”BABES-BOLYAI” UNIVERSITY OF CLUJ-NAPOCA
FACULTY OF PHYSICAL EDUCATION AND SPORTS
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Ph.D. THESIS SUMMARY

PERIODIZATION OF PHYSICAL TRAINING IN THE JUNIOR TO SENIOR TRANSITION USING THE B.i.T. METHOD

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Gratitude

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List of published scientific papers

1. Sandor Iosif, **Neag Simina-Aurelia** – ”*Study regarding the value of the players anthropometric indicators members of the elite european handball teams qualified at the final tournaments”* Studia Universitatis Babes-Bolyai Educatio Artis Gymnasticae, Volume 66 (LXVI), Year: 2021 Issue:2, pp.117-126. http://www.studia.ubbcluj.ro/download/pdf/1380.pdf

2. Sandor Iosif, Isidori Emanuele, **Neag Simina-Aurelia**, Stan Delia-Claudia – ”*Is E-training a successful method for athletes during covid-19? An answer based on a case study”* eLSE 2021 - The 17th International Scientific Conference “eLearning and Software for Education” Education & Technology in (Post)pandemic times, Volume I, pp.55-60. https://proceedings.elseconference.eu/index.php?r=site/index&year=2021&index=papers&vol=38&paper=e15cdef8e5efe1c1c6e9e9c9c3b0b13e

3. **Neag Simina-Aurelia**, Sandor Iosif, Isidori Emanuele, Pătrașcu Adrian - *”The transition from junior to senior in handball: estimating throwing acceleration with a portable device”* - The 18th International Scientific Conference eLearning and Software for Education Bucharest, May 12-13, 2022

4. **Neag Simina-Aurelia** - *”Study regarding the profile of the youngest players at the European Handball Championships”* – Entrepreneurship through digital transformation and social changes, Presa Universitară Clujeană, 2022, pp.206-212.

5. Emanuele Isidori, Irina Leonova, Natalia Poplavskaya, Mario De Martino, **Simina-Aurelia Neag**, Iosif Sandor ”*In Search of Relationship Between Pedagogy and Medicine: Towards a Holistic Paradigm of Well-being Education”* - ERD 2024 - The 12th International Conference

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Content

PART I

CHAPTER I. INTRODUCTION

1.1 The importance of the research topic and its contemporany relevance

Handball is a sport in which two teams compete against each other in two 30-minute halves, performing individual and group actions with the objective of scoring a goal and preventing the opponent from scoring (Lamas et al., 2014; Michalsik, 2018; Wagner et al., 2014).

The recent modifications to the regulations have led to a notable intensification of the game. The sport has evolved into a highly dynamic and fast-paced discipline, characterised by a high level of spectacle within the sporting arena.

The extended competition period has led to an increase in the number of matches, and the physical preparation of athletes must be at a higher level in order to be able to perform in national and international competitions with both club and national teams.

Achieving successful actions in both phases of the game requires players to have a higher level of conditioning in terms of speed, strength, endurance, coordination skills, anaerobic work capacity, as well as aerobic strength and endurance (Michalsik, 2018).

A team's success also depends on selecting physically fit players for the playing positions, but also on developing a tactical approach that matches the strengths of the available players (Weber & Wegner, 2016).

The level and quality of performance in this sport depends, first and foremost, on the level and quality of athletes' physical preparation (Bompa & Haff, 2014; Dragnea et al., 2006; Foretic et al., 2021; Ghermănescu et al., 1983; Michalsik, 2017).

The preparation of an athlete is determined by the development of motor skills, mental skills and how to cope with fatigue. The means by which all of these can be achieved is the tool called the periodized training plan (Bompa, 2013).

Periodization of training starts with general goals set in the multi-year or annual training plan. The annual plan sets the general pathway for a year of training, while the other cycles establish the means, methods, and modes used to reach the primary competitive goals (Haff et al., 2016).

Periodized training must optimize various factors that influence the physical, technical, tactical and psychosocial characteristics of players to achieve performance (Côté & Gilbert,

2009). Understanding physical demands is essential to optimize physical preparation and minimize the occurrence of fatigue and the risk of injury (Karcher & Buchheit, 2014b).

Trainers need to take into account the profile of the athlete, the context in which the athlete trains and the tasks to be accomplished (Gambetta, 2007; Issurin, 2010; Kiely, 2011; Lyle et al., 2010; Plisk & Stone, 2003; Smith, 2003; Turner, 2011).

The main trends in World and European handball are also systematically developing and spreading in junior training (Solovey et al., 2020).

One of the most important prerequisites for a successful transition from juniors to seniors is that players can cope from a physical point of view in contact with adult opponents (Pehrson et al., 2017).

The current trend in transition research is towards contextualizing studies by clearly positioning participants in their sport and cultural environment (Stambulova et al., 2017; Stambulova & Ryba, 2014). Conditions, environmental and individual characteristics play a determining role in the successful achievement of sport trajectory development and, consequently, the transitions that occur in athletes' pathway to elite level (Savage et al., 2017).

The transition from juniors to seniors a very difficult process with a large number of athletes dropping out of their sports career, and statistics indicate that only one third of them manage to successfully complete this stage (Franck, Stambulova, & Ivarsson, 2016; Franck, Stambulova, & Weibull, 2016; Güllich et al., 2023).

Henriksen (2010) places an important emphasis on the analysis of the sport environment which provides valuable information for expanding knowledge about the development of athletic potential.

The Romanian women's championship at the senior level is rated as the second strongest European Championship, and the men's championship is also considered strong. On a closer analysis of the national handball phenomenon, the large number of foreign players playing in the national championships draws our attention. It is a fact that junior players are unable to cope with the demands of competition at the beginning of the transition to senior level.

The statistics of recent years show an extremely low number of junior players who manage to perform at senior level in the internal championship (Caba, 2017; Romanian Handball Federation, 2021).

1.2 Motivation for choosing the topic

My interest in studying this topic came both as a former handball player who has gone through all the stages of a transition process, but also as an observer and lover of Romanian handball.

There is a gap between the extraordinary results achieved by the junior and youth national teams and the disappointing results of the senior national teams.

It is worrying that those young players with results at European and World Championships end up getting lost on the road to senior level. Another phenomenon in national championships is the increasing presence of foreign players.

The very good results achieved by the national youth and junior national teams in official competitions reinforce the fact that there is great potential in this country to produce elite adult players. However, many young players who had all the chances to become great players have failed and even dropped out of top sports.

The undervaluing of young talents and the insufficient physical and technical-tactical preparation acquired during the junior period are two of the primary reasons why clubs select players who have undergone training abroad. Another factor that can be identified as an obstacle in this process is the absence of a comprehensive national strategy that encompasses all levels of competition, beginning with the national teams and subsequently extending to the other categories.

A player who is promoted to a senior team must be very well prepared physically, technically, tactically and psychologically to cope with the new demands.

From a physical point of view, the elite players have a certain physical profile that helps them to perform at the highest level and in simultaneous competitions, both with the club team and the national team.

The lack of objective research on the subject in the Romanian space has created confusion among the "actors" in the world of handball, with solutions being expressed in the form of subjective opinions, which have failed to provide a complete picture of this process.

SUMMARY. Chapter II. The junior to senior transition

The junior to senior transition is a process that involves a number of specific demands, and athletes need to resort to different coping strategies in order to cope with these demands (Stambulova, 2003, 2009). Transitions that occur during a sports career are based on three factors; these relate to the life domain in which the transition takes place, the predictability of the transition and the outcome of the transition (Stambulova et al., 2017).

The transitions are categorized according to their outcome as successful when requirements are met or crisis when the approach is ineffective and intervention is needed (Stambulova, 2003).

The transition to the professional level in a team sport starts in adolescence, from the moment when the young player makes the first contact with the senior team through participation in training and ends when the athlete is fully integrated into the team. More than 80% of athletes describe it as a real crisis (Stambulova et al., 2009, 2017). The junior level is an environment that focuses predominantly on development, whereas the senior level is a professional environment that focuses almost exclusively on performance and achieving results (Richardson et al., 2013).

Statistics highlight that only one-third of athletes successfully complete this stage (Franck, Stambulova, & Ivarsson, 2016; Franck, Stambulova, & Weibull, 2016; Güllich et al., 2023). The integration of juniors into the senior environment also includes an introduction into the adult world, and this comes with a set of expectations and a team atmosphere in which young people experience a lot of negative feedback from mature colleagues (Hanton et al., 2005).

The transition in sport overlaps with the transition from adolescence to young adulthood, which is why athletes go through many psycho-emotional states that have a major impact on self-esteem and self-identity (Brewer et al., 2000).

The challenges faced in junior to senior transition are largely development and performance demands as athletes, but they also include the need for a balance between school and sport which is another major source of stress (Christensen & Sørensen, 2009; Solhaug et al., 2021; Stambulova et al., 2020).

The demands are many and involve demands that young athletes must fulfill (Bruner et al., 2008; Debois et al., 2012; Wylleman & Reints, 2010). These demands are part of the physical, psychological, and social preparation, but challenges also exist in the academic and financial spheres (Franck, 2018). The major demands have been identified in the physical level,

with athletes having to cope with training and competition at a level where the physical demands are much higher compared to the lower level.

In recent decades there has been an increasing amount of research investigating career transition in sport. Several models have been proposed and designed with the aim of better understanding this dynamic and complex phenomenon. The first work that studies the transition from juniors to seniors in relation to a temporal structure is by Stambulova et al. (2017). The model named "Stages of transition from juniors to seniors" was validated by Pehrson et al., (2017) and proposes four stages in relation to the temporal structure: preparation, orientation, adaptation and stabilization.

Each phase is assigned a time frame in which it is realized. In all four phases the most important components such as demands, resources, barriers, coping strategies and outcomes can be identified. These variables differ from phase to phase. Each athlete has an individual trajectory in this process, some manage to go through these stages in a shorter time, others in longer periods of time. The role changes, onset and duration of each stage represent the characteristics of a particular transition. Environmental factors and individual athlete characteristics interact with the continuous adaptive process of transition (Rosenkilde et al., 2019).

At the junior level the focus is on individual athlete development, whereas at the senior level this changes. The focus shifts to the whole team with the aim of developing a successful team rather than individual athletes (Morris et al., 2017).

A higher level of fitness is one of the essential prerequisites for a successful transition. It is paramount that young players can cope physically in contact with mature opponents.

SUMMARY Chapter III . Training factors in the modern handball

The complexity of team sports requires an approach which implies a special responsibility in the preparation of athletes, taking into account scientific and methodological advances in this field. In order for athletes to reach their full potential, coaches need to know and understand technical and tactical procedures and be familiar with modern physical and mental training methods. A good knowledge and thorough understanding of technical and tactical training is a solid foundation that determines the creativity coaches need to create an effective physical training plan (Bompa, 2013).

In performance, it is necessary for the athlete to have the ability to integrate several factors, some of which can be trained (physical preparation) and others can be learned (techniques and tactics). Success depends on the optimal integration of physical, physiological, psychological, technical and tactical factors (Matveev, 1981) at the highest level.

Developing a sports training program should integrate the physical, technical, tactical, psychological and theoretical aspects of training regardless of the athletes' age, developmental level or previous training experience (Bompa & Haff, 2014).

The basis on which the sports training program is built is the physical preparation, and the development of the other technical, tactical and psychological aspects also depends on its level. Technical preparation is based on a high level of physical preparation, and the development and application of tactical methods is strongly interconnected with the level of technique (Haff et al., 2016). In order to develop these factors on which success depends, it is necessary for athletes to go through a process called sports training. In Harre's (1982) view, training is the physical, technical, tactical and psychological preparation of an athlete.

Handball is a complex team sport in which achieving success depends equally on the individual level of the players, but also on the technical-tactical components of the team and the connectedness of the members (Wagner et al., 2014). Social factors, environmental and material conditions also play a significant role in achieving performance in modern handball (Michalsik, 2004, 2015; Wagner et al., 2014).

The fundamental physical actions that characterize the game of handball are throwing, jumping, running, and hand-to-hand combat with the opponent (Michalsik, 2018; Ortega-Becerra et al., 2018; Rios et al., 2021; Wagner et al., 2014).

The basis of the physical demands that a handball player has to fulfill during the time of a match is provided by the specific characteristics of the cardiovascular and respiratory systems, muscles and nervous system. These characteristics are primarily determined by

genetic factors, but also can be developed through training (Michalsik, 2018). Knowing the demands of the game from a physical point of view is the most important aspect and is essential in preparing an optimal training program (Karcher & Buchheit, 2014b).

Physical preparation is the element that makes the difference between the winning and losing team (Michalsik, 2018). The team with the best physical condition reaches fatigue more slowly, and in the important moments of a game the athletes have the ability to make the best decisions for the team.

It can be argued that the level of good physical preparation is the secret of sports training to achieve performance (Mojoiu, 2017).

The physiological adaptations developed through optimal physical preparation are the foundation of technical and tactical preparation. The development of a physical training program should target those parameters that are instrumental in achieving performance.

SUMMARY Chapter IV. Training periodization

Training planning is one of the most important responsibilities for a coach (Lyle, 2002). It is recommended that planning begins with the development of an annual plan that provides a comprehensive overview of the entire training process (DeWeese et al., 2015a, 2015b; Haff et al., 2016; Suchomel et al., 2018). The annual plan is the planning document that encompasses all training, competition and additional training over the course of a year. It is an important component of periodization that divides the training year into different periods each having specific objectives. It is the foundation for stimulating physiological and psychological adaptations concomitant with fatigue management, and each athlete or team must have a plan made in a logical and appropriately structured manner so that the proposed objectives can be achieved (Bompa & Haff, 2014).

Periodization theory was published in a Russian monograph by Leonid Matveyev in 1964. The paper summarized the most important information about the periodization and proposed a general approach to sports training (Matveyev, 1964).

The term periodization has several definitions because confusion has arisen among those who have addressed the subject, with periodization often being confused with programming.

Programming can be interpreted as the micro-management of different phases of training by changing the number of sets, repetitions, volume, load, training frequency, exercise selection, and rest periods (Cunanan et al., 2018; DeWeese et al., 2015b; Suchomel et al., 2018). Periodization can be considered as the macro-management of the training process on the annual plan (Kataoka et al., 2021).

The most studied periodization models are classical or traditional periodization and block periodization (Api & Arruda, 2022).

Traditional periodization proposes dividing the annual training plan into three stages: preparatory, competitive and transition. Russian literature, but also other authors propose that the annual plan should be regarded as a macro-cycle in which the development of macro-cycle structures is done in relation to the competitive program and the set goals. The mesocycle is used for the 4-8 week training stages which has a general structure of preparation, and the microcycle represents the smallest training cycle which consists of a 1 week or 3-7 day program being the most important functional planning tool (Dick, 2002; Kurz, 2001; Matveev, 1981; Zatsiorsky, 1995).

The load of this model shifts from high volume and low intensity to low volume and high intensity throughout the macrocycle. This relationship between volume and intensity also occurs within mesocycles.

Traditional periodization has for a long time been universally accepted as the basis of sports training in all disciplines and for athletes at all levels. Although the original version of classical periodization has been modified several times, the evolution of the sports field as well as the contradictions that have emerged between what traditional periodization proposes and the experiences of top coaches have led some specialists to claim that this type of periodization has some limitations that are incompatible with achieving performance (Bondarchuk & Yessis, 2007; Issurin, 2010; Issurin & Yessis, 2008a; Stone et al., 2021; Verkhoshansky, 1977, 1979).

Block periodization is embodied in medium-sized training cycles called block mesocycles that are more focused, specialized and manageable (Issurin, 2008b).

The limitations and problems of sports training that could not be solved by the traditional periodization option were the basis for the development of another type of periodization, namely block periodization.

The idea of sequencing the block was conceptualized, then its effectiveness was proven by practice, and later published (Issurin & Kaverin, 1985). With the realization of this study in 1985 in which kayak-canoe athletes were included, three types of mesocycle-block were proposed which are medium-sized training cycles:

1) accumulation which has been attributed to the development of basic skills such as general aerobic endurance, cardiorespiratory fitness, muscular strength and general coordination. This mesocycle is characterized by a relatively high volume and low intensity of workloads. Its duration varies from 2 to 6 weeks.

2) transmutation is aimed at developing sport-specific skills such as aerobic or anaerobic endurance, strength, sport-specific technique and tactics. This meso-block is the most strenuous cycle and lasts approximately 2-4 weeks.

3) realization was designed as a pre-competitive training phase, with the main purpose of competition simulation and rapid active recovery before competition and lasts between 8-15 days.

Block periodization proposes that the training phase consisting of the three half-blocks should be considered as the most important component of alternative training periodization.

One of the most important criticisms of block periodization concerns the fact that by dividing the annual training process into several small blocks there is a probability that achieving a high level of fitness will not be possible (Krüger, 2016; Lyakh et al., 2014, 2015).

Sports training through traditional periodization aims at the development of several basic sport skills in the preparatory period followed by their decline in the competitive period, while sport-specific skills stagnate in the preparatory period and develop in the competitive period. In contrast, the block periodization system involving multi-peaked preparation allows athletes to maintain both basic and sport-specific skills in a relatively narrow range throughout the championship (Issurin, 2010).

The two periodization models, traditional and block, have both advantages and limitations. Both types of periodization have limitations due to the particularities of the Romanian handball game at the level of juniors I, male and female, which suffers many changes during the championship.

Thus, in the context of Romanian handball and the national championships held at junior level, we propose the B.i.T. (Blocks in Traditional) periodization as an alternative that combines the two philosophies, traditional periodization and block periodization. Through the B.i.T. model we aim to minimize the limitations of the two types of periodization and to streamline the physical preparation of athletes for a successful transition to seniority.

The reasoning behind this proposal results from the fact that:

1) the traditional periodization is too rigid for the national junior I championship, which in recent years has been changing its method of organization and the matches do not have a regular schedule throughout the competitive year;

2) the block periodization allows a concentration on independent and autonomous periods fulfilling restricted objectives, while the players at junior I level are in the period in which they still need to develop more physical skills which contradicts the principles underlying the block periodization.

The B.i.T. periodization keeps the structure of the preparatory stages of the traditional model, which consists of the preparatory stage, the competitive stage and the transitional stage.

The competitive phase is structured in blocks in which the preparation is organized and planned according to the match schedule. This match scheduling differs for each team, depending on the geographical area to which the team belongs and the number of teams in the group. Another reason for the unstructured championship schedule is that some junior I teams are also registered in the A Division Championship and the match schedule has to take this competition into account. As some teams may play 2 matches in 3 days and have a break of 1 month, the schedule of matches being irregular, the B.i.T. periodization blocks cannot maintain the three specific block periodization half-blocks of accumulation, transmutation and realization.

The aim of B.i.T. periodization is to keep the physical preparation of athletes at a level that allows them to be always ready in such an unstable competitive year and that in the end increases their chances of a successful transition to the next level.

In each block, the principles of sports training are respected, the training should cover the physical, technical, tactical, psychological and theoretical components of training. An issue that many coaches face in planning and systematizing training is related to the distribution of the number of hours on the factors of training so that athletes are always prepared in an unstable championship. In handball game any individual or collective action is characterized by the simultaneous presence of all training components. Voicu (2003) and Ghermănescu et al. (1983) have proposed a percentage distribution of the time dedicated to these components, from which it can be observed that there is no consensus in this direction.

We have chosen to apply the model to the junior I level because it is the most difficult period in an athlete's career. It is during this period that most players have to make the decision whether to continue or give up their sporting career. We believe that a high level of their conditioning can lead to a positive transition which is an important prerequisite for a successful sports career at senior level.

PART II

SUMMARY Chapter V. Study analysing the principal physical parameters of the romanian team registered at the european women's handball championship 2020

5.1 Introduction

Knowing and understanding the physical demands during formal competitions is essential to achieve results in high performance handball (García-Sánchez et al., 2023). Each playing position has specific demands, and coaches need to optimize athletic preparation so that different factors develop to produce positive outcomes (Côté & Gilbert, 2009; Karcher & Buchheit, 2014b; Michalsik, 2018; Wagner et al., 2014).

The objective interpretation of data obtained from the analysis of sports performance and its comparison are essential in team sports (Clemente et al., 2017; Hughes & Franks, 2004; Kempe & Memmert, 2018; Valeria et al., 2017; Zapardiel Cortés et al., 2017). In the sports environment, the practice of using information taken from a competition that has ended in order to prepare for a future one is widespread (McGarry et al., 2002).

5.2 Purpose

The aim of this study is to identify which are the parameters of performance at the highest level and which are the values recorded for the Romanian national handball team at the European Women's Handball Championship 2020.

Through this research we aim to investigate possible quantitative differences in the values for throwing speed, sprint and jumping height between the Romanian national team and the other teams participating in the European Championship.

The objective of this study was to identify the trend of these values for the players of the national team.

5.3 Subjects

In this study, data from 255 female players with an age of 26.5±4.3 years and a height of 176±6 cm were analyzed. Of these a total of 217 were field players and 38 were goalkeepers. The team we focused on in this study was the Romanian national team.

The Romanian team consisted of a total of 17 female players aged 26.7±3.8 years and 177±4.3 cm in height. Of these, 3 played as goalkeepers and 14 were field players.

5.4 Materials and methods

The European Women's Handball Championship 2020 took place from December 3-20 and was held in Denmark. Sixteen national teams participated in this edition, and Romania is at its 13th participation out of 14 editions.

The study includes data recorded at the European Women's Handball Championships 2020 for throwing speed expressed in km/h, sprint expressed in km/h and jumping height expressed in centimeters (cm). Data were collected during the game using the KINEXON system. The data was taken from the official competition website.

5.5 Results

After collecting the data, the statistical processing of the data was carried out. The descriptive statistical results have been systematized in the following tables.

Table No. 1 . Throwing speed (km/h) for each team

Rank	Team	N	Amplitude	Minimum	Maximum	Mean	Std.dev.
1	Nor_V.ar	15	37.00	77.00	114.00	98.07	8.53
2	Fra_V.ar	15	56.00	56.00	112.00	98.13	13.11
3	Cro_V.ar	15	32.00	80.00	112.00	93.27	8.50
4	Dan_V.ar	14	30.00	78.00	108.00	94.14	11.22
5	Rus_V.ar	15	40.00	73.00	113.00	99.67	10.67
6	Ola_V.ar	14	46.00	60.00	106.00	93.14	12.73
7	Ger_V.ar	14	21.00	80.00	101.00	92.57	6.93
8	Mun_V.ar	13	43.00	72.00	115.00	91.69	13.24
9	Spa_V.ar	14	59.00	60.00	119.00	94.57	14.39
10	Ung_V.ar	14	33.00	81.00	114.00	96.57	9.53
11	Sue_V.ar	13	47.00	66.00	113.00	97.15	13.05
12	Rom_V.ar	14	64.00	65.00	129.00	93.00	16.08
13	Ser_V.ar	14	83.00	38.00	121.00	88.07	19.07
14	Pol_V.ar	13	49.00	64.00	113.00	88.46	13.41
15	Ceh_V.ar	12	53.00	60.00	113.00	89.00	14.68
16	Slo_V.ar	10	53.00	61.00	114.00	90.70	17.71

At the European Women's Handball Championships 2020, the Romanian team had an average throwing velocity of 93 km/h (DS=16.08) with an amplitude of 64. The 1st placed

team had an average of 98.07 km/h (DS=8.53) with an amplitude of 37. The second placed team of France averaged 98.13 km/h (SD=13.11) with an amplitude value of 56 and the third placed team averaged 93.27 km/h (SD=8.50) with an amplitude value of 32.

Table No. 2. Sprint values (km/h) for each team

Rank	Team	N	Amplitude	Minimum	Maximum	Mean	Std.dev.
1	Nor_V.al	15	8.00	20.00	28.00	25.13	2.26
2	Fra_V.al	15	5.00	23.00	28.00	26.00	1.77
3	Cro_V.al	15	6.00	22.00	28.00	24.13	1.60
4	Dan_V.al	14	6.00	22.00	28.00	25.14	1.61
5	Rus_V.al	15	7.00	21.00	28.00	24.93	2.15
6	Ola_V.al	14	8.00	21.00	29.00	25.07	2.25
7	Ger_V.al	14	5.00	23.00	28.00	25.07	1.33
8	Mun_V.al	13	6.00	22.00	28.00	25.77	1.69
9	Spa_V.al	14	8.00	22.00	30.00	25.43	2.14
10	Ung_V.al	14	7.00	21.00	28.00	24.40	1.80
11	Sue_V.al	13	6.00	21.00	27.00	24.79	1.85
12	Rom_V.al	14	7.00	22.00	29.00	24.79	1.93
13	Ser_V.al	14	6.00	21.00	27.00	23.71	1.77
14	Pol_V.al	13	7.00	21.00	28.00	24.46	2.50
15	Ceh_V.al	12	10.00	21.00	31.00	25.14	2.35
16	Slo_V.al	10	15.00	13.00	28.00	24.15	3.63

The team representing Romania had an average sprint of 24.79 km/h (SD=1.93) with an amplitude of 7. Norway's team, ranked 1st place, had an average sprint value of 25.13 km/h (SD=2.26) with an amplitude of 8. France's representative team, ranked 2nd place, had an

average sprint value of 26 km/h (SD=1.77) with an amplitude of 5. The 3rd place holder has an average of 24.14 km/h (SD=1.60), amplitude 6.

Table No. 3. Jump height (cm) for each team

Rank	Team	N	Amplitude	Minimum	Maximum	Mean	Std.dev.
1	Nor_Sar.	15	49.00	22.00	71.00	45.50	13.73
2	Fra_Sar	15	35.00	38.00	73.00	57.64	11.74
3	Cro_Sar	15	41.00	25.00	66.00	46.67	13.89
4	Dan_Sar	14	44.00	29.00	73.00	52.33	14.24
5	Rus_Sar	15	42.00	22.00	64.00	45.79	13.27
6	Ola_Sar	14	52.00	18.00	70.00	45.69	14.59
7	Ger_Sar	14	44.00	21.00	65.00	48.31	14.35
8	Mun_Sar	13	40.00	22.00	62.00	43.09	14.05
9	Spa_Sar	14	50.00	23.00	73.00	47.79	14.96
10	Ung_Sar	14	48.00	19.00	67.00	44.71	16.23
11	Sue_Sar	13	46.00	22.00	68.00	44.15	15.44
12	Rom_Sar	14	55.00	20.00	75.00	45.57	15.83
13	Ser_Sar	14	38.00	27.00	65.00	42.00	12.74
14	Pol_Sar	13	36.00	22.00	58.00	38.00	11.02
15	Ceh_Sar	12	46.00	27.00	73.00	46.62	14.50
16	Slo_Sar	10	52.00	20.00	72.00	45.70	19.39

Romania's team average in the high jump is 45.57 cm (DS=15.83) with an amplitude of 55. The average value of the 1st place team is 45.50 cm (SD=13.73) with amplitude 35. The representative of Croatia, 3rd place, has an average jump height of 46.67 cm (SD=13.89) with an amplitude of 41.

In the following table we present the recorded performances (throwing speed, sprint, jumping height) for each of the players of the Romanian team.

Table No. 4. Performances for throwing speed, sprint and jumping height by the Romanian team players

	Players	Throwing speed (Km/h)	Sprint (Km/h)	Jumping height (cm)
1	DINCA Elena	84	29	75
2	SUBTIRICA IOVANESCU Alexandra	65	24	22
3	BUCESCHI Eliza	97	23	37
4	NEAGU Cristina	129	24	70
5	TICU Ana	77	23	35
6	LASLO Cristina	105	25	58
7	POPA Andreea	87	24	48
8	POPA Laura	112	27	46
9	POLOCOSER Anca	103	25	58
10	SERAFICEANU Sonia	93	27	42
11	IUGANU Ana	81	26	47
12	SAVU Ana	98	22	42
13	DINDILIGAN Alexandra	87	25	20
14	OSTASE Lorena	84	23	28

5.6 Discussion

Physical parameter data were recorded, for the first time in such a women's competition, during the match. It is therefore very difficult to compare the results obtained in this study with other results because the other studies were conducted under pre-determined training conditions. In this edition, the national team ranked 12th, among the worst results ever obtained in this competition.

One objective of this study was to identify the trend in the values of the Romanian team's throwing speed, sprint and jumping height indexes among the female players.

For the first physical parameter analyzed, throwing speed, it can be seen that only four players have values above 100 km/h. The difference between the maximum and the minimum value is double, and this shows that the team values are not homogeneous and that the range of values is very wide.

For the sprint, most values are closer to the minimum than to the maximum. The values recorded for jumping height again show that the differences between the maximum and

minimum values are large. The average value is increased due to the fact that one Romanian player has the maximum value of the competition. It can also be seen that the athlete who has been named "best player in the world" several times has the second highest value of the team for the high jump. The next best on the team is 12 cm lower than the second best jump. This is a big difference between the first two highest values and the rest of the team.

5.7. Conclusions

The young players of the new generation of the Romanian team show values that tend towards the minimum values of both the team and the competition. Romania's last-placed finish and the fact that the new generation of players is failing to maintain the team's level and sustain the team's performances raises an issue related to the general preparation of an athlete before he or she reaches the national team.

The results obtained by the national women's handball team in recent years show us that there is a downward trend in performance at major European and world competitions. There are many reasons for these results, but Romania's last-place finish at the 2020 European Championships indicates that the new generation of players is failing to maintain the team's high level of performance.

SUMMARY. Chapter VI. Preliminary study on the effectiveness of the mbient lab sensor for measuring throwing arm acceleration

6.1. Introduction

For a throw to be considered successful in handball it must fulfill two requirements. The first requirement implies that the throw must be fast, and the second requires the accuracy of the throw in order to place the ball in the chosen area (Vila Suárez & Ferragut, 2019).

The accelerometer detects the physical manifestations of force on the device, such as acceleration and deceleration in uni- or multi-axial motions.

Most wearable devices today include tri-axial tracking with a sampling rate of 100 Hz. Reaching this level of maturity has allowed these devices to be used in the analysis of human motion (Cunniffe et al., 2009; Montgomery et al., 2010).

6.2 Purpose

The aim of this study was to identify a reliable and easy-to-use method to measure the acceleration of handball throwing. The method can be implemented in the training of young players who, through a controlled and balanced learning process, can make the step to professional teams.

6.3 Subjects

We recruited a total of 70 handball players divided as follows: 4 youth teams and 2 professional teams. There were 23 young female subjects, aged 16±1 years old, and 13 adult female subjects, aged 21+ years old. At the same time, the study also included male subjects: 10 adults, aged over 19 years, and 24 youth, aged 16±1 years.

6.4 Materials

For this study, we used the MbientLab MetaMotionS sensor kit for biomechanical analysis (Figure 1).

Figure No. 1. MbientLab MetaMotionS sensor kit

The sensor is a solution designed to be used as a wrist-worn device that provides recorded and real-time data. The data collection was performed through the MetaWear iOS application that was developed by the MbientLab team (Figure No. 2).

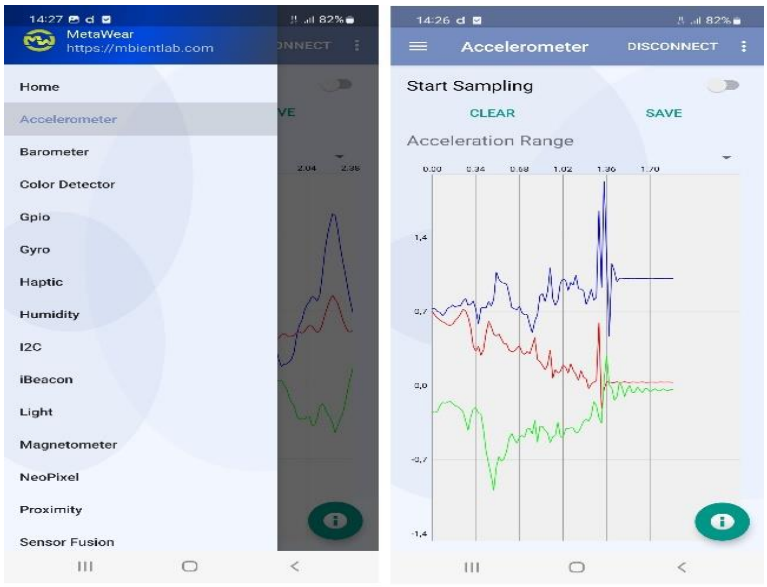

Figure No. 2. MbientLab MetaWear iOS app

6.5 Testing protocol

Each subject had to follow a standardized warm-up, each participant performed a total of 5 throws, and the best of the 5 was kept. The distance we chose for the throw was the 7m line of the handball court. The accelerometer was positioned at each subject's wrist using the device's watch strap. We made sure that the orientation of the sensor was always the same and consistent with left or right handed players.

6.6 Results

The collected data were analyzed using SPSS 17. Mean acceleration was calculated for each subject and then a descriptive statistical analysis was performed for each of the 6 teams. The reason for analyzing the mean acceleration values was based on the purpose of this study. We were not aiming for peak performance of the players, but to test the device in the context of its future integration as a tool to help in the transition from youth to seniors.

Table No. 5. Average x-axis acceleration for the 6 teams

	N	Minimum	Maximum	Average	St.dev.
MAcc_X_T1	11	-0.63	0.89	-0.03	0.45
MAcc_X_T2	12	-0.45	0.70	0.09	0.39
MAcc_X_T3	12	-0.90	0.59	-0.28	0.60
MAcc_X_T4	12	-0.56	0.44	0.01	0.29
MAcc_X_T5	13	-1.11	0.91	-0.03	0.56
MAcc_X_T6	10	-0.80	0.96	-0.09	0.57

In terms of antero-posterior motion axis, we did not have major variations in standard deviation among the 6 teams. The data for team #4 (M = 0.01, SD = 0.29) is the smallest of the six, as it is the adult male professional team. Even though their results are well outside the range of the others, this is to be expected given that the players are not geographically tied, but are selected from a wider area based on their experience and performance in handball. Given that we expect major fluctuations in the data between groups, the fact that for the x-axis of motion the acceleration values do not show such dynamics may indicate that this device can be used as a learning tool.

Table No. 6. Average y-axis acceleration for the 6 teams

	N	Minimum	Maximum	Mean	Std. Deviation
MAcc_Y_T1	11	-2.32	2.85	-0.52	1.86
MAcc_Y_T2	12	-1.60	1.45	0.02	1.14
MAcc_Y_T3	12	-2.65	1.57	-0.30	1.55
MAcc_Y_T4	12	-2.14	1.52	0.30	1.32
MAcc_Y_T5	13	-1.71	2.60	0.07	1.48
MAcc_Y_T6	10	-2.22	1.75	-0.48	1.72

Lateral acceleration data (Table 6) show a slight increase in fluctuation compared to the x-axis of motion. This is explained by the complex biomechanics of the over-the-shoulder throwing technique. All 3 major joints of the arm are involved in twisting and rotational

motions during the throw, even though this might not be evident at such high execution speeds. However, this analysis is competing in terms of variation with the anterior-posterior results.

Table No. 7. Average z-axis acceleration for the 6 teams

	N	Minimum	Maximum	Mean	Std. Deviation
MAcc_Z_T1	11	-1.97	-0.46	-1.30	0.43
MAcc_Z_T2	12	-0.95	-0.35	-0.58	0.19
MAcc_Z_T3	12	-1.41	0.39	-0.65	0.49
MAcc_Z_T4	12	-1.10	0.07	-0.49	0.32
MAcc_Z_T5	13	-0.88	0.03	-0.49	0.26
MAcc_Z_T6	10	-0.83	0.21	-0.42	0.36

The last analysis was performed on the vertical acceleration data. This batch of data indicates that the device can detect subtle vertical movements during the throw. We attempted, with the type and style of throwing chosen for this study, to minimize the up and down motion, with the secondary goal of identifying possible errors or deviations in throwing technique. The acceleration detected on this axis of motion, even if consistent in its values of variation, may indicate possible errors in learning and reinforcing this throwing technique.

6.6 Conclusions

The results of the current study showed that, using MbientLab MetaMotionS, accelerometer data accurately estimated the throwing acceleration of both young and senior handball players.

As a result, the collected accelerometer-based data can provide an efficient detection of possible differences between young and senior players and encourage an active monitoring of the development of young players and possibly avoid a negative transition. In the future, it seems that the determination of throwing velocity and arm twist using a wrist-mounted accelerometer will be a topic of interest for specialists.

As a result, the proposed device and testing methodology has the potential to provide a reliable method for estimating throwing accelerations in handball as a tool to monitor the development of young players for a successful transition to professional teams.

SUMMARY. Chapter VII. Personal research on the impact of B.i.T. method on the periodization of physical training in the context of the junior to senior transition

7.1. Introduction

Block periodization appears to be more effective than other types of periodization with respect to experienced athletes. The explanation comes from the fact that the training of professional athletes involves more complex training structures with higher volume and specific exercises (Rasmussen et al., 2013; Schoenfeld, 2020), but Api and Arruda (2022) present in their study that traditional training periodization is more indicated in novice athletes to develop strength, power and endurance.

Kniubaitė (2020) recommends that based on the principles of traditional periodization, the training program of the competitive year should be modeled in blocks. A conclusion of the research was that specific sports performance of high-performance female handball players is the most important prerequisite for winning a handball match. Through B.i.T. we aim to achieve the same positive results in a national junior 1 championship for both male and female.

7.2 Purpose

The study aims to implement B.i.T. periodization and to determine its effects on arm throwing velocity, jump force and respiratory system. The chosen variables provide us with information about the level of specific physical preparation after a competitive year in which the proposed periodization was used.

We want to test the B.i.T. periodization model, and the obtained results will be analyzed in order to draw conclusions at the end of the intervention program to support the work of coaches and decision makers.

7.3 Research hypotheses

Through experimental research we aimed to create some premises for a positive transition to senior teams by implementing a new periodization model.

Our hypothesis assumes that the implementation of B.i.T. periodization at the junior level results in the development of arm throwing velocity, jumping strength and respiratory capacity.

If our hypothesis is confirmed, we will be able to propose a new type of periodization in the training of junior handball players in order to increase the main physical parameters of sports performance.

7.4 Research objectives

Given the conclusions drawn from the first study and the fact that an increasing number of foreign players are playing in Romania, and that young Romanian athletes are less and less promoted, we decided to propose an intervention plan that would help to achieve the desired results. The objectives of the experimental research are:

- Development of a periodization model that aims to control the periodization of physical preparation (physical parameters of performance: jumping strength, arm throwing speed, and respiratory capacity);

- Implementation of the B.i.T. periodization over the period of a competitive year at the level of male and female juniors 1;

- Monitoring the evolution of physical parameters during a competition year in the context of the implementation of B.i.T. periodization.

7.6 Subjects

A total of 35 junior players participated in the study, 18 male and 17 female. In addition to the juniors, 20 senior players were also included, 8 male and 12 female. In the research we also included senior athletes because one of the main themes of this paper is the juniors to seniors transition and we wanted to follow the evolution of the junior groups in relation to the senior groups.

Table No. 8. Anthropometric indicators for Experiment and Control groups Juniors Male and Female at M1 and M2

	M1				**M2**			
	Age	Height	Weight	BMI %	Age	Height	Weight	BMI %
ExpM	16.4	179.9	77.16	66.4	16.9	180.07	78.88	69.7
ContrM	16.3	184.2	84.8	81.9	17.3	184.7	86.7	81.4
ExpF	15.6	168.4	63.4	60.3	16.3	176.0	91.2	96.8
ContrF	16.6	171.8	66.2	64.6	17.0	172.5	67.8	64.6

Table No. 9. Anthropometric indicators for Senior Male and Female Control groups M1 and M2

	M1					M2				
	Age	Height	Weight	BMI	Fat	Age	Height	Weight	BMI	Fat
ContrSM	23.6	189.6	89.4	16.6	24.1	24.1	189.0	89.8	16.4	25.1
ContrSF	24.1	174.2	73.6	31.6	24.2	24.7	174.2	74.6	32.8	24.4

Junior athletes were participated in the Men's and Women's Junior I National Championships. The senior men's subjects participated in the Men's National League and the senior women's subjects competed in Division A in the 2021-2022 competitive year.

7.7 Research organization

We conducted a longitudinal study that ran over a 7-month period from October 2021 to April 2022. The study included:

- Three periods:

o Initial measurement (M1) - September 2021;

o Experimental run (intervention protocol) October 2021- April 2022;

o Final measurement (M2) - April 2022;

- 6 groups of subjects:

o 2 junior experiment groups (ExpM - male experiment, ExpF - female experiment);

o 2 junior control groups (ContrM - male control, ContrF - female control);

o 2 senior control groups (ContrSM - senior male control, ContrSF - senior female control);

- Implementation period of independent variable:

o Implementation of Blocks I-IV;

o Supervision of training to meet the requirements of the intervention plan;

o Monitoring changes during the implementation of the intervention program;

o Data collection.

7.8. Materials and methods

In order to have a research with a solid grounding of the concepts used in its implementation, we used the literature review method. We used this method to ensure that the information gathered is valid and reliable.

In order to achieve the proposed objectives, we used the observation method to record special situations that arose during the implementation of the intervention program.

Hypothesis testing was carried out by experiment. For a better visualization of the obtained results and their interpretation, we used the graphical representation method. The collected data were analyzed using the statistical-mathematical method.

ATMI NetForce Platform

The BMS400600 is a mountable force plate model from AMTI. As part of the Optima Biomechanical Measurement Series (BMS), this platform offers superior accuracy, high natural frequency and flexibility in all applications.

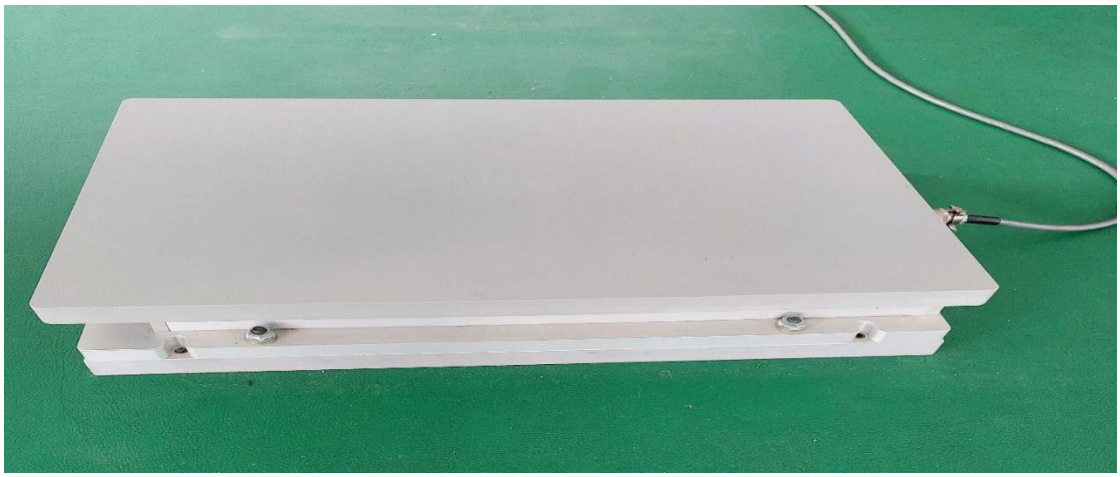

Figure No. 3. ATMI NetForce Platform - Model BMS400600

The data was processed with software related to the Netforce platform which generated the following parameters that we tracked: Release Force (Newton (N)), Shock force (N), Release Power (Watt (W)) and Shock Power (W).

MbientLab MetaMotionS sensor kit

The sensor is a solution designed to be used as a wrist-worn device that provides real-time and recorded data. It incorporates various sensors that can be used separately or simultaneously during a measurement: accelerometer, gyroscope, magnetometer, IMU sensor, temperature sensor, barometer, ambient light detector.

Figure No.4. MbientLab MetaMotionS sensor kit

Data were collected via the MetaBase App and we tracked acceleration (m/s ²) and velocity (km/h) parameters.

Spirobank II MIR Spirometer

Spirobank MIR II is a small spirometer with an optional pulse oximetry module. It can operate autonomously and can be connected to a PC or printer using any of several available methods: RS232, USB, Bluetooth. Automatic test interpretation complies with the latest ATS (American Thoracic Society) classification level.

Figure No. 5. Spirometer Spirobank MIR II

Data collected with analyzed through winspiroPRO software. The software provides a graphical presentation of a number of parameters related to human respiratory function. In our

study we analyzed parameters for Vital Capacity (l), Forced Vital Capacity (l) and Maximum Voluntary Ventilation (l/min).

7.8.2 Intervention program

The objectives of implementing the B.i.T. periodization are aimed at the specific physical preparation that allows the quantitative gains from the general physical preparation stage to be reflected in an optimal way in the competitive period so that the quantitative gains are transformed into qualitative gains.

The B.i.T. periodization emphasizes the competitive stage which is structured in 4 blocks.

For the male experiment group we applied:

- Block I from October to December 2021:

- consisting of 35 trainings and 4 official matches.

- Block II in the period December 2021 - January 2022:

- Composed of a centralized training period in the mountains with 11 training sessions preceding the training in the gym - 9 training sessions;

- comprised the break period between the two competitive parts.

- Block III in the period January - February 2022:

- Includes 19 trainings in the gym and 3 official matches.

- Block IV during February - April 2022:

- is structured of 30 trainings, 3 official matches and 4 friendly matches.

The intervention plan applied to the female experimental group was also structured in 4 blocks as follows:

- Block I took place from October to December 2022:

- contained 16 training sessions, 3 official matches and 2 friendly matches.

- Block II ran from December 2020 to January 2021:

- covered the period between the two parts of the championship;

- consisted of 11 training sessions in the gym and a centralized mountain training of 9 training sessions.

- Block III covered the period January - February 2021:

- consisted of 21 trainings, 4 official matches and 4 friendly matches.

- Block IV ran from February to April 2022:

- comprised 24 training sessions, 4 official matches and 3 friendly matches.

7.9.Results

7.9.1 Results in the men's group results

Statistical analysis of the results of the CMJ Jumping and SQJ Jumping tests

In the following tables we have used the abbreviations:

Fd_CMJ/ SQJ – Release force for CMJ/SQJ Jump;

Fa_CMJ/ SQJ– Shock force for CMJ/SQJ Jump;

Pd_CMJ/ SQJ– Release power for CMJ/SQJ Jump;

Pa_CMJ/ SQJ – Shock power for CMJ/SQJ Jump;

M1 - Measurement 1;

M2 - Measurement 2.

Table No. 10. CMJ and SQJ in male groups (independent samples)

Parameter	Group	Mean	Std.dev.	Sig. (2-tailed)	Parameter	Group	Mean	Std.dev.	Sig. (2-tailed)
Fd_CMJ_1	ExpM	1624.27	365.63	0.065	Fd_SQJ_1	ExpM	1720.67	324.05	0.044
	ContrM	1930.65	265.22			ContrM	1985.15	115.07	
	ExpM	1624.27	365.63	0.017		ExpM	1720.67	324.05	0.050
	ContrSM	1961.81	58.46			ContrSM	1955.68	65.51	
Fd_CMJ_2	ExpM	2002.99	107.11	0.563	Fd_SQJ_2	ExpM	1976.36	112.48	0.284
	ContrM	1972.29	112.88			ContrM	1852.13	291.10	
	ExpM	2002.99	107.11	0.334		ExpM	1976.36	112.48	0.905
	ContrSM	1955.16	79.82			ContrSM	1970.20	85.31	
Pd_CMJ_1	ExpM	3536.64	704.97	0.130	Pd_SQJ_1	ExpM	3795.73	713.66	0.706
	ContrM	3998.36	459.39			ContrM	3911.95	524.72	
	ExpM	3536.64	704.97	0.007		ExpM	3795.73	713.66	0.077
	ContrSM	4355.40	360.31			ContrSM	4403.59	542.87	
Pd_CMJ_2	ExpM	4549.43	327.32	0.195	Pd_SQJ_2	ExpM	4571.72	730.80	0.129
	ContrM	4249.74	601.35			ContrM	4093.11	470.41	
	ExpM	4549.43	327.32	0.448		ExpM	4571.72	730.80	0.565
	ContrSM	4410.99	405.42			ContrSM	4380.58	531.83	
Pa_CMJ_1	ExpM	4731.32	1063.53	0.320	Pa_SQJ_1	ExpM	4302.64	946.08	0.021
	ContrM	5146.08	456.17			ContrM	5284.04	584.29	
	ExpM	4731.32	1063.53	0.046		ExpM	4302.64	946.08	0.015
	ContrSM	5750.80	754.72			ContrSM	5494.71	773.33	
Pa_CMJ_2	ExpM	5167.49	711.23	0.877	Pa_SQJ_2	ExpM	5015.30	993.04	0.470
	ContrM	5109.69	850.02			ContrM	4710.57	676.01	
	ExpM	5167.49	711.23	0.228		ExpM	5015.30	993.04	0.252
	ContrSM	5599.38	674.41			ContrSM	5552.29	781.36	

- Regarding the CMJ jump, statistical analysis of the values for independent samples shows that there are statistically significant differences for the parameters Fd_CMJ_1 (p=0.017), Pd_CMJ_1 (p=0.007) and Pa_CMJ_1 (p=0.046) between the ExpM and ContrSM groups;
- For the SQJ jump test, the statistical analysis of the values for independent samples shows that there are statistically significant differences for the parameters Fd_SQJ_1 between ExpM and ContrM group (p=0.044) and between ExpM and ContrSM group (p=0.050), for Pa_SQJ_1 between ExpM and ContrM group (p=0.021) and between ExpM and ContrSM group (p=0.015).

Table No. 11. CMJ and SQJ in the male experimental group (paired samples)

Pair	Mean	Std. Dev.	t	df	Sig. (2-tailed)	(Cohen's d)
Fd_ExpM_CMJ_2 - Fd_ExpM_CMJ_1	2002.99 1624.27	107.11 365.63	3.934	9	0.003	1.24
Fa_ExpM_CMJ_2 - Fa_ExpM_CMJ_1	756.82 781.60	142.41 177.65	-0.617	9	0.552	-0.20
Pd_ExpM_CMJ_2 - Pd_ExpM_CMJ_1	4549.43 3536.64	327.32 704.97	3.886	9	0.004	1.23
Pa_ExpM_CMJ_2 - Pa_ExpM_CMJ_1	5167.49 4731.32	711.23 1063.53	1.585	9	0.147	0.50
Fd_ExpM_SQJ_2 - Fd_ExpM_SQJ_1	1976.36 1720.67	112.48 324.05	2.296	9	0.047	0.73
Fa_ExpM_SQJ_2 - Fa_ExpM_SQJ_1	757.93 781.74	144.01 177.52	-0.590	9	0.570	-0.19
Pd_ExpM_SQJ_2 - Pd_ExpM_SQJ_1	4571.72 3795.73	730.80 713.66	4.547	9	0.001	1.44
Pa_ExpM_SQJ_2 - Pa_ExpM_SQJ_1	5015.30 4302.64	993.04 946.08	4.119	9	0.003	1.30

- For the CMJ jump, statistical analysis of values for paired samples in the ExpM group identified statistically different values between the two measurements for the parameters Fd (p=0.003) and Pd (p=0.004). The large effect sizes for the two parameters Fd (1.24) and Pd (1.23) indicate that the intervention had a major impact from a statistical, but also a practical, point of view.

- Regarding the SQJ jump, the statistical analysis of the values for paired samples in the ExpM group shows statistically significant differences for the parameters Pd (p=0.001) with a large effect size (1.44) and for Pa (p=0.003) with a large effect size (1.30).

Statistical analysis of Throwing test results

Vit_Max – maximum speed; Vit_Med – average speed

Table No. 12. Maximum Speed and Average Throwing Speed for male groups (independent samples)

Parameter	Group	Mean	Std.dev.	t	df	Sig. (2-tailed)
Vit_Max_1	ExpM	80.05	4.48	-1.382	17	0.185
	ContrM	83.31	5.64			
	ExpM	80.05	4.48	-0.361	13	0.724
	ContrSM	80.85	3.75			
Vit_Max_2	ExpM	81.85	3.98	-0.92	17	0.370
	ContrM	84.48	7.65			
	ExpM	81.85	3.98	-0.125	6.6	0.904
	ContrSM	82.3	8.18			
Vit_Med_1	ExpM	32.88	1.39	-1.231	17	0.235
	ContrM	33.76	1.69			
	ExpM	32.88	1.39	-3.229	13	0.007
	ContrSM	35.07	1.1			
Vit_Med_2	ExpM	33.75	1.27	-1.146	17	0.268
	ContrM	34.57	1.79			
	ExpM	33.75	1.27	-3.308	13	0.006
	ContrSM	36.15	1.53			

- The statistical analysis of the values for independent samples shows a statistically significant difference for the parameter Vit_Med at measurement 1 (p=0.007) between the ExpM and ContrSM groups and at measurement 2 (p=0.006).

Table No. 13. Maximum velocity and Average throwing velocity in male experiment group (paired samples)

Pair	Mean	Std. Dev.	t	df	Sig. (2-tailed)	(Cohen's d)
Vit_Max_ExpM_2 - Vit_Max_ExpM_1	81.85 80.05	3.98 4.48	7.249	8	0.000	1.16
Vit_AVG_ExpM_2 - Vit_AVG_ExpM_1	33.75 32.88	1.27 1.39	6.807	8	0.000	1.25

- Statistical analysis of the values for paired samples of the experimental group indicates a statistically significant difference for both Vit_Max (p=0.000) and Vit_Med (p=0.000) between the two measurements. The values obtained for the effect size indicate that B.i.T. periodization had a strong effect on the two parameters analyzed.

Statistical analysis of Respiratory Capacity test results

CV – vital capacity; CVF – forced vital capacity; VVM – maximum voluntary ventilation.

Table No. 14. Vital Capacity, Forced Vital Capacity and Maximum Voluntary Ventilation in male groups (independent samples)

Parametru	Grup	Media	Deviația Std	t	df	Sig. (2-tailed)
CV_1	ExpM	4.78	1.15	-1.919	15	0.070
	ContrM	5.85	1.11			
	ExpM	4.78	1.15	-2.1	15	0.050
	ContrSM	5.83	0.78			
CV_2	ExpM	4.69	1.06	-1.125	15	0.28
	ContrM	5.27	1.02			
	ExpM	4.69	1.06	-2.24	15	0.040
	ContrSM	5.76	0.81			
CVF_1	ExpM	4.82	0.44	0.097	7.29	0.926
	ContrM	4.78	1.12			
	ExpM	4.82	0.44	-2.91	15	0.011
	ContrSM	5.86	1.01			
CVF_2	ExpM	5.11	0.52	-0.615	7.39	0.557
	ContrM	5.42	1.29			
	ExpM	5.11	0.52	-3.02	15	0.009
	ContrSM	6.44	1.26			
VMV_1	ExpM	148	34.12	-1.119	15	0.281
	ContrM	168.79	42.53			
	ExpM	148.00	34.12	-1.32	15.00	0.208
	ContrSM	166.37	16.17			
VMV_2	ExpM	162.84	24.68	-0.623	15	0.543
	ContrM	171.97	36.06			
	ExpM	162.84	24.68	-0.28	15.00	0.785
	ContrSM	166.23	24.99			

- The statistical analysis of the values for independent samples shows statistically significant differences for the CV parameters at measurement 1 between the ExpM and ContrSM groups (p=0.050), as well as at measurement 2 (p=0.040).

- A statistically significant difference is also observed for the CVF parameter for the same groups, ExpM and ContrSM, both for M1 (p=0.011) and M2 (p=0.009).

Table No. 15. Vital Capacity, Forced Vital Capacity and Maximum Voluntary Ventilation in male experimental group (paired samples)

Pair	Mean	Std. Dev.	t	df	Sig. (2-tailed)	(Cohen's d)
CV_ExpM_2 - CV_ExpM_1	4.69 4.78	1.06 1.15	-0.411	9	0.690	-0.13
CVF_ExpM_2 - CVF_ExpM_1	5.11 4.82	0.52 0.44	1.671	9	0.129	0.53
VMV_ExpM_2 - VMV_ExpM_1	162.84 148.00	24.68 34.12	1.964	9	0.081	0.62

- On statistical analysis of the values for paired samples of the male experimental group it can be observed that there is no statistically significant difference for the analyzed parameters between the two measurements.

7.9.2 Results in the women's groups

Statistical analysis of the results of the CMJ Jumping and SQJ Jumping tests

Table No. 16. CMJ and SQJ in female groups (independent samples)

Parameter	Group	Mean	Std. Dev.	Sig. (2-tailed)	Parameter	Group	Mean	Std. Dev.	Sig. (2-tailed)
Fd_CMJ_1	ExpF	1373.49	192.91	0.006	Fd_SQJ_1	ExpF	1301.08	440.25	0.087
	ContrF	1725.12	256.27			ContrF	1664.69	369.61	
	ExpF	1373.49	192.91	0.003		ExpF	1301.08	440.25	0.009
	ContrSF	1761.20	319.19			ContrSF	1825.14	383.01	
Fd_CMJ_2	ExpF	1885.48	324.72	0.890	Fd_SQJ_2	ExpF	1841.31	326.79	0.879
	ContrF	1905.64	256.89			ContrF	1815.95	348.10	
	ExpF	1885.48	324.72	0.455		ExpF	1841.31	326.79	0.648
	ContrSF	1776.72	322.66			ContrSF	1775.10	321.80	
Fa_CMJ_1	ExpF	561.52	43.71	0.012	Fa_SQJ_1	ExpF	603.46	112.91	0.437
	ContrF	639.63	67.40			ContrF	640.15	67.76	
	ExpF	561.52	43.71	0.008		ExpF	603.46	112.91	0.083
	ContrSF	712.18	146.14			ContrSF	710.10	144.38	
Fa_CMJ_2	ExpF	634.39	99.49	0.763	Fa_SQJ_2	ExpF	623.28	105.76	0.605
	ContrF	648.53	88.97			ContrF	648.53	88.94	
	ExpF	634.39	99.49	0.194		ExpF	623.28	105.76	0.148
	ContrSF	715.58	158.58			ContrSF	715.93	159.18	
Pd_CMJ_1	ExpF	2336.32	244.91	0.005	Pd_SQJ_1	ExpF	2291.79	280.67	0.008
	ContrF	2757.43	284.88			ContrF	2707.52	277.02	
	ExpF	2336.32	244.91	0.001		ExpF	2291.79	280.67	0.003
	ContrSF	2842.27	318.86			ContrSF	2750.10	317.58	
Pd_CMJ_2	ExpF	2630.00	271.49	0.113	Pd_SQJ_2	ExpF	2754.94	395.59	0.616
	ContrF	2893.20	371.79			ContrF	2853.68	398.39	
	ExpF	2630.00	271.49	0.151		ExpF	2754.94	395.59	0.583
	ContrSF	2785.63	206.47			ContrSF	2681.13	203.13	
Pa_CMJ_1	ExpF	2660.74	413.01	0.001	Pa_SQJ_1	ExpF	2888.79	692.43	0.177
	ContrF	3647.08	554.73			ContrF	3352.50	652.37	
	ExpF	2660.74	413.01	0.001		ExpF	2888.79	692.43	0.076
	ContrSF	3642.59	626.63			ContrSF	3568.65	905.78	
Pa_CMJ_2	ExpF	3515.93	982.82	0.202	Pa_SQJ_2	ExpF	3477.40	855.70	0.784
	ContrF	4017.76	498.89			ContrF	3593.38	859.00	
	ExpF	3515.93	982.82	0.760		ExpF	3477.40	855.70	0.645
	ContrSF	3403.95	499.83			ContrSF	3326.76	622.40	

- For the CMJ jump, the statistical analysis of the values for independent samples shows statistically significant differences in the parameters Fd_CMJ_1 between the ExpF and ContrF groups (p=0.006), as well as between the ExpF and ContrSF groups (p=0.003).

- Also for the CMJ jump, the statistical analysis shows statistically significant differences for the parameter Fa_CMJ_1 between ExpF and ContrF (p=0.012) and between ExpF and ContrSF (p=0.008); differences were also observed for the parameter Pd_CMJ_1 between ExpF and ContrF (p=0.005) and between ExpF and ContrSF (p=0.001).
- CMJ jumping also showed statistically significant differences in the parameter Pa_CMJ_1 between ExpF and ContrF (p=0.001) and between ExpF and ContrSF (p=0.001).
- In the case of the SQJ jump, statistically significant differences were observed for the parameter Fd_SQJ_1 between the ExpF and ExpSF groups (p=0.009), for the parameter Pd_SQJ_1 between the ExpF and ContrF groups (p=0.008), and between the ExpF and ContrSF groups (p=0.003).

Table No. 17. CMJ and SQJ in female experimental group (paired samples)

Pair	Mean	Std. Dev.	t	df	Sig. (2-tailed)	(Cohen's d)
Fd_ExpF_CMJ_2 - Fd_ExpF_CMJ_1	1885.48 1373.49	324.72 192.91	3.824	8	0.005	1.27
Fa_ExpF_CMJ_2 - Fa_ExpF_CMJ_1	634.39 561.52	99.49 43.71	2.408	8	0.043	0.80
Pd_ExpF_CMJ_2 - Pd_ExpF_CMJ_1	2630.00 2336.32	271.49 244.91	2.081	8	0.071	0.69
Pa_ExpF_CMJ_2 - Pa_ExpF_CMJ_1	3515.93 2660.74	982.82 413.01	2.819	8	0.023	0.94
Fd_ExpF_SQJ_2 - Fd_ExpF_SQJ_1	1841.31 1301.08	326.79 440.25	3.795	8	0.005	1.27
Fa_ExpF_SQJ_2 - Fa_ExpF_SQJ_1	623.28 603.46	105.76 112.91	1.520	8	0.167	0.51
Pd_ExpF_SQJ_2 - Pd_ExpF_SQJ_1	2754.94 2291.79	395.59 280.67	4.032	8	0.004	1.34
Pa_ExpF_SQJ_2 - Pa_ExpF_SQJ_1	3477.40 2888.79	855.70 692.43	2.156	8	0.063	0.72

- For the CMJ jump, the statistical analysis of the values for the paired samples in the experimental group shows that there are statistically significant differences between the two measurements for the parameters Fd (p=0.005), Fa (p=0.043) and Pa (0.023).
- For the SQJ jump, the statistical analysis shows statistically significant differences between M1 and M2 for the parameter Fd (p=0.005) and Pd (p=0.004).

Statistical analysis of Throwing test results

Table No. 18. Maximum speed and Average throwing speed in female groups (independent samples)

Parameter	Group	Mean	Std.Dev.	t	df	Sig. (2-tailed)
Vit_Max_1	ExpF	76.00	3.60	-0.743	17.00	0.468
	ContrF	77.13	3.06			
	ExpF	76.00	3.60	-2.015	17.00	0.060
	ContrSF	80.94	6.51			
Vit_Max_2	ExpF	77.87	3.36	-0.472	17.00	0.643
	ContrF	78.70	4.23			
	ExpF	77.87	3.36	-0.802	17.00	0.434
	ContrSF	79.28	4.21			
Vit_Med_1	ExpF	28.96	1.08	-2.267	12.19	0.042
	ContrF	31.03	2.64			
	ExpF	28.96	1.08	-4.778	17.00	0.000
	ContrSF	32.02	1.62			
Vit_Med_2	ExpF	29.72	1.25	-1.610	17.00	0.126
	ContrF	31.18	2.43			
	ExpF	29.72	1.25	-3.760	15.58	0.002
	ContrSF	32.50	1.93			

- The statistical analysis of the values for independent samples shows statistically significant differences for the parameter Vit_Med at M1 between the ExpF and ContrF groups (p=0.042), as well as between the ExpF and ContrSF groups (p=0.000); for the same parameter analyzed, Vit_Med, a statistically significant difference is also observed at M2 between the ExpF and ContrSF groups (p=0.002).

Table No. 19. Maximum velocity and Average throwing velocity in female experimental group (independent samples)

Pair	Mean	Std. Dev.	t	df	Sig. (2-tailed)	(Cohen's d)
Vit_Max_ExpF_2 - Vit_Max_ExpF_1	77.87 76.00	3.36 3.60	4.508	8	0.002	0.99
Vit_Med_ExpF_2 - Vit_Med_ExpF_1	29.72 28.96	1.25 1.08	6.206	8	0.000	1.10

- Statistical analysis of the values for paired samples of the experimental group indicates a statistically significant difference for both Vit_Max (p=0.002) and Vit_Med

(p=0.000) between the two measurements. The values obtained for the effect size indicate that B.i.T. periodization had a strong effect on the two parameters analyzed.

Table No. 20. Vital Capacity, Forced Vital Capacity and Maximum Voluntary Ventilation in female groups (independent samples)

Parameter	Group	Mean	Std.Dev.	t	df	Sig. (2-tailed)
CV_1	ExpF	3.80	0.51	-0.386	15.00	0.705
	ContrF	3.91	0.65			
	ExpF	3.80	0.51	-1.808	19.00	0.086
	ContrSF	4.36	0.80			
CV_2	ExpF	3.71	0.51	0.047	15.00	0.963
	ContrF	3.69	0.91			
	ExpF	3.71	0.51	-0.829	19.00	0.417
	ContrSF	3.94	0.71			
CVF_1	ExpF	3.91	0.48	-1.057	15.00	0.307
	ContrF	4.19	0.63			
	ExpF	3.91	0.48	-1.328	19.00	0.200
	ContrSF	4.23	0.61			
CVF_2	ExpF	4.05	0.69	-0.090	15.00	0.930
	ContrF	4.08	0.65			
	ExpF	4.05	0.69	-0.920	19.00	0.369
	ContrSF	4.32	0.66			
VMV_1	ExpF	125.82	22.34	1.677	15.00	0.114
	ContrF	103.90	31.31			
	ExpF	125.82	22.34	-0.118	19.00	0.908
	ContrSF	126.93	20.42			
VMV_2	ExpF	129.09	17.99	1.682	15.00	0.113
	ContrF	111.36	25.26			
	ExpF	129.09	17.99	0.714	19.00	0.484
	ContrSF	123.40	18.14			

- Statistical analysis of the values for independent samples shows no statistically significant differences for the spirometric parameters tracked in the two measurements.

Table No. 21. Vital Capacity, Forced Vital Capacity and Maximum Voluntary Ventilation in female experimental group (paired samples)

Pair	Mean	Std. Dev.	t	df	Sig. (2-tailed)	(Cohen's d)
CV_ExpF_2 - CV_ExpF_1	3.71 3.80	0.51 0.51	-2.782	8	0.024	-0.93
CVF_ExpF_2 - CVF_ExpF_1	4.05 3.91	0.69 0.48	0.888	8	0.401	0.30
VMV_ExpF_2 - VMV_ExpF_1	129.09 125.82	17.99 22.34	0.855	8	0.417	0.29

- Statistical analysis of paired sample values for the experimental group indicates a statistically significant difference for the CV parameter (p=0.024) between the two measurements.

7.10 Discussions

Achieving and maintaining an optimal physical level for performance requires a complex and multidisciplinary approach that is embodied in a periodized physical training program.

By the B.i.T. periodization we aimed to increase the level of the main physical parameters in achieving performance in the game of handball and to follow what happens to the physical preparation during a competitive year following the application of the proposed program.

Bompa and Haff (2014) indicate that there is no general "recipe" that works equally effectively for all athletes.

Jumping test - men's groups

In the case of the male experimental group, there is a progress that is recorded for the CMJ jump release force and CMJ jump shock power. The results suggest that the implemented periodization model has a direct effect on these CMJ jump parameters with important role in the explosive force of the lower train.

In the case of SQJ jump, the results recorded for the detachment force show a significant progress in the experimental group. Compared to the junior control group which recorded a decrease in the values, as far as the experimental group is concerned, we can state that the B.i.T. periodization has a positive impact on this parameter. Moreover, the level reached by the subjects in the experimental group is almost identical to that of the senior athletes.

Throwing test - men's groups

Through the implemented program we were able to increase the maximum and average arm throwing velocity, which is an essential aspect when the young player makes the transition to the professional level. Although there is quite a large difference between the values of the experimental group and the values recorded by the senior control group, the fact that there is a direct effect of the intervention program over a duration of about 7 months may indicate a likelihood that these parameters may be able to be better developed if the program is implemented over a longer duration.

Respiratory capacity test - male groups

Results obtained by the experimental group for spirometric parameters are directly influenced by the level of anthropometric parameters. In our case, the experimental group recorded lower mean values for age, weight, height, BMI compared to the control group of juniors.

Jumping test- women's groups

The values obtained from the research carried out indicate a progress of the important parameters that determine the anaerobic actions of the lower body and their falling within the range of values obtained by the senior players that can determine a positive transition.

Throwing test - female groups

With regard to the experimental group, we can state that what was worked on and the way in which the training was planned during the experiment led to a progress in the maximum throwing arm velocity, as in the case of the average throwing velocity.

Respiratory capacity - female groups

Although the progress of the experimental group cannot be directly attributed to the implemented periodization, the fact that there is an increase in the values can be considered a positive aspect.

The results of our study in terms of the level of Vital Capacity, Forced Vital Capacity and Maximum Voluntary Ventilation of the experimental groups in relation to the senior control groups is in agreement with the findings of other studies indicating a direct correlation between anthropometric parameters and pulmonary test results (Durmic et al., 2017; Maiolo et al., 2003; Park et al., 2012).

7.11 Experimental research conclusions

At the end of the experiment we can state that B.i.T. periodization improves jumping and throwing performances, and the way in which the values evolved indicates that they follow an upward trend towards the level of senior athletes. This is crucial in achieving a successful transition. Under these conditions we can state that the proposed hypotheses have been confirmed.

We consider it important to mention that in the case of the male experimental group, 9 athletes were included in the experimental research, 2 of which were under the age required by the J1 level. Of the 9 athletes included in the study, 5 of them made the transition to the senior team and were active in 2022-2023 in Division A.

In the case of the female experimental group, 9 sportswomen were part of the experimental research, 7 of which were under the age limit imposed by the J1 national championship. Of the female athletes participating in the study, 2 of them made the transition to the senior team in the following championship.

Chapter VIII. General conclusions

Sudying the literature helped us to have a broad view of the juniors to seniors transition and to identify what are the requirements for this process to be successful. Once the primary requirement (physical preparation) was identified, we deepened from the data exposed in the field which are those physical parameters determinants of performance in the handball game. This objective was achieved through the realization of Study 1 in which we wanted to identify which are the most followed physical parameters in an elite competition, which are their values, as well as which is the level at which the sportswomen in our country are. Through the research carried out in Study 2 we aimed to verify whether the measurement tool we proposed is viable for the objectives we set.

The large number of young athletes who drop out of the sport at the end of their junior career and the large presence of foreign athletes in national championships require a different approach to the training of junior athletes.

The B.i.T. periodization combines the traditional periodization model to which athletes have been accustomed and the block periodization that has proven to be more effective at the professional level, where young athletes want to perform at the end of their junior years. The modern trend is that the training model of the senior athletes should be transmitted to the lower levels. Moreover, the intensity and dynamics of the modern game have required that the way of approaching the training factors has to change. Thus, by periodizing the B.i.T. we aimed to maintain the proposed percentages for each of the training factors, with emphasis on physical preparation.

Statistical analysis results obtained in Study 3 show that the B.i.T. periodization determined the improvement of the physical parameters followed and that their values are close to the values obtained by seniors. From a physical point of view, this is a positive result in terms of the transition process. The sports performances and the results obtained at the end of the championship by the athletes included in the study are another positive aspect. Both groups of subjects (male and female) qualified for the final tournament of the category they belonged to, and from the following competitive year onwards they were athletes who were called up to the senior teams.

Considering these results, we can conclude that the hypotheses have been confirmed, the B.i.T. periodization has produced the desired effects, namely the development of physical parameters so that their level allows a positive initiation of the transition process.

The information obtained from all the results presented in this paper can contribute to the development of the approach to the training of young athletes and to offering a modern

alternative of periodization. Therefore, B.i.T. periodization can be applied in the preparation of junior athletes for the improvement of essential parameters in the handball game.

Research limitations and original contributions:

This research encountered some limitations among which we would like to mention:

- lack of data recorded by the men's national handball team at a final tournament in order to have a benchmark of the level at which the Romanian athletes are physically (the men's national team has not qualified for a final tournament for over two decades);
- impossibility to perform the same measurements as those presented in Study 1;
- Testing subjects under standardized, training conditions, without an opponent;
- decrease in the number of subjects during the intervention (injuries, transfers);
- modification of the competitive program during the intervention;
- short implementation period of the intervention program;
- the structure of the school year (for some subjects the Baccalaureat exam was to follow).

The originality of this work lies in the development of a new periodization model that allowed the improvement of important physical parameters in handball performance. Another element of originality is the fact that we implemented the same model in a group of male subjects, but also in a group of female subjects. Increasing the percentage allocated to physical training, we consider it also an element of originality of this work, as well as the use of the MbientLab MetaMotionS Sensor Kit which proved to be a reliable method to measure the arm throwing velocity. We also had an active involvement in the implementation of the B.i.T. periodization content while maintaining an active collaboration with the management team of each team. Due to the long time period over which the intervention took place, the study was longitudinal.

Selective bibliography

Api, G., & Arruda, D. (2022). *Comparison of periodization models: A critical review with practical applications*. *2*, 29. https://doi.org/10.37393/JASS.2022.02.7

Araujo, D., Silva, P., & Davids, K. (2015). *Capturing group tactical behaviors in expert team players* (pp. 209–220).

Auweele, Y. V., Martelaer, K., Rzewnicki, R., Knop, P., & Wylleman, P. (2002). *Parents and coaches: A help or harm? Affective outcomes for children in sport*.

Baro, J. P. M., Garrido, R. E. R., & Hernández-Mendo, A. (2016). The relationship between the sports psychological profile and competitive anxiety in beach handball players. *Revista de Psicologia del Deporte*, *25*(1), 121–128.

Baron-Thiene, A., & Alfermann, D. (2015). Personal characteristics as predictors for dual career dropout versus continuation—A prospective study of adolescent athletes from German elite sport schools. *Psychology of Sport and Exercise*, *21*, 42–49. https://doi.org/10.1016/j.psychsport.2015.04.006

Barreiros, A., Côté, J., & Fonseca, A. M. (2014). From early to adult sport success: Analysing athletes' progression in national squads. *European journal of sport science*, *14*(sup1), S178–S182.

Bencke, J., Tillaar, R., Moller, M., & Wagner, H. (2018). *Throwing Biomechanics: Aspects of Throwing Performance and Shoulder Injury Risk* (pp. 69–79). https://doi.org/10.1007/978-3-662-55892-8_6

Bompa, T. O. (2013). *Antrenamentul pentru sporturile de echipă*. Centrul Național de Formare și Perfecționare a antrenorilor.

Bompa, T. O., & Haff, G. G. (2014). *Periodizarea-Teoria și metodologia antrenamentului*. Ad Point Promo.

Caba, V. (2017). *Strategie pentru integrarea tinerilor jucători într-o echipă de seniori* [Academic Master Coach].

Carroll, K. M., Bazyler, C. D., Bernards, J. R., Taber, C. B., Stuart, C. A., DeWeese, B. H., Sato, K., & Stone, M. H. (2019). Skeletal Muscle Fiber Adaptations Following Resistance Training Using Repetition Maximums or Relative Intensity. *Sports (Basel, Switzerland)*, *7*(7). https://doi.org/10.3390/sports7070169

Clemente, F., González-Víllora, S., Delextrat, A., Martins, F., & Pastor Vicedo, J. (2017). Effects of the Sports Level, Format of the Game and Task Condition on Heart Rate Responses, Technical and Tactical Performance of Youth Basketball Players. *Journal of Human Kinetics*, *58*, 141–155. https://doi.org/10.1515/hukin-2017-0080

Colquhoun, R. J., Gai, C. M., Walters, J., Brannon, A. R., Kilpatrick, M. W., D'Agostino, D. P., & Campbell, B. I. (2017). Comparison of Powerlifting Performance in Trained Men Using Traditional and Flexible Daily Undulating Periodization. *Journal of Strength and Conditioning Research*, *31*(2), 283–291. https://doi.org/10.1519/JSC.0000000000001500

Côté, J., & Gilbert, W. (2009). An Integrative Definition of Coaching Effectiveness and Expertise. *International Journal of Sports Science & Coaching - INT J SPORTS SCI COACH*, *4*, 307–323. https://doi.org/10.1260/174795409789623892

Cowden, R. (2017). Mental Toughness and Success in Sport: A Review and Prospect. *The Open Sports Sciences Journal*, *10*, 1–14. https://doi.org/10.2174/1875399X01710010001

Crăciun, M. (2014). *Psihologia sportului pentru antrenori* (a II a). Risoprint.

Cunanan, A. J., Deweese, B., Wagle, J. P., Carroll, K. M., Sausaman, R. W., Hornsby, W. G., Haff, G. G., Triplett, N. T., Pierce, K. C., & Stone, M. H. (2018). The General Adaptation Syndrome: A Foundation for the Concept of Periodization. *Sports Medicine*, *48*, 787–797.

Dragnea, A., Bota, A., Stănescu, M., Teodorescu, S., Șerbănoiu, S., & Tudor, V. (2006). *Educaţie fizică şi sport – teorie şi didactică*. Editura FEST.

Drew, K. (2020). Investigating the Junior-to-Senior Transition in Sport: Interventions to Support the Transitional Process. În *Investigating the Junior-to-Senior Transition in Sport: Interventions to Support the Transitional Process*.

Foretić, N., Uljević, O., Rogulj, N., & Marinović, M. (2013). *Pulmonary function of different age category handball players PULMONARY FUNCTION OF DIFFERENT AGE CATEGORY HANDBALL PLAYERS*. *28*, 47–51. https://api.semanticscholar.org/CorpusID:79370003

Franck, A. (2018). *The junior-to-senior transition in Swedish athletes: A longitudinal study*. Linnaeus University Press.

Franck, A., & Stambulova, N. (2018). The junior to senior transition: A narrative analysis of the pathways of two Swedish athletes. *Qualitative Research in Sport, Exercise and Health*, 1–15. https://doi.org/10.1080/2159676X.2018.1479979

Franck, A., Stambulova, N. B., & Ivarsson, A. (2016). Swedish athlete adjustment patterns in the junior-to-senior transition. *International Journal of Sport and Exercise Psychology*, *16*, 398–414.

Franck, A., Stambulova, N., & Weibull, F. (2016). Profiles of personal characteristics and relevant pathways in the junior-to-senior transition: A longitudinal study of Swedish athletes. *International journal of sport psychology*, *47*, 483–507. https://doi.org/10.7352/IJSP2016.47.483

Gromeier, M., Koester, D., & Schack, T. (2017). Gender Differences in Motor Skills of the Overarm Throw. *Frontiers in Psychology*, *8*, 212–212. PubMed. https://doi.org/10.3389/fpsyg.2017.00212

Gruic, I., Vuleta, D., & Milanovic, D. V. (2006). Performance indicators of teams at the 2003 Men's World Handball Championship in Portugal. *Kinesiology: international journal of fundamental and applied kinesiology*, *38*, 164–175.

Grund, T. U. (2012). Network structure and team performance: The case of English Premier League soccer teams. *Social Networks*, *34*(4), 682–690.

Haff, G. G., & Haff, E. E. (2012). *Training Integration and Periodization*. https://api.semanticscholar.org/CorpusID:150461496

Haff, G., Triplett, N. T., & National Strength & Conditioning Association. (2016). *Essentials of strength training and conditioning* (Fourth edition). Human Kinetics Champaign, Illinois; WorldCat.

Issurin, V. (2010a). *Block Periodization: Scientific Concept and Implementation*.

Issurin, V. (2010b). New Horizons for the Methodology and Physiology of Training Periodization. *Sports Medicine*, *40*(3), 189–206. https://doi.org/10.2165/11319770-000000000-00000

Issurin, V. (2016). Benefits and Limitations of Block Periodized Training Approaches to Athletes' Preparation: A Review. *Sports Medicine (Auckland, N.Z.)*, *46*(3), 329–338. https://doi.org/10.1007/s40279-015-0425-5

McGhie, D., Østerås, S., Ettema, G., Paulsen, G., & Sandbakk, Ø. (2020). Strength Determinants of Jump Height in the Jump Throw Movement in Women Handball Players. *Journal of Strength and Conditioning Research*, *34*(10), 2937–2946. https://doi.org/10.1519/JSC.0000000000002684

Michalsik, L. (2018a). *On-Court Physical Demands and Physiological Aspects in Elite Team Handball* (pp. 15–33). https://doi.org/10.1007/978-3-662-55892-8_2

Michalsik, L. (2018b). *On-Court Physical Demands and Physiological Aspects in Elite Team Handball* (pp. 15–33). https://doi.org/10.1007/978-3-662-55892-8_2

Nikolaidis, P. T., & Ingebrigtsen, J. (2013). Physical and physiological characteristics of elite male handball players from teams with a different ranking. *Journal of Human Kinetics*, *38*, 115–124. https://doi.org/10.2478/hukin-2013-0051

Nuzzo, J. L., Anning, J. H., & Scharfenberg, J. M. (2011). The reliability of three devices used for measuring vertical jump height. *Journal of Strength and Conditioning Research*, *25*(9), 2580–2590. https://doi.org/10.1519/JSC.0b013e3181fee650

Pummell, E., & Lavallee, D. (2018). Preparing UK tennis academy players for the junior-to-senior transition: Development, implementation, and evaluation of an intervention program. *Psychology of Sport and Exercise, 40*. https://doi.org/10.1016/j.psychsport.2018.07.007

Pyne, D., & Touretski, G. (1993). An analysis of the training of Olympic sprint champion Alexandre Popov. *Australian swim coach*, *10*(5), 5–14.

Rosenkilde, N., Christiansen, N., & Rossing, N. (2019). *Being in the right place at the right time-Resources and barriers in the transition from youth to senior in a Danish elite football club (English version)*.

Rosser-Stanford, B., Backx, K., Lord, R., & Williams, E. M. (2019). Static and Dynamic Lung Volumes in Swimmers and Their Ventilatory Response to Maximal Exercise. *Lung*, *197*(1), 15–19. https://doi.org/10.1007/s00408-018-0175-x

Savucu, Y., Arslan, C., Gacar, A., Karadağ, A., Bicer, Y., & Gur, E. (2012). Evaluation of respiratory and echocardiography parameters in young female handball players. *African journal of microbiology research*, *6*, 3744–3748. https://doi.org/10.5897/AJMR12.254

Schinke, R., Stambulova, N., Trepanier, D., & Oghene, P. (2015). Psychological support for the Canadian Olympic Boxing Team in meta-transitions through the National Team Program. *International Journal of Sport and Exercise Psychology*, *13*. https://doi.org/10.1080/1612197X.2014.959982

Stambulova, N., Franck, A., & Weibull, F. (2012). Assessment of the transition from junior-to-senior sports in Swedish athletes. *International Journal of Sport and Exercise Psychology, 10*. https://doi.org/10.1080/1612197X.2012.645136

Stambulova, N., Pehrson, S., & Olsson, K. (2017). Phases in the junior-to-senior transition of Swedish ice hockey players: From a conceptual framework to an empirical model. *International Journal of Sports Science & Coaching*, *12*, 174795411769492. https://doi.org/10.1177/1747954117694928

Wagner, H., Finkenzeller, T., Wuerth, S., & Von Duvillard, S. (2014). Individual and Team Performance in Team-Handball: A Review. *Journal of sports science & medicine*, *13*, 808–816.

Zapartidis, I., Gouvali, M., Bayios, I., & Boudolos, K. (2007). Throwing effectiveness and rotational strength of the shoulder in team handball. *The Journal of sports medicine and physical fitness*, *47*, 169–178.