not been used before.

In turn, Prof I. Ķīsis (Ķīsis, 2018) offers a different type of assessing the results of physical conditioning for boys aged 14 – 15, in five levels: low level, below average level, average level, above average level, and high level (see Table 2).

Table 2

Physical conditioning assessment scale for boys aged 14 and 15 (Ķīsis, 2003)

Indicators and measurement units	**Low level**	**Below average level**	**Average level**	**Above average level**	**High level**
points	1	2	3	4	5
For boys aged 14					
Long jump from place (m)	<1.81	1.82 – 1.94	1.95 – 2.07	2.08 – 2.20	> 2.21
60m run from a standing start (s)	9.5	9.4 – 9.0	8.9 – 8.8	8.7 – 8.6	8.5
For boys aged 15					
Long jump from place (m)	< 1.95	1.96 – 2.07	2.08 – 2.20	2.21 – 2.32	> 2.33
60m run from a standing start (s)	9.1	9.0 – 8.8	8.7 – 8.5	8.4 – 8.3	8.2

In order to assess versatile physical conditioning, at least 5 control exercises for different physical abilities must be used in one testing. An athlete receives positive assessment if the result in each test is assessed with at least 3 points – average level (Ķīsis, 2018).

This study takes the assessment scale developed by the LYBL for 2020/2021. Until 2020, the control standards shown in Tables 3 – 4 were in power, which did not envisage separate assessment of general physical conditioning.

Table 3

Basketball control standards (2017 – 2020) MT – 5

Technical conditioning control exercises	Movement 5m x 6m (s)	Passes with both hands from the chest from 2m distance in 30s (number of repetitions)	Size 6 ball throws over distance (long-distance pass)	Foul throws until the 2nd mistake	Three-point shots in one minute
Girls	9,3	32	13	3	1
Boys	8,3	32	15	3	2

Table 4

Basketball control standards (2017 – 2020) MT – 6

Technical conditioning control exercises	Movement 5m x 6m (s)	Passes with both hands from the chest from 2m distance in 30s (number of repetitions)	Size 6 ball throws over distance (long-distance pass)	Foul throws until the 2nd mistake	Three-point shots in one minute
Girls	9,1	33	14	4	2
Boys	8,1	33	16	4	3

Description of control exercises

1. *Movement 5m x 6m in various ways with a change of direction*

The field has a marked rectangle 5m x 6m. The basketball player takes the starting position outside the lines of the rectangle corner. After the signal, the player runs forward (5m), then assumes the guarding position sideways (6m), runs backwards (5m), and assumes the guarding position sideways (6m).

2. *Passes with both hands against the wall at 2m distance*

Being located behind a border (an exercise bench, a barrier, etc.), the player tries to make the highest number of passes within 30 sec.

3. *Throwing the basketball over distance (long-distance pass) from place*

It is not allowed to step outside the border or the throw line.

4. *Foul throws*

Unsuccessful throw is counted as a mistake.

5.*Three-point shots*

The number of successful shots within a minute is being counted. The player chases the thrown ball, catches it and dribbles while returning behind the three-point line to perform the next shot.

6. *Returning rebounds into the basket*

The player assumes a position behind the foul line, throws the ball against the backboard, follows the ball, and forces it into the basket.

7. *Complex exercise*

The coach prepares a complex exercise that includes dribbling, passing, and one-handed shots from under the basket.

From 2020/2021, the LYBL changed the control standards by dividing them into general physical conditioning and technical conditioning using basketball elements (the latter control standards were not considered in this study).

Table 5 shows the results of the LYBL standards before the beginning of Covid-19 emergency and those taken in 2021.

Table 5

Results for control standards in 2 exercises in 2017 and 2021

MT – 5	2017 – 2020	2021	A. Rudzītis, 2003
Passes with both hands from the chest from 2m distance in 30s (Number of repetitions)	32 times	30 times	25 times
Throwing the ball over distance (long-distance pass)	15m	15m	20m
MT – 6			
Passes with both hands from the chest from 2m distance in 30s (Number of repetitions)	33 times	35 times	24 times
Throwing the ball over distance (long-distance pass)	16m	16m	22m

The table shows that disciples of group MT-5 have decrease in results in "Passes with both hands from the chest from 2m distance in 30s (number of repetitions)" by two times, but the disciples of MT-6 group show the increase by two times in this exercise.

Material and Methods

The study included basketball players from BJBS Rīga/Centrs and BJBS Rīga/VEF of A. Krauklis's basketball sport schools from age groups MT-5 (36 disciples) and MT-6 (30 disciples). The performance of control tests at schools was to be completed by the 31st of August 2021. In view of the fact that sport bases could be used only during summer camps, the testing and the performance of control exercises also took place at that time.
Following the requirements developed by the LYBL, each disciple had to perform the following tests (see tables 6 and 7): 20m run from a standing start (s); 60m run from a standing start (s); skipping with a skipping rope (number of times), passes with both hands from the chest over the distance of 2m within 30s (repetitions), long jump from place (m), long-distance pass (using a basketball) (m) (Rudzītis, 2003, Vispārējās fiziskās sagatavotības normatīvi 2020/2021, 2021).

Standards developed by the LYBL for years 2020/2021 are shown in tables 6 and 7 (Vispārējās fiziskās sagatavotības normatīvi 2020/2021, 2021).

Table 6

Basketball control standards (2020/2021) MT – 5

Exercise **Target group**	20m run from a standing start (s)	60m run from a standing start (s)	Skipping with a skipping rope (number of repetitions in 30s)	Passes with both hands from the chest om 2m distance in 30s number of repetitions)	Long jump from place (cm)	Long-distance pass (m)
Girls	4	10.1	50	30	160	13
Boys	3.9	9.9	50	30	165	15

Table 7

Basketball control standards (2020/2021) MT – 6

Exercise **Target group**	20m run from a standing start (s)	60m run from a standing start (s)	Skipping with a skipping rope (number of repetitions in 30s	Passes with both hands from the chest from 2m distance in 30s (number of repetitions)	Long jump from place(cm)	Long-distance pass (m)
Girls	3.98	9.7	55	35	170	14
Boys	3.88	9.5	55	35	175	16

1.20m runs 60m from a standing start. The disciple assumes a position behind the starting line, with one foot place immediately at the starting line. On the "Go!" signal the disciple runs at maximum speed to the finish line that is located at the distance of 20m and 60m and crosses it. The chronometer is stopped when the athlete's upper body has crossed the finish line. The test is simultaneously performed by two disciples. The result in the 20m run is taken with the precision of up to one hundredth, and in the 60m run with up to one tenth. The test is performed twice. The final result is taken to be the better result.

2. Long jump from place. The disciple stands behind the line, the feet placed at the shoulder width, swings the arms, and jumps from place as far as possible. The disciple lands on both feet and goes forward from the jumping pit. The distance is measured in meters and centimetres to the place where the disciple touched the sand for the first time (the closest point of contact with the ground in relation to the take-off place). The test is to be performed twice. The final result is taken to be the better result.

3. Passes with both hands against the wall over 2m distance. Standing behind a border (an exercise bench, a barrier, etc.), the player tries to make the highest number of passes within 30s.

4. Throwing the basketball into the distance (long-distance pass), from place. It is not allowed to step over the border or the shot line.

5. 40s run with a change of direction (m). The athlete should try to run over as many basketball courts as possible. The size of one court is 28m. 6 – 7 courts must be run in 40s.

In order to pass the control standards, MT-1 to MT-7 groups must pass 4 out of 6 criteria (Vispārējās fiziskās sagatavotības normatīvi 2020/2021, 2021). MT-5 and MT-6 groups do not include the 40s run control standard. The performance of the control standard exercises takes place within one day.

Results

MT-6 group disciples showed the average result in 20m run from a standing start 3.31±0.19s, while the passing result determined by the LYBL is 3.88s. The best result was 3.03s, and the lowest result was 3.78s. (see

Table 8). The variation coefficient is 5.90%, which means that the group is uniform. All disciples of the age group were able to perform the set standard.

MT-6 group disciples in 60m run from a standing start showed the average result of 8.6±0.45s, while the passing result determined by the LYBL is 9.5s. The best result was 7.7s, and the lowest result was 9.5s. (see Table 8). The variation coefficient is 5.25%, which means that the group is uniform. All disciples of the age group were able to perform the set standard.

MT-6 group disciples in long jump from place showed the average result of 2.13±0.19m, while the passing result determined by the LYBL is 1.75m. The best result was 2.82m, and the lowest result was 1.82m (see Table 8). The variation coefficient is 8.93%, which means that the group is uniform. All disciples of the age group were able to perform the set standard.

MT-6 group disciples in skipping with the skipping rope in 30s showed the average result of 65.1±9.89 skips, while the passing result determined by the LYBL is 55 skips. The best result was 94 skips, and the lowest result was 51 skip (see Table 8). The variation coefficient is 15.20%, which means that the group is not uniform. This is explained by the fact that 27 disciples of this age group were able to perform the standard, and three failed to do so, because they broke the skipping rhythm by tripping over the rope.

MT-6 group disciples in passes with both hands from the chest at 2m distance against the wall in 30s showed the average result of 40.4±3.03 passes, while the passing result determined by the LYBL is 35 passes. The best result was 46 passes, and the lowest result was 35 passes (see Table 8). The variation coefficient is 7.51%, which means that the group is uniform. All disciples of the age group were able to perform the set standard.

MT-6 group disciples in the long-distance pass with one hand showed the average result of 21.4±2.81m, while the passing result determined by the LYBL is 16m. The best result was 28m, and the lowest result was 16m (see Table 8). The variation coefficient is 13.18%, which means that the group is not uniform, showing a significant spread of the results. All disciples of the age group were able to perform the set standard.

MT-6 group disciples showed uniform results in 4 control exercises, while 2 control exercises showed a marked spread of results, with the variation coefficient above 10%.

Table 8

Control standard results MT-6 group disciples in 2021

Exercise / **Disciples**	20m run from a standing start (s)	60m run from a standing start (s)	Skipping using a skipping rope (number of repetitions in30s)	Passes with both hands from the chest from 2m distance in 30s (number of passes)	Long jump from place (m)	Long-distance pass (m)
1	3.10	8.1	69	42	2.35	28.0
2	3.20	8.5	61	44	2.21	21.0
3	3.30	9.4	53	39	1.99	19.0
4	3.30	8.9	62	38	2.11	22.0
5	3.78	9.3	61	41	2.05	18.0
6	3.24	8.9	63	39	2.15	19.0
7	3.41	8.8	51	39	2.09	20.0
8	3.03	7.7	64	46	2.82	24.0
9	3.32	8.1	69	43	2.14	25.0
10	3.35	8.6	62	44	2.10	23.0
11	3.45	8.8	64	39	1.98	20.0
12	3.43	9.2	56	38	2.10	21.0
13	3.41	8.6	81	46	2.14	20.0
14	3.63	9.1	60	42	1.98	18.0
15	3.78	9.5	61	38	1.82	17.0
16	3.65	9.3	56	37	2.00	20.0
17	3.19	8.5	55	41	1.99	16.0
18	3.25	8.5	62	43	1.97	22.0
19	3.18	8.3	73	37	1.95	19.0
20	3.38	8.3	59	46	1.94	20.0
21	3.09	8.7	94	43	2.21	21.5
22	3.48	8.1	81	38	2.16	24.5
23	3.23	8.4	68	38	2.37	22.5
24	3.14	8.2	74	41	2.21	24.0
25	3.09	8.5	70	39	2.25	23.0
26	3.18	8.2	80	40	2.33	27.0
27	3.18	8.5	51	35	2.14	23.0
28	3.28	9.2	56	41	2.01	24.0
29	3.40	8.8	67	41	1.92	20.0
30	3.17	8.2	70	35	2.30	20.0
Average result	3.31	8.6	65.1	40.4	2.13	21.4
Standards determined by the LYBL	3.88	9.5	55	35	1.75	16
Variance	0.03815	0.20593	97.88621	9.21954	0.03606	7.94282
Standard Deviation	0.19532	0.4538	9.89375	3.03637	0.18989	2.8183
Coefficient of variation	5.90%	5.25%	15.20%	7.51%	8.93%	13.18%

MT-5 group disciples showed the average result in 20m run from a standing start 3.41±0.24s, while the passing result determined by the LYBL is 3.9s. The best result was 3.09s, and the lowest result was 4.10s (see Table 9). The variation coefficient is 7.18%, which means that the group is uniform. 29 disciples of this age group were able to perform the defined standard, and one failed it, due to increased body weight and inability to take off well.

MT – group disciples in 60m run from a standing start showed the average result of 9.0±0.88s, while the passing result determined by the LYBL is 9.9s. The best result was 8.1s, and the lowest result was 12.2s (see Table 9). The variation coefficient is 9.79%, which means that the group is uniform. 27 disciples of this age group were able to perform the defined standard, but three disciples failed it.

MT-5 group disciples in long jump from place showed the average result of 2.05±0.22m, while the passing result determined by the LYBL is 1.65m. The best result was 2.54m, and the lowest result was 1.50m (see Table 9). The variation coefficient is 10.95%, which means that the group is not uniform, showing a spread of results. 29 disciples of this age group were able to perform the defined standard, and one failed it, due to increased body weight and inability to take off well.

MT-5 group disciples in skipping with the skipping rope in 30s showed the average result of 65±13.47 skips, while the passing result determined by the LYBL is 50 skips. The best result was 110 skips, and the lowest result was 43 skips (see Table 9). The variation coefficient is 20.79%, which means that the group is not uniform, showing a spread of results. 34 disciples of this age group were able to perform the defined standard, and two disciples failed it, because they broke the rhythm by catching the rope; two disciples could make 50 skips within 30s.

MT-5 group disciples in passes with both hands from the chest at 2m distance against the wall in 30s showed the average result of 36±3.69 passes, while the passing result determined by the LYBL is 30 passes. The best result was 43 passes, and the lowest result was 28 passes (see Table 9). The variation coefficient is 10.28%, which means that the group is not uniform, showing a spread of results. 34 disciples of this age group were able to perform the defined standard, and two disciples failed to do it, because they made a mistake in the rhythm of shots and did not catch the ball well.

MT-5 group disciples in the long-distance pass with one hand showed the average result of 20.5±3.29m, while the passing result determined by the LYBL is 15m. The best result was 27m, and the lowest result was 14m (see Table 9). The variation coefficient is 16.07%, which means that the group is not uniform. 34 disciples of this age group were able to perform the defined standard, but two could not reach the mark of 15m, and their result was 14m. This shows weakness of the arm muscles, which were not trained during distance training or the disciples, avoided performing this exercise.

Table 9

Control standard results for MT-5 group disciples in 2021

Exercise **Disciples**	20m run from a standing start (s)	20m run from a standing start (s)	Skipping using a skipping rope (number of repetitions in 30s)	Passes with both hands from the chest from 2m distance in 30s (number of passes)	Long jump from place (m)	Long-distance pass (m)
1	3.09	8.7	94	43	2.21	21.5
2	3.18	8.5	57	35	2.14	23.0
3	3.18	8.1	81	38	2.16	24.5
4	3.33	8.2	65	37	1.98	22.0
5	3.23	8.4	68	38	2.37	22.5
6	3.78	9.8	55	32	1.96	21.0
7	3.28	9.2	50	41	2.01	24.0
8	3.39	9.3	50	36	1.86	24.0
9	3.50	9.0	54	33	1.82	16.0
10	3.60	8.7	68	41	1.95	18.0
11	3.44	9.9	60	36	1.89	19.0
12	3.51	9.2	54	38	1.97	18.0
13	3.40	8.8	67	41	1.92	20.0
14	3.61	9.6	78	37	1.94	17.0
15	3.52	9.1	52	30	1.71	15.0
16	3.14	8.2	74	41	2.21	24.0
17	3.88	9.8	55	38	1.87	17.0
18	3.67	9.5	58	34	1.82	15.0
19	3.09	8.5	70	29	2.25	23.0
20	3.19	8.2	80	40	2.33	27.0
21	3.37	8.6	70	37	2.00	23.0
22	3.17	8.2	70	35	2.20	20.0
23	3.20	8.1	68	35	2.54	24.5
24	3.28	8.6	68	38	2.33	24.5
25	3.35	8.8	58	37	2.23	25.0
26	3.60	8.5	71	39	2.21	22.0
27	3.16	8.3	66	32	2.32	20.0
28	3.40	9.0	53	35	2.11	20.5
29	3.80	10.9	61	28	1.69	14.0
30	3.32	8.4	65	35	2.19	20.5
31	3.40	9.0	51	32	2.11	22.5
32	4.10	12.2	45	28	1.50	14.0
33	3.45	9.6	43	30	20.5	18.0
34	3.26	8.4	69	34	2.26	20.0
35	3.52	9.1	110	35	2.11	21.0
36	3.86	10.8	75	37	1.70	20.0
Average result	3.41	9.0	65	36	2.05	20.5
Stand. determined by the LYBL	3.9	9.9	50	30	165	15
Variance	0.06012	0.78229	181.4754	13.68492	0.05059	10.85714
Standard Deviation	0.24519	0.88447	13.47128	3.69931	0.22493	3.29502
Coefficient of variation	7.18%	9.79%	20.79%	10.28%	10.95%	16.07%

MT group disciples demonstrated uniform results in 2 control exercises, whereas in 4 control exercises variation in results is visible, with variation coefficient above 10%.

Summarising the obtained results performed by the disciples of MT-5 and MT-6 groups at summer camps, we can conclude that the standards determined by the LYBL are easy to perform and do not facilitate the development of the best disciples, which is necessary. The system developed in 2003 included the grading of the results, but for 2020-2021 only minimum requirements that should be met were developed.

Discussion

The authors of the Spanish study "Psychological States and Training Habits during the COVID-19 Pandemic Lockdown in Spanish Basketball Athletes" do not discuss the results of the tests but turn to other important isssues – psychological condition and changes in training habits (Lorenzo et al., 2021).

In another scientific study, which was likewise produced in Spain, the authors used a questionnaire to address the issue of "Sports in time of COVID-19: Impact of the lockdown on team activity," where one of the questions pertained to testing. A small percentage of teams performed physical tests before the lockdowns (12% international and 10% "other level"), intending to compare the level of physical fitness of the players before the RTS in a reliable way. When no test was carried out, expecting a shorter period of confinement was the reason given by the majority of the teams. Anthropometric tests (50% international and 30% "other levels"), followed by strength tests (33% international and 39% "other levels"), were the ones that the teams carrying out any form of assessment employed the most before and after COVID-19 lockdowns. When the comparison is drawn between the responses received from Spain and those that came from the rest of the world, not expecting such a long period of confinement is again the reason chosen on the highest number of occasions to explain the fact that really few teams performed pre-lockdowns physical tests (71% for Spain and 90% for the rest of the world) (Pena et al., 2021). This study does not describe the tests, either.

The Romanian study "„Sports Training during COVID-19 First Lockdown – A Romanian Coaches' Experience" summarizes the coaches' experience and changes in the coaching schedule rather than particular soccer tests (Teodorescuet al., 2021).

The authors of the Polish study "Effect of Online Training during the COVID-19 Quarantine on the Aerobic Capacity of Youth Soccer Players" focus on the process of distance training rather than tests during COVID-19 pandemic (Kalinowski et al., 2021).

LYBL developed control exercises and results for one particular country only, based on the restrictions set for this country; therefore, no similar studies can be found in scientific literature.

As Prof. A. Rudzītis and Prof. V. Lāriņš acknowledge, the more control results are collected, the more objective the developed assessment will be. Using different methods and tools for collecting results, with the one athlete performing the same control exercises or tests, the results can be totally different. Thus, in registering the results of short distance running, the difference in results can be up to 0.5s. Therefore, it is necessary to develop a unified control exercise system for youth basketball players that would take into account the athletes' age and sex as well as methodology for collecting identical results of control exercises (Rudzītis & Lāriņš, 2008).

In order to facilitate the development of the best disciples, the differentiation of the results should be introduced.

Conclusions

The standards developed by the LYBL for 2020/2021 training under Covid-19 conditions are easy to meet.

The LYBL should collect the results of the control tests from all Latvian coaches working with disciples of this age and should develop objective standards to improve the general conditioning level among the youth basketball players.

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REVIEW PAPER

HOME-BASED EXERCISE INTERVENTIONS IN HEALTHY ADULTS AGED 65 TO 75 DURING COVID-19 PANDEMIC: A SYSTEMATIC OVERVIEW OF LITERATURE

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Background. No current study summarized the possible effects of this type of exercises during COVID-19 lockdown in healthy older adults. The purpose of this review was to summarize the existing literature regarding the effects of home-based exercise programs during COVID-19 quarantine. Aims. The present systematic review aimed to evaluate the last two years of the literature reporting the effectiveness of home-based exercise interventions on physical fitness and muscle strength for healthy older adults during COVID-19 pandemic. Methods. A literature search was performed in three electronic databases including PubMed, SCOPUS, and Web of Science. Results and Conclusions. Only results of exercise interventions performed during COVID-19 time on healthy older adults were considered. Only five studies were included with a total of 227 healthy older adults (59.5% females). Resistance and multicomponent exercise trainings appear to be the most efficient intervention to increase physical function and muscle strength in older adults. Independently of the intervention, a high adherence and moderate rate of drop-out were identified. The current evidence showed that few studies investigated the effect of home-based exercise in older adults during COVID pandemic.

Keywords: *Home-based training; physical function, older adults; SARS-CoV-2; social isolation*

Abbreviations:

wk, week; CG, control group; EG, experimental group; TSC, Tai-chi snacking; C, Combination; ES, Exercise snacking; EP, Exercise+Placebo; ENS, Exercise+Nutritional Supplementation; Mini-BES Test, Mini Balance Evaluation Systems Test; FTSS, 5 times sit to stand test; 10MW, 10-m walk test; TUG – Timed Up and Go test; ECMLS – eye-closed mediolateral postural sway velocity on stable platform; ECAPS – eye-closed anteroposterior postural sway velocity on stable platform; ECVMS – eye-closed velocity moment on stable platform; ECMLU – eye-closed mediolateral postural sway velocity on unstable platform; ECAPU – eye-closed anteroposterior postural sway velocity on unstable platform; ECVMU – eye-closed velocity moment on unstable platform.

Introduction

For controlling COVID 19, many austere measures, as social distancing, self-isolation, home confinement and quarantine have been introduced (Lage et al., 2021; Chaabene et al., 2021). However, these specific measures, necessary for contrasting and controlling the viral spread, can cause physical and psychological detrimental effects, especially in vulnerable people as older adults (Lage et al., 2021).

Lockdown measures during COVID-19 limited opportunity to exercise regularly and decreased daily physical activity levels, both in quality and in quantity, and increased sedentary behaviour (e.g., the daily sitting time) (Chtourou et al., 2020; Yamada et al., 2021; Tison et al., 2020; Ammar et al., 2020; Schlichtiger et al., 2021). It was demonstrated that after COVID was declared a global pandemic, a reduction of about 6% and 27% in steps counted after 10 and 30 days respectively was observed in general population (Tison et al., 2020). Related to this, an international study showed a decrease of about 33% minutes per week was observed in moderate-to-vigorous physical activity, as well as in walking activity (12.64% min/week) (Ammar et al., 2020). In contrast, an increase in sitting activities, (i.e., watching television, reading, crocheting, and knitting, etc.,) was observed (Chtourou et al., 2020; Ammar et al., 2020; Nascimento et al., 2021). A similar trend was observed also among older adults. For example, Brazilian older adults reduced their total walking time of about 2 hours per week (Duarte et al., 2021). More interesting, it was also observed that the sedentary behaviour (i.e. 4 or more hours/day) resulted about 3 times higher in older adults living alone (Mazo et al., 2021) with a significantly higher risk of incident frailty (i.e., 2 times) in comparison with those who were not living alone and socially active (Yamada et al., 2021). Overall, these tendencies may lead to develop inactivity related muscle waste, sarcopenia and other severe comorbidities (Schlichtiger et al., 2021) and to increase incidences of frailty, disability, or mortality (Yamada et al., 2021). Additionally, the increase in physical inactivity may negatively affect sleep (Trabelsi et al., 2021) and mental health, with an increase of depressive symptoms, stress and anxiety (Chtourou et al., 2020; Faulkner et al., 2021). For instance, a multi-country research highlighted that the individuals with a negative physical behaviour change showed a poorer mental health and well-being in comparison with individuals with positive or no change in their exercise behaviour (Faulkner et al., 2021).

Regular physical and exercise activities remain a milestone and an important strategy for a healthy aging (Chodzko-Zajko et al., 2009) and for counteracting the negative consequences of certain chronic diseases (i.e., cardiovascular disease, diabetes, hypertension, and respiratory disease) (Pedersen et al., 2015) and specific age-related diseases, such as frailty and sarcopenia (Chodzko-Zajko et al., 2009; Aguirre et al., 2015). Moreover, in relation to COVID-19, a moderate-intensity physical activity may improve immune system (Gjevestad et al., 2015) and consequently prevent COVID infection (Lakicevic et al., 2020; Seman et al., 2021). Furthermore, lower levels of perceived stress and anxiety are associated with a regular physical activity (Altena et al., 2021) and may help alleviate negative mental health impacts of the concurrent COVID pandemic. Due to physical inactivity-induced losses, it is crucial for older adults to maintain an active lifestyle and to preserve and improve their health status (Lakicevic et al., 2020; Jiménez-Pavón et al., 2020). For this purpose, the World Health Organization enfatized and launched the campaign *"be active at home during the COVID-19 outbreak"* to sensitize older adults to be physically active during self-isolation, home confinement and quarantine (Chaabene et al., 2021).

In the setting of COVID-19 pandemic home-based physical exercise may be a valid alternative and approach to face-to-face training to counteract the unintended consequences of confinement and quarantine and to reach an appropiate level of week physicalactivity. Indeed, home-based programs are a simple, easy and feasible method for avoiding inactivity-induced losses and for maintaining physical fitness and health both in older adults and in pre-and frailty people (Chaabene et al., 2021; Lakicevic et al., 2020; Kis et al., 2019). Furthermore, the employment of particular technological elements, as digital platforms (e.g., smart phones and tablets) or remote controlled and wearable devices (e.g., wrist bands and pedometers) for promoting home-based exercise may increase participation rates and adherence levels (Schwartz et al., 2021) and motivation providing counselling and facilitating communication (Riegel et al., 2006) . Indeed, it is possible to employ videoconference platforms for providing individually tailored exercise sessions, but also interventions in a virtual 'group-based' setting with supervised group exercise training (Blad et al., 2020).

A recent metanalysis on the topic (Chaabene et al., 2021), focusing on healthy older adults (age range 65 – 83 years), reported as home-based exercise appears effective to improve muscle strength and muscular endurance and skill-related to physical fitness (i.e., muscle power, balance), important factors to reduce the risk factors and rate of falls (Mittaz Hager et al., 2015). Interesting, resistance training induceda higher increase in muscle strength and balance compared to multicomponent training (Chaabene et al., 2021). Home-based exercise appears to improve both cardiovascular and psychological parameters (De Almeida et al., 2020), to positively impact on anxiety, mood, and social and emotional well-being (Loh et al., 2019) and to increase health-related quality of life (Chien et al., 2011). For all these reasons, home-based exercise should be a public health policy, widely publicized, disseminated and adjusted to the new social dynamics, seeking to encourage people's autonomy and independence, and strengthening self-care (Souza Filho et al., 2020).

Summing up, a more concerted effort on physical exercise promotion in older people is urgently needed to stay active, as well as to disclose specific guidelines and some practical recommendations for maintaining a healthy lifestyle during the lockdown restrictions and preserving_both physical and mental health. To the best of our knowledge, while different studies describe the effect of home-based training on physical function, (Chaabene et al., 2021) no current study summarizes the possible effect of home-base exercise programs during COVID lockdown in older adults. Therefore, the purpose of this brief systematic review is to summarize the existing literature regarding the effect of home-based exercise program during quarantine including the physical function and muscle strength.

Materials and Methods

Search strategy

This systematic review was carried out using three electronic databases including PubMed, SCOPUS and Web of Science. Due to the specific aim of the study, a date restriction to 2020 and 2021 was considered. The systematic search was carried out in December 2021. According to a previous meta-analysis (Lage et al., 2021; Chaabene et al., 2021) on the topic, the following Boolean search syntax was used:

Key term #1: "exercise" OR "neuromuscular training" OR "strength training" OR "resistance training” OR "balance training" OR "plyometric training" OR "power training";

Key term #2: "residential" OR home OR "home-based" OR "tele-rehabilitation" OR "exergame" OR "exergaming training";

Key term #3: "physical conditioning" OR "physical function" OR "physical fitness" OR “fitness” OR “strength” OR “power” OR “balance” OR “endurance”;

Key term #4: "coronavirus" OR "sars-cov-2" OR "COVID" OR "severe acute respiratory syndrome" OR "pandemic" OR "social distancing" OR "lockdown" OR "self-isolation" OR "quarantine".

Eligibility Criteria

For inclusion eligibility, the review included female and male healthy older adults over the age of 60 years. Home-based exercise intervention using balance, mobility function and muscle strength, as primary or secondary outcomes, were included. Due to the date restriction of the research (i.e., 2020 and 2021), both non-randomized and randomized controlled interventions were included. Studies presenting data about participants with acute or chronic diseases (e.g., Parkinson disease or sclerosis multiple), endocrinological diseases (e.g., diabetes) and oncological patients and older adults with cognitive impairment were excluded. Only original, peer-reviewed studies written in English language were included. Protocols with no results, reviews, meta-analyses, abstracts, opinion articles, books, statements, letters, editorials, comments, and non-peer-reviewed journal articles were excluded. This systematic review was registered on Open Scientific Framework (OSF; https://osf.io/y7dth).

Article Selection

All potential studies were imported into Endnote 20 (https://endnote.com) and duplicates were removed. A summary of the study screening protocol and selection is presented in Table 1. The selection process was conducted by two authors (A.K. and P.R.B.), who independently screened the title and/or the abstract to identify studies that potentially met the inclusion criteria. Then, the full texts of the potential suitable studies were examined for eligibility. Disagreements were resolved through discussion between the two authors, who finally decided in case of conflicting results.

Table 1.

Summary of the reviewed studies (alphabetical order) including study population and training information

Study information			Study population			Training information						
First author	Location	Year	Sample size	Mean age (range)	Gender (%f)	Type	Intensity	Progression	Frequency (session/ wk)	Session Duration	Training duration (wks)	Training monitoring
Granacher et al.	GER	2021	N=51 Control group CG=24 Exercise group EG=27	CG= 66.2±3.3 EG= 65.1±1.1 (60-72)	52.9	Balance Training	Not reported	Continuous reduction in support base. Inclusion of an unstable element	7 (2 per session/ Day)	3min Per session	8	Weekly phone calls
Liang Et al.	UK	2021	N= 63 Exercise snacking ES=15 Tai-chi snacking TCS=16 Combination C=15 Control group CG=17	ES=71.1±3.6 TCS= 72.6±5.0 C=73.3±5.3 CG=71.9±4.7 (65-83)	54	ES = low resistance training TCS = simple Tai-Chi exercise. C=ES + TCS All interventions were snacking exercise	Not reported	Not reported	7 (2 per session/ Day)	8min Per session	4	Exercise log
Nilsson Et al.	CAN	2021	N=32 Exercise +placebo EP=16 Exercise+ nutritional supplementation ES=16	EP=74.4±1.3 ES=77.4±2.8 (not reported)	0	EP = whole-body elastic Band exercise + nutritional placebo ES = whole-body elastic. Band exercise + nutritional supplementation	3 sets 10–15 reps	Progressive increase of elastic band tension	3	Not reported	12	Bi-weekly E-mail or phone calls
Vitale Et al.	ITA	2020	N = 11 Control group CG=5 Exercise group EG= 4	CG=1±9 EG= 66±4 (62.9–73.1)	96.7	Resistance-training	3/4 sets 12/15 reps 60-90s rest	Increase of sets, repetitions, and rest time	4	45min	24	Weekly phone calls + daily diary
Yi et al.	South Korea	2021	N =70 Control group CG=35 Exercise group EG=35	CG = 77.31±5.57 EG = 76.11±6.31 (65 and older)	Male/female CG = 8/27 EG= 4/31	Fall prevention exercise program Movements using kayak paddles as a basis Stretching, vestibular rehabilitation core and Limb strengthening and motion range exercises	Not reported	Increase of tempo and adding of dynamic moments	2 Sessions per week	40min	8	Phone calls twice a week

Notes: wk, week; s, second; min, minutes; rps, repetitions, N, number; CG, control group; EG, experimental group; TSC,Tai-chi snacking ; C,Combination ; ES,Exercise snacking ; EP,Exercise +Placebo; ENS, Exercise+ Nutritional Supplementation

Results

After removing duplicates, the initial search revealed 330 potentially relevant articles. After screening titles and abstracts, 233 articles were excluded. After evaluation of 18 complete text articles, 5 were included in the review.

Study characteristics

The characteristics of each of the five reviewed studies are presented in Table 1. The five papers included in the review covered three continents: Asia (Yi et al., 2021), Europe (Granacher et al., 2021; Liang et al., 2021; Vitale 2020) and North America (i.e., Canada) (Nilsson et al., 2020). Sample sizes across the reviewed studies ranged from 11 to 70 older adults. Overall, 227 healthy older adults were recruited in the reviewed studies.

Four studies (Yi et al., 2021; Granacher et al., 2021; Liang et al., 2021; Vitale et al., 2020) involved both female and male older adults, while one included only male older adults (Nilsson et al., 2020). Additionally, 92 (40.5%) participants were female, and 135 (59.5%) were male older adults. The age ranged from 60 to 83 with a mean age of 74.9 years.

Characteristics of home-based interventions

Home-based interventions included low resistance training (Liang et al., 2021; Vitale et al., 2020; Nilson et al., 2020; Nilsson et al., 2020a), balance training (Granacher et al., 2021), tai-chi or combination of tai-chi and low resistance exercise (Liang et al., 2021) and movements using kayak paddles (Yi et al., 2021). Considering resistance training exercise, one study proposed intervention with whole-body elastic band (Nilsson et al., 2020), one used body weight and/or low extra weights (i.e., water bottles) (Vitale et al., 2020) and the last one only used participants' body weight (Liang et al., 2021). The balance exercises proposed by Granacher et al. (Granacher et al., 2021) were in barefooted or alternatively with socks under different stance and surface conditions. Considering tai-chi intervention the exercise focused on Five Chen Style Tai-Chi movements (Liang et al., 2021). Finally, the exercise program based on movements using kayak paddles consisted in a multicomponent intervention (including stretching, vestibular rehabilitation, core and limb strengthening exercises, joint motion range exercises, and balance exercises) (Yi et al., 2021). Only one study proposed also nutritional supplementation in combination with whole-body elastic band exercises (Nilsson et al., 2020a).

All reviewed studies, except one (Nilsson et al., 2020), had at least two groups (home-based exercise vs. control group). Moreover, the study of Nilsson et al. (2020) proposed in both groups a home-based exercise, but one group with nutritional supplementation.

The duration of the intervention lasted between 4 (Liang et al., 2021) and 24 weeks (Vitale et al., 2020) with an heterogeneity in frequency and session duration. Frequency ranged from 2 (Yi et al., 2021) to 14 sessions per week (i.e., two brief exercise sections for day) (Granacher et al., 2021; Liang et al., 2021) with a duration from 3min (Granacher et al., 2021) to 45min (Vitale et al., 2020) per session. Both the study of Granacher et al. (2021) and Liang et al. (2021) proposed snacking exercises. The first one included the training during daily tooth brushing routine (twice a day) (Granacher et al., 2021), while the second one two separated sections of about 8 minutes.

Considering the intensity of exercises, the studies investigating the effect of resistance training (Vitale et al., 2020) and whole-body elastic band exercise (Nilsson et al., 2020) reported the number of sets (i.e., 3 or 4) and repetitions (from 10 to 15). No data was reported by the other two reviewed studies (Granacher et al., 2021; Liang et al., 2021). It is necessary to point out that the regulation of exercise intensity is more difficult for balance compared to resistance training (Granacher et al., 2021). Liang et al. (Liang et al., 2021) proposed to the participants to attempt as many repetitions as possible in one minute for one exercise, before resting for one minute and repeating the process with four more exercises. Finally, exercise intervention using kayak paddles adjusted the difficulty level during the 16 weeks of intervention including various movements from a sitting to a standing position (Yi et al., 2021).

Considering the progression of exercises, only one study did not reported data (Liang et al., 2021), while Vitale et al. (2020) reported an increase of sets, repetitions and a decrease in rest time, Nilsson et al. (2020) a progressive increase of elastic band tension and Granacher et al. (2021) a continuous reduction in base of support (i.e., from step over tandem to one-legged stance) and inclusion of an unstable element (i.e., rolled up towel). Yi and Yim (2021) reported an increase in exercise tempo and the adding of dynamic movement. Differently the study of Liang et al. (2021) proposed the same exercise routine during the four weeks of intervention.

Table 2.

Summary ofrelevant results for thereviewed studies (alphabetical order).

Study	Physical Outcomes	Adherence	Drop out	Main results
Granacher 2021	Balance - Romberg test (Static); - Functional-Reach-Test (dynamic) Physical function - 10m single- and dual-task walk test - Timed Up and Go Test Muscle strength - Chair Rise Test (Lower limbs)	EG=92%	N=4 CG=2 EG= 2	- Dynamic steady-state balance, pro-active balance, and muscle strength significantly improved in both experimental groups. - For all tests, no difference in the interaction time x group was observed.
Liang 2021	Balance: - Right/left leg standing balance (Static Balance) Muscle strength - 5 reps Sit-to-Stand; - 60s sit-to-stand (Lower Limbs)	ES=90% TCS=84% C=83%	N=5	- Balance scores were mixed among the groups. - Increase in 60s chair rise number and reduction in 5 repetition times was observed at the end of the four intervention weeks in all four groups.
Nielson 2021	Physical function: - Short Physical Performance Battery (SPPB). - 6 meters Walking Test - Timed up and Go Test - 4-Step Stair Climb Muscle strength - 5 times Sit to Stand - 1-RM grip strength (upper limbs) - 1-RM leg press - 1-RM isometric knee extension (lower limbs)	EP=89% ES=84%	N=10 EP=5 ES= 5	- Functional strength (i.e., 5 times sit-to-stand test) was significantly improved in both experimental groups. - Maximal strength (i.e., leg press and hand grip) was generally improved in both groups but only significantly for ES group.

Countiniu Table 2.

Study	Physical Outcomes	Adherence	Drop out	Main results
Vitale 2020	Balance: - Mini-BES Test Muscle strength - 30s chair stand test - Max Isometric Strength of Knee Flexors and Extensors Muscles (lower limbs) - Grip strength (upper limbs)	Not reported	N=4 EG= 4	-Improvement between pre and post intervention was observed -in EG considering lower limbs strength (30s chair stand test) (+19.8%, p = 0.048 and ES:1.0, moderate)
Yi 2021	Grip and lower limb muscle strength: - FTSS - Grip strength (upper limbs) Gait abilities: - 10m Walking Test - Gait speed - Step length - Stride length Dynamic postural balance: - Timed up and Go Test Static postural balance: - ECMLS - ECAPS - ECVMS - ECMLU - ECAPU - ECVMU	Not reported	EG=3 CG=6	A statistically significant improvement for experimental group in all presented physical outcomes compared to the control group

Notes: N, number; EG, experimental group; CG, control group;ES,Exercise snacking ; EP,Exercise +Placebo; TSC,Tai-chi snacking; C, Combination; Mini-BES Test, Mini Balance Evaluation Systems Test; s, second; FTSS, 5 times sit to stand test; 10MW, 10-m walk test; TUG – Timed Up and Go test; ECMLS – eye-closed mediolateral postural sway velocity on stable platform; ECAPS – eye-closed anteroposterior postural sway velocity on stable platform; ECVMS – eye-closed velocity moment on stable platform; ECMLU – eye-closed mediolateral postural sway velocity on unstable platform; ECAPU – eye-closed anteroposterior postural sway velocity on unstable platform; ECVMU – eye-closed velocity moment on unstable platform.

Outcomes of intervention programs

The Table 2 presents the outcomes of the five reviewed studies, the adherence and drop-out on the intervention programs, as well as a summary of the main results obtained by the studies.

Balance. Three reviewed studies evaluated the effect of home-based exercises on static balance using Romberg Test (Granacher et al., 2021), Single Leg Balance Test (Liang et al., 2021), and Postural Sway Test (Yi et al., 2021). Additionally, Vitale et al. (2020) evaluated balance using the Mini-BESTest that includes 14 items evaluating four different aspects of dynamic balance. Moreover, Granacher et al. (2021) also investigated proactive balance using the Functional Reach Test.

Granacher et al. (2021) reported a main effect for time, but not a significant group *x* time interaction both for static and proactive balance assessment. A similar fashion was observed in the study of Vitale et al. (2020a) where not within- and between-group differences were observed. Differently, Yi and Yim (2021) reported a group *x* time interaction both for static (Postural Sway Test). The experimental group showed an improvement in balance ability compared to the control group. Differently, the study of Liang et al. (2021) reported mixed results with a wide variance in scores among the groups.

Physical function. Physical function changes were investigated by three studies (Granacher et al., 2021; Nilsson et al., 2020). Test assessments included walking performance (Yi et al., 2021; Granacher et al., 2021; Nilsson et al., 2020), also during dual-task performance (Granacher et al., 2021), gait analysis (Yi et al., 2021), Timed Up and Go Test (Yi et al., 2021; Granacher et al., 2021; Nilsson et al., 2020), 4 Step Stair Climb or the Short Physical Performance Battery (SPPB) (Nilsson et al., 2020).

Yi and Yim (2021) reported that experimental group significantly improved the gait ability (i.e., walking performance and gait speed, step length, and stride length) compared with the control group. Granacher et al. (Granacher et al., 2021) reported a significant improvement in both experimental groups (i.e., home-based balance training and passive control group) considering walking ability (both in single- and dual-task) and Timed Up and Go Test, but not significant group *x* time interaction. Similarly, also Nilsson et al. (2020) observed a general improvement across all physical function tests (i.e., Timed Up and Go Test, SPPB score, walking test) in both groups (i.e., home-based elastic band training and ditto with nutritional supplementation), although statistical significances were not observed. Only a significant improvement was observed in 4 Step Stair Climb in home-based resistance training with nutritional supplementation group (increased of about 8%). Nevertheless, no statistical analysis was reported.

Muscle Strength. All studies evaluated lower muscle strength both using functional tests (Yi et al., 2021; Granacher et al., 2021; Liang et al., 2021) and laboratory measures (i.e., 1RM or isometric test) (Vitale et al., 2020; Nilsson et al., 2020). Moreover, three studies also evaluated upper limbs strength (i.e., grip strengt (Yi et al., 2021; Nilsson et al., 2020; Vitale et al., 2020).

After 8 weeks of kayak paddles exercise training both lower and upper limb muscle strength significantly increased compared with the control group (Yi et al., 2021). Vitale et al. (2020) reported an improvement after six-months resistance training program in lower limb strength evaluation using the 30 seconds Chair Rise (improvement of about 19%). Similarly, Nilsson et al. (2020) found an improvement in 5s Sit-to-Stand test in both experimental groups (increased in performance times of about 8%). Moreover, the same study found a significant improvement in maximal strength evaluation with leg press and a borderline significance for knee extensor strength in both experimental groups (i.e., home-based resistance training with nutritional placebo or nutritional supplementation). However, post hoc analyses revealed a significant increase in leg press only for the training group with nutritional supplementation (improvement of about 16%). Liang et al. (2021) reported an increase in 60s chair rise number and a reduction of 5 times Sit-to-Stand at four weeks in all considered groups. Nevertheless, no statistical analysis was reported. Finally, Granacher et al. (2021) found a significant main effect for time, but not for group x time interaction.

Considering upper limb strength, improvements were only observed in the study of Nilsson et al. (2020) that reported a significant increase for training group with nutritional supplementation between baseline and post intervention assessment in maximal grip strength only (improvement of about 8%). Differently, no significant improvement was reported by Vitale et al. (2020).

Dropout and adherence to home exercises. The studies drop-out was generally low with a range from 10 (Nilsson et al., 2020) to 4 (Vitale et al., 2020) participants. The compliance to the study was monitored using weekly phone calls (Granacher et al., 2021), bi-weekly e-mail or phone calls (Yi et al., 2021; Nilsson et al., 2020), exercise log (Liang et al., 2021), and the combination of the two methods (i.e., weekly phone calls and compilation of a daily diary) (Vitale et al., 2020). The studies adherence ranged from 92% (Granacher et al., 2021) to 83% (Liang et al., 2021) even if one study did not report this data but only the minimum acceptable adherence to the training program (i.e., 75%) (Vitale et al., 2020). Among the 31 older adults who dropped out of the reviewed studies, 18 cases were in home-based exercise group. The studies of Yi and Yim (2021) and Liang, Perkin (2021) reported only the total amount of dropout. See Table 2 for more details.

Discussion

The present systematic review aimed to evaluate the last two years of the literature reporting the effectiveness of home-based exercise interventions on physical fitness and muscle strength for healthy older adults during COVID-19 pandemic. In addition, we also considered the feasibility of the intervention in term of adherence and drop-out. The main findings of our results are: 1) home-based exercise intervention focused on resistance or multicomponent training exercise appears to be the most efficient intervention to increase physical function and muscle strength in healthy older adults; 2) nevertheless, this effect seems to be small; 3) independently of the intervention a high adherence and moderate rate of drop-out were identified.

Physical inactivity is a critical problem among aged populations. Exercise interventions may mitigate and contrast age-related decline in physical function (Chodzko-Zajko et al., 2009), preserving older adults from frailty and sarcopenia (Chodzko-Zajko et al., 2009; Aguirre et al., 2015) and reducing rate and risk of fall (Mittaz Hager et al., 2015). According to the World Health Organization (WHO) recommendations, older adults should perform a varied multicomponent physical exercise, that emphasizes functional balance and strength training, at moderate or greater intensity three or more days a week (Bull et al., 2020). The importance of exercise intervention increased with the present COVID-19 pandemic, during which self-isolation, home confinement and quarantine were imposed, decreasing daily physical activity levels and increasing sedentary behaviour (Chtourou et al., 2020; Yamada et al., 2021; Tison et al., 2020; Ammar et al., 2020; Schlichtiger et al., 2021).

During COVID-19 pandemic, a variety of intervention strategies et al., were tested in reviewed studies, including low resistance training with elastic band (Nilsson et al., 2020) or body weight and/or low extra weights (Liang et al., 2021; Vitale et al., 2020), or kayak paddles exercise (Yi et al., 2021) as well as balance (Granacher et al., 2021) or Tai-chi training (Liang et al., 2021). Our results showed that an unsupervised home-based resistance intervention significantly increased muscle strength and physical function. These findings are consistent with the results of Chaabene et al. (2021) and Kis et al. (2019) that highlighted as home-based exercises, based on strength training also with a minimum supervision, resulted to have moderate effects on muscle strength and balance (Chaabene et al., 2021; Kis et al., 2019). On the other hand, both meta-analyses, showed no effect of multicomponent exercise (i.e., combination of both resistance training and balance exercise) in increasing these effects.

A higher heterogeneity in exercise dosage (i.e., frequency, session, and training duration and intensity) was observed. Two studies investigated the efficacy of home-based intervention using short bout exercise (i.e., less than 10 minutes) twice a day for seven days a week (Granacher et al., 2021; Liang et al., 2021), while the other ones proposed long bout exercise three or two times a week (Yi et al., 2021; Nilsson et al., 2020; Vitale et al., 2020). In this regard, our analysis underlined that a better improvement in physical function and muscle strength was observed in long bout exercise interventions (Yi et al., 2021; Vitale et al., 2020; Nilsson et al., 2020). The short bout of proposed by Granacher et al. (2021) and Liang et al. (2021) were less if compared with the international guidelines recommendation of 150 minutes/week of moderate-intensity physical activity in older adults for health benefits (Nelson et al., 2007). Nevertheless, this exercise dosage was in line with the recent WHO suggestion emphasizing the potential health benefit also with a physical activity less than 10 minutes. It is possible to suppose that a higher weekly exercise dosage leads to more health benefits for healthy older adults. Nevertheless, it is necessary to also consider the different training duration that may affect the results. Indeed, the training duration was less in the short bout exercise interventions than in long bout exercise interventions (mean of 4 weeks Vs 24 weeks, respectively).

Considering the training monitoring, all the reviewed studies assessed this aspect using phone calls or e-mail (weekly or bi-weekly) or daily exercise without the direct supervision of the trainer. Studies diverged on the type of technology used, telemonitoring duration and intensity, and/or feedback. It is possible to suggest that this typology of monitoring assessment may lead to a poor technical movement skill competency during the execution of the exercises (Chaabene et al., 2021) and this may affect the results of the reviewed studies. Even if phone calls and exercise logs are common tools for supervising home-based exercise, recently internet and video might provide more possibilities than telephone contact. In this regard, telemonitoring interventions (e.g., interventions in a virtual group-based setting with supervised group exercise training) are a relatively new field in older adult research for providing individually tailored exercise sessions (Blad et al., 2020). Exercise protocols including telemonitoring (e.g., online lessons) were similar in several aspects such as the training provided to participants and the process of data collection and transmission (Chan et al., 2007). Supervision online exercise training might be more effective than non-supervised programs (Ashworth et al., 2005). This allows us to conclude that the participants might not have full-fledged learning of skilled movements with this modality of training. Overall, it can be concluded that there is a lack of studies about supervised tele-trainings throughout the entire workout and it could not be determined in this review. Indeed, only one reviewed study provided real-time intervention by accessing through their Wi-Fi internet connection (Yi et al., 2021). Despite this, the adherence on the reviewed articles was higher. In line with these results, the rate of drop out was generally lower. Together, these findings suggest that supervised home-based training seems to be a good alternative to face-to-face exercising.

Some limitations should be finally pointed out. In this systematic review, we focused home-based exercise interventions for healthy older adults on physical fitness and muscle strength during COVID-19 pandemic (i.e., 2020 and 2021 years). For this reason, only five studies were included, and a meta-analysis was not performed. Thus, our discussion was based on a relatively low number of studies and participants. Unfortunately, data in this specific field of research, particularly in healthy older adults, is limited. Again, the reviewed research time is limited, and this may affect the low number of studies examined. Despite this, our results may be used for future studies on the topic and give information about home-based exercise protocol on older adults during COVID pandemic. Future research should investigate the efficacy of this type of intervention in this specific population also considering not only unsupervised programs but also considering the use of videoconference platforms that may provide one-on-one individually tailored exercise sessions. Finally, we only focused on English articles, disregarding relevant studies published in other languages.

In conclusion, our results showed that few studies investigated the effect of home-based exercise in older adults during COVID pandemic. Based on this first evidence, strength training seems to be more efficient and a good alternative to face-to-face exercise for increasing physical function in older adults. The current evidence on the impact of smart tele-training in comparison with supervised face-to-face exercise interventions is insufficient and further research is required.

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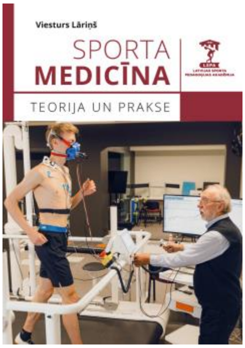
SCHORT COMMUNICATION

Viesturs Lāriņs

SPORT MEDICINA (THEORY AND PARCTICE)



The book is intended to provide knowledge in sports medicine to a wide range of sports science and health care professionals, sports educators, coaches, physiotherapists, rehabilitation therapists, and other health professionals. The book is also meant for students of Sports science and Health care programs to obtain knowledge in sports medicine and other study courses. The book can also serve as reference material on the physical development and fitness of people that are physically active or engaged in sports, and its changes under the influence of regular sports.

The book covers topics on sports medicine as a scientifically practical medical discipline that combines health care for people involved in physical activities and sports, and determines the impact of training and exercises on the body and organ systems. The book consists of seven interconnected chapters.

The first chapter is devoted to general issues of sports medicine – the scope of sports medicine as a branch of medicine, its content, theoretical and methodological foundations and main tasks. Sports medicine is defined as an interdisciplinary field of practical and theoretical general medicine associated with the treatment and rehabilitation of athletes after injuries and diseases, as well as investigates physiological, morphological, biochemical, pathological and other changes in the body caused by physical activity and sports in order to improve the health of athletes, to ensure prevention, rehabilitation and the beneficial effects of sports.

The second chapter examines the development of sports medicine in the world from ancient times to the present day and its development in Latvia from its origins – during the 1928 Winter Olympics in St. Moritz, Switzerland, Latvia was among the 11 countries tries that founded the International Association of Sport Medicine Doctors, Later Federation – FIMS (International Federation of Sports Medicine)

The third chapter introduce the organization of medical care for athletes and its content in accordance with the legislation of Latvia and the decisions of the Cabinet of Ministers.

Chapter four is devoted to the determination of the level of physical development methods for determining the position of posture, physique, legs and feet. In addition to the methods of external examination or somatoscopy in determination of physical development, methods of anthropometric measurements and analysis of body mass composition are used, including determination of the amount of fat, muscles and bones within the body.

The fifth chapter covers the issues of physical fitness, physical performance capacity, and methods for determining aerobic and anaerobic performance, tests and their evaluation.

Chapter six compiles the issues on athletes' functional fitness: methods and tests to determine and assess the physical and functional condition of the nervous, cardiovascular and respiratory systems.

Chapter seven addresses the issues of common principles for combating doping in sport in accordance with the World Anti-Doping Code (2021) in order to defend and ensure fair, equitable competition and honest competing among all athletes. The body responsible for compliance with the World Anti-Doping Code, the implementation of anti-doping programs and activities is the World Anti-Doping Agency (WADA), which annually updates and publishes the List of Prohibited Substances and Prohibited Methods, that lists the substances and methods that are prohibited during competitions and outside them. The use of Prohibited Substances and Prohibited Methods is prohibited for ethical and medical reasons. Ethical principles provide fair and equal rules for all athletes. Adherence to doping rules ensures fair conduct of competitions. Medical considerations are intended to prevent the harmful effects of doping on the body. Improper and unjustified use of medical devices and methods can be hazardous to an athlete's health with a variety of serious side effects.

CONGRATULATION

We congratulate Einārs Pimenovs, PhD student at the Latvian Academy of Sport Education, who has defended his thesis "OPTIMISATION OF COMPLEX AND VARIED JUDO STANDING FIGHTING BASIC TECHNIQUES IN JUDOKAS AGED 7-12" for obtaining the Doctoral (Ph.D.) Degree in the field of Health and Sports Science in the Sub-branch of Sport pedagogy at the Latvian Academy of Sport Education on 26th of July, 2022.

Scientific innovativeness: 1. Having developed and interpreted the technical range of the standing fighting of the international and Latvian judokas and description of efficiency, and determined its significance in the judoka's technical conditioning and training process. 2. Having developed the main principles of the judo standing fighting fundamental techniques and their short descriptions in Latvian. 3. Having developed and approbated the judo standing fighting fundamental technique teaching optimisation model. Practical significance: The work contains scientifically practical recommendations: 1. Have developed recommendations for optimisation model of the judo standing fighting fundamental technique, which a judo coach can use in their practical work. The author of the study has adopted judo standing fighting fundamental technical terms (designations) from Japanese and compiled short definitions and classification in Latvian. The work also contains the characterisation of the main standing fighting fundamental techniques and its teaching in 12 coaching algorithm chains. The model performance includes 40 fundamental techniques from all standing fighting techniques from all standing fighting throws' classification groups. 2. Have develop guidelines on the judo fundamental technique assessment conditions. The guidelines content has judo standing fighting fundamental techniques for school students from 5-1 mastery degree; Judo coach will be able to include these recommendations in their work plans in teaching judo standing fighting fundamental technique, and also technical conditioning assessment.

Supervisors: Prof. Dr.paed. Andra Fernāte (LASE)
Advisors: Doc. Mg.paed. Andris PIMENOVS (LSPA)

has been developed by ESF support withim the project "Strengthening of the Academic Staff of the Latvian Academy of Sport Education in the Field of "Health Care"

LSPA LATVIJAS SPORTA PEDAGOĢIJAS AKADĒMIJA
NACIONĀLAIS ATTĪSTĪBAS PLĀNS 2020
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IEGULDĪJUMS TAVĀ NĀKOTNĒ

CONGRATULATION

We congratulate Valters Āboliņš, PhD student at the Latvian Academy of Sport Education, who has defended his thesis “CHANGES IN THE FORCE PRODUCED BY THE FINGERS OF THE HAND AND THEIR INTERDEPENDENCE IN ISOMETRIC TASKS” for obtaining the Doctoral (Ph.D.) Degree in the field of Health and Sports Science in the Sub-branch of Sport pedagogy at the Latvian Academy of Sport Education on 29th of Juny, 2022.

The scientific novelty of the research: this thesis summarises the results of five separate but related scientific studies on finger motor control and stability in different tasks. The stability of finger interdependence in isometric tasks is investigated for the first time. The scientific literature on finger interdependence is summarised, and the possible mechanism of this phenomenon is described. The phenomenon of force loss in isometric tasks and force increase in enslaved fingers are investigated. The results obtained refute the hypotheses previously put forward and provide new knowledge about this phenomenon. A new direction of research has been created in a currently still little explored and not understood area. The practical significance of the research The five scientific articles that make up the unified set of articles included in the PhD. thesis deal with a number of fundamental issues of neural control of movement, using motor control of the human fingers as the object:

1. Voluntary motion control theory with time-varying reference coordinates of the involved effectors. This theory was used to interpret the results of studies with unintentional force-displacement/drift. The theory also addressed force perception.

2. Lack of independence of the fingers of the human hand (finger interdependence). In our studies, this phenomenon was interpreted at two levels: at the level of control by finger coordinates and the neurophysiological level related to cortical control.

3. Specialization of the fingers of the hand for different tasks. Studies have shown that the index finger, generally considered the most controllable, performs worse on tasks requiring action stability. Overall, this research is relevant to a number of applied areas, such as movement rehabilitation and training of athletes in different sports, treatment of movement disorders in patients with neurological disorders, and ergonomics.

Scientific advisor: Prof. Dr. paed. Jānis LANKA (LASE)
Scientific consultant: Prof. PhD. Mark L. LATASH (Penn State, USA)

CONGRATULATION

We congratulate Mārtiņs Veispals, PhD student at the Latvian Academy of Sport Education, who has defended his thesis "CHANGES IN THE POWER OF THE STROKE, LOAD VOLUME AND PERFORMANCE OF A PADDLER IN A MEGACYCLE" for obtaining the Doctoral (Ph.D.) Degree in the field of Health and Sports Science in the Sub-branch of Sport pedagogy at the Latvian Academy of Sport Education on 29th of November, 2022.

Scientific Novelty of the Research: A detailed quantitative case study has been conducted on the content of the training process, the load volume, and the change in the power of the stroke over a three-year megacycle of a high-performing paddler (a world junior champion, world champion medallist and Olympian). Significant contribution – information on stroke parameters for a 200m distance with maximum effort in natural conditions of the sport – on water, provided by the only device currently available on the market that measures the power and force applied to the stroke, and a comparison with the same distance covered on an ergometer. Information is provided on strength loads and their manifestations in using power volume in the training process to achieve the highest results. Quantitative descriptive longitudinal research, which shows the parameters and forces (including a graphical representation of the force-to-power ratio) of a stroke of a high-performing paddler when covering a competition distance with maximum effort. Of the physiological indicators (including heart rate (HR) and lactate indicator recovery) examined from an eight-year period, correlation with sport achievements was found only in the increase of the power of the stroke. Changes in HR recovery 57 indicators have put forward a hypothetical, additional clarification (which has also been confirmed in the scientific publication) in the context of adaptation theory.

Practical Significance of the Research: The author's division of the training load volume and content into four main categories, which consist of nineteen sub-categories, can be used for recording and planning of training load in canoe sport. Analysis of physiological indicators (including HR recovery and lactate recovery indicators) provides information to coaches and other sport specialists, which indicators can be used to assess the progress of the training process. In general, the developed recommendations for coaches and other sport specialists provide information on planning a successful training process in canoe sprint.

Scientific Advisors: Assoc. Prof. Dr.paed. Antra Gulbe (LASE), Dr.biol. Andris Konrads (LASE)

has been developed by ESF support withim the project "Strengthening of the Academic Staff of the Latvian Academy of Sport Education in the Field of "Health Care"

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CURRENT NEWS

Latvian Academy of Sport Education

LASE International Scientific Conference in Sport Science
SPORTS SCIENCE AND HEALTH CARE IN SPORTS IN 2023
February 2, 2023 LASE, Riga, Latvia

LASE 15th PhD and Master Students Conference
SPORTS AND SOCIETY
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The information is placed on the website: www.lspa.lv

14th Baltic Sport Science Conference
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OSRESS

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GUIDELINES FOR CONTRIBUTORS

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Research or project reports, case studies of practice, action research reports, and reports on teaching practice or techniques will be accepted.

Research reports should include a description of the practical application(s) of the ideas tested, while reports of teaching practice or techniques should contain an explanation of the theoretical foundation underlying the practice or technique in question.

Material in the form of illustrations or photos is welcomed. This material should be accompanied by text clearly setting out its philosophical or practical origins or implications. All material should be clearly referenced to its sources.

Arrangement

The manuscripts should be arranged as follows: title page, abstract and body text.

Title page should contain title of the paper, first and last names of authors with affiliation, first and last name of corresponding authors with postal address, telephone, fax and e-mail.

Abstract (up to 250 words) consisting of the following sections: justification and aim of the study, material and methods, results, conclusions, as well as 3 – 6 key words, should be provided before the body text.

Body text should be sectioned into: Introduction, Material and Methods, Results, Discussion, Conclusions, Acknowledgements (if necessary) and References. In articles of other types, the text should follow in a logical sequence and headings of its sections should reflect issues discussed therein.

Introduction – should be short and concise; it should introduce readers into research problems addressed in the study as well justify undertaking the research and specify its aim.

Material and methods – should describe the subject of the study (in the case of human subjects' data should include their number, age, sex and any other typical characteristics) and methods applied in a sufficiently exhaustive way to enable readers to repeat the experiments or observations. For generally known methods only references should be given, whereas detailed descriptions are to be provided for new or substantially modified methods.

Results – should be presented in a logical sequence in the text, tables, and figures. Data collated in table and figures should not be repeated in the text which should summarize the most important observations.

Discussion – should emphasize new or important aspects of experimental results and discuss their implications. Results of own studies are to be compared with findings described in the respective domestic and international references used by the Authors.

Conclusions – should be started in points or descriptively and should be logically connected with objectives stated in the *Introduction*. Statements and conclusions not derived from own observations should be avoided.

Author's declaration on the sources of funding of research presented in the scientific article or of the preparation of the scientific article.

References

References should follow the instructions for Authors on References (APA style).

This document describes standards for preparing the references in the APA style.

Citing in-text. Following artificial text shows different types of in-text citation:

Claessens (2010) found 6 evidence that attention will be given to multi-compartment models, such as the 3-water, 3-mineral and 4-compartment models, to assess percentage of body fat.

However, Raslanas, Petkus and Griškonis (2010) noted that Aerobic physical load of low intensity got 35.1% of total trainings time. Research on physical loading also focused on identifying the basis of much years' research of physical activity (Bytniewski et al., 2010). According to Ezerskis (2010), "… heavy physical loads had the undulating character depending on the dynamics of workloads…" (p. 71) yet girls are more ascertained that the Track & Field training helps to develop courage.

Instructions for Authors on References (APA style)

Please provide all the required elements in the references to your paper. Please pay particular attention to spelling, capitalization, and punctuation. Accuracy and completeness of references are the responsibilities of the author. Before submitting your article, please ensure you have checked your paper for any relevant references you may have missed.

A complete reference should give the reader enough information to find the relevant article. If the article/book has DOI number, the author should include it in the references. And most importantly, complete, and correct references may allow automatic creation of active links by the MetaPress technology that we use for making the electronic version of our journal. Active reference linking is regarded as the greatest benefit of electronic publishing, and it adds a lot of value to your publication.

Additional information about APA style writing is found on LASE web page: http://www.lspa.lv/.

Tables – should be prepared on separate pages (saved in separate files) and numbered using subsequent Arabic letters. They should be provided with titles (above). Every column in a table should have a brief heading and more extensive explanation should be given under the table, e.g., statistical measures of variability.

Figures – should be prepared in an electronic form and saved in separate files. A separate page should be provided with legends to figures, authors' names, manuscript's title, and consecutive number of figures with "*bottom*" or "*top*" identification. Photographs or other illustrative materials may be submitted in an electronic form (*.tif, *.jpg, image resolution: 300 or 600 dpi) or any other form suitable for final technical typesetting by the Editorial Office. In the appropriate places in the text consecutive numbers of tables or figures should be provided in parentheses, e.g. (Tab. 1) or (Fig. 1).

General principles – the Editorial Office reserves for itself the right to correct stylistic errors and to make necessary changes (abridgements) in the text without Author's knowledge. Articles not accepted for publication are not returned. Manuscripts not prepared following *Instruction to Authors* will be sent back to Authors for revision. Galley proofs of manuscripts will be sent to Authors for proofreading. It is the Author's responsibility to return the proof within one week. Each Author will receive free-of-charge one copy of the issue in which their work appears.

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The articles should be sent to:

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