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CONTENT – SOMMAIRE – INHALT – CUPRINS

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USEFUL TOOLS TO PREDICT FUTURE PERFORMANCE? ANALYSIS OF FORMER INDIVIDUALLY PRIZED YOUNG SELECTED MALE BASKETBALL PLAYERS

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ABSTRACT. Success in team sports foremostly depends on individual performance and the cooperation of the team members. We aimed to investigate the individual performance changes of youth awarded basketball players from youth to senior national team level. For this purpose we examined four game-related basketball statistics: Minutes Played (MP), Points Scored (PS), Rebounds (REB), and Assists (AST) both in youth and senior level with regression analysis. We collected all the individually prized players of former youth European Championships available on the most reliable websites (N=323). We used descriptive statistical methods and also investigated correlation between their prized performance and their senior peak performance on national level ($p<0.01$). Our analysis showed that a larger amount of the previously awarded players became member of their senior national team (58%, n=188). 90.71% of the awarded players (n=293) were the first or second best scoring leader of their own team in their youth prime. We found moderate significant correlation between youth rebounds and senior rebounds, also youth assists and senior assists, but only weak correlation between youth and senior Minutes Played and Points Scored. From this aspect getting awards on youth level can boost an athlete's career, but it doesn't mean to reach the same peak when they are selected to the senior squads as time and age are dominant background variables, an extended analysis is needed in the future.

Keywords: *basketball players, performance, game-related statistics, selection, youth sport*

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Introduction

From basketball to other team sports it became more and more widespread to predict future performance from past and present data (Senderovich et al. 2018). These generated added values can help the coaches and other decision makers to select the best available option during a single game, a tournament or a season. In the case of some individual sports, senior achievement can be predicted from early stages of young athletes' early career. Schumacher et al. (2006) stated that those cyclists who had taken part in the junior world championships were more successful as adults than those who had not had that opportunity. More research confirmed the point of view saying that exceptional individual performance in youth age can increase success in adulthood. Brouwers et al. (2012) and Pereira et al. (2014) ended up with similar results in gymnastics and tennis. From an additional aspect Barreios et al. (2014) investigated 395 athletes at four different sports. Their results showed difficulties of predicting late success based on youth achievements. All of the studies agree on the fact that until peak senior performance leads a long and rocky road.

Analysing youth national competitive experience at basketball, Kalén et al. (2017) came to the conclusion that those teams and players who performed better had a bigger number of former senior championships, showing that a particular competition experience can be a defining element of success both in individual and team performance. Arrieta et al. (2015) analysed FIBA U16, U18, U20 Championships, and concluded that at the U20 category, the oldest players had the best performance, and in all categories the oldest athletes played the most. We can observe that the most researched statistics are the game-related statistics, furthermore the most often used measures for analysing individual performance in scientific context are the game-related statistics (Sampaio et al., 2010). Scientific researches focus on the crucial factors that differentiate between winning and losing teams, and determine the result of a match or a championship (Zhang et al., 2020, Casals & Martinez, 2013, Csataljay et al., 2009, Puente et al., 2015, Zhang et al., 2018, Gomez et al., 2016). Despite the fact that recent studies analyse team performance indicators mostly (Kubatko et al. 2007), our goal was to examine the individual performance change and correlation in youth and senior levels. We believe that performance analysis in basketball can lead to better understanding and decisions.

Materials and methods

However, these game-related statistics give a plenty of opportunity to evaluate basketball performance nowadays, the explosive amount and depth of data can be reached just in recent years. Some research has identified the

field-goal percentage, defensive rebounds (Summers, 2013, Özmen, 2016, Ibanez et al., 2008), assists (Özmen, 2016) as the game-related statistics that highly correlates with success (Summers, 2013). Assists, steals and blocks are also important factors, when taking key winning factors into account (Sampaio, Lago, & Drinkwater, 2010b, Ibanez et al., 2008). Lorenzo et al. (2019) examined average points, assists, field goal percentages and free throws amongst senior basketball players, and concluded that during their career there is a positive trend in assists and free throw percentages. We decided to choose four main variables: Minutes Played (MS), Points Scored (PS), Rebounds (REB), and assists (AST), because these statistics are also well accessible from former youth tournaments and still used in statistical comparisons.

Our research aim was threefold:

(1) to evaluate the value of „youth level" prizing from the viewpoint of senior national team selections by descriptive statistical methods

(2) to examine the importance of scoring in youth age

(3) to examine correlations between youth and senior game-related statistics

Firstly, we collected all of the former youth basketball players who have participated at youth European Championships and were selected to the „All-star team" or „Most Valuable Player" of the tournament. According to FIBA Regulations (2016) these awards are provided by the organisers of the youth tournament and the Organising Committee decides about the list of the awarded players. Five players are selected to the „All-star" team, and one player is named as the MVP (Most Valuable Player). Similar to previous studies (Sampaio et al. 2018, Kalén et al., 2017) we used the FIBA archive pages and FIBA official tournament sites for data retrieval. A total amount of 323 players (mean age: 27.75±4.42) were collected during a three months period. (November 2020 to January 2021). The data was cleaned and clustered with Microsoft Excel 2010, which was then imported to IBM SPSS Statistics. To evaluate prizing we created four groups with roles:

- bench role – a player, who played 0 to 10 minutes at senior level
- additional role – a player who played 10 to 20 minutes at senior level
- key role – a player who played 20 to 30 minutes at senior level
- star role –a player who played 30 to 40 minutes at senior level

We determined senior peak performance as the highest statistical average value that the player reached during a single senior tournament. We considered youth performance values at the tournament where the player was awarded by an individual prize. There were 51 players, who were prized more than once, in that case the higher performing tournament was taken into consideration.

We used the guideline of Cohen (1992) to interpret the correlation coefficient at the significance level of $p<0.01$ with the following intervals: -0.3 to +0.3 Weak; -0.5 to -0.3 or 0.3 to 0.5 Moderate; -0.9 to -0.5 or 0.5 to 0.9 Strong; -1.0 to -0.9 or 0.9 to 1.0 Very strong.

We maintained the following hypothesises:

(1) We hypothesised that players, who were awarded at youth level can reach senior national team rosters. These players can get a defining role at a senior national team level.

(2) Moreover we hypothesised that the awarded players were the best point scorers of their team during their awarded tournaments.

(3) We assumed that performance indicators (PS, MP, REB and AST) at our analysis can correlate at youth and senior age. Talented players like formerly prized athletes can use youth European Championships as a test event which can forecast the potential of their senior peak performance.

(4) We also assumed that a connection between formerly prized U20 players' junior and senior performance can be higher. We thought the correlation is higher in this age group then in the total sample. This presumption is based on the competition system that this is the nearest challenge to adult basketball. From this stage, players can easily reach professional status and join possibly the senior national team.

Results

Evaluation of the roles of youth awarded players at senior level

First of all, we used descriptive statistical methods as we introduce the percentages of former youth selected players participating at senior national teams. 58% of the players were able to attend at their senior team at least once (n=188). We can assume that it can be a significant amount. As a comparison in football it is observed at the Dutch national team that 50% of the youth selected players were deselected after two years (Verbeek et al., 2017). A high fluctuation between age groups and early dropout were also identified within the German youth national football teams (Schroepf and Lames, 2018). From this point of view, we can assume that prizing at young age could boost young players' career. Prizing at youth level can also effect a player's decision at choosing the professional career.

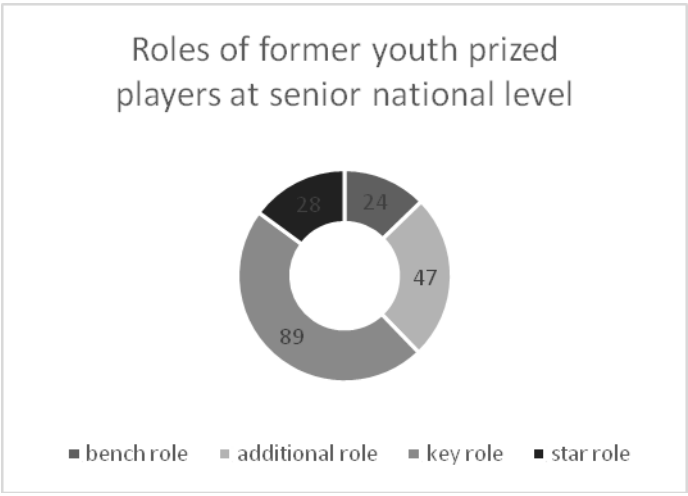

Figure 1. Roles of former youth prized players at senior national level (figure by the author)

From those players who were awarded at youth categories and later joined their senior national team the smallest portion has a bench role. Only 13% of these senior selected players (n=24) get 0 to 10 minutes at their peak. It is also rare that someone from the youth awarded player later becomes the most used player (30 to 40 minutes) at senior level, which means 15% (n=28) of the formerly prized players will be favoured the most by senior national team coaches.

There are athletes who reach senior national team squads with an additional role, these players get 10 to 20 playing minutes at their peak. We can diagnose that most of the youth awarded players take part a huge role at senior national level, almost half of the prized players 47% (n=89) spend 20 to 30 minutes on the court at their senior peak. According to these results it can be noted that the bigger part of the youth awarded players 62% (n=117) have a determinant role at senior tournaments.

Heuristic traps in prizing?

Recent research proves that despite the fact that we can already measure the efficiency of individuals and teams in a complex way, in the case of awards, salaries, or all-star voting, scoring is primarily what even professionals take into account, e.g. with the shooting percentage. Berri, Brook, and Fenn (2011) asked decision makers what statistics are used to select potential players from universities by NBA teams. Based on university player statistics, the point/minute ratio has the greatest impact on selection. In contrast, the throwing percentage

has a relatively low effect on the draft position, rebounds and turnovers have virtually no effect on the position on the player's exchange. However, the age of the players, as well as the fact that the player's team was among the top four in the university league, had outstanding relevance in the draft order. Berri, Brook, and Schmidt (2007) summed up coaches 'votes for the best NBA rookies between 1995 and 2007 and found that points scored were the most important statistical indicators of nominations, while professionals rated throwing percentages, rebounds, and turnovers also to be statistically significant.

Berri, VanGilder and Fenn (2014) made a similar conclusion when analysing the votes, and - as in the best rookie vote - in this statistical context, the points scored determined the outcome of the MVP vote mostly, however the shooting efficiency among sports journalists was not a significant factor in the selection.

According to our research, more than 90% of the award winners were the best or second-best scorers of their teams. We investigated the awarded youth athletes and from the total population 293 (90.71%) player was the leader or the second option of their team in scoring. In our interpretation we can refer this effect as a heuristic trap. We use heuristics when we want to reach a quick yet easily accessible solution. Decision makers simplify their decisions by reducing the effort of making a decision to a satisfactory solution. (Simon, 1956). Before the award-giving ceremony the Organising Committee has to name five extraordinary players to receive the prize. It is assumable that decision makers take points scored into consideration with a huge impact.

Usually prized players have a huge, comprehensive skill set, and in most cases decision-makers recognize talents (the "coach's eye"), however it can be a danger to reduce the attention (even unintentionally) to one statistic dimension. If we make this mistake there is a chance to disregard players with high shooting efficiency or rebounding, passing ability. As the role of prizes becomes more important, the responsibility of decision-makers increases as well.

If higher portion of youth awarded athletes later reach first class teams and the senior national squad, individual recognition does matter. In case individual recognition is significant, from our point of view it is appropriate to give these awards on the basis of more objective criteria especially in youth categories.

Correlations between Minutes Played (MP), Points scored (PS), Rebounds (REB), and Assists (AST) at youth and senior events

As minutes played (MP) is the indicator on basis of which players based on their role can be ranked (Zilinyi et al., 2020) we intended to examine if youth MP can be associated with senior national team level. Our results can be seen at the next table and graph:

Table 1. Correlation matrix of youth and senior MP (table by the authors)

Correlations

		Youth MP	Senior MP
Youth MP	Pearson Correlation	1	.259**
	Sig. (2-tailed)		.000
	N	188	188
Senior MP	Pearson Correlation	.259**	1
	Sig. (2-tailed)	.000	
	N	188	188

**. Correlation is significant at the 0.01 level (2-tailed).

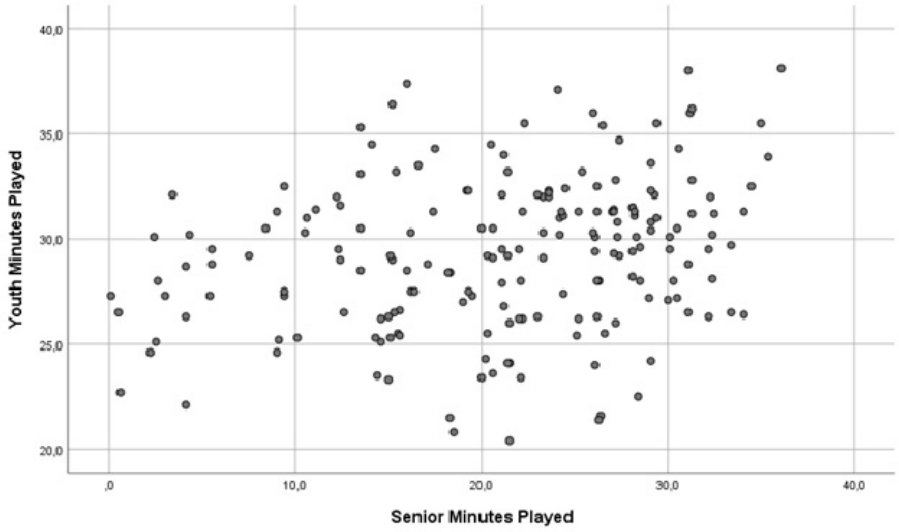

Figure 2. Senior and youth minutes played (figure by the author)

The correlation coefficient is low (r=0.259), which means correlation between youth and senior MP is weak. U20 awarded players' (n=101) minutes have almost the same, low correlation (r=0.232) at senior peak age. From this angle to have the same amount of playing time, athletes have to earn their spot with hard work if they reach the senior squads, as it is not guaranteed, even if they were nominated to a prize at the last youth category. As awarded athletes played an average of 29.3 minutes during their award-winning tournament,

this number decreased when they reached their peak at a single senior tournament. Those who were selected to their senior national squads spent an average of 21 minutes on the court.

The Standard Deviation significantly changed in senior level (±8.6), as some athletes played more minutes, but most of the players had a small decrease in playing time. At senior level players had to deal with a larger amount of competitors, this can be one of the reason why the MP may vary on a larger scale. The Standard Deviation at youth level (±3.62) can be explicable with the fact that these players were the best of their categories and their coaches gave the most opportunity for them as they were considered as young prospects. These players participated at almost full games for most of the time, as it is crucial to win games with the best available players on the court.

We can also differentiate the achievement in youth ages and in the adult era, if we investigate the PS and MP at both level. We can see a strong (r=0.521) correlation at youth level, and a stronger correlation (r=0.823) at adult performance.

Table 2 and 3. Correlation matrixes of youth and senior MP, youth and senior PS

Correlations

		MP Senior	PS Senior
MP Senior	Pearson Correlation	1	.823**
	Sig. (2-tailed)		.000
	N	188	188
PS Senior	Pearson Correlation	.823**	1
	Sig. (2-tailed)	.000	
	N	188	188

**. Correlation is significant at the 0.01 level (2-tailed).

		MP youth	PS youth
MP youth	Pearson Correlation	1	.521**
	Sig. (2-tailed)		.000
	N	188	188
PS youth	Pearson Correlation	.521**	1
	Sig. (2-tailed)	.000	
	N	188	188

**. Correlation is significant at the 0.01 level (2-tailed).

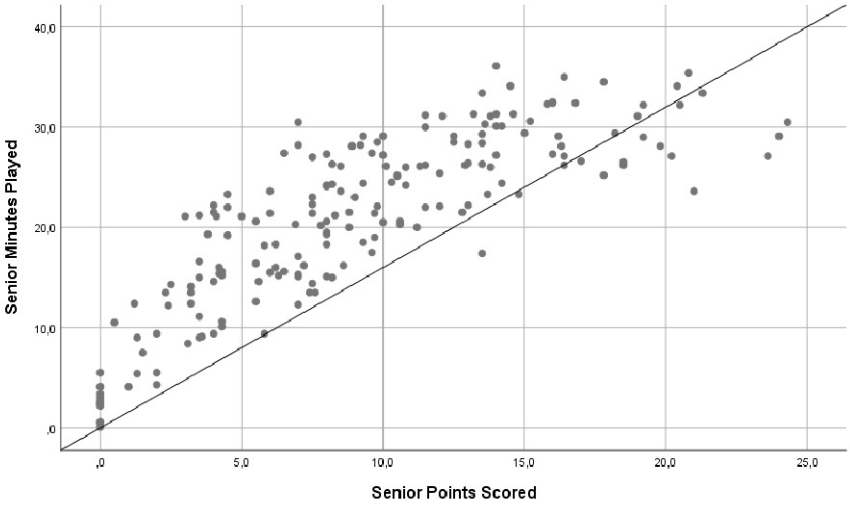

Figure 3. Senior MP and senior PS (figure by the authors)

From this point of view in accordance of points it is presumable that at senior age a mature and reliable performance can be calculated from these players, while at youth categories point scoring is least stable and doesn't depend on playing time that much. We can assume that the bigger linear connection between points and minutes in senior age can related to higher consistency. At younger age player's performance may vary bigger even inside a single tournament. The following graphs show the difference and difficulty of scoring at senior level.

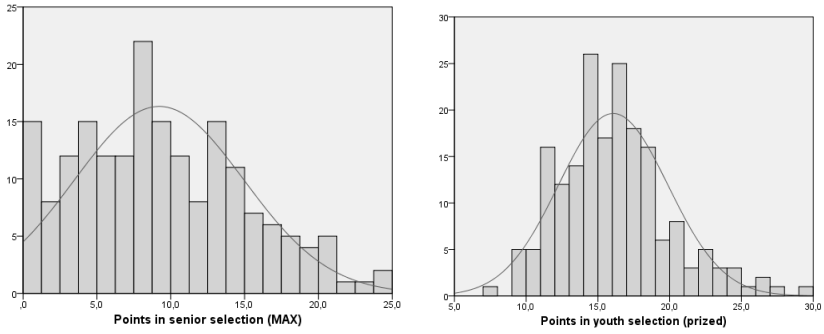

Figure 4. Points at youth and adult age (figure by the author)

It is clear from the results that only a few players can score the same average of points at senior age, most of them has a significant drop at points. Difficulties of scoring at senior age strengthen the transition challenges from junior to adult sport at the highest level. Analysing the correlation between youth and senior PS, we found a weak correlation. (r=0.265).

Table 4. Correlation matrix of points scored (table by the authors)

		PS YOUTH	PS SENIOR
PS YOUTH	Pearson Correlation	1	.265**
	Sig. (2-tailed)		.000
	N	188	188
PS SENIOR	Pearson Correlation	.265**	1
	Sig. (2-tailed)	.000	
	N	188	188

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation coefficient was a little bit higher when we investigated the link between youth and senior points in the case of U20 prized players, a moderate correlation was diagnosed (r=0.305) during the analysis. At this context the outcome can confirm our third assumption, that outstanding performance at U20 categories can be related better with the senior peak performance, than outstanding performance at lower youth categories. This presumption was strengthened during the analysis of REB and AST on both levels. Although in the case of rebounds, the correlation was moderate (r=0.453) between youth and senior level at the whole sample of the players, the coefficient's value increased when we investigated only the U20 awarded athletes. We found a strong correlation between U20 youth REB and senior REB. (r=0.576). The connection between youth AST and senior AST was also strong (r=0.511), however there were no significant difference between the whole sample and the U20 players (r=0.558).

Table 5. and 6. Correlation matrix of rebounds and assists (table by the authors)

Correlations

		REB YOUTH	REB SENIOR
REB YOUTH	Pearson Correlation	1	.453**
	Sig. (2-tailed)		.000
	N	188	188
REB SENIOR	Pearson Correlation	.453**	1
	Sig. (2-tailed)	.000	
	N	188	188

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

		AST YOUTH	AST SENIOR
AST YOUTH	Pearson Correlation	1	.511**
	Sig. (2-tailed)		.000
	N	188	188
AST SENIOR	Pearson Correlation	.511**	1
	Sig. (2-tailed)	.000	
	N	188	188

**. Correlation is significant at the 0.01 level (2-tailed).

Discussion

Roles and minutes are often cleaner at senior selections, because achievement and success is primary. In youth categories individual development is one of the key responsibility for coaches. It is also recognizable that adolescent player's performance is very inconsistent.

We can agree with the statement that most of the awarded players will be selected to their senior national squads (58%), it is a great sign predicting for the future performance to compete, perform well, and being awarded in these youth tournaments.

On the other hand, we have to notice the limitation of this paper. As time and age are dominant background variables, the above graphs and tables, the sample's size can change dynamically due to time. Younger players can get more minutes, and the list of senior selected players can grow. The peak performance of an athlete can vary due to their sport. Bradbury (2009) conducted a research in baseball, and he found that baseball players peak much later than assumed, at age 29 or 30. In Basketball Berri et al. (2006) found that the peak can be as early as 24 or 25. Pelton (2010) had significant results about players' performance and aging at the NBA, a slightly negative linear association between age and performance was observed. As in the current research some players still didn't have the chance to reach their peak, it is reasonable to conduct the same research a few years later.

It can be another interfering factor that clubs and national associations are counter-interested in the athletes' participation at senior national tournaments. However there is a clear federal intention to approach the positions of the stakeholders. Injuries can also effect players' potential improvement and opportunities. If we think about player selection for prizing at the end of a youth tournament, other distorting effects can be detected: the potential lobby of domestic teams, the psychological pressure of team strengths and rankings, the nationality and

composition of the jury. It is foreseeable that everyone can't be rewarded who excels in some statistical indicators, it would be a reasonable step from the international basketball association (FIBA) to determine the exact factors that influence the decisions of the awards.

Conclusion

Although we didn't find significant correlation in points scoring and minutes playing at youth and senior peak performance, these statistics can dominate player evaluation (Berri et al., 2007). Previous researches about salary determination, employment discrimination, and post season awards have all amplified the importance of scoring (Berri et al., 2010). From this purpose it is important for the players to improve their scoring ability. This study confirms that double selection (youth selection and awarding) can promote the transition to the senior national team, as the awarded players' bigger part joined the senior squad later.

Decision makers can often notice and identify talent owing to grandiose statistics like points scored, but the fluctuation of performance of youngsters also has to take into consideration during evaluation. Furthermore, we can agree with that as more and more data is available for national coaches, if the coaching staff does a proficient monitoring, they can choose the most reliable players for their game strategy. Due to the fact that rebounding and assists can be also game-determinative, the link between U20 and senior performance at this segment can help to project the future potential of the awarded youth players in these statistic dimensions. As double selection (youth selection and awarding) can still strengthen a career, and the selected players' significant portion could make it to the NBA, it is an individual aim for players to attempt shots and be a leader to their team. In this situation collective efforts and intents are in contrary with personal goals.

Although determinative factors of team wins due to previous studies are (among others) rebounds and field goal percentage, attacking the rim and taking responsibility for young talented players can increase their chance to be selected for youth awards, and from youth awards senior national team and professional status is not a huge step. However, it cannot be stated that shooting the ball is the only way to be a star player, it is clear that athletes with scoring abilities will be noted by scouts, coaches and tournament organisers.

In the context of transition from youth to senior performance, further analysis is needed. Correlation with shooting accuracy (free throw and field goal percentage) could be a next step to compare in youth and senior level as it is one of the most important factor, which can determinate winning and

losing teams. (Puente et al. 2015, Csataljay et al., 2009). Talent identification and player evaluation is a multilevel task, with the analysis of game- related statistics further development can be reached in this context.

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WITHIN-SESSION RELIABILITY AND VALIDITY OF OVERHAND BALL THROW TEST TO EVALUATE POWER ABILITY IN JUNIOR TENNIS PLAYERS

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ABSTRACT. Introduction: Coaches should be able to estimate successfully different physical attributes of junior tennis player's performance such as power, in order to monitor players' progress and to design the most appropriate training program. However, this process requires reliable and valid field tests. **Objective:** Aim of this study was to examine absolute and relative reliability of overhand_ball throw (OBT) test within testing session and to investigate its validity. **Methods:** 257 Hungarian junior boy and girl tennis players (aged 11-17) separated into four groups, performed OBT and serve speed (SS) tests of standardised protocol. **Results:** Dependent sample t-test revealed no significant ($p= 0.31\text{-}57>0.05$) difference between test and retest sample means within testing session and magnitude of effect size ($dz=0.1\text{-}0.5$) were trivial for all groups. Furthermore, all groups had low typical percentage error (CV= 3-4 %), and standard error of measurement values was consistently low (SEM= 0.12-0.18). Within test-retest consistency illustrated strong relative reliability (ICC= 0.98-0.99). Moreover, significantly large to very large positive correlations were found between OBT and SS ($r= 0.57\text{-}0.81$; $p<0.01$) tests. The coefficient of determination indicated that OBT explained 32-65% of the SS for groups. **Conclusions:** These findings suggest that absolute and relative reliability of OBT test is high within testing session and validity of OBT test is acceptable for measuring power ability of flat serve execution in junior tennis players.

Keywords: *field based test, serve speed, power ability*

Introduction – Objective

Power is an ability that is associated with force and velocity of movement (Fernández-Fernández, Ulbricht & Ferrauti, 2014). This ability to generate and transfer force rapidly may be a key element in determining success in many ball games. The strokes of tennis can be most frequently characterised by power

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execution. This power execution (that involves a stretch – shortening cycle muscle contraction) manifests itself through different high-speed strokes such as flat serve, which is the most dominant and important stroke in modern junior tennis as well (Fernandez-Fernandez, Ellenbecker, Sanz-Rivas, Ulbricht & Ferrauti, 2013; Kovalchik & Reid, 2017).

Junior tennis players are at the beginning of their careers and their physical attributes are in the developmental stage, therefore coaches should be able to estimate different physical attributes of junior tennis player's performance successfully such as power, in order to monitor the players' progress and to design the most appropriate training program. In the literature, several field-based tests were designed to estimate the power ability generated by the total body or the upper and lower extremities. These widely used field based tests performed by different equipment and protocol, include, counter movement jumps, depth jumps, repeated jumps, different push-up variations, chest, side and overhead medicine ball throws and tosses (Beckham et al., 2019; Buchheit, Spencer & Ahmaidi, 2010; Fernández-Fernández, Ulbricht & Ferrauti, 2014; Fernandez-Fernandez, Villarreal, Sanz-Rivas & Moya, 2016; Genevois, Frican, Creveaux, Hautier, & Rogowski, 2013; Harris et al., 2011; Markovic, Dizdar, Jukic & Cardinale, 2004; Sayers & Bishop, 2017; Zalleg et al., 2018). From these, medicine ball throw tests are the most common ones to measure power ability of upper extremities in junior tennis players. These tests involve integrated, multidirectional movements and specific attributions, so they well demonstrate the movement pattern demands of tennis strokes. Furthermore, several studies demonstrated that the results of medicine ball throw tests and medicine ball exercises are associated with stroke-speed in junior tennis players (Fernández-Fernández et al., 2014, 2016; Genevois et al., 2013). However, it should be noted, that these tests are executed with two hands. In other words, execution of these tests requires bilateral movement. We know that during the execution of a flat serve, tennis players only use their dominant arms (unilateral movement), so it may be a good idea to apply such field tests performed with one hand, for example the overhand_ball throw (OBT) test. Furthermore, our several studies (Dobos, 2011, 2018) have proved that OBT test seems to be suitable for measuring power ability of the flat serve in junior tennis players.

Reliability and validity are the two most important criteria to judge the quality of measurement (Hopkins, 2000). Reliability refers to reproducibility and repeatability of the test results within (test stability within one testing session) and between (test stability between two testing sessions) the test sessions. Validity expresses the test's ability to measures what is supposed to measure (Hopkins, 2000; Stockbrugger & Haennel, 2001). One part of the

previously mentioned field tests has indicated good reliability and validity as well as that this information is available (Beckham et al., 2019; Buchheit et al., 2010; Harris et al., 2011, Markovic et al., 2004; Sayers & Bishop, 2017; Zalleg et al., 2018). However, reliability and validity values of tennis specific medicine ball throw and OBT tests are not readily available, especially for a wide range of junior tennis population.

Therefore, aim of this study was to examine the absolute and relative reliability of the OBT test within the testing session and to investigate the validity of the OBT test as a practical tennis specific field test for assessing the power ability of flat serve execution on a wide range junior tennis population comprising both genders and different age categories.

Methods

Participants

Altogether 257 (aged 11-18) Hungarian youth tennis players participated in the research (Table 1.). They played 25-60 matches per year and participated an average 8-14 h of combined training (i.e. on and off court) per week. Tennis players were divided into 4 groups (1. under 14 boys (U14); 2. under 14 girls (U14); 3. under 18 boys (U18); 4. under 18 girls (U18)), based on the criteria of the American Tennis Association (USTA) and Roetert and Ellenbecker (2007).

Table 1. Individual characteristics and serve speed of junior tennis players (n=257*)*

Group	Age	Body weight (kg)	Body height (cm)	SS (km/h)
U14 boys (n=92)	12.55±1.20	38.03±6.21	150.60±7.10	131.89±8.22
U18 boys (n=50)	16.13±1.21	67.18± 5.23	179.43±5.24	171.06±7.42
U14 girls (n=75)	12.65±1.19	32.60±4.76	146.40±8.22	122.50±7.88
U18 girls (n=40)	16.27±1.17	62.27±4.12	167.22±4.31	151.10±6.52

SS=serve speed

Procedures

One week before each testing session players had a meeting when both the players and the parents were informed in an oral and written form about the testing procedure and aim of the research, and declarations of consent were asked from the parents. In addition, the testing protocol (OBT and serve speed (SS) tests) was presented in order to show how to execute them properly.

Players could participate the testing session with valid medical certificate and consent of their parents. The ethical standards were in harmony with the principles of the Helsinki declaration (Harriss, MacSween & Atkinson, 2019).

To avoid the effect of tiredness, testing session was carried out outdoors, in the summer season, at the same time (late morning) and in optimal weather conditions (17-25 C degrees), 48 hours after a heavy training or match. Four players were measured at the same time and before testing session height and weight of the players were measured (Table 1.), then they executed a general and a specific warm-up of 10-15 minutes. Warm-up comprised aerobic-type running, general mobilizing and stabilizing exercises. Reliability and validity of the tests were examined (the order of which was as follows: OBT and SS test), during which players had two OBT and eight flat serve attempts. After the warm-up and between the tests, players had 5-minute passive resting time, between the OBT attempts they could rest for 4 minutes and between the serves for 25 seconds.

Neither the measuring equipment, nor the person carrying out the task was modified during the testing session.

Description of selected field tests

OBT (Figure 1.): Player stood in a forward straddle position behind the throw-line with the ball in the dominant arm, in front of the thigh. The preparatory phase comprised hip and trunk rotations. At the same time, the ball was swung backwards behind the back with flexed knees. After this phase, player began to extend the knees, turned hips forward and swung the dominant arm forward. At the point of release, legs were almost fully extended, trunk a little bit tilted, dominant arm abducted to trunk with elbow slightly bent, wrist and ball above the head. During the execution of the throw and release of the ball, the player was not allowed to touch or cross the throw-line. The aim was to throw the ball as far as possible. The distance from the throw-line to the point, where the ball landed was measured in m. Two trials and their averages were recorded and used for statistical analysis. To gain the validity of the OBT test the best result was used. Furthermore, at the OBT test, a 103-gram small

(diameter 8 cm) ball and a calibrated tape-measurer (marked at every cm) were applied. Additional information can be found about this test in the Nadori et al. (2005) book.

SS test (Figure 1): the test was intended to measure the speed of the flat serve and the power ability of the chest, dominant hand and shoulder. The player served from the deuce (right) court and executed eight flat serves into the 180x180 cm target, located in the corner nearest to the respective T-line of the tennis court. The player was instructed to execute the flat serve with maximal speed. Only the correctly executed flat serves and the speed of those balls, landing within the target area were measured in km/h and the best result was used for later analysis. The radar instrument measuring the speed of the serve was located in the centre, 4 m behind the baseline, at a height covering the contact point of the serve. For the SS test, the "Stalker ATS II" (Applied Concept, Inc., Dallas) serve speed measurer (within ±3 km/h of accuracy and operating frequency: 34.7 GHz [Ka-Band] ± 50 MHz) and "Slazenger Ultra Vis" (53-56 gram and 6.5 diameter) balls were used. Before each testing session, the radar gun was calibrated in accordance with the manufacturer's specifications and new balls were used. Players used their own tennis racquets. The intertrial reliability for serve velocity was 3.2% and the ICC for this test was 0.91–0.94 as used in previous researches (Fernandez-Fernandez et al., 2013; Hornery, Farrow, Mujika & Young, 2007; Kovacs & Ellenbecker, 2011) Additional information can be found about this test and instrument ("Stalker ATS II" radar) in previous researches (Ferrauti & Bastiaens, 2007; Fernández-Fernández et al., 2014, 2016).

Figure 1. Serve speed and overhand ball throw tests

Statistical analysis

First, normality of distributions was controlled with the Kolmogorov-Smirnov test. Absolute reliability was evaluated by dependent sample t-test to determine the differences between the test/retest sample means within the testing session. Effect size (ES) was estimated by Cohen's d test to assess the meaningfulness of difference. The magnitude of the ES was considered trivial (<0.20=trivial, 0.2-0.59=small, 0.6-1.19=moderate, 1.2-2.0=large, and>2.00=very large) (Hopkins, 2000). Coefficient of variance (CV) was calculated. Less than 10% of CV was considered an acceptable absolute reliability (Atkinson & Nevill, 1998; Clark, Bryant & Reaburn, 2006). Moreover, standard error of measurement (SEM) was calculated to assess the perfect absolute reliability of the OBT test. Furthermore, the intraclass correlation coefficients (ICC) were computed to determine relative reliability (Hopkins, Marshall, Batterham & Hanin, 2009; Weir, 2005). ICC value equal to or above 0.70 was considered acceptable (Hopkins, 2004; Weir, 2005).

To evaluate validity of the OBT test, the Pearson correlation coefficients (r), gained from the best between OBT and SS values were calculated. The magnitude of correlation was determined according to Hopkins (r<0.1=trivial; 0.1-0.3=small; 0.3-0.5=moderate; 0.5-0.7=large; 0.7-0.9=very large>0.9=nearly perfect) (Hopkins, 2000).

Finally, simple linear regression analyses were separately used for each group, in order to calculate coefficient of determination (R^2) and set up regression models. Level of significance for all statistical tests was accepted at ($p<0.05$) and statistical analysis of the data was carried out with the SPSS 21.0 software.

Results

The Kolmogorov-Smirnov test found that all data were normally distributed ($p> 0.05$) therefore the mean and the standard deviations were calculated.

Dependent sample t-test revealed no significant difference between test and retest sample means within testing session and the magnitude of the ES were trivial for all groups (Table 2.). All CV values of each group are below the accepted threshold of 10% and SEM values are low. Moreover, the ICC values for each group were higher than the acceptable threshold value 0.70 (Table 2.).

Significantly large to very large positive correlations were found between the OBT and SS (Table 3.) tests. Based on the linear regression analyses of the OBT explained 32-65% of the variance of SS for groups (Table 4).

Table 2. Within session absolute and relative reliability of overhand ball throw test for junior boy and girl tennis players (n=257)

Groups	Tests (m)	Retest (m)	p	dz	Mean±SD	SEM	CV%	ICC
U14 boys (n=92)	31.63±1.30	31.66±1.22	0.44	0.01	31.64±1.26	0.12	3	0.99
U18 boys (n=50)	46.33±1.88	46.44±1.84	0.57	0.05	46.38±1.86	0.18	4	0.99
U14 girls (n=75)	24.83±1.21	24.89±1.22	0.56	0.05	24.86±1.21	0.17	4	0.98
U18 girls (n=40)	30.50±1.29	30.55±1.27	0.31	0.04	30.52±1.28	0.12	4	0.99

dz=Cohen's d for dependent sample t-test; SD=standard deviation, SEM=Standard error of measurement; CV=Coefficient of variation; ICC=Intraclass Correlation Coefficient

Table 3. Pearson's correlation coefficients between overhand ball throw and serve speed test for junior boy and girl tennis players (n=257).

	OBT and SS U14 boys (n=92)	OBT and SS U18 boys (n=50)	OBT and SS U14 girls (n=75)	OBT and SS U18 girls (n=40)
r (95 % CI)	*0.81 (0.73-0.87)	*0.57 (0.35-0.75)	*0.79 (0.70-0.85)	*0.78 (0,64-0,87)

r=correlation coefficient; CI=confidence interval; OBT= overhand ball throw; SS=serve speed *denotes significant correlations at *p<0.05

Table 4. Simple linear regression analysis of junior tennis players (n=257)

Group		B	SEM	β	t	p
U14 boys	Intercept	57.69	5.64		10.22	<.001
(n:92)	overhand ball throw	2.34	0.17	0.81	13.37	<.001
U18 boys	Intercept	119.56	5.78		10.77	<.001
(n:50)	overhand ball throw	1.11	0.23	0.56	4.69	<.001
U14 girls	Intercept	53.63	6.48		8.27	<.001
(n:75)	overhand ball throw	2.76	0.25	0.78	10.85	<.001
U18 girls	Intercept	103.34	6.33		16.32	<.001
(n:40)	overhand ball throw	1.56	0.20	0.78	7.69	<.001

Dependent variables: serve speed
(U14 boys) R^2=0.65; adj R^2=0.65; F (1-90)=178.95; p<0.05
(U18 boys) R^2=0.32; adj R^2=0.31; F (1-48)=22.02; p<0.05
(U14 girls) R^2=0.62; adj R^2=0.62; F (1-73)=117.75; p<0.05
(U18 girls) R^2=0.60; adj R^2=0.59; F (1-38)=59.26; p<0.05

Discussion

Aim of the present study was to analyse the absolute and relative reliability within the testing session and the validity of the OBT test in a wide range junior tennis population. Main finding of the present study revealed that the absolute and relative reliability of the OBT test was high within the testing sessions and the validity of the OBT test was acceptable for measuring power ability in the flat serve execution.

Within session reliability of OBT test

In all groups and genders the OBT test had typically low percentage error (CV3-4%) and the SEM values were also low consistently (0.12-0.18). Furthermore, the test-retest consistency showed strong reliability (ICC=0.98-0.99) and there was no difference between test and retest sample means, ES were trivial (dz=0.1-0.5). Thus, both measurements showed almost similar results, the errors were also low. Some values differed from the average in a very small percentage; they showed a positive direction and a significant correlation ($p<0.05$). As a result, it can be said that the repeated testing was not influenced by experience, practice and tiredness. Therefore, absolute and relative reliability of the OBT test within the testing session is acceptable. Moreover, our results trend is consistent with the recent previous tennis specific studies; Fernandez- Fernandez et al., (2016) and Kramer, Huijgen, Elferink-Gemser and Visscher (2016) have reported acceptable ICC values (0.86-0.99) at overhead medicine ball throw test executed with two hands in junior tennis players. In addition, reliability results of the present study are also in line with other previous investigations, which have frequently showed high absolute (CV=2.6-5.3%; SEM=0.12-0.012) and relative reliability (ICC=0.87-0.99) in medicine ball throw test performed with two hands from sitting and standing position in different samples (Beckham et al., 2019; Harris et al., 2011 Sayers & Bishop, 2017; Stockbrugger & Haennel, 2001).

Validity of the OBT test

The best result of the OBT showed a significantly large to very large positive correlation (0.57-0.81) of the best value of SS in each group ($p<0.05$). The results indicated that the power manifested in the OBT could be well transferred to the movement pattern of the flat serve. Thus, the main groups of muscles participating in the flat serve mostly control the OBT movement. For

example: movement of the dominant arm and shoulder, as well as the chest muscles (the pectorals), play a key role in the acceleration of tennis racket or ball (Fleisig, Nicholls, Elliott & Escamilla, 2003; Roetert & Kovacs, 2011). At the point of release in the OBT test, the abduction degree of the dominant shoulder (100°±10°) is similar to the contact point of the flat serve (Reid, Elliott & Alderson, 2008). Furthermore, the direction vector of force in both movement is decisively horizontal and the execution of the movement (using dominant hand) is unilateral from point of view of upper body. Moreover, this result was in line with the previous research, demonstrating that medicine ball exercise and distance of medicine ball throw executed with one and two hands correlates to the strokes speed (r=0.79-0.87) in junior tennis players (Dobos, 2011, 2018; Fernandez-Fernandez et al., 2013; Genevois et al., 2013). In addition, based on the F test and on its related significance ($p<0.05$) level and on low SEM, it can be said that the regression model is suitable to explain the dependent variable.

Regarding the coefficient of determination (R^2) in the U18 boy group the best result of OBT explained 32% of the variance of the best value of SS that is smaller than that of the other groups (60-65%). The possible explanation is that besides the previously mentioned similarities, the biomechanical features and specialities of racket handling can much better contribute to the technical execution in the older boy group. This suggestion was confirmed by Reid, Giblin and Whiteside (2015), and Wagner et al. (2014), who found that during the acceleration phase of the peak trunk twist and elbow extension, velocities were significantly higher in the OBT, yet the peak shoulder internal rotation and the angular velocities of the wrist flexion were significantly greater in the flat serve. However, in spite of the mechanical differences, the OBT test probably could be more suitable for assessing the power ability of the flat serve execution in contrast to medicine ball throw executed with two hands, because the OBT test well simulates those physical attributes (explosive force generation) and mechanical components (unilateral movement, decisively horizontal force exertion, role of similar muscle groups) manifested during the flat serve motion (Wagner et al., 2014). Therefore, according to the authors' opinion, the execution of OBT might form a proper basis of the serving motion. Furthermore, based on the large to very large significant positive correlation coefficient values, the OBT test is considered valid.

A limit of this study was that we analysed the absolute and relative reliability of the OBT test only within the testing session, therefore further investigation is needed to examine it between the testing sessions. However, to the author's best knowledge it was the first study to detect OBT test reliability within the testing session and its validity in a wide-range of junior tennis population (U14-U18 boys and girls, n=257) to allow for the sport science practitioners and coaches to get a real, available information about it.

Conclusions

The OBT test is reliable within the testing session and is a valid test to assess power ability in the flat serve execution. The serve speed is determined by the ability of the lower extremities, chest, dominant hand and shoulder muscles to generate power actions (Kovacs & Ellenbecker, 2011). The OBT test well simulated these explosive force generations especially in the chest, dominant hand and shoulder muscles, therefore the OBT test is suggested as a tennis-specific field based test that can be part of tennis players' general preparation and be used as a tool of power performance diagnostics in junior tennis population.

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THE INFLUENCE OF AN 8-WEEK TRAINING PROGRAM WITH SMALL-SIDED GAMES ON THE ANAEROBIC CAPACITY OF JUNIOR FOOTBALL PLAYERS

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ABSTRACT. Introduction. The level of development of anaerobic capacity at footballers requires the achievement of sporting performance. **Objective.** The study analyses whether the anaerobic capacity is developed as a result of the participation of the athletes in a training program with small-sided football games. **Methods**. A group of 40 athletes aged 16-18 years old were grouped in two equal teams, named: experimental group (EG) and control group (CG). During the period of the study, which was between 5.01.2021 – 27.02. 2021, the two groups were exposed to different training programs: the EG in a small-sided football games training program and the CG in a classic way. The following technology was used: Hosand GT.a – to measure HR – and the WittyGateMicrogate2 system for timing of the stress sample. Subjects took the YYIRTL1 sample. SPSS program, variant 23 was used for statistical analysis of the data. **Results.** The results taken in the initial test (IT) between the two groups had no statistical significance in YYIRTL1 field sample was concerned, but there could be noticed significant differences in the final test (FT) for the parameter indicating the hold time in the anaerobic zone>81%HRmax ($U = 67.50$, $N_1 = 20$, $N_2 = 20$, two-tailed $p = .000336$, $d = 1.46$). **Conclusions.** The study shows that the anaerobic capacity of subjects has developed through the implementation of an 8-week period program where small-sided football games have been used.

Keywords: *small-sided games, anaerobic capacity, maximum heart rate, football*

REZUMAT. ***Influența unui program de antrenamente de 8 săptămâni cu jocuri pe teren redus asupra capacității anaerobe a fotbaliștilor juniori .*** **Introducere.** Nivelul de dezvoltare al capacității anaerobe la fotbaliști condiționează obținerea performanțelor sportive. **Obiectiv.** În acest studiu a fost investigat dacă se dezvoltă capacitatea anaerobă a sportivilor în urma participării la un proces de pregătire care include jocuri de fotbal pe teren redus. **Metode.** Un eșantion format din 40 de sportivi cu vârsta de 16-18 ani, divizat în echipe egale: grupa de experiment (GE) și grupa de control (GC). Pe parcursul

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perioadei de desfășurare a acestui studiu 5.01.2021-27 .02.2021, cele două grupe au participat la antrenamente diferite: GE la antrenamente cu jocuri de fotbal pe teren redus, iar GC la antrenamente care au utilizat exerciții tradiționale. Următoarea tehnologie a fost utilizată: Hosand Gt.a – pentru a măsura FC – și sistemul WittyGateMicrogate2 pentru cronometrarea timpului la proba de efort**.** Subiecții au efectuat proba YYIRTL1. A fost utilizat programul SPSS, varianta 23, pentru analiza statistică a datelor. **Rezultate.** Rezultatele înregistrate la testarea inițială (TI) nu prezintă diferențe statistic semnificative între cele două grupe la testul YYIRTL1, dar au fost observate diferențe statistic semnificative la testarea finală (TF) pentru parametrul care indică timpul de menținere în zona anaerobă >81%FCmax (U = 67,50, N_1 = 20, N_2 = 20, two-tailed p = ,000336, d = 1,46). **Concluzii**. Studiul efectuat demonstrează că jocurile de fotbal pe teren redus incluse într-un program de antrenamente pot dezvolta capacitatea anaerobă de efort a sportivilor, după 8 săptămâni de pregătire.

Cuvinte-cheie: *jocuri pe teren redus, capacitate anaerobă, frecvența cardiacă maximă, fotbal*

Introduction

The integrated training method includes small-sided games as a modern concept, successfully applied to football. However, only few studies have shown that training with small-sided games can cause exercise intensities (>90%HRmax) providing a specific incentive to improve effort capacity, values obtained by Hoff, Wisloff, Engen, Kemi, & Helgerud (2002).

Although the aerobic metabolism is the main support of the football efforts (Bangsbo, Norregaard, & Thorso, 1991; Stolen, Chamari, Castagna, & Wisloff, 2005), anaerobic energy is decisive for winning the 1vs1 duels or making your sprints at a superior performance level, which contributes decisively to the final outcome of a football game (Little & Williams, 2003).

The total time of elite footballers' sprints during a match is about 30 seconds (Bangsbo, 2008, p. 62), and the actions of the ball players account for between 0.5 and 3% of the total distance run during a match (Ali & Farrally, 1991; Bangsbo, 2008, p. 63). These actions are often decisive in winning or losing matches, and the need to include anaerobically-type training in training programs (Sporis, Ruzic, & Leko, 2008) is evident. Mohr, Krustrup, & Bangsbo (2003), shows the importance of training anaerobic capacity in achieving sports performances, noting the superior number of sprints, accelerations and decelerations made by elite athletes compared to lower-tier players during a football match.

Training exercises or actions in high-intensity football matches, such as speed runs, sprints, directional changes, bouncing, acceleration, decelerations,

require the generation of anaerobically-powered energy, and the development of these skills is the main objectives in football training (Balsom, Lindholm, Nilsson, & Ekblom, 1999; Reilly, 2007, pp. 83-84; Stolen, Chamari et al., 2005, p. 502).

Anaerobic metabolic processes produce the energy required to perform peak intensity actions, involving the rapid development of muscle force such as sprints, accelerations and decelerations (Bradley et al., 2009; Dellal, Hill-Haas, Lago-Penas, & Chamari, 2011a; Dellal, Lago-Penas, Wong, & Chamari, 2011b; Reilly, 2007, p. 94).

Objective

This research aims to measure the development of the anaerobic capacity in the young football players, as an effect of exposing them to a training program of 8 weeks with small-sided football games.

Materials and methods

Research protocol

a) The period and place of the research

The research was carried out from 5.01.2021 to 27.02.2021 at the multifunctional base of the sports complex at Deva Stadium at the beginning of the preparatory period of the annual training plan.

b) Subjects and lots

The subjects of the study were 40 footballers aged 16-18 years old, divided in groups of 20 individuals – experiment group (EG) and control group (CG). All subjects and their parents have given their written consent to participation in this research, and the medical protocol for outdoor sports activities has been followed. The participation of subjects in the study was voluntary.

c) Applied tests

Subjects took the Yo Yo Intermittent Test Level 1 (Bangsbo, Iaia, & Krustrup, 2008; Bangsbo, 2008, pp. 103-106) at the beginning and end of the experiment, to measure HRmax for delimiting sport-specific effort zones and to assess anaerobic capacity in relation to athletes' ability to maintain, as a time duration, in the anaerobic effort zone > 81%HRmax (Figure 1). YYIRTL1 is a validated, aerobic and anaerobic physical performance evaluation sample specific to footballers (Castagna, Impellizzeri, Chamari, Carlomagno, & Rampinini, 2006; Gumusdag, Unlu, Cicek, Kartal, & Evli, 2013).

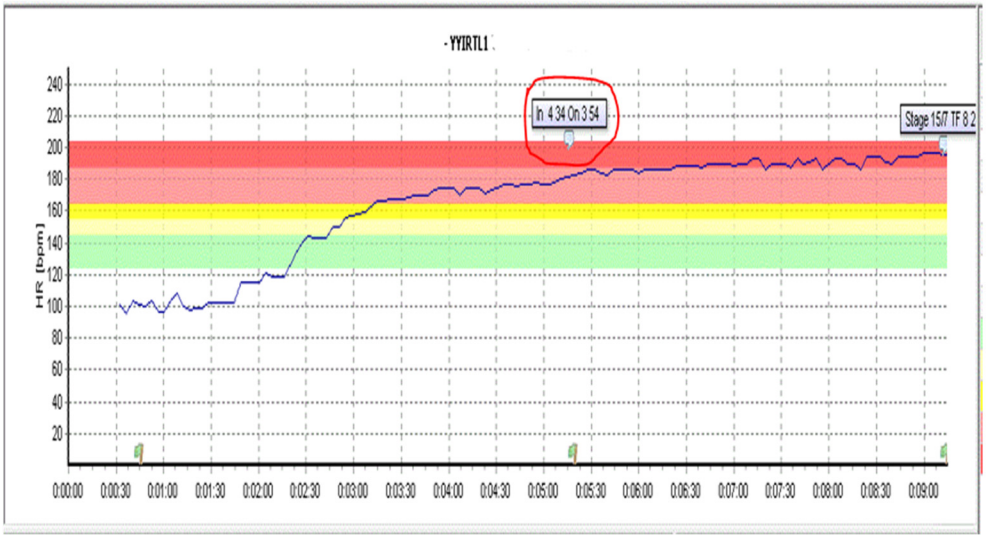

Figure 1. Heart rate monitoring YYIRTL1 sample, with emphasis on hold time in anaerobic zone

d) The intervention program

The intervention program included a total of 24 training with small-sided football games, of which 16 were specific anaerobically defined during the 8 weeks of research. As part of weekly microcycles, small-sided anaerobically football games were planned on Wednesday and Friday. Weekly microcycles also included training with small-sided, but aerobic, games every month and technical-tactical specific training on Tuesday, both forms at 55-60% of HRmax. In the training program, after the maximum intensity, lactate anaerobic training, held every Wednesday, theoretical lessons were planned on Thursday.

Throughout the research, the subjects participated in 5 trainings per week, with an average duration of 90 minutes, with the training program patterned after the training objectives of the preparatory period. For the EG athletes, 3 of the 5 weekly training lessons included small-sided football games and for the CG athletes the training program contained classic training means.

The structure and content of small-sided football games have been adapted to training objectives specific to the training period. For the best effort management, the microcycles training have been structured according to the rest periods necessary to restore the body after effort. The intensity of training means has been monitored by measuring HR (Figure 2).

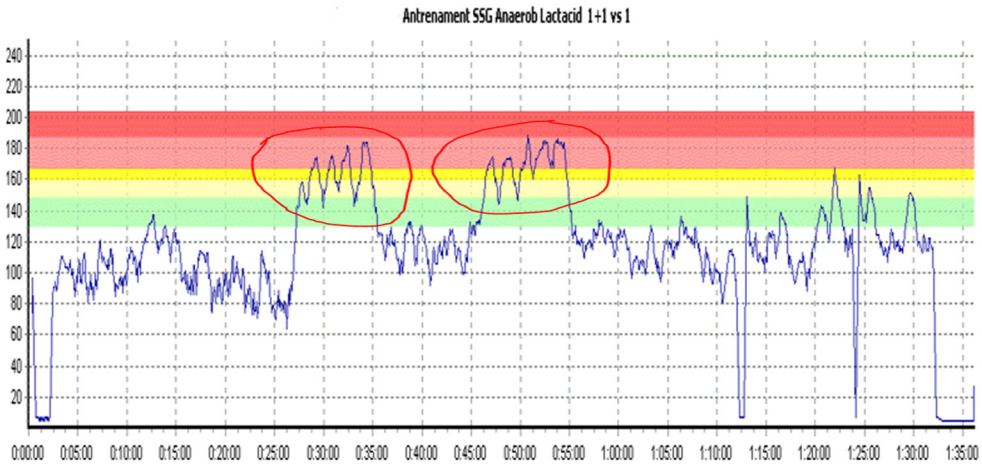

Figure 2. Small-sided football games heart rate monitoring anaerobic effort zones (1+1vs1)

Small-sided football games (Table 1) have been standardized to develop anaerobic capacity, depending on the optimal dynamics of effort/break ratio in lessons and microcycles training. Thus, the maximum intensity anaerobic lactacid exercises were included on Wednesday, theoretical lessons were planned on Thursday and the alactacid anaerobes were scheduled on Friday.

Table 1. The characteristics of small-sided football games used in the intervention program

SSG Format	Sizes	Effort/Break	Variables No.of repetitions	Variables HR effort/break	Effort scale	Effort type
1vsGk	10x15	10``/2`	10	190/120	>90%HRmax	Alactacid anaerob
1vs1	10x15	15``/2`	8	190/120	>90%HRmax	Alactacid anaerob
2vs2	10x15	2`/1	6	185/140	>81%HRmax	Lactacid anaerob
3vs3	10x15	3`/1	6	185/140	>81%HRmax	Lactacid anaerob

Note: HR = Heart rate; SSG – small sided games

To direct training intensity and quantify athletes' physical and physiological capabilities to resist in the anaerobic zone, heart rate was monitored using the Hosand GT.a. In the initial and final tests, the YYIRTL1 sample, the Witty Gate Microgate2 electronic timing system was used.

e) Statistical processing

The analysis and interpretation of the results was carried out using the SPSS program, version 23.0, with the materiality threshold $p < 0.05$ applied. The Shapiro Wilk test was used in the analysis of data distribution normality and parametric or non-parametric tests were used to compare the results obtained by subjects in the two groups depending on the distribution of the data. The size of the effect was also calculated (Cohen, 1988).

Results

The analysis of data distribution and the interpretation of the Shapiro Wilk test for YYIRTL1 sample revealed that in the initial test (IT) the data were distributed normally at the parameter indicating the hold time in the anaerobic zone > 81%HRmax for the experiment group (EG) ($p = .445$), but not normally distributed for the control group (CG) ($p = .009$). Regarding the final test (FT), the distribution was normal for EG at the parameter indicating the hold time in the anaerobic zone >81%HRmax ($p = .325$); the data distribution was not normal for CG ($p = .049$).

The next step was to compare the averages of the distribution of the data using parametric tests (paired samples t-test) in case of normally distributed data and non-parametric tests (Mann-Witney U or Wilcoxon) if the data were not normally distributed. The size of the effect has also been calculated (Cohen, 1988).

The Mann Whitney U test shows that in the initial test the difference between the two groups' averages at the parameter indicating holding time in the anaerobic zone >81%HRmax is not statistically significant ($U = 153.50$, $N_1 = 20$, $N_2 = 20$, two-tailed $p = .208$, $d = .42$), the groups are homogeneous (Table 2). After the completion of the intervention program, the measurements for the sample under investigation were repeated and the results are also statistically analyzed (Table 2). The difference between the scores averages of the two groups was statistically significant for the parameter indicating the holding time in the anaerobic zone >81%HRmax ($U = 67.50$, $N_1 = 20$, $N_2 = 20$, two-tailed $p = .000336$, $d = 1.46$).

Table 2. Comparison of averages and effect size, YYIRTL1 sample, variable OnzonaAn > 81%HRmax, EG and CG, before and at the end of the intervention program (N = 40)

Time	Variable	Group	Mean	AS	ES	Test statistics U*	df.	Sig.	Cohen d
IT	OnZonaAn >81%HRmax	EG (20)	3.68	.68	.15	153.50*	38	.208	.42
		CG (20)	3.42	.54	.12				
FT	OnZonaAn >81%HRmax	EG (20)	5.05	.60	.13	67.50*	38	.000	1.46
		CG (20)	4.15	.63	.14				

Note: IT – initial test; FT – final test; OnzonaAn>81%HRmax – holding time in anaerobic effort zones.

The change in the subjects of the groups produced by the intervention program was also analyzed by comparing the averages recorded by the subjects at the two moments of the study. Thus, the paired samples t-test (Table 3) shows that in the experiment group the differences are significant for the variable indicating the holding time in the anaerobic zone > 81%HRmax (t = -7.337, df = 19, p = .000, d = 2.12). It was used he Wilcoxon test for comparing the control group averages (Table 3) and it appears that there are also significant statistical differences in this group with the holding time variable > 81%HRmax (Z = -3.059, two-tailed p = .002, d = 1.23).

Table 3. Comparison of the averages and effect size of the YYIRTL1 sample, for the variable OnzonaAn >81%HRmax, in the experiment and control groups, before and after the intervention program (N = 40)

Pair	Time	Variable	Paired Samples Statistics		Paired Samples Test[a,b]			
			Mean	Std Deviation	t[a]\Z[b]	df	p	d
Pair 1 EG	**IT**	OnzonaAn >81%HRmax	3.6885	.68558	-7.337[a]	19	.000	2.12
	FT	OnzonaAn >81%HRmax	5.0540	.60945				
Pair 2 CG	**IT**	OnzonaAn >81%HRmax	3.4235	.54950	-3.059[b]	19	.002	1.23
	FT	OnzonaAn >81%HRmax	4.1530	.63911				

Note: a. EG t-test; b. CG Wilcoxon Signed Ranks Test; OnzonaAn >81%HRmax – holding time in anaerobic effort zones.

Discussions

The results obtained show that, after 8 weeks of small-sided football training, the anaerobic performance of athletes, measured by measuring holding time in the anaerobic effort zone > 81% HRmax, is significantly better for

athletes in EG than in CG, who used classic means in the training program. Thus, the EG athletes recorded 5 minutes and 5 seconds of holding in the anaerobic effort zone in the YYIRTL1 sample as compared to the CG athletes who achieved only 4 minutes and 15 seconds.

From the analysis of the results obtained by the two test groups, we can see significant differences in both groups, these data indicating that traditional exercise training also produces effects on the development of the anaerobically available potential of sportsmen after a training program over an 8 week period, as in our case. However, compared to the performance of CG athletes, the results of the EG athletes are higher and the size of the effect is higher (2.12 versus 1.23).

In the analysis carried out by Halouani, Chtourou, Gabbett, Chaouachi, & Chamari (2014), several studies are presented, whose results highlight the effectiveness of the small-sided games method in achieving intensities generally exceeding 80%HRmax, with small-sided games training leading to benefits in both the development of physical qualities, as well as improving the technical-tactical skills specific to football. The results from the studies presented in this analysis show that the differentiated standardization of small-sided games according to the specific requirements of this type of training influences the physiological responses highlighted by the reported HRmax level (Halouani et al., 2014).

Specialists recommend training anaerobic resistance, physical quality specific to football, and to direct physical effort, it is necessary to determine physical performance and physiological characteristics. Research has also been carried out using the monitoring of physiological parameters such as HR (Bangsbo, 2008, pp. 140-142; Ferretti, 140, p. 63; Hoff et al., 2002, p. 219).

Impellizzeri et al. (2006) highlighted the advantages of using small-sided football games in training footballers, by analyzing the effect on fitness while training in this specific program compared to the traditional one. The study was carried out at the level of two groups of 20 athletes, over 12 weeks, 4 in the preparatory period and 8 in the competition period. Data from the two groups show that both methods are effective in developing physical capacity at the level of junior football players. Results from applied training programs showed a significant improvement in retention time in the anaerobic effort zone 90-95%HRmax (Impellizzeri et al. 2006) being similar to those recorded in our study. The studies also show that in junior and senior players the anaerobically threshold is between 76.6%HRmax and 90.3%HRmax (Casajús, 2001; Chamari et al., 2004; Helgerud, Engen, Wisloff, & Hoff , 2001).

Several studies examined the effects of small-sided games training programs in football, handball or rugby compared to the use of other training methods. The results of small-sided games show significant improvements in physical performance in 5 of these studies (Chaouachi et al., 2014; Gabbett, 2006; Iacono,

Eliakim, & Meckel, 2015; Iacono, Ardigò, Meckel, & Padulo, 2016; Seitz, Rivière, de Villarreal, & Haff, 2014; Young & Rogers, 2014). Dellal et al. (2008) have demonstrated that the small-sided games method in football training results in intensities of more than 80%HRmax, comparable to running on an intermittent basis, resulting in positive effects for improving the anaerobic resistance of athletes.

Conclusions

The analysis of the results of the study carried out allows us to draw the following conclusions:

1. The results demonstrate the efficiency of training with small-sided football games over a period of 8 weeks on the development of the anaerobic capacity of the 16-18-year-old juniors.
2. The standardization of small-sided football games for the development of anaerobic capacity, as well as their timing in the training program, has proved effective.
3. Results from the end of the study show that both methods produce improvements in anaerobic effort capacity, but the effects of small-sided games football training are higher than traditional practice training.

Constraints of the research

Even if the study was carried out in two groups, each consisting of numbers in relation to the number of athletes in a football team, the increase in the number of subjects would contribute to the objectivity of the research.

The differences between the two groups after 8 weeks of experiment have shown statistical significance, however we propose that further investigations be carried out over a longer period of time, which would allow for more obvious progress in the development of resistance in the anaerobic effort zone.

Conflicts of interests

The authors declare that there is no conflicts of interests.

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THE IMPACT OF COVID-19 ON SPORT ORGANIZATIONS IN CARAŞ-SEVERIN COUNTY

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ABSTRACT. Background: The beginning of 2020, more precisely the month of March, when the Covid-19 pandemic was declared, represents the beginning of one of the darkest pages in the history of world sport. The reason is a well-known one, namely the fact that the implementation of measures to prevent the spread of the SARS-CoV-2 virus have led to the cessation of competitions and the training process, for certain periods of time, in almost all sports. The aim of this study was to see how these measures have influenced the sports activity in Romania, especially that of the sports organizations from Caraş-Severin County (C-S). Thus, a number of 43 sports organizations from CS County were targeted, of which 39.3% being clubs/associations that work only at the level of children and juniors, 12.5% are clubs/associations that have only senior team, and 48.2% are clubs/associations that have both senior team and children/junior teams. All participants agreed that information could be processed and used for scientific purpose, and the study has obtained Research Ethics Approval from The Scientific Council of the Babeş-Bolyai University of Cluj-Napoca. **Methods:** An online questionnaire survey was conducted, with 31 items, which aimed to outline an accurate picture of the existing situation among sports organizations, which was the situation of sports competitions in 2020, respectively the 2019-2020 season, which was the situation of the training process in the 10 pandemic months of 2020, but more importantly, what are the current situation of the training process and that of the competitive system. **Results:** Compared to the sports activity carried out at the level of CS county, a number of 8 team sports and a number of 12 individual sports were taken into account, the answers offered being in proportion of 73% from the coaches from team sports, and 27% from individual sports coaches. It was observed that in team sports 78% of the respondents showed that the 2020-2021 competitive season had not yet started until January 2021, while 14.6% it started and was interrupted. Only 7.3% of the teams are in full competition season, the 2020-2021 championship not being embodied due to the Covid-19 pandemic. It was also found that after the resumption of stopped training, as a result of the application of measures to prevent the spread of the pandemic, the number of

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children decreased both in individual sports and team games. **Conclusion:** Based on the results, we can see the negative impact of sports organizations that are in the lower leagues, as well as those that are at the level of children and juniors. The fact that training has not been resumed, the measures imposed by the pandemic, the fear induced by a possible infection with the SARS-CoV-2 virus can cause the disappearance of a significant number of sports organizations, which will have a negative effect not only on the performance sport, but also on the level of public health.

Keywords: *sports clubs, Covid-19 pandemic, training, competition, lockdown*

REZUMAT. ***Impactul covid-19 asupra antrenamentului în organizațiilor sportive din județul Caraș-Severin.*** **Introducere:** Începutul anului 2020, mai exact luna martie, atunci când a fost declarată pandemia de Covid-19, reprezintă debutul uneia dintre cele mai negre pagini din istoria sportului mondial. Motivul este unul arhicunoscut și anume, implementarea unor măsuri de prevenire a răspândirii virusului SARS-CoV-2 au determinat sistarea competițiilor și a procesului de antrenament, pentru anumite perioade de timp, în aproape toate ramurile sportive. Tocmai pentru a vedea modul în care aceste măsuri au influențat activitatea sportivă din România, în special cea a organizațiilor sportive din județul Caraș-Severin (C-S), a fost inițiat acest studio. Astfel, au fost vizate un număr de 43 de organizații sportive care își desfășoară activitatea în județul C-S, dintre acestea 39,3% fiind cluburi/asociații care activează doar la nivel de copii și juniori, 12,5% sunt cluburi/asociații care au doar echipă seniori, iar 48,2% sunt cluburi/asociații care au atât echipă seniori, cât și echipe de copii și juniori. **Metode:** A fost realizat o anchetă pe bază de chestionar online, cu 31 de itemi, care a urmărit conturarea unei imagini cât mai exacte a situației existente în rândul organizațiilor sportive, care a fost situația competițiilor sportive în anul 2020, respective sezonul 2019-2020, care a fost situația procesului de antrenament în cele 10 luni pandemice din anul 2020, dar și mai important, care sunt situația actuală a procesului de antrenament și cea a sistemului competițional. **Rezultate:** Raportat la activitatea sportivă desfășurată la nivelul județului C-S au fost avute în vedere un număr de 8 sporturi de echipă și un număr de 12 sporturi individuale, răspunsurile oferite fiind în proporție de 73% de la antrenorii de la sporturile de echipă, iar 27% de la antrenorii de la sporturi individuale. S-a putut observa că la sporturile de echipă 78% dintre respondenți au arătat că sezonul competițional 2020-2021 încă nu începuse până în luna ianuarie a anului 2021, iar pentru 14,6% a început și a fost întrerupt. Doar 7,3% dintre echipe sunt în plin sezon competițional, campionatul 2020-2021 neîntrupându-se din cauza pandemiei de Covid-19. De asemenea, s-a putut constata că după reluarea antrenamentelor sistate, ca urmare a aplicării măsurilor de prevenție a răspândirii pandemiei, numărul de copii a înregistrat o scădere atât la nivelul sporturilor individuale, cât și la jocurile de echipă.

Concluzii: Ca urmare a rezultatelor se poate constata pericolul în care se află organizaţiile sportive care îşi desfăşoară activitatea în ligile inferioare, precum şi cele care activează la nivel de copii şi juniori. Faptul că nu au mai fost reluate antrenamentele, măsurile de prevenire a răspândirii pandemiei, teama indusă de o posibilă infectare cu virusul SARS-CoV-2 poate cauza dispariţia unui număr important de organizaţii sportive, ceea ce va avea un efect negativ nu doar asupra sportului de performanţă, ci şi asupra nivelului de sănătate publică.

***Cuvinte-cheie**: cluburi sportive, pandemie Covid-19, antrenament, competiţie, lockdown*

Introduction

2020 will remain a reference year in the history of world sport, being the year when, for various time intervals, sport activities, whether we talk about performance sport or grassroots sport, have ceased to exist.

The reason for the appearance of such a situation was the emergence and spread of SARS-CoV-2 virus, as well as the worrying global increase of diseases, facts that have led the World Health Organization to declare as of 11 March 2020 the emergence of the Covid-19 pandemic.

The Covid-19 pandemic has quickly spread, so governments all around the world have adopted various measures, primarily aimed at physical and social distance, which has led to lockdowns of businesses, schools, and overall social life (Bas, Martin, Pollack, & Venne, 2020). The need for measures such us: social distance, on-line school, suspension of the activity of some economic agents as solutions in order to reduce the spread of disease, has also disrupted many aspects of everyday life, obviously including here both sport and recreational physical activities.

To protect the health of athletes and others involved, but also to prevent the spread of the virus, the most important international, regional, and national sport events have been canceled or postponed – from marathons to football tournaments, athletics championships, handball, basketball, rugby, hockey, and more. The Olympic and Paralympic Games, for the first time in the history of modern games have been postponed and will probably take place in 2021 (Bach, et al., 2020). In addition to negative effects on sport and social issues, the implementation of these anti Covid-19 measures has significantly contributed also to the global economic evolution. It is recognized that the overall value of the sports industry is estimated at 756 billion dollars annually (Somoggi, 2020), but in the new context, globally, many millions of jobs are directly affected not only for sport professionals, but also for those in related retail industries and sport services, which include travel, tourism, infrastructure, transport, catering and mass-media among others.

Large sport organizations have shown their solidarity with efforts to reduce the spread of the virus. FIFA, for instance, has teamed up with the World Health Organization (WHO) and has launched the campaign „Pass the message to kick out coronavirus", leaded by star footballers, in 13 languages, urging people to follow five key steps to stop the spread of the disease by focusing on: handwashing, cough, avoid touching the face, physical distance and stay home in case of sickness (FIFA, 2020).

In Romania, even if the evolution of diseases has not seen a galloping increase, to limit SARS-CoV-2 infection among the population the authorities decided the establishment of an emergency state as of 16 March 2020, initially for one month, then extended until 14 May 2020.

Practically, this was the period when on Romanian territory all sport activities were stopped, whether we discuss about training or competitions. In fact, these measures aimed to eliminate the possible agglomerations caused by the organization of various sport events which in Europe have caused outbreaks of SARS-CoV-2 virus spread (Wackerhage, et al., 2020). The measures taken in Romania were not different from most countries in the world, the few countries that have not suspended the sport competitions make some exceptions.

After the Second World War, the year 2020 was the period with the worst influences on the way we live, on health and economy (ibidem), but also with the worst moments in the history of sport, when not only the spectators/ fans were deprived of their presence on the stadium, but also athletes. Or, as it is well known, the lack of coaching periods causes decreases in physical capacities of athletes, each week means a decrease by around 10% (Peña, et al., 2020).

Because of limited opportunities to leave the house and to train intensively and systematically, when players are allowed to practice for a shorter period, they tend to overcome efforts to maximize the impact, which could increase the injuries and could trigger a feeling of doubt and frustration, the reason is as time passes without coaching or competition, the sense of self-identity of athletes is also contested. In addition, the pressure on performance athletes is also caused by ongoing replanning of sport coaching, trying to keep in shape, but they risk losing important sponsors, which, in turn, can no longer honor agreements initially concluded. Although most of athletes have been negatively affected by this situation, others might have considered it positively. This could include injured athletes, who following the suspension of competitions and coaching sessions had more time to recover (Samuel, Tenenbaum & Galily, 2020).

Thereafter, the lifting of the state of emergency and the setting up of a state of alert, until the end of 2020, period during which preventive measures on the new SARS-CoV-2 infection and combating the COVID-19 epidemic have

been adopted, offered the opportunity to resume coaching and certain competitions without the presence of the spectators, under strict rules, aiming continuously to avoid physical contact and maintain both personal and environmental hygiene rules. Although people thought restrictive measures had been relaxed, the rules to which clubs'/sports associations had to comply have created a lot of issues in resuming the activity at all levels competitive and all age groups. Thus, sport organizations have seen put themselves in a position to reviewing their entire coaching activity, they have to adapt also to the requirements of the new context, to be able to participate in organized competitions.

The result was as expected, in year 2020 in a very small number of national competitions the winners have been chosen on the field, the most affected being team games. There have been situations in which the final ranking was the one recorded at the time of the interruption of the championship as a result of the measures required by the adoption of the state of emergency or due to the state of alert, as was the case with the male and the female volleyball, or National Super League of polo or they have not been awarded the titles of champions, such situations having been recorded in the National Handball League (male and female), National Basketball League (male and female).

Thus, neither the activity carried out by athletes nor teams from Caraş-Severin County (C-S) could not make a note of discrepancy with the issue registered at national level.

Research design

Ten months after the declaration of the COVID-19 pandemic, we have proposed ourselves to assess the impact of the measures implemented during this period on sport organizations from Caraş-Severin County.

In this respect we conducted an investigation based on online questionnaire aiming clubs'/ sport associations/ school establishments for extracurricular activities/ other sport entities contained in the national competitive system organized by the federations/ specialized leagues or other competitions organized at county level/ regional by structures subordinated to the specialized federations.

A number of 43 sport organizations acting in Caraş-Severin County were considered; 37 of these are public clubs, 5 private clubs, 6 sports associations and 8 other entities, this category includes schools for extracurricular activities (Children's Palace) and sport groups active in the National Minifootball Championship. 39.3% of these are clubs/ associations competing only at children and juniors' level, 12.5% are clubs/ associations with senior team only, and 48.2% are clubs/associations with senior team, but also children and junior teams too.

Figure 1. Disposal of research clubs

Table 1. Typology of research sport structures

Typology of Sport Structures	Public club		Private club		Sport associations		Other	
Club/association/ children and juniors' team	14	63.64%	3	13.64%	3	9.09%	3	13.64%
Club/association/ seniors team	1	14.29%	0	0%	1	14.29%	5	71.43%
Club/association/ seniors + children and juniors	22	81.48%	2	7.40%	2	11.11%	0	0%

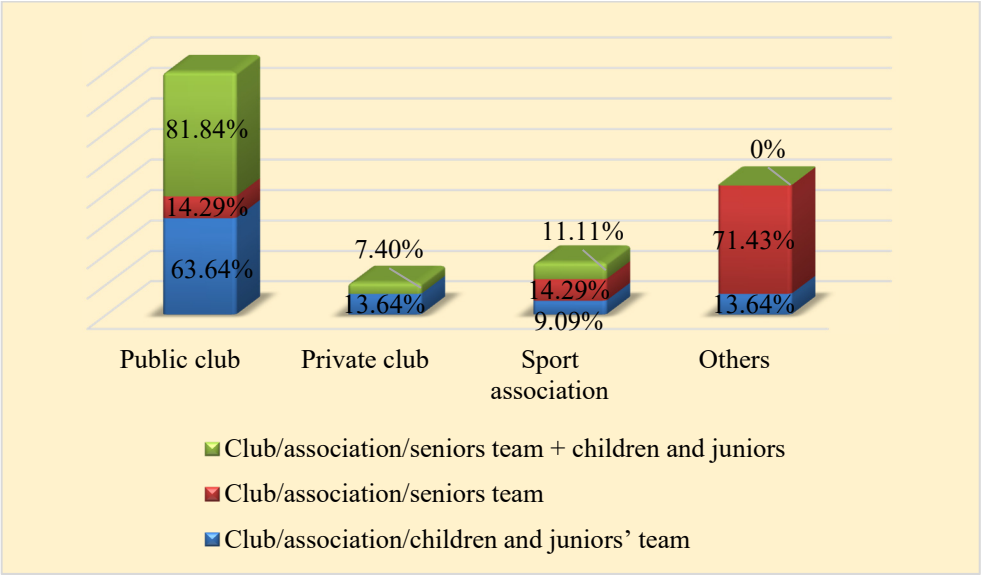

Figure 2. Typology of research sport structures

Table 2. Clubs representation at a competitive level

Competitive level		**Competitive level**
League 1		2
League 2		2
League 3		1
National championships	National championships	10
	children/ juniors	11
County /local championships	County /local championships	17
	League 5	2
	children/ juniors	17

The questionnaire applied consisted of 31 items aiming:

- the regular development of sport coaching at clubs/associations/sport organizations before the COVID-19 pandemic;
- the situation of coaching during the states of emergency and alert;
- which sports sectors/disciplines have more easily adapted to the measures required by the prevention of the spread of the SARS-COV-2 virus in the organization and conducting of coaching process and competitions;

- the situation of the completion of sport competitions held in competition year 2019-2020;
- the situation of the beginning of sport competitions for the season 2020-2021;
- if all the 2020 competitions were held according to the initial planning or some changes have been recorded.

The information requested was strictly related to the activity of coaches and children teams/ juniors/ seniors, i.e. of those involved in practice activity, which was intended to gather the most accurate information about the conducting of coaching and sport competitions since the Covid-19 pandemic started on the Romanian territory and about the implementation of preventive measures against the new coronavirus infection.

Results and debates

Once the responses have been centralized, analysed and interpreted, we can state that among the respondents of the survey of this research 87% were male coaches, 13% were female coaches, and 71.4% of them coach children and juniors while 28.6% coach senior's teams.

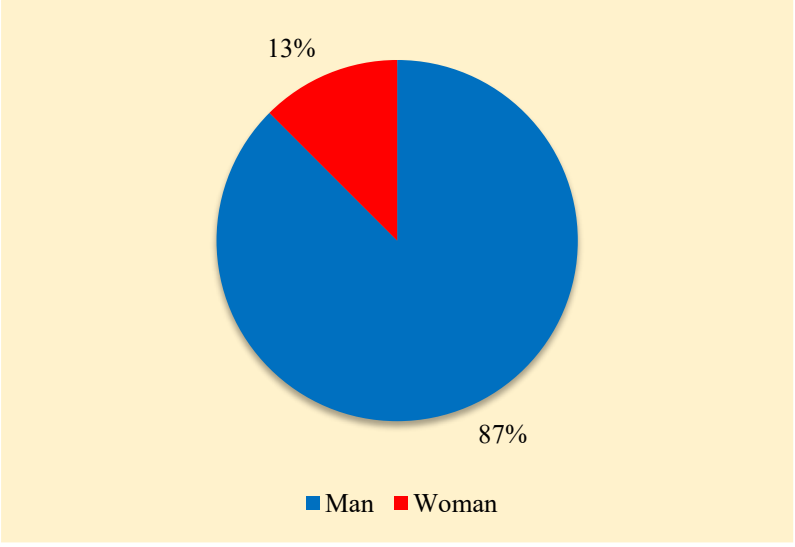

Figure 3. Gender of coaches participating in research

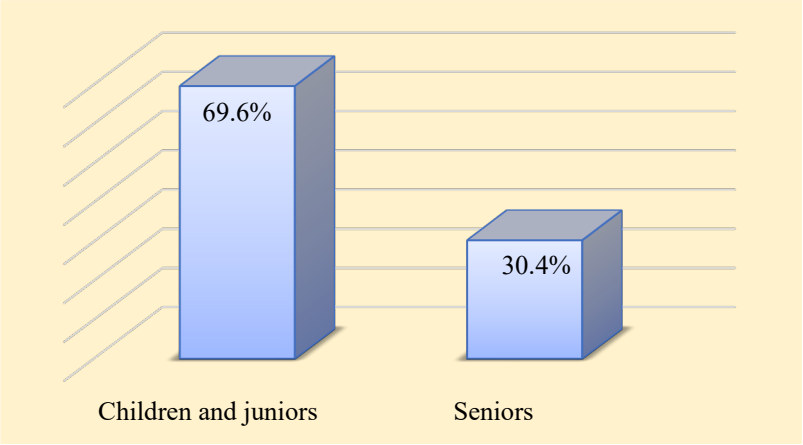

Figure 4. Age category that respondents are coaching

60.71% of coaches working with children and juniors' groups are men and 10.71% are women, while at seniors' level 26.79% of coaches are men and only 1.79% women.

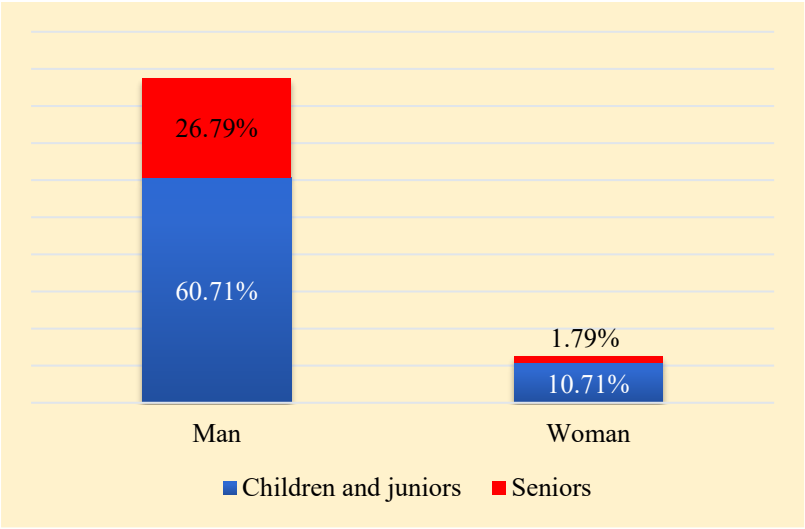

Figure 5. Coaches distribution by age and gender

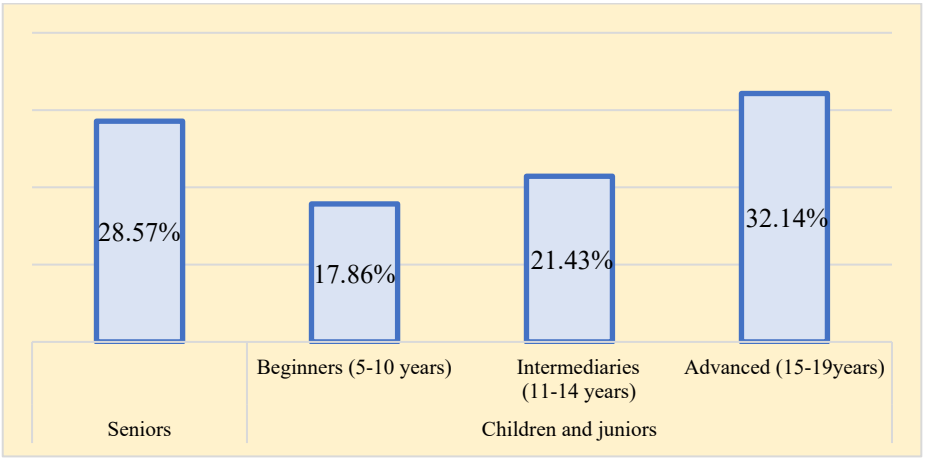

Figure 6. Coaches distribution by level of preparation

As regards the level of qualification of coaches we can notice a large group of qualified coaches, only 12.50% having no qualification in this area.

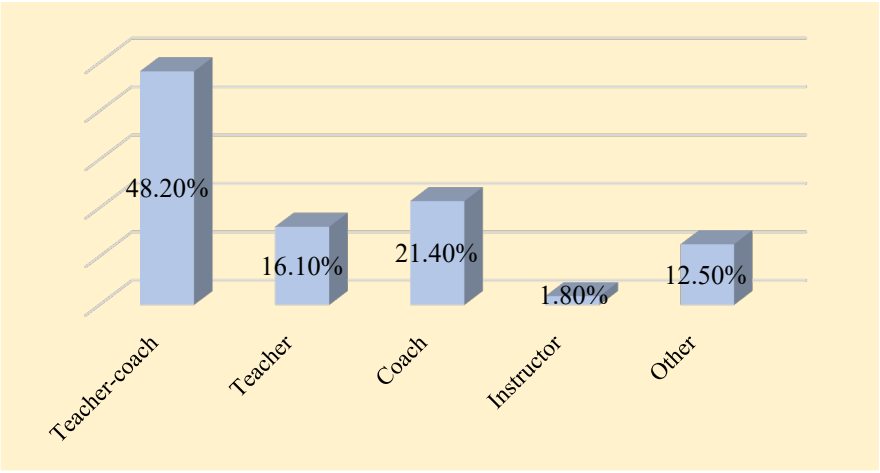

Figure 7. Level of qualification of respondents

Among coaches who replied to the questionnaire applied, related to the sports profile they coach, 73% are team sports coaches, and 27% are individual sports trainers. In Caraș-Severin County a number of 8 team sports and 12 individual sports were considered, 66.1% of respondents involved in research come from public clubs, 8.9% from private clubs, 10.7% sport associations, 14.3% from other sport organizations.

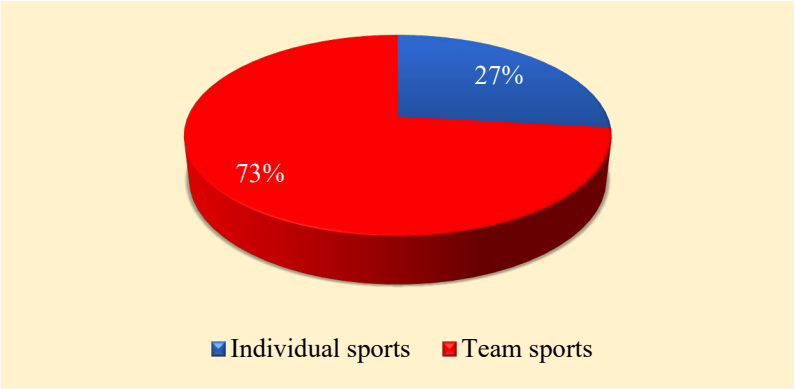

Figure 8. Profile of the sports they coach

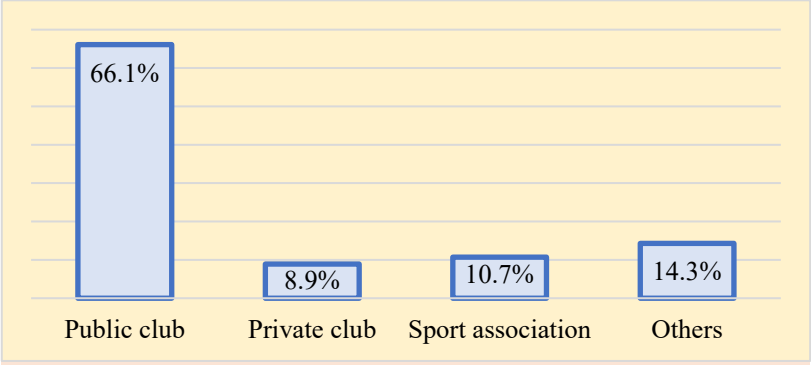

Figure 9. Profile of responding sport structures

At the questionnaire answered teachers/coaches from 6 team sports, with the mention that basketball is a club in training, not participating in any sports competition, still at selection level, and teachers/coaches from 8 individual sports.

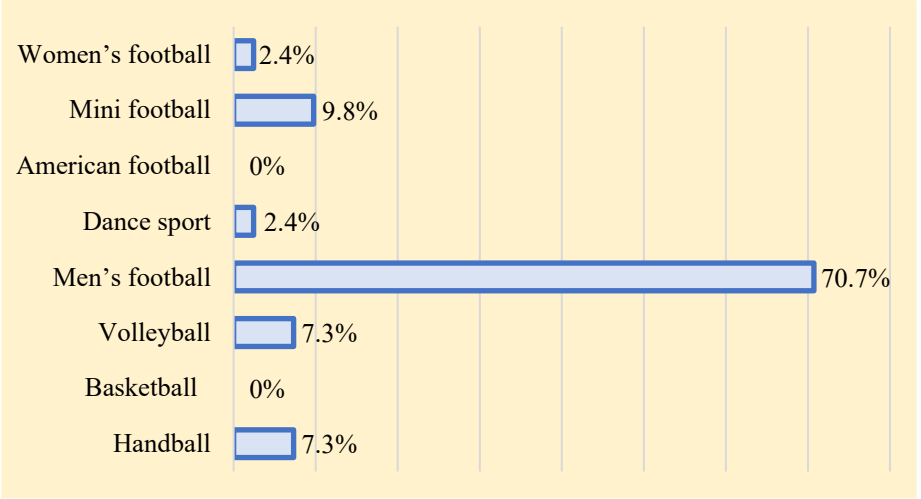

Figure 10. Representation of team sports included in this research

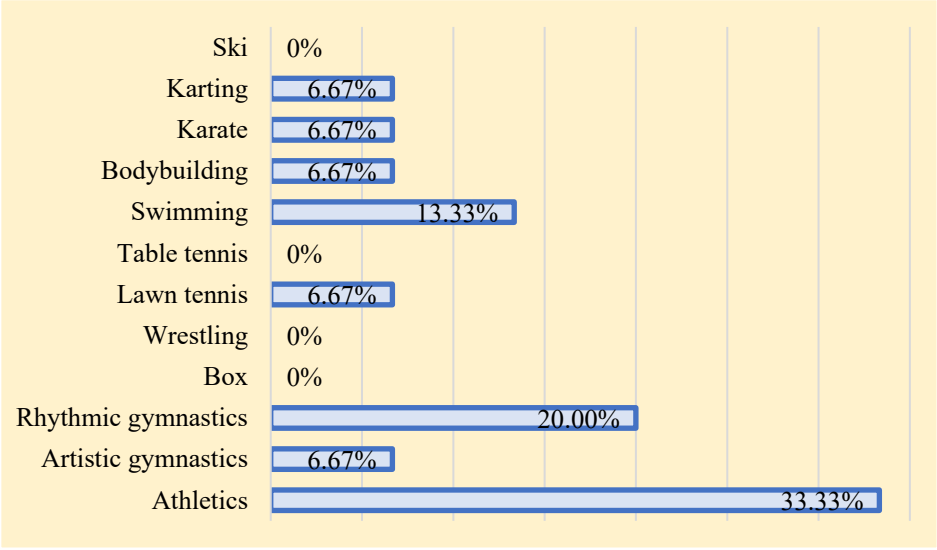

Figure 11. Representation of individual sports included in this research

From the responses provided by respondents who coach in individual sports, we can notice that at none of the sport disciplines included in this research, in 2020, for athletes from Caraş-Severin County sports competitions were no longer held according to the competitive calendar established at the beginning of the year, thus in 100% of cases the competitive calendar has

changed, whether we talk about competitions organized at national/ regional/ county or local level. As regards team sports, 100% of respondents state the league edition 2019-2020 was not completed on the field. In fact, only play-off games in League 2 of football managed to complete the championship 2019-2020 on the field, this was not the case of Reşiţa team.

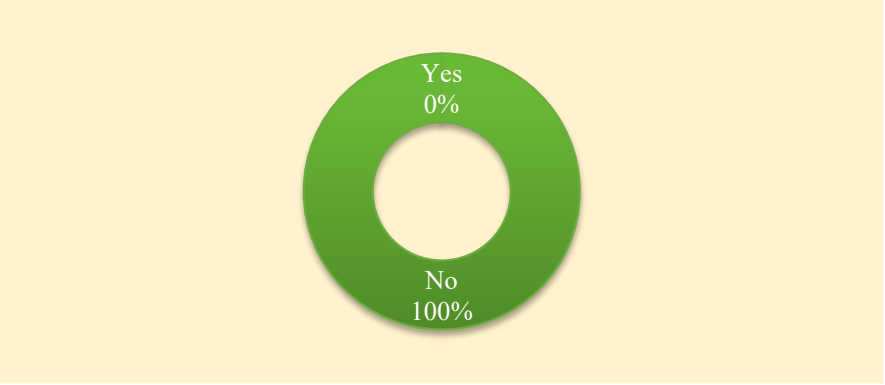

Figure 12. Fulfilment of sports calendar in year 2020

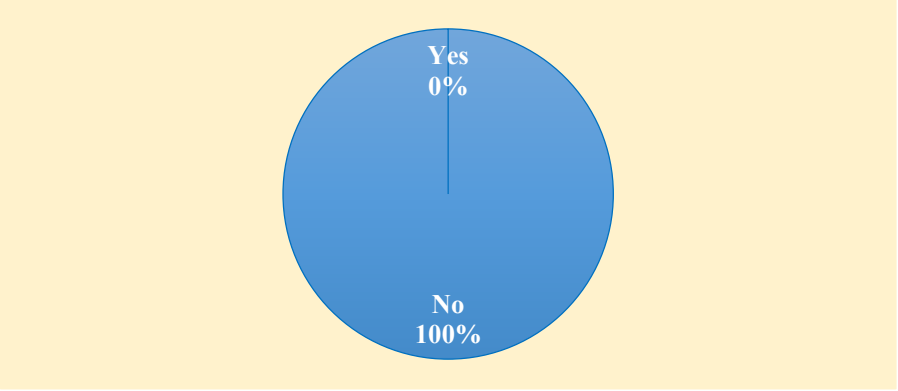

Figure 13. Completing the season competitions of 2019-2020

Nowadays, team sports coaches from Caraş-Severin County state that for 78% of respondents the competitive season 2020-2021 had not yet started by January of year 2021, and for 14.6% had started and interrupted. Only 7.3% of teams are in the middle of a competitive season, the championship 2020-2021 was not interrupted due to the Covid-19 pandemic.

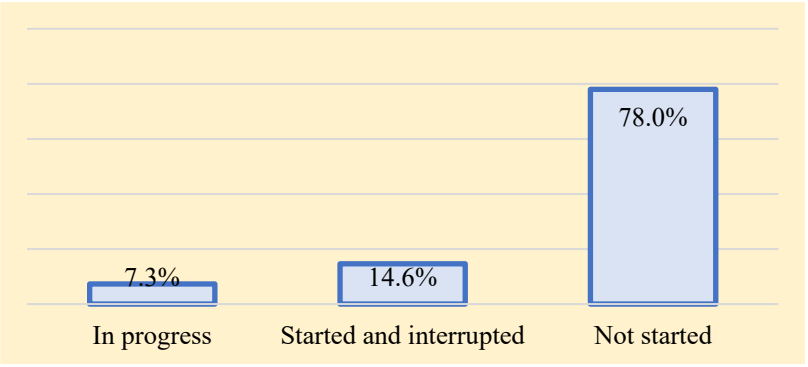

Figure 14. Situation of season 2020-2021 for teams from Caraș-Severin County

As regards team games in season 2020-2021, we can note that sport competitions started only for the top leagues, lower leagues as well as children and juniors' competitions have not started yet.

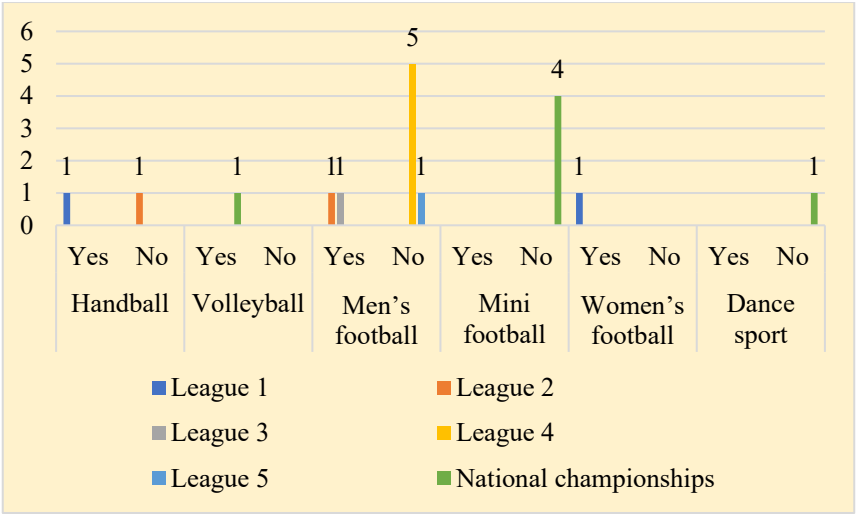

Figure 15. Record of the beginning of competitions in season 2020-2021 depending on team sport and category

Regarding the training schedule, before the Covid-19 begins, only 3.6% of respondent's state teams/athletes they are preparing had been coaching occasionally, for the rest 96.4% were coaching regularly, the number of coaching sessions varies from 1 to 2 weekly and daily.

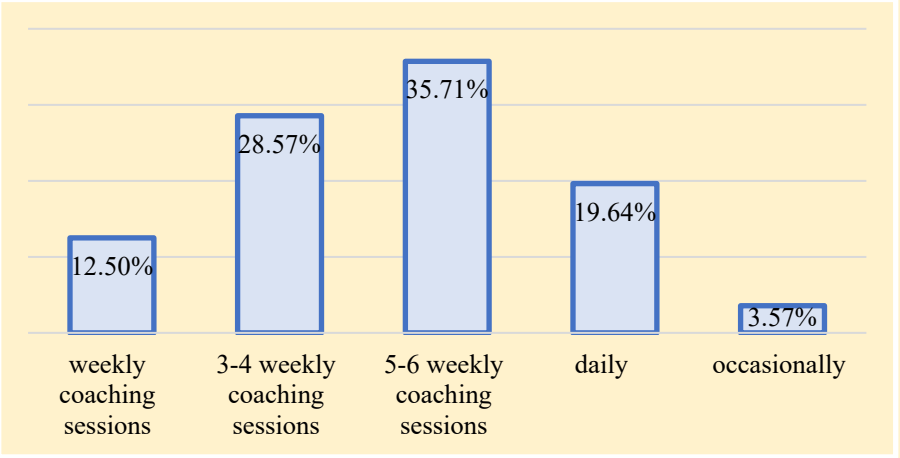

Figure 16. Record of the periodicity of coaching sessions before the pandemic

Since the beginning of the pandemic until now, coaching programs of all teams/associations have changed, no sport organization has been operating normally.

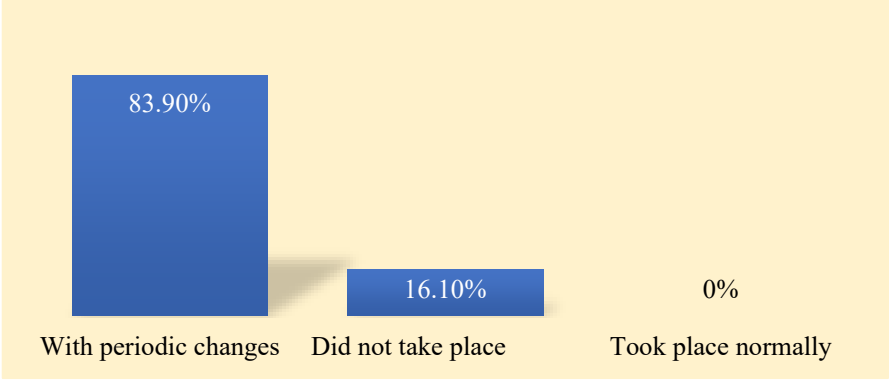

Figure 17. Record of changes in the coaching process during March-December

Most of the coaches (42.86%) state the period of interruptions of coaching has overcame 10 weeks, and in 17.86% of cases coaching has not yet resumed.

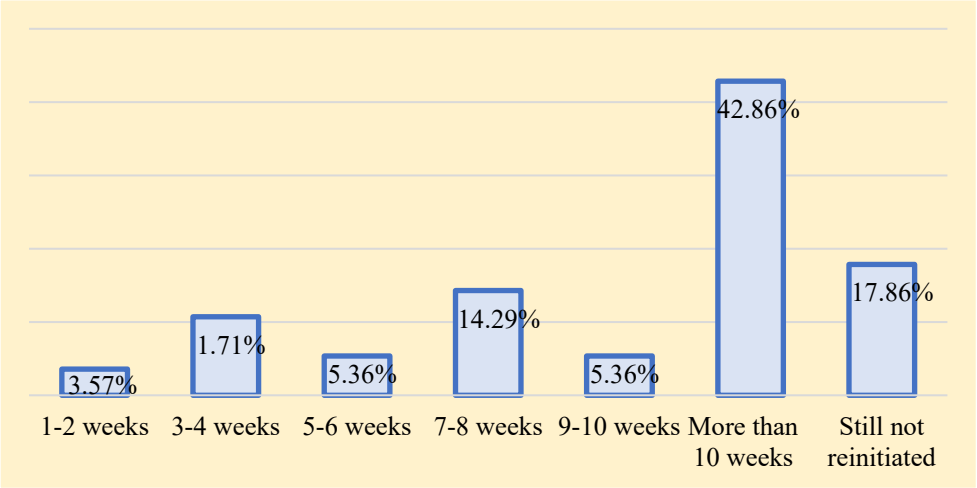

Figure 18. Period of interruption of coaching sessions during the states of emergency and alert

The period with the most rigorous measures for sport life in Romania was recorded during the state of emergency when 73.2% of coaches say they had no training session. As restrictions are relaxed, with regard to sport coaching the number of teams that reinitiated coaching has increased, the percentage of those who did not have any coaching session dropped from 73.21% to 17.86%.

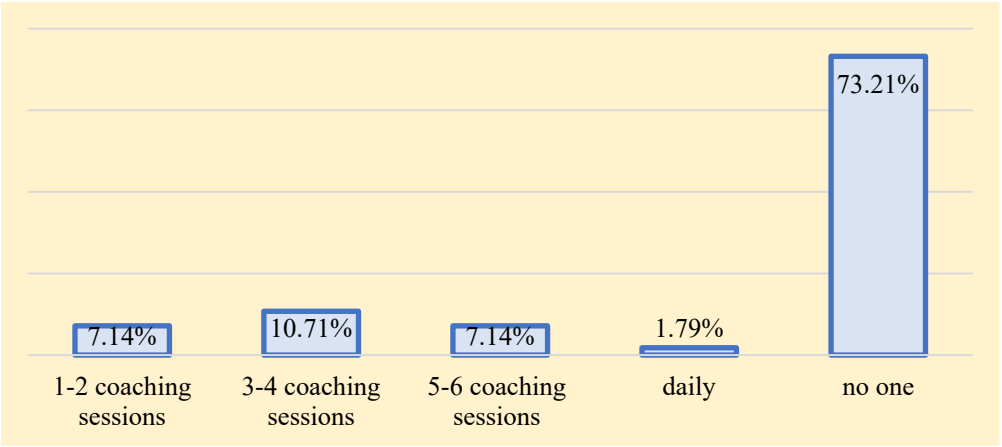

Figure 19. Frequency of coaching sessions during March-April

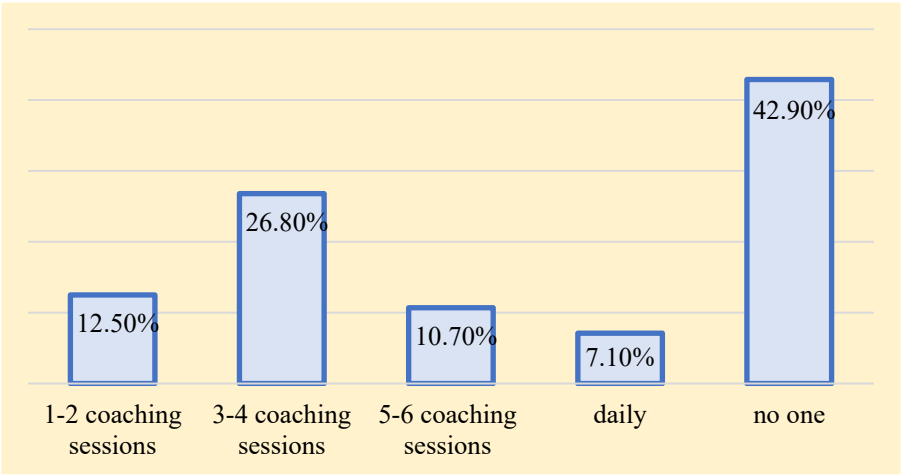

Figure 20. Frequency of coaching sessions during May-June

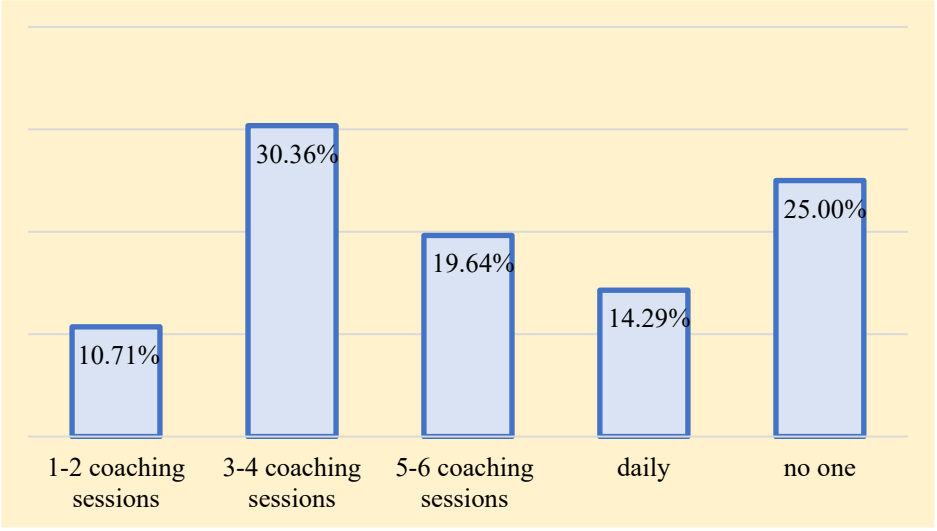

Figure 21. Frequency of coaching sessions during July-September

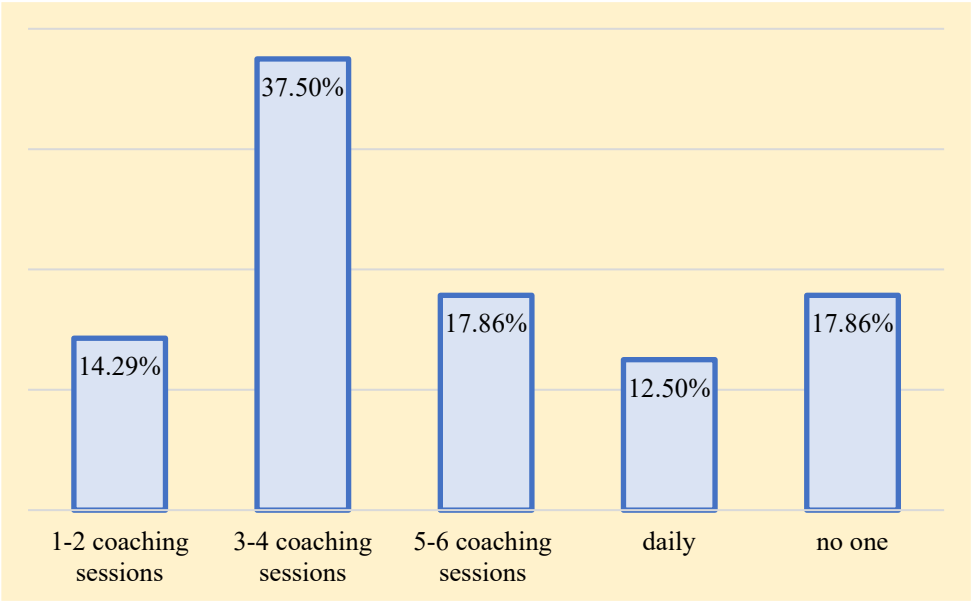

Figure 22. Frequency of coaching sessions during October-December

Overall, coaching activity has started to improve from one pandemic stage to another, but unfortunately, we are still talking about 17.86% of coaches who have not resumed the activity with their groups.

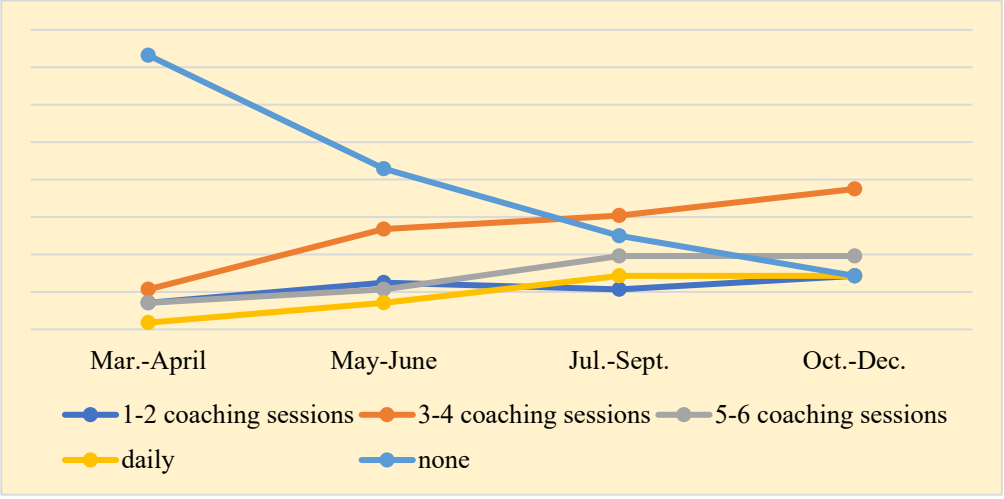

Figure 23. Evolution of the frequency of coaching sessions during March-December

Figure 24a

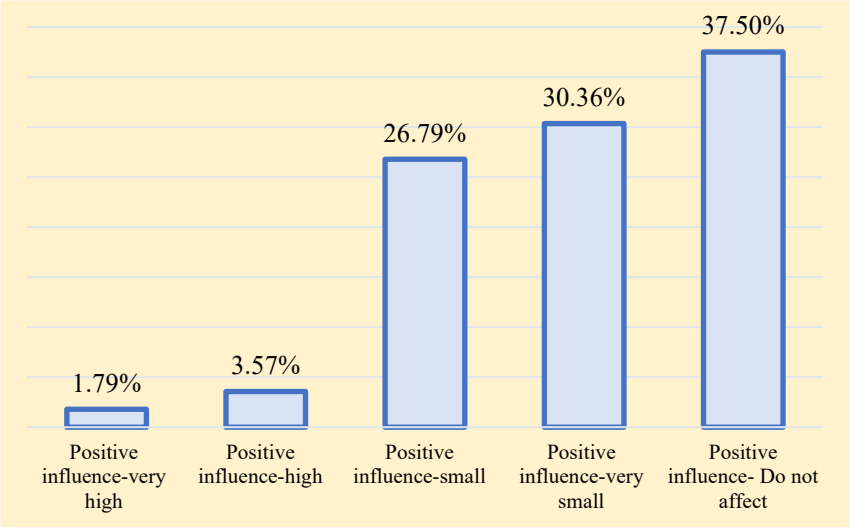

Figure 24b

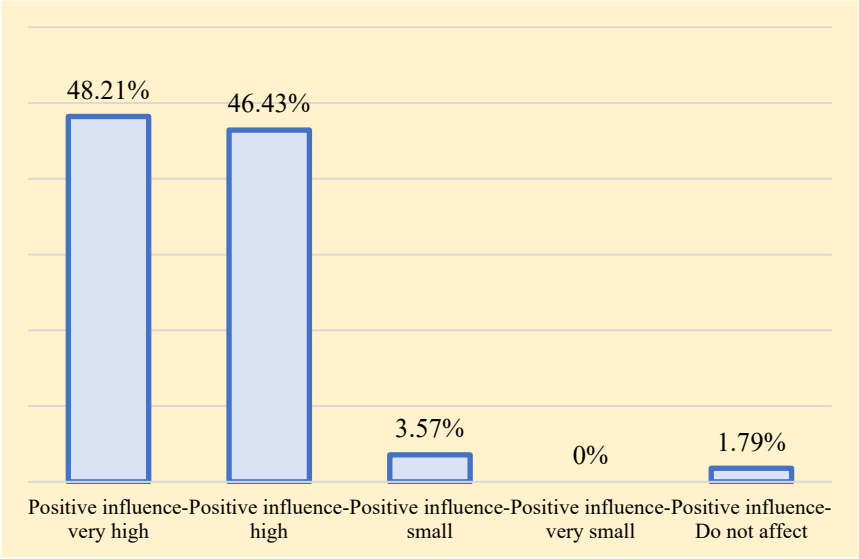

Figure 24 (a & b). Coaches opinion related to the influence of the measures imposed during the pandemic period on coaching

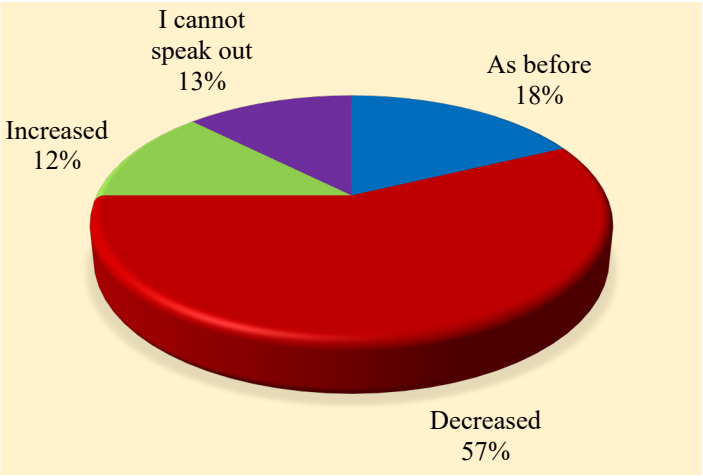

Figure 25. Percentage of children who have come/returned to coaching after the relaxation of restriction measures

We can notice that most of the decreases in the number of children were recorded in individual sports, coaches responded unanimously there has been a decrease in some disciplines. There have been decreases of players in team sports too, with one exception: the women football team, this is actually a team of seniors participating in League 1.

Figure 26a

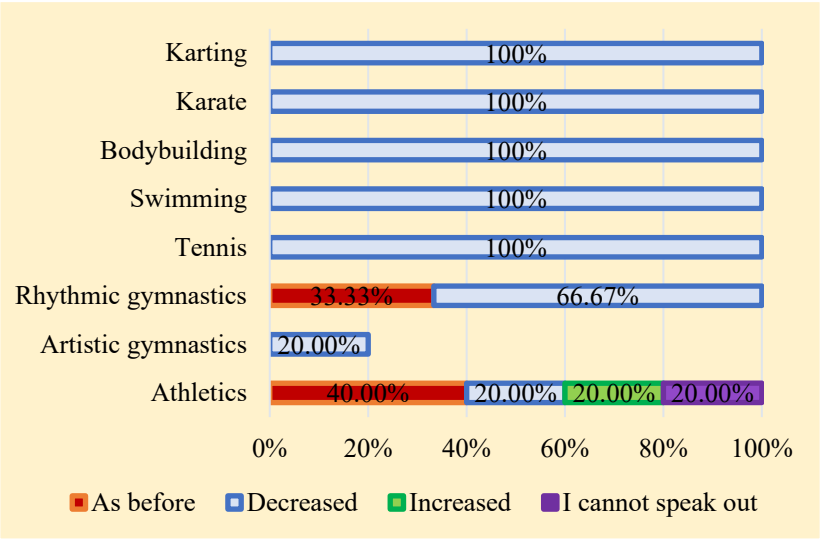

Figure 26b

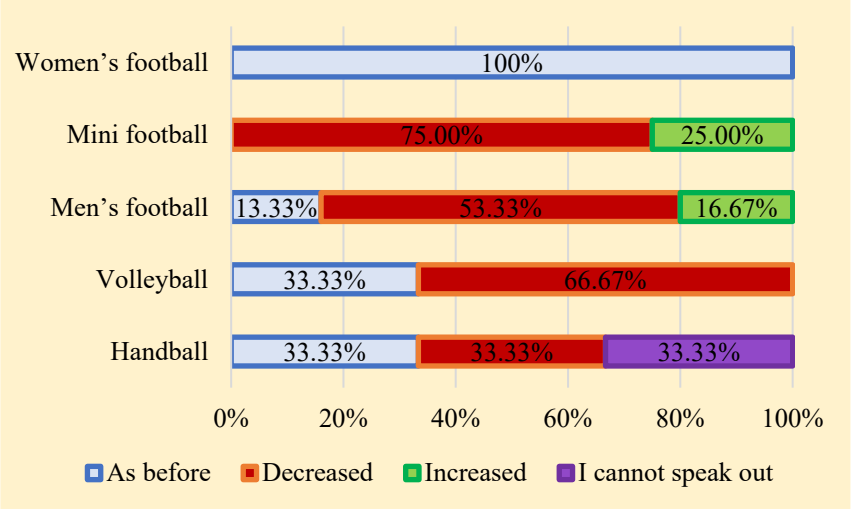

Figure 26 (a & b). Situation of coming/returning to coaching in individual and team sports

Almost one year after the Covid-19 pandemic was declared, on Romanian Territory the clubs coaching process is carried out at 73.21%, adapted to the measures required to prevent the spread of SARS-CoV-2 virus and at 26.79% of teams the activity is interrupted.

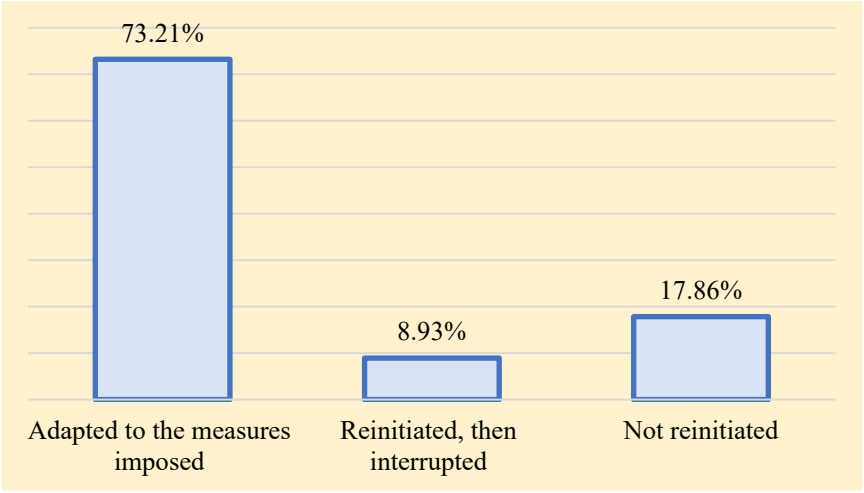

Figure 27. Current coaching methods

Conclusions

Today, one year after the beginning of Covid-19 pandemic, we can state without fear of making a mistake there is no longer any activity which has not been affected by the measures required in an attempt to reduce the spread of SARS-CoV-2 virus.

The COVID-19 pandemic has had and will have significant effects on sports world, and the physical and mental well-being of the people in the whole world. In this respect, it is recommended that governments and other interested parties to support measures to reopen sports events safely and to support physical activity during and after the pandemic.

Regarding sport coaching, breaks caused by the restrictions have caused a decrease in athletes' efficiency, and the current measures, although much more permissive make training difficult, as 83.93% of coaches have pointed out, while 10.71% of those state breaks make coaching impossible. Most of the issues were encountered by teams in the lower, children and juniors' leagues where during this period, especially in teams' games no official competition has taken place.

The new context has led to a decrease in number of athletes in both individual and team sports. This is not a situation to create a favourable perspective for sport performance, long periods of inactivity stop the value growth of athletes, there is a risk that an increasing number of young people quit sport activities.

Moreover, even if it may be early to give a concrete perspective on the future of performance sport, as a result of the fact that the Covid-19 pandemic has not yet been eradicated, measures to prevent the spread of SARS-CoV-2 virus still exist, and researches still analyse the various influences that the pandemic had globally. With the examples so far, we can predict the major risk to disband many sports structures acting at the lower leagues, their financial support is increasingly difficult to achieve as a result to the financial issues faced by local authorities and economic entities.

Acknowledgments

We would like to thank all the coaches who showed their willingness to participate in this research, trying in this way to outline a more accurate picture of the influences of COVID-19 on the activity of sports organizations in Caraș-Severin County.

Authors' contributions

AIB designed the study, coordinated the data collection activity, participated in the analysis and interpretation of the results and edited the final version of the manuscript. IC participated in designing the analysis and interpretation of the study results. VMG participated in the design of the study, data collection and edited the initial version of the manuscript. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

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CORRELATION OF BODY MASS INDEX, SKELETAL MUSCLE, SUBCUTANEOUS AND VISCERAL ADIPOSE TISSUE IN HEALTHY ADULTS: A CROSS SECTIONAL STUDY

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ABSTRACT. Introduction. Obesity is one of the 21st century major health challenges. Adipose tissue is distributed in different proportions in the human body depending on where it is located in the body. **The purpose of the research.** This study aims to determine the relationship between body mass index, skeletal muscle, subcutaneous and visceral adipose tissue in case of first year students of Partium Christian University from Oradea. **Subjects and methods.** The research included a sample group of 112 students. The analysis of the body composition was performed using the method of bioelectrical impedance. **Results.** The registered data reveal that 23% of the subjects were overweight or obese and 15% had a low percentage of skeletal muscle. **Conclusions.** In case of both genders there is a significant negative correlation between the percentage of skeletal muscle and subcutaneous adipose tissue and a significant negative correlation between the percentage of skeletal muscle and visceral adipose tissue.

Keywords: *body mass index, skeletal muscle, subcutaneous adipose tissue, visceral adipose tissue*

REZUMAT. ***Asocierea dintre indicele de masă corporală, masă musculară, ţesutul adipos subcutanat şi cel visceral la adulţi sănătoşi: studiu transversal.*** **Introducere.** În secolul XXI obezitatea reprezintă una dintre marile provocări medicale ale lumii. Țesutul adipos este distribuit în diferite proporţii în corpul uman în funcție de localizarea sa. **Scopul cercetării.** Scopul acestui studiu constă în determinarea relației dintre indicele de masă corporală, masa musculară, ţesutul adipos subcutanat şi cel visceral la studenţii din anul I ai Universităţii Creştine Partium din Oradea. **Subiecţi şi metode.** Cercetarea a inclus un eşantion de 112 studenţi. Analiza compoziției corporale s-a făcut prin metoda bioimpedanţei electrice. **Rezultate.** Conform datelor înregistrate 23% dintre subiecţi au fost supraponderali sau obezi şi 15% au avut un procent de mușchi scheletici scăzut.

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Concluzii. În cazul ambelor genuri există o corelație negativă semnificativă între procentul de mușchi scheletic și țesutul adipos subcutanat și o corelație negativă semnificativă între procentul de mușchi scheletici și țesutul adipos visceral.

Cuvinte-cheie: *indicele de masă corporală, masă musculară, țesut adipos subcutanat, țesut adipos visceral*

Introduction

Obesity is one of the 21st century major health challenges. Adipose tissue can be categorized into two types, depending on where it is located in the body. Thus, there is a visceral (intraperitoneal) adipose tissue and two types of subcutaneous adipose tissue, distributed in the upper or lower part of the body (Grundy, 2015). Although both types of adipose tissue are important, the world pays more attention to visceral adipose tissue which in some cases is associated with an increased risk of developing certain pathologies.

Adipose tissue is distributed in different proportions in the human body depending on gender (Wu et al., 2001), age (Kyle et al., 2001), genetic inheritance (An et al., 2000), diet (Ramos et al., 2001), physical activity (Kanaley et al., 2001), hormone levels and medication (Evans et al., 2001).

There are two important theories regarding the manner in which the distribution of adipose tissue can influence the appearance and maintenance of metabolic syndrome: a) central or visceral obesity leads to increased mobilization of fatty acids in the portal circulation (Frayn et al., 1996), b) metabolic syndrome originates in the visceral tissue through the accumulation of macrophages, which in turn occurs following adipocyte hypertrophy (Cinti et al., 2005, Trayhurn et al., 2008).

The analysis of body composition using the BIA method is frequently applied in clinical studies and it is considered an accessible, efficient and less expensive method for determining body composition (Mourtzakis et al., 2008 & Kyle et al., 2004).

Subjects and Methods

The research took place between December the 3rd and the 21st, 2018, on a sample group of 112 students aged 18 and 19, in first year at Partium Christian University of Oradea.

The anthropometric method was used to measure the two somatic indicators: height and weight, using a Seca 213 height measure and an Omron BF511 electronic scale. The BMI was calculated according to the reference chart based on age and gender using four categories of nutritional status (Barlow & Committee 2007).

In order to determine the percentage of subcutaneous AT, indicative standard values were used according to the age and gender of the subjects (McCarthy, Cole, Fry, Jebb & Prentice, 2006 and Gallagher, Heymsfield, Moonseong, Jebb, Murgatroyd & Sacamoto, 2000) and it is classified into four levels by Omron Healthcare: a) below the normal limit (BNL) (for girls <21.0%; for boys <8.0%), b) normal values (NV) (for girls 21.0 - 32.9%; for boys 8.0 - 19.9 %) c) excess adipose tissue (EAT) (for girls 33.0 - 38.9%; for boys 20.0 - 24.9%) d) obesity (OBS) (for girls ≥ 39.0%; for boys ≥ 25.0%).

Omron Healthcare's indicative standard values were used to determine the percentage of visceral AT and it is classified into three levels: normal values (1-9), high (10-14), very high (15-30) (Manual de instrucțiuni, 2011).

The interpretation of the result for the percentage of skeletal muscle was calculated according to the indicative values of Omron Healthcare and it is classified into four levels: a) low level (for girls <24.3%, for boys <33.3%; b) normal (for girls 24.3 - 30.3%, for boys 33.3 - 39.3%); c) high (for girls 30.4 - 35.3%, for boys 39.4 - 44.0%); very high (for girls ≥ 35.4%, for boys ≥ 44.1%) (Manual de instrucțiuni, 2011).

To test the significance of the differences between the mean values, we used the non-parametric Mann Whitney-U test, and in cases of a normal distribution of the scores, we used the Independent Sample t test. To see the strength and direction of the relationship between the variables, we used the Pearson correlation coefficient (parametric) and the Spearman rho coefficient (non-parametric).

Results

Following the processing of the collected data, it resulted that 73 women and 39 men participated to the measurements. Using the Kolmogorov-Smirnov test, the normality of the distribution of the obtained data was checked (table 1) resulting in values below the threshold of 95% for the following variables in case of women (weight, BMI, percentage of subcutaneous adipose tissue and visceral adipose tissue). For these variables the data are not normally distributed, thus the non-parametric tests will be used in those cases.

Table 1. Testing the normality of the distribution of the research's variables (N=112)

Variable	Tests of Normality Kolmogorov-Smirnov					
	Women			Men		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Height	0.064	73	0.200*	0.126	39	0.123
Weight	0.155	73	< 0.001	0.119	39	0.177
BMI	0.184	73	< 0.001	0.076	39	0.200*
Percentage of subcutaneous adipose tissue	0.105	73	< 0.05	0.089	39	0.200*
Visceral adipose tissue	0.211	73	< 0.001	0.103	39	0.200*
Percentage of skeletal muscle	0.095	73	0.168	0.134	39	0.076

Note: Df = the degrees of freedom (which is equal to N)

Table 2. Distribution of BMI depending on the gender of the subjects (N=112)

BMI Percentile / Nutritional status	W		M		W+M	
	N	%	N	%	N	%
Underweight BMI percentile < 5	1	2	4	10	5	4
Normal weight BMI percentile 5-85	55	75	26	67	81	73
Overweight and obesity BMI >85	17	23	9	23	26	23
Obesity BMI percentile ≥ 95	8	11	3	8	11	10
Total	73	100	39	100	112	100

Note: W = Women, M = Men

The registered data reveal that 73% of the subjects had a normal weight, 13% were overweight and 10% were obese (Table 2). According to Table 3, 48% had a percentage of AT within normal values (44% in case of girls; 54% in case of boys including BNL), 24% were overweight (25% in case of girls; 23% in case of boys) and 28% were obese (31% of girls; 23% of boys).

Table 3. Distribution of the subcutaneous adipose tissue depending on the gender of the subjects (N=112)

Indicative standard value	W		M		W+M	
	N	%	N	%	N	%
Below normal limit	-	-	1	2	1	1
Normal values	32	44	20	52	52	47
Excess adipose tissue	18	25	9	23	27	24
Obesity	23	31	9	23	32	28
Total	73	100	39	100	112	100

Note: W = Women, M = Men

Out of the total sample group, 97% had a percentage of visceral AT within normal values (108 subjects) and 3% (4 subjects) had high values.

Table 4. Distribution of the percentage of skeletal muscle depending on the gender of the subjects

Nutritional status	W		M		W+M	
	N	%	N	%	N	%
Low	16	21	2	5	18	15
Normal	53	73	10	26	63	57
High	3	4	22	56	25	23
Very high	1	2	5	13	6	5

Note: W = Women, M = Men, (N=112)

According to Table 4, 73% of girls and 26% of boys had a percentage of skeletal muscle within normal values. 6% of girls and 69% of boys had a high and very high percentage of skeletal muscle. According to Table 5, there is a significant negative correlation ($p < 0.001$ in case of women, $p < 0.05$ in case of men) between BMI and skeletal muscle percentage, and a significant positive correlation ($p < 0.001$) between BMI and the percentage of subcutaneous and visceral AT.

Table 5. The correlation between BMI and the SM percentage, subcutaneous AT percentage and visceral AT percentage

Variable	Women N = 73		Men N = 39	
Percentage of SM	$r_{xy} = - 0.73^{**}$	$r_s = - 0.76^{**}$	$r_{xy} = - 0.37^{*}$	-
	$p < 0.001$	$p < 0.001$	$p < 0.05$	-
	$n = 73$	$n = 73$	$n = 39$	-
Percentage of subcutaneous AT	-	$r_s = 0.97^{**}$	$r_{xy} = 0.89^{**}$	-
	-	$p < 0.001$	$p < 0.001$	-
	-	$n = 73$	$n = 39$	-
Percentage of visceral AT	-	$r_s = 0.91^{**}$	$r_{xy} = 0.95^{**}$	-
	-	$p < 0.001$	$p < 0.001$	-
	-	$n = 73$	$n = 39$	-

Note: r_{xy} = Pearson correlation coefficient, r_s = Spearman rho correlation coefficient, SM = skeletal muscle, AT = adipose tissue

Referring to women, there is a significant negative correlation between the percentage of skeletal muscle and subcutaneous adipose tissue ($r_{xy} = - 0.87$, $df = 73$, $p < 0.001$), ($r_s = - 0.88$, $df = 73$, $p < 0.001$). At the same time, there is a significant negative correlation between the percentage of skeletal muscle and visceral adipose tissue ($r_{xy} = - 0.63$, $df = 73$, $p < 0.001$), ($r_s = - 0.72$, $df = 73$, $p < 0.001$).

In case of boys, there is a significant negative correlation between the percentage of skeletal muscle and subcutaneous adipose tissue (r_{xy} = - 0.67, df = 39, p < 0.001). At the same time, there is a significant negative correlation between the percentage of skeletal muscle and visceral adipose tissue (r_{xy} = - 0.61, df = 39, p < 0.001).

Discussions

The adipose organ becomes fully developed at the age of puberty, its development being supported primarily by the proliferation process. However, it has recently been described that, regardless of age or BMI, 10% of fat cells are renewed annually, which demonstrates the existence of a dynamic process of adipocyte turnover in the adult adipose organ (Spalding and others, 2008). BMI is a tool representing the standard in assessing the risks occurred as a result of excess weight. According to the results of BMI values, 13% of the subjects were overweight and 10% were obese, compared to the values of adipose tissue from which it results that 24% were overweight and 28% obese. We notice a difference of 29% of the subjects with weight problems.

According to studies on a sample group of 52 students from Safarik University in Košice, Slovakia, 50% of the subjects were overweight (BMI ≥ 85th %ile) out of which 15% were obese (BMI ≥ 95th %ile) (Brtkova et al., 2014).

Conclusions

In case of girls, there is a significant negative correlation between the percentage of skeletal muscle and subcutaneous adipose tissue (r_{xy} = - 0.87, df = 73, p < 0.001), (r_s = - 0.88, df = 73, p < 0.001) and there is a significant negative correlation between the percentage of skeletal muscle and visceral adipose tissue (r_{xy}= - 0.63, df = 73, p< 0.001), (r_s = - 0.72, df = 73, p < 0.001). In case of boys, there is a significant negative correlation between the percentage of skeletal muscle and subcutaneous adipose tissue (r_{xy} = - 0.67, df = 39, p < 0.001) and there is a significant negative correlation between the percentage of skeletal muscle and visceral adipose tissue (r_{xy} = - 0.61, df = 39, p < 0.001).

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BACK SCHOOL PROGRAM: DEVELOPMENT OF BACK CARE KNOWLEDGE AND SPINE DISEASE PREVENTION AND TRUNK STATE AMONG 6-7-YEAR-OLD CHILDREN

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ABSTRACT. Introduction: The prevalence of posture deformities and muscle weakness among primary school children is high (50-65%). **Objective:** To assess and improve the back care knowledge and spine disease prevention, the strength of the trunk muscles, the flexibility of the lower limb muscles, the posture, and the lumbar motor control ability of primary school children by a 1-school year back school program. **Methods:** 102 (mean age: 6.549±0.500 years) children were examined at the baseline, and 48 (23 boys, 25 girls) were chosen for the program. Back care knowledge was examined by validated questionnaire, trunk muscle strength, and muscle flexibility by Lehmann tests, posture by New York Posture Rating Chart, and lumbar motor control by Sitting Forward Lean Test. **Results:** The complete back care knowledge (2.423±3.911, 19.115±2.833 points; $p<0.001$), trunk flexor (3.615±7.910, 56.885±113.748 sec; $p<0.001$), trunk extensor (8.962±5.963, 77.000±139.801 sec; $p<0.001$) static muscle strength, lower limb flexibility ($p<0.001$), habitual posture (53.846±10.130, 81.154±9.829 points; $p<0.001$), posture deemed correct 40.962±16.311, 91.346±6.566 points; $p<0.001$) and lumbar motor control (8.269±5.474, 0.154±0.368 mm; $p<0.001$) significantly improved in the intervention group for the end of the program. **Conclusions:** The back school program improves the back care knowledge and the trunk state among 6-7 years old children.

Keywords: *primary school children, back school, back care knowledge and spine disease prevention, trunk state, lumbar motor control ability*

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Introduction

The back school programs develop specialized knowledge and skills in primary, secondary, and tertiary prevention in adults and children, healthy and ill (Szilágyi, 2019).

The purpose of back school programs is to apply "spine-friendly" forms of exercises at skill level (Szilágyi, 2019). The ability to use the spine correctly is the "automated component of conscious activity" (Zakarné, 2003), which is known through the knowledge and multiple application of spine protection rules, partial-, progressive-, isolation-, global-, applying- or processing practices, and analytical-, global - or it can be developed by the method of transferable learning (Zakarné, 2003; van Middelkoop, 2011).

The back school programs include anatomy, biomechanics, ergonomics education, and practice. Elements of patient education: develop the patient's sense of personal responsibility, the patient's ability to recognize adverse spine motions (Moseley, 2004; Ribeiro, 2008) and learn about one's own body, muscle tone through body sensation and body experience, perceive muscle activity types and evolve functionally biomechanically correct posture, recognize muscle balance, acquire spine-friendly lifestyle and apply at school, work, and leisure time.

Patient education includes disease-specific knowledge in the topic of body biomechanics, spinal anatomy, and ergonomics (Szilágyi, 2019), which is repeatedly asked in the form of tests measuring the effectiveness of education, with the help of back care knowledge questionnaires (Szilágyi, 2021; Monfort-P, 2016; Miñana-S, 2015). Practical classes teach the correct posture and the correct use of the spine, strengthen the muscles that support and maintain them and, if necessary, increase their flexibility by stretching exercises. Education also covers ergonomic work situations, spine-friendly leisure activities, resting postures, load-bearing and working techniques, and relaxation exercises. Back school programs support the teaching of spine-friendly lifestyles with biomechanical explanations and foundations that have proven to be more effective in therapeutic follow-up (Szilágyi, 2019; Lehmann, 2001; Kollmuß, 2001).

Back school programs are not standardized, there are many back school model variations. Child back school programs are available in many countries (USA, Germany, Belgium, Brazil, Poland, Spain, Turkey, Australia, Iran), in „class" groups (20-30 children/ group), with varied duration (3 weeks-1 year), frequency (1-2 occasion/week), time (30-90 minutes/ occasion) and follow-up (3 month-2 years). The effectiveness of back school programs is intensity and content dependent. In terms of intensity, short-term, short-time programs are less effective, than longer-term programs. There are a few complex back school programs that include theory and practice. On the personal lessons, participants

receive mostly written materials providing theoretical and practical information. There are few child back school programs for children aged 6-7 years (Geldhof, 2007; Dolphens, 2011; Vieira, 2015; Ritter, 2015; Fonseca, 2015; Brzek, 2016; Santos, 2017; Miñana, 2019; Szilágyi, 2019).

Objectives

The study aimed to develop a 1-school year child back school program, and complex test system that measures the knowledge taught during the child back school program (spine anatomy, body biomechanics, ergonomics, rules of spine protection and utilization) and physical abilities and skills needed for the use of spine- friendly lifestyle (muscle balance, posture, lumbar motor control) for 6-7 years old primary school children.

Also, our goal was to develop, implement, and test the effectiveness of the long-term child back school program on the change of the developed and measured parameters.

Material and Methods

Study design

The study was conducted between 2016 and 2018, in Pécs, Hungary. The director of the schools provided a Declaration of Support. All the parents were informed about the process of the back school program and have provided written consent permitting their children to participate in the study. The parents were assured of the anonymity and confidentiality based on the Data Protection Act of Hungary. The study was approved by IRB of the Regional Research Committee of the Clinical Center, Pécs, Hungary (No.: 6125).

Participants

At the baseline examination, 102 (52 boys, 50 girls) primary school first-grader (6.549±0.500 years) children were tested. With not random sample selection, 26 children (11 boys, 15 girls) were chosen in the intervention group, who took part in the back school program. In the control group, 22 children (12 boys, 10 girls) were included, who did not participate in the back school program, they only took part in the regular physical education classes. Table 1 shows the mean values of the age, body height, body weight, and the body mass index (BMI) of the examined population.

Table 1. Mean values of the examined population

	The examined population (n=102)		Intervention group (n=26)				Control group (n=22)			
	mean pre	SD	mean pre	SD	mean post	SD	mean pre	SD	mean post	SD
Age (years)	6.549	0.500	6.577	0.504	7.308	0.679	6.591	0.503	7.318	0.716
Body height (cm)	126.549	5.140	126.558	5.013	130.654	7.322	126.500	5.198	131.364	6.433
Body weight (kg)	26.135	3.467	26.377	3.515	27.531	5.459	26.118	3.405	27.600	4.642
BMI (kg/m^2)	16.291	1.766	16.445	1.827	15.968	1.723	16.311	1.879	15.867	1.426

SD: standard deviation; BMI: body mass index; pre: baseline, before the program; post: after the program

Inclusion criteria: 6-7 years old primary age children.

Exclusion criteria: Congenital or acquired spinal cord disease, severe locomotor, internal or neurological illness, non- mature child for school, certified athletes, sports club members (Lehmann, 1998; Kollmuß, 2001; Szilágyi, 2019).

Data collection

Health Questionnaire on Back Care Knowledge and Spine Disease Prevention for Children

The questionnaire was filled out by the children before and after the back school program. We used a self-developed and validated questionnaire (Szilágyi, 2021). The questions have been read aloud for them and were illustrated by drawings, pictures, and figures. Five questions addressed the anatomical and biomechanical properties of the spine, three questions were about spine utilization and ergonomics.

Scoring

There are questions, with more correct answers, for every correct answer a point can be given, thus who can find all the correct answers a total of 7 points can be given for question 1, 2 points for question 2, 2 points for question 3, 3 points for question 4, 2 points for question 5, 1 point for question 6,

and 1 point for question 7. For the wrong answer, 0 point was given. A maximum of 18 points can be obtained in the questionnaire and a minimum of 0 point. The total possible score was 21 points, for anatomical and biomechanical questions (1,2,5,7) 15 points, for spine use and ergonomical questions (3,4,6) 6 points could be awarded. Between 100-80%, the knowledge is appropriate, between 79-60% it needs to be developed, and between 59-0%, it is inappropriate.

Habitual posture and posture deemed correct with New York Posture Rating Chart

Three pictures were taken from the children, one from the back view and two from the side views. While taking the photo, children had to be barefooted, in tight fit or with the naked upper body; for girls, long hair had to be tied to avoid covering the neck and shoulders. Children were standing in front of a black background and behind a plumb line that almost reached the ground. From the back view, the plumb line had to go through the head, spine and had to end between the two legs in the middle. From the side view, the plumb line had to go through the ear, lumbar I. and V. vertebrae and the lateral ankle. Pictures were taken 3.048 m far from the student, with NIKON D3400 camera.

For showing habitual posture, we asked the children to stand in front of the screen, to show how they usually stand in everyday life.

For posture deemed correct, we asked the children to stand in front of the screen as they think it was correct (Kovácsné, 2016; McRoberts, 2013; The University of the State of New York, 1972).

Scoring

First, the New York Posture Rating Chart was published in 1958 (The University of the State of New York, 1972), then in 1992 Howley and Franks modified it, instead of 13 segments, 10 segments were examined and scored independently from each other by a qualified examiner. From the back view (frontal plane), head, shoulders, spine, hips, and legs were examined and scored. From the side view (sagittal plane) cervical, upper thoracic, and lower thoracic part (trunk), the abdominal part and lumbar part were examined and scored. Writing a short comment was allowed for each segment. According to the modified rating, 10 points meant correct posture, 5 points fair posture, and 0 point poor posture. The maximum score was 100 points for the correct posture of each segment (McRoberts, 2013).

Trunk muscle strength and lower limb flexibility with Lehmann test

Trunk flexor static muscle strength

Children are in supine lying on a mattress, the hips and knees are in 90° flexion at both lower limbs. Shoulders stay on the ground, upper limbs have an angle of 45° with the trunk, they are straight, lifted 3-5 cm from the ground, palms are looking upwards. The position of the head: stretch with the head, the face is looking to the ceiling, the chin doesn't approach the chest. The head is lifted 3 cm from the ground, beside the kept of the upper and lower limbs in the correct position, the lumbar part is pressed down to the ground and must be kept on the ground during the examination. We measure the time in seconds to maintain the correct posture during the examination. The examination is finished, in case of the lumbar part comes up from the ground, or the position of the lower, upper limbs change.

Scoring

Keeping the correct posture for 10 seconds means normal muscle strength for a 7-year-old child. Less than 10 seconds means not normal muscle strength for a 7-year-old child (Lehmann, 1998).

Trunk extensor static muscle strength

Children are in prone lying on a mattress, and the lower limbs are straight and in a little straddle, the foot leans on the floor, knees are on the floor. Upper limbs are at the level of the shoulder, and the elbow is in 90⁰ flexion, the palms face each other, the fingers are straight, the thumb looks upwards. The head (nose-ground) is lifted 2 centimeters from the ground, and the upper limbs are lifted 5 centimeters from the ground. During the examination, we measure the time in seconds to maintain the correct posture. The examination is finished, in case of the position of the head, upper, and lower limbs change.

Scoring

Keeping the correct posture for 10 seconds means normal muscle strength for a 7-year-old child. Less than 10 seconds means not normal muscle strength for a 7-year-old child (Lehmann, 1998).

Hip flexor muscle flexibility

The child is sitting at the end of the treatment bed, embrace the left lower limb from below, slowly leaning back to supine, the left hip is in 90° flexion. The right lower limb is relaxed, and the knee is in 90° flexion. In this case, the right lower limb is tested. We perform the test on the other lower limb.

Scoring

The flexibility of the hip flexor is appropriate if the examined limb is on the table, the knee is in 90°, and the longitudinal axis of the femur points downwards (Lehmann, 1998).

Knee flexor muscle flexibility

The child is in supine, and both legs are on the floor. Arms are straightly beside the body. The right leg is straightly raised to 90° hip flexion, while the left leg is loosely on the ground. In this case, we examine the flexibility of the right knee flexor.

Scoring

The flexibility of the knee flexor is appropriate if the lifted lower limb beside extended knee reaches 90° flexion in the hip, and the lower limb (knee) on the ground does not lift off (Lehmann, 1998).

Lumbar motor control ability with Sitting Forward Lean test

The child is sitting on a treatment bed or chair, and the soles do not touch the ground, the knee bend touches the edge of the bed, the hip and knee are in 90° flexion, the spine, including the lumbar part, is in the neutral position. We help the child to have the correct posture. We sign the upper endplate of the first sacral vertebra and measure 7 centimeters upwards in the middle of the spine, that point is also signed. After the checkmarks, we ask the child to pull up the lower limbs after each other five times, equally raise up the upper limbs straightly together beside the ear. After the exercises, we ask the child to have the correct sitting posture, and then we measure the distance with a tape measure between the two markers, the obtained value is recorded in millimeters. The obtained value is the difference between the two values.

Scoring

The normal value is when the difference is less than 3 millimeters in a positive or negative direction. The lumbar motor control ability is not normal, if there is a bigger difference than 3 millimeters in a positive or negative direction (Enoch, 2011; Kovácsné, 2017).

The applied back school program

Theoretical, educational curriculum

Children were provided with 15 minutes of theoretical curriculum each week within the class. We started the lessons with easy introductory games, followed by theoretical knowledge, with the aid of devices designed for demonstration of spine functions. Children had to show the bony markers on themselves and each other through play. During the theoretical course, we taught anatomical, biomechanical, ergonomic, and spine-related knowledge to the children. This knowledge has been collected together and published as a book in English and Hungarian. The book was made by physiotherapists, a writer, a nursery school governess, an instructress, and an infantile clinical psychologist, family therapist (Szilágyi, 2019).

Exercise program

The exercise sessions lasted 30 minutes each week within the class, under the leadership of two physiotherapists, separated in groups. Additionally, children spent four times a week, 10 minutes with exercises connected to the back school program in physical education classes, under the leadership of the teacher. These exercises were designed by physical therapists. Finally, seven times a week, we asked them to spend 10 minutes of exercising based on instructions included in the didactic material for home (Szilágyi, 2019; Kollmuß, 2001; Cardon, 2007; Hill, 2015).

Didactic material for home

The didactic material for home included review questions from the theoretical curriculum learned in the previous lesson, questions to control knowledge, as well as the exercise material of games played during the lessons. In the didactic material, children had to indicate how many times a week, with how many repetitions and how many minutes they did each exercise.

Data Analysis

SPSS software version 22.0 was used for statistical analyses. The results are presented in frequency and confidence interval, as well as in mean±standard deviation, median and interquartile range values. Based on the results of the normalcy tests (Kolmogorov-Smirnov test) the distribution of the data does not imply normal. Differences between the intervention and control group were

examined by the chi-square test and Mann-Whitney U test, while the effectiveness of the program was examined by chi-square test and Wilcoxon test. The results were considered significant at $p<0.05$ level.

Results

Results at the baseline measurement (n=102)

The mean point of the total score targeted to the back care knowledge was 2.490±2.536 points, the mean point of the anatomical, biomechanical knowledge was 1.167±2.092 points, and the mean point of the spine use, ergonomic knowledge was 1.324±1.109 points. The total score of the back care knowledge was inadequate in 99.020% (CI lowest: 94.902; CI highest: 100.000) (adequate: x≤80%).

The mean point of the total score in habitual posture was 53.137±10.576 points, the mean point of the posture deemed correct was 41.225±14.631 points. The maximum point of both types of postures was close to 50 points, which is the half score of the maximally correct posture. We can say that these are low scores, inappropriate knowledge.

The mean second of the trunk flexor static muscle strength was 3.804±6.482 seconds, and of the trunk extensor static muscle strength was 8.029±6.180 seconds. None of the trunk static muscle strength tests reached the normal range (normal: x≥10 sec).

The frequency of the negative results of the hip flexor muscle flexibility in the right leg was 48.039 (38.343-57.735)%, in the left leg was 49.020 (39.318-58.721)%, and the frequency of the negative results of the knee flexor muscle flexibility in the right leg was 26.471 (17.909-35.032)%, in the left leg was 29.412 (20.569-38.254)%. The hip flexor flexibility test on both sides was positive at more than half of the children, and the knee flexor flexibility test on both sides was positive at more than 70% of the children.

The mean millimeter of the lumbar motor control ability was 8.353±5.055 millimeters. It was out of the normal range (normal: -3<x<3 millimeter).

Back Care Knowledge and Spine Disease Prevention (Table 2)

Table 2. The results of knowledge of spinal function in the intervention and control groups

		Intervention group (n=26)		**Control group (n=22)**		**Differences between the intervention and control groups**
		Mean ± SD (point)	**p-value**	**Mean ± SD (point)**	**p-value**	**p-value**
Total score	pre	2.423 ±3.911	<0.001	2.318 ±1.862	0.155	0.245
	post	19.115 ±2.833		3.227 ±2.159		<0.001
Anatomical, biomechanical	pre	1.154 ±3.082	<0.001	1.045 ±1.253	0.346	0.104
	post	13.846 ±1.642		1.636 ±2.037		<0.001
Spine use, ergonomics	pre	1.269 ±1.185	<0.001	1.273 ±1.241	0.331	0.982
	post	5.269 ±1.343		1.591 ±1.297		<0.001

Pre: baseline, before the program; post: after the program; SD: standard deviation

Habitual posture and posture deemed correct (Table 3)

Table 3. The results of the total score of habitual posture and posture deemed correct in the intervention and control groups

		Intervention group (n=26)		Control group (n=22)		Differences between the intervention and control groups
		Mean ± SD (point)	p-value	Mean ± SD (point)	p-value	p-value
Total score of habitual posture	pre	53.846 ±10.130	<0.001	52.500 ±10.089	0.644	0.645
	post	81.154 ±9.829		54.091 ±11.406		<0.001
Total score of posture deemed correct	pre	40.962 ±16.311	<0.001	41.364 ±13.903	0.118	0.983
	post	91.346 ±6.566		45.909 ±8.679		<0.001

Pre: baseline, before the program; post: after the program; SD: standard deviation

Trunk static muscle strength (Table 4)

Table 4. Results of the trunk muscle strength in the intervention and control groups

	Intervention group (n=26)		Control group (n=22)		Differences between the intervention and control groups
	Mean ± SD (s)	**p-value**	**Mean ± SD (s)**	**p-value**	**p-value**
TFSM pre	3.615 ±7.910	<0.001	3.818 ±8.404	0.203	0.950
TFSM post	56.885 ±113.748		4.318 ±2.801		<0.001
TESM pre	8.962 ±5.963	<0.001	8.045 ±4.603	0.649	0.917
TESM post	77.000 ±139.801		8.682 ±4.714		<0.001

TFSM: trunk flexors' static muscle strength; TESM: trunk extensors' static muscle strength; pre: baseline, before the program; post: after the program; s: second; SD: standard deviation

Lower limb muscle flexibility (Table 5)

Table 5. Results of the lower limb muscle flexibility in the intervention and control groups

	Intervention group (n=26)		Control group (n=22)		Differences between the intervention and control groups
	Frequency (%) CI (lower-upper)	**p-value**	**Frequency (%) CI (lower-upper)**	**p-value**	**p-value**
Right HF pre	46.154 (27.991-65.316)	0.004	50.000 (29.106-70.894)	1.000	0.793
Right HF post	84.615 (70.747-98.484)		54.545 (33.738-75.353)		0.024
Left HF pre	46.154 (26.991-65.316)	0.002	50.000 (29.106-70.894)	1.000	0.793
Left HF post	84.615 (70.747-98.484)		54.545 (33.738-75.353)		0.024
Right KF pre	23.077 (6.882-39.272)	<0.001	27.272 (8.662-45.883)	1.000	0.741
Right KF post	80.769 (65.620-895.918)		31.818 (12.355-51.281)		0.001
Left KF pre	26.923 (9.873-43.973)	<0.001	31.818 (12.355-51.281)	1.000	0.713
Left KF post	80.769 (65.620-895.918)		36.363 (16.262-56.465)		0.002

HF: hip flexor; KF: knee flexor; pre: baseline, before the program; post: after the program; %: negative test percentage; CI: confidence interval

Lumbar motor control ability (Table 6)

Table 6. Results of lumbar motor control ability in the intervention and control groups

	Intervention group (n=26)		Control group (n=22)		Differences between the intervention and control groups
	Mean ± SD (mm)	**p-value**	**Mean ± SD (mm)**	**p-value**	**p-value**
LMC pre	8.269 ±5.474	<0.001	8.682 ±4.970	0.614	0.489
LMC post	0.154 ±0.368		8.136 ±4.144		<0.001

LMC: lumbar motor control ability; pre: baseline, before the program; post: after the program; mm: millimeter; SD: standard deviation

Discussion

Back Care Knowledge and Spine Disease Prevention

Habybabady et al. (2012) examined 404 children (203 in the intervention group, 201 in the control group, aged 10-11) before and after a back care education program on the change of back care knowledge and behavior. A week after the intervention, knowledge promotion in the intervention group was significantly higher than the control group after adjusting for primary knowledge scores ($p<0.001$) (Habybabady, 2012).

Cardon et al. (2007) measured the change of back care knowledge and fear-avoidance beliefs among 555 children (mean age at baseline: 9.7 years±0.7 years). In the group combining back care with physical activity promotion were 190 pupils, in the back care group were 193 children and the control group consisted of 172 children. In both intervention groups, the scores for back care related knowledge and back care behavior were significantly ($p<0.05$) higher than the control group (Cardon, 2007).

In the research of Tóthné and Tóth (2015), they measured the back care knowledge of 111 children before and eight months after the „Porci Berci" back education program. 79.33% of the children gave correct answers to the questions about lexical knowledge acquired from the spine, 93% recognized correct posture, and 79.01% managed to acquire spine-friendly movements (Tóthné, 2015).

We did not find any questionnaire targeted the curriculum, therefore we used a self-developed back care knowledge questionnaire. In the intervention group, the total score, the anatomical-biomechanical, and the spine use-

ergonomic knowledge were significantly ($p<0.001$) better for the end of the program and were significantly ($p<0.001$) better than the control group's results after the program.

Habitual posture and posture deemed correct

Kovácsné et al. (2016) examined the change of the habitual posture among 30 (mean age: 12.7±2.2 years) ballet dancers and 32 (13.7±2.9 years), hip-hop dancers, on the effect of a 3-month core stability training program. The habitual posture measured after the program improved by a high percentage in both groups (ballet 52.17%, hip-hop 37.5%) (Kovácsné, 2016).

Kayapinar et al. (2012) tested the efficacy of a back school program among 80 (40: intervention group, 40: control group) 5-7 years old children on the change of posture. They also used the New York State Posture evaluation. In the intervention group, 8 from the 13 measured parameters showed significant ($p<0.05$) improvement in the intervention group and 4 parameters measured after the program were significantly ($p<0.05$) better in the intervention group than in the control group (Kayapinar, 2012).

In our research, the total score of the habitual posture ($p<0.001$) and posture deemed correct ($p<0.001$) significantly improved in the intervention group for the end of the program and were significantly ($p<0.001$) better than the control group's results after the program.

Trunk muscle strength and lower limb muscle flexibility

As a result of the „Porci Berci" program, between 1998-2009, 1138 children were measured with the Matthias test (posture test). According to the results in 1998, although 249 between the ages 8-10 years 30.52 % of the children could carry the test correctly, in 2004, 2005 and 2009, the repeated tests showed a steadily deteriorating tendency (Tóthné, 2015).

In the research of Somhegyi et al., during the school year of 2001/2002, 200 6-14 years old children took part in the primary prevention program of the Hungarian Spine Society and 213 in the control group. In the intervention group, all the 12 muscle tests (responsible for posture) significantly ($p<0.01$) improved. In the control group in some of the abdominal and back muscle tests significant ($p<0.01$) improvement came to be, though this result was significantly ($p<0.01$) lower than the improvement in the intervention group, 6 muscle tests have not been changed and 4 showed significant ($p<0.05$) decadence (Tóthné, 2015). In the school year of 2009/2010, they measured 530, 7-12 years old children, who took part in the same program for 6 months. The static muscle strength and muscle flexibility showed significant ($p<0.001$) improvement at the end of the program (Tóthné, 2015).

In the research, that we conducted the trunk flexor ($p<0.001$), trunk extensor ($p<0.001$) static muscle strength, and the lower limb flexibility ($p<0.001$) tests significantly improved in the intervention group for the program and were significantly better than the control group's results measured at the end of the program.

Lumbar motor control ability

We did not find any back school program research in the literature that examined the lumbar motor control ability. We can compare our results to the research of Kovácsné et al., who examined 30 (mean age: 14.86±1.00 years) ballet dancer children's lumbar motor control ability after the implementation of a new core prevention training program for low back pain. For the end of the 3-month program, the lumbar motor control ability improved significantly ($p<0.001$) (Kovácsné, 2017). The lumbar motor control ability significantly ($p<0.001$) improved in the intervention group for the end of the program.

Conclusions

We measured the back care knowledge with the evaluated and developed back care knowledge and spine disease prevention questionnaire, we evolved a complex (trunk flexor-extensor static muscle strength, flexibility of shortening muscles, influencing the posture, habitual posture and posture deemed correct, lumbar motor control ability) test system, and a 1-school year back school program, that improves back care knowledge, and spinal function (theory) and trunk state (practice), under the name of „The Amazing Spinal Trip". The program should be tested in kindergarten.

Limitations

The research was conducted on a small size of the population, a more significant number of the population would allow more reliable conclusions. There was no follow-up in the study.

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Disclosure of interest

The authors report no conflict of interest.

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STUDY OF SPORTS MOTIVATION OF STUDENTS FROM THE TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

MIHAI OLĂNESCU[1]

ABSTRACT. Introduction*:* The purpose of this article is to analyze the motivation to practice sports and physical activities among university students. **Objectives:** To identify the perceived reasons, as well as the existing differences between the students from the Technical University of Cluj-Napoca, regarding the motivation to practice sports and physical activities, depending on the gender and the area of residence. **Methods**: To find out what motivates university students to take part in various physical sports activities, we conducted a study in the academic year 2019-2020, with 257 participants. The method of quantitative research and the technique of administering questionnaires by sociological survey was used. The research tool was the Sports Motivation Scale-6 (SMS-6; Mallett et al., 2007), which is an evaluation of contextual motivation meant to ascertain the perceived reasons for practicing sports activities. **Results:** Regarding the behavior of practicing sports among students at the Technical University of Cluj-Napoca, male students are more motivated compared to female students and intrinsic motivation is predominant compared to other types of motivation. The area of residence does not seem to influence differently the motivation of students to practice sports, the scores obtained on each type of motivation being very close between the respondents from rural and urban areas. **Conclusions*:*** Physical education and sports are perceived by some students as a school obligation (external motivation), by others as a recreational, compensatory or recovery activity, while for most of them it means fun, a way to meet new people and to enjoy their company (intrinsic motivation).

Keywords: *physical activity, motivation, sport, student, university.*

REZUMAT. *Studiul motivației sportive a studenților de la Universitatea Tehnică din Cluj-Napoca*. Introducere: Scopul acestui articol este de a analiza motivația de a practica sport și activități fizice în rândul studenților. **Obiective:** Identificarea motivelor percepute, precum și a diferențelor existente între studenții Universității Tehnice din Cluj-Napoca, cu privire la motivația de a practica sport și activități fizice, în funcție de sex și zona de reședință. **Metode**: Pentru a afla ce motivează studenții universitari să ia parte la diferite activități sportive, am realizat un

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studiu, în anul universitar 2019-2020, cu 257 de participanți. A fost utilizată metoda cercetării cantitative și tehnica de administrare a chestionarelor prin sondaj sociologic. Instrumentul de cercetare utilizat a fost Scala de motivare sportivă-6 (SMS-6; Mallett și colab., 2007), care este o măsură a motivației contextuale menită să identifice motivele percepute pentru participarea la activități sportive. **Rezultate**: În ceea ce privește comportamentul practicării sportului în rândul studenților de la Universitatea Tehnică din Cluj-Napoca, studenții sunt mai motivați în comparație cu studentele și motivația intrinsecă este predominantă în comparație cu celelalte tipuri de motivație. Zona de reședință nu pare să influențeze diferit motivația studenților de a practica sport, scorurile obținute pe fiecare tip de motivație fiind foarte apropiate între respondenții din mediul rural și cel urban. **Concluzii:** Educația fizică și sportul sunt percepute de unii studenți ca o obligație școlară (motivație externă), de alții ca o activitate recreativă, compensatorie sau de recuperare, în timp ce, pentru cei mai mulți dintre ei înseamnă distracție, un mod de a cunoaște oameni noi și de a se bucura de compania lor (motivația intrinsecă).

***Cuvinte-cheie**: activitate fizică, motivație sport, student, universitate.*

Introduction

Motivation is a psychological construct that occurs as a result of an individual's intention, need, interest or desire. Motivation is the basis of the most fascinating issues in the world of sports, as a consequence of the evolution of social networks, like emulation, determination, learning and performance (Vallerand, Deci & Ryan, 1987 cited in Pelletier et al., 1995).

Motivation is a topic of great interest in sports and exercise psychology, which is debated in various circumstances, such as sport, exercise, physical education, and health (Lindahl, Stenling, Lindwall & Colliander, 2015). One of the main ideas is that individuals have various motivations to practice sport and physical activities (Ryan & Deci, 2017).

Motivation it is described as: "the direction and intensity of effort" (Sage, 1977 cited in Weinberg & Gould, 2011, p.51); the state that energizes behavior and gives it direction (Atkinson & Hilgard, 2005); forces that initiate, direct and sustain behavior (Green, 1996).

Vallerand & Thrill, 1993 defines motivation as "Hypothetical construct used to describe the internal and/or external forces that produce initiation, direction, intensity and persistence of behavior". Direction refers to the choice of the objective by each individual and the intensity is the effort that the individual makes to reach his goal. In practice the two dimensions are found in a conditioning relationship, in general the choice of an objective is followed by the desire to make a considerable effort to achieve it.

The psychology of sport provides several tools for evaluating motivation. Sport Motivation Scale (SMS – 28 Pelletier et al., 1995) is the most widely used questionnaire, which demonstrates sound validity for athletes of both sexes and is appropriate to use when translated into other languages (Taylor, 2018, p. 87).

Self-determination theory SDT (Deci & Ryan, 1985; Ryan & Deci, 2017) underlies the assessment of motivation in SMS. From the SDT perspective, we can speak about several types of motivation that evolves from amotivation to intrinsic motivation, all in direct relation to self-determination (Cox, 2002).

Intrinsic motivation is the prototype of the autonomous activity and involves the active engagement of a person in a task that he/she considers interesting, without needing a reward, other than carrying out the activity itself. By intrinsic motivation it is understood that a person likes to practice a certain sport without thinking about how it could be rewarded. Students can participate in various physical sporting activities for internal reasons, such as the joy of movement, rather than focusing on the benefits that can arise from practicing them (Thogersen-Ntoumani & Ntoumanis, 2006). It is more likely that intrinsically motivated people to get involved in sport activities and, at the same time, to persevere to improve their sports skills.

Extrinsic motivation refers to the motivation that comes from outside. It appears in different forms, the common examples being the material benefits, the trophies, the medals, the social approval, but also the fear or the punishment. Most students practice various physical sports activities not only because are interesting or enjoyable to them, but rather because they have something to gain from practicing these activities, for example, by improving their health, shape and body appearance.

In fact, in most sports physical activities we find a combination of these two types of motivation, even the most enjoyable sports activities require periods of external motivation for learning and improving certain specific skills. Motivation is present regardless of our favorite sport and sometimes the two types of motivation combine or, why not, intrinsic motivation can be transformed into extrinsic motivation and vice versa.

The individual characterized by amotivation or relative absence of motivation does not establish any connection between results and actions, and the level of motivational impulse is very low. Demotivated individuals perceive their behavior as being determined by forces beyond their control. There are several reasons why a person lacks motivation. A major reason would be that the person does not feel competent, this may result from the lack of necessary knowledge and/or specific skills, another reason is that the person does not see any connection between the action and the desired results, and in the end, the person simply does not want to act (Ryan, Patrick & Deci, 2009).

Material and methods

The aim of the study:

- analysis of the perceived reasons that determine the students of the Technical University of Cluj-Napoca to practice sports and physical activities.

Objectives:

- identifying the reasons perceived by students for participating in sports;
- evaluating the various motivational orientations of university students regarding the practice of sports;
- identification of the existing differences, depending on the gender and the area of residence, between the students of Technical University of Cluj-Napoca, regarding the sports motivation.

Methods, techniques, and research tools:

- the method of quantitative research and the technique of administering the questionnaire by sociological survey were used.

The research tool used was the Sport Motivation Scale-6 (SMS-6; Mallett et al., 2007), which is a measure of contextual motivation meant to identify the perceived reasons for taking part in sports activities. SMS-6 measures six forms of motivation that reflect varying degrees of self-determination along a continuum of motivation. Students are asked to answer the question "Why do you practice sport? Participants respond using a five-point Likert scale ranging from 1=does not match at all to; 2=corresponds a little; 3=corresponds moderately; 4=corresponds a lot and 5=corresponds exactly.

Participants: The research was conducted in the academic year 2019-2020 and involved 257 students from the Technical University of Cluj-Napoca.

Descriptive statistics on respondents in the sample highlights the following:

The gender distribution of the sample shows that, out of a total of 257 students who participated in this study, 137 (53.3%) are male students and 120 (46.7%) are female students.

The distribution of respondents by area of residence shows that most of them, namely 110 (42.8%) of the students surveyed come from a village. The number of students who stated that they grew up in a small town is 74 (28.8%), and those they come from a big city is 73 (28.4%).

The survey participants were involved in various sports activities at least twice a week.

Results

The SPSS program was used for the interpretation of the collected data. In order to determine the degree of motivation of the students, in the analysis of the obtained data, we took into account only the values that correspond a lot or correspond exactly, which are presented in the table below:

Table 1. Independent variables on each type of motivation

Type of motivation **Why do you practice sport?**	**Independent variable**		**Corresponds a lot**	**Corresponds exactly**
Amotivation I don't think I'm able to do sports anymore. I don't want to do sport anymore. I don't find myself in sport. I don't like sports anymore.	**Gender**	Male	3,25%	2,30%
		Female	5,63%	1,50%
	Area of Residence	Urban	4,58%	1,97%
		Rural	3,98%	1,87%
External Regulation Because I can be appreciated by other people For the reputation of being an athlete. For other benefits offered by the practice of sports (material, social). To show others that I am a valuable athlete.	**Gender**	Male	15,43%	10,13%
		Female	7,85%	4,20%
	Area of Residence	Urban	12,90%	8,00%
		Rural	10,60%	7,53%
Introjected Regulation You have to do sports to be fit. Playing sports makes me feel good. I wouldn't feel good without sports. Because sport has to be part of the daily routine.	**Gender**	Male	26,55%	31,10%
		Female	22,55%	22,17%
	Area of Residence	Urban	26,98%	26,67%
		Rural	21,85%	27,87%

Type of motivation Why do you practice sport?	Independent variable		Corresponds a lot	Corresponds exactly
Identified Regulation Sport prepares me for other areas of life. Because sport is very helpful in other activities of daily life. It helps me have a good relationship with my friends. Because only through sustained training can I increase my performance.	**Gender**	Male	23,73%	22,23%
		Female	17,80%	11,93%
	Area of Residence	Urban	21,55%	19,90%
		Rural	20,10%	14,63%
Integrated Regulation Because for me, sport is a way of life. Because sport is an extension of me. Because playing sport corresponds to my life principles. Because sport is a part of my lifestyle.	**Gender**	Male	23,25%	18,23%
		Female	16,13%	11,00%
	Area of Residence	Urban	21,75%	18,40%
		Rural	18,03%	10,57%
Intrinsic Motivation For the excitement of playing sport Because knowing some elaborate training techniques makes me very happy. Because improving my own skills gives me a sense of satisfaction. For the good feeling offered by learning new strategies.	**Gender**	Male	30,60%	35,40%
		Female	23,73%	20,57%
	Area of Residence	Urban	27,50%	33,23%
		Rural	27,13%	23,33%

The table shows the data obtained after calculating the average value for each type of motivation. The 28 questions in the questionnaire are grouped into six groups of 4 questions, each group corresponds to a type of motivation.

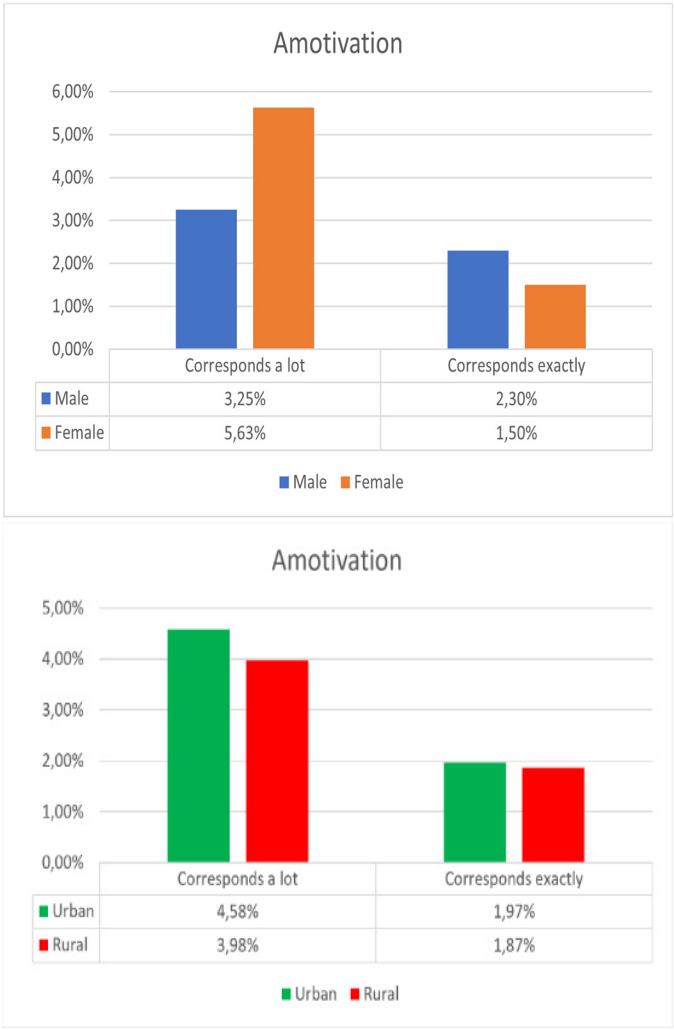
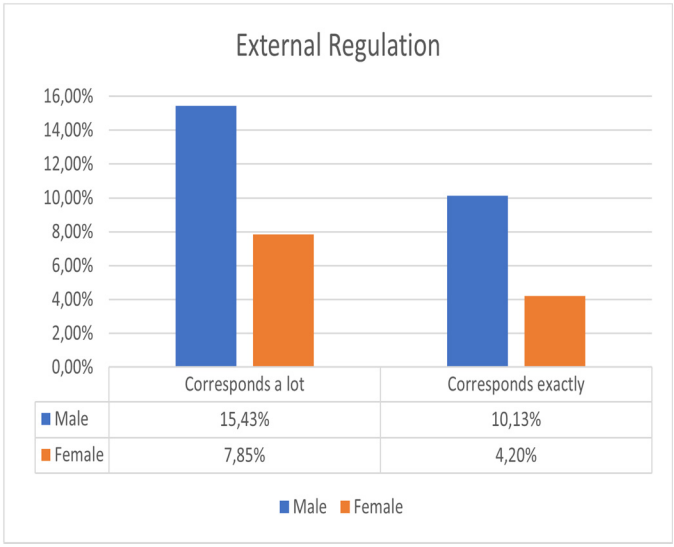


Figure 1. Amotivation

Amotivation. The results from Figure 1 shows that a very small percentage of respondents declared that are amotivated. For the independent variables, female students and those who grew up in urban areas are more demotivated. This shows that the vast majority of respondents are interested in sport and attach great importance to it.



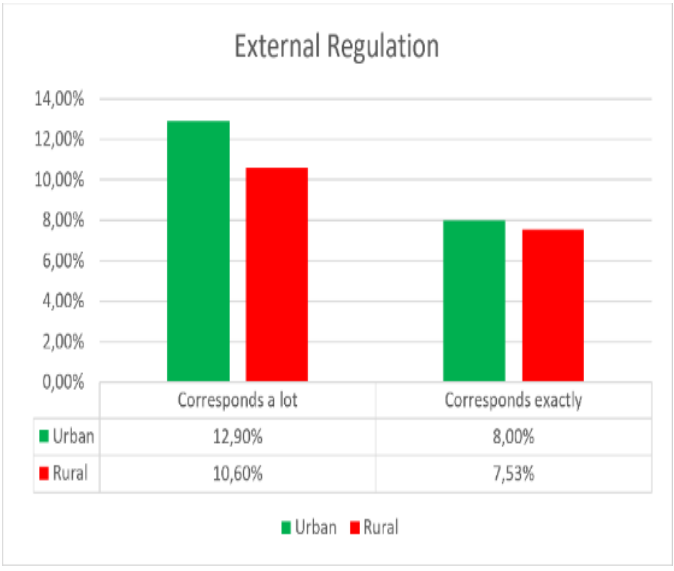


Figure 2. External Regulation

External Regulation. In Figure 2 we notice that a small number of students are externally motivated, the percentage being higher among male students (approximately 25%) and those who grew up in urban areas (approximately 20%). A small number of surveyed students participate in sports activities with the intention of being rewarded or to escape a possible sanction.

Some students attend physical education classes not because they are really interested in the subject, they do it with the desire to get a reward, more precisely to pass the exam.

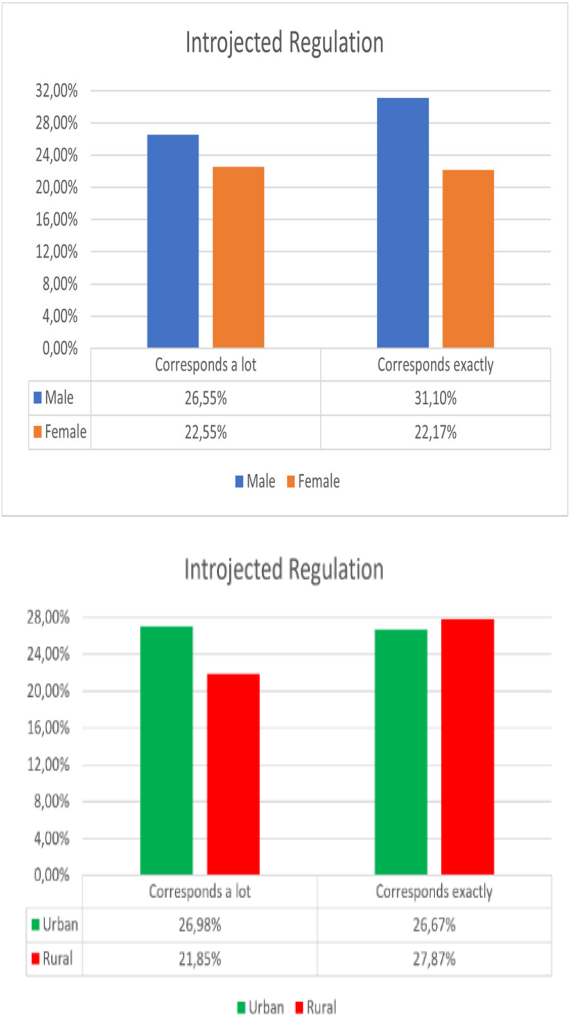
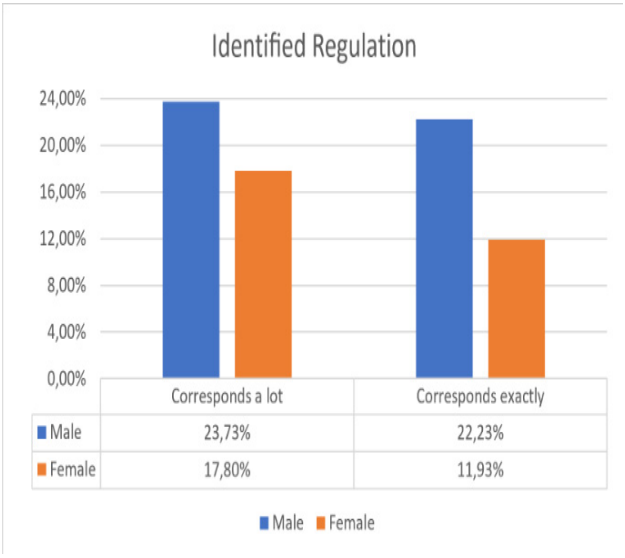


Figure 3. Introjected Regulation

Introjected Regulation. Female students are less motivated compared to male students. Students participate in sports activities to avoid external sources of disapproval or to obtain external approval from colleagues, friends, parents of coaches and teachers.



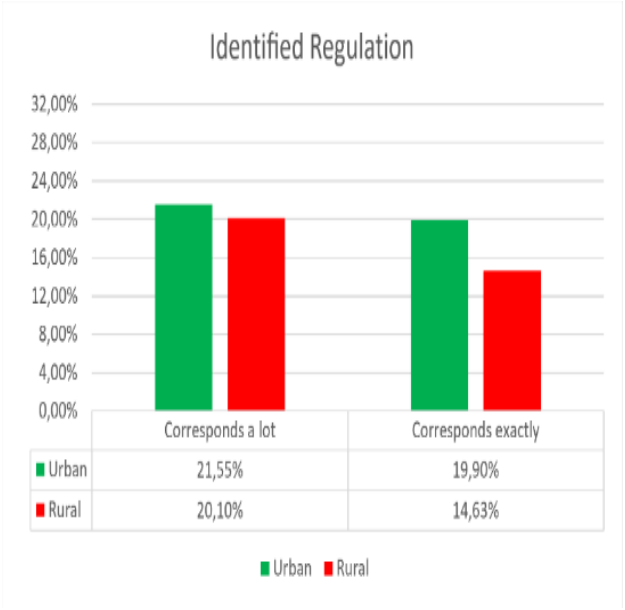


Figure 4. Identified Regulation

Identified Regulation. Students practice sports activities on their own initiative, with the desire to learn new sports skills, to be better prepared physically and to look better.

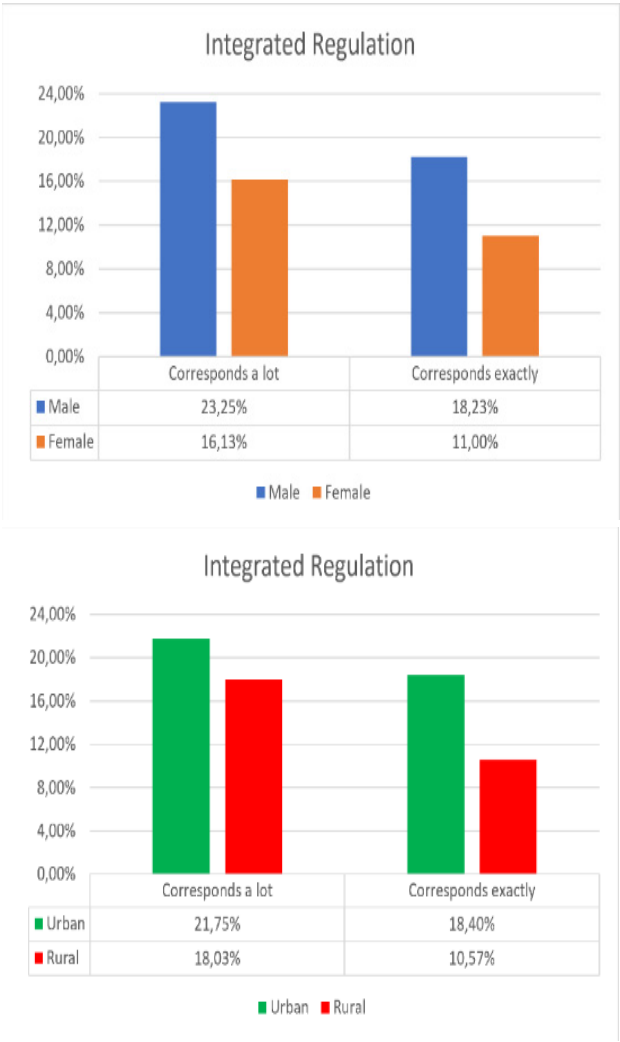


Figure 5. Integrated Regulation

Integrated Regulation. And in this case, male students and those who grew up in an urban area are more motivated (Fig. 5). For these students, the behavior of playing sports responds to the psychological needs, more precisely the need to exercise.

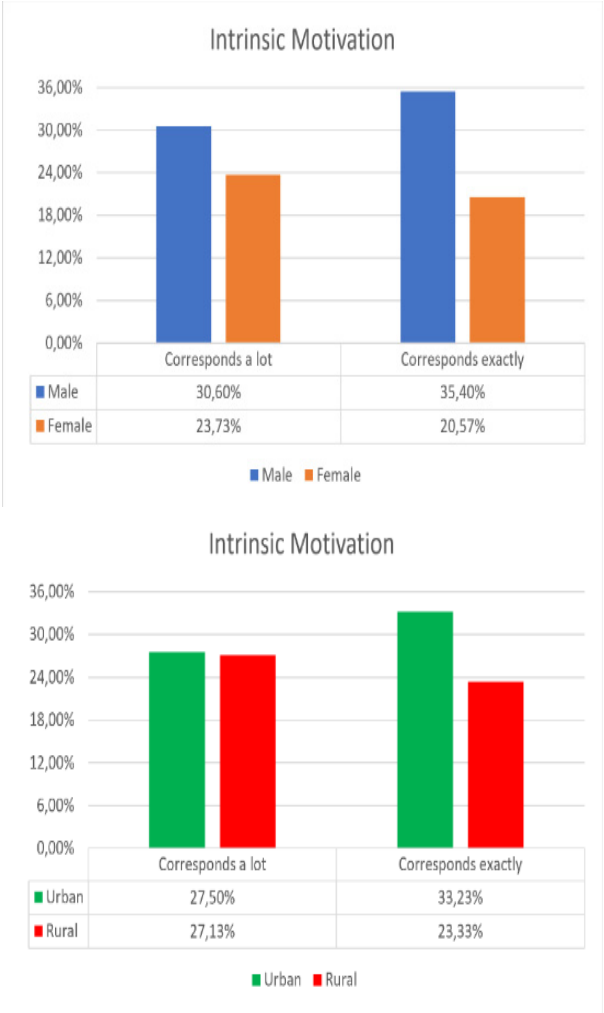


Figure 6. Intrinsic Motivation

Intrinsic Motivation. Male students are more intrinsically motivated than female students. Students who grew up in urban areas are more intrinsically motivated than those who grew up in rural areas. The highest percentage of answers that correspond exactly or a lot are found in the type of intrinsic motivation (Fig. 6). This shows the fact that most of the students are intrinsically motivated, they practice sports voluntary, for enjoyment, movement and fun, without external obligations or rewards. The intrinsic motivation for playing sports is given by the pleasure of participating and the increased interest in such activities.

Conclusions

In conclusion, we must emphasize that the students from the Technical University of Cluj-Napoca have a higher intrinsic than extrinsic motivation and there is an even higher motivation among male students than among female students.

The average results of the answers that correspond exactly or more show us that the highest percentages are found among male students and those who grew up in a city.

The area of residence does not have a significant influence on the behavior of students' sports activities, the differences between the scores that correspond exactly or very much of the respondents from urban and rural areas being very small. Those from rural areas may be more motivated to play sports, probably due to the small number of places available for sports in those areas and the limited access to them.

Physical education and sport are specific activities based on physical exercises performed by people of different ages, of both sexes and for different reasons. Physical education and sports are perceived by some students as a school obligation (external motivation), by others as a recreational, compensatory or recovery activity, while for most of them it means fun, a way to meet new people and to enjoy their company (intrinsic motivation).

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TOPOGRAPHICAL PROMINENCE OF THE PEAKS FROM FĂGĂRAŞ MOUNTAINS (ROMANIA) WITH RELEVANCE TO THE MOUNTAIN ACTIVITIES. METHODOLOGICAL AND PRACTICAL ASPECTS

IOAN BÎCA[1]

ABSTRACT. The peaks of the mountains have aroused the interest of people since ancient times. The route to get there, the difficulty of climbing, the view that was visible to the eyes there were challenges for everyone. And these turmoils, generated, over time, a special activity that targeted the mountain tops, mountaineering. From the moment Mont Blanc was conquered (Balmat, Paccard, 1786), then Everest (Hillary, Tenzing, 1953), mountain lovers are constantly looking to reach the peaks, to get drunk with ephemeral success, and become conquerors of useless (Terray, 1961). But the peaks, in addition to being bastions that need to be attacked, are also distinguished by geomorphometric approaches, and one of these approaches is the prominence, a parameter that represents the level difference by which a peak jumps over its base from the surrounding regions. Therefore, the higher this jump, the more important the tip is for mountaineers, and the more it should be included in the list. In this context, this paper aims to analyze and establish the prominence of the peaks of the most coveted mountain massif in the Romanian Carpathians, namely Făgăraş Mountains, highlighting a practical side of the problem, materialized by the methodological approach included in the research.

Keywords: *mountain prominence, key-saddle, key col, line parent chain, parent-peak, mountain hierarchy, orometric dominance, mountaineering*

REZUMAT. ***Proeminența topografică a vârfurilor din Munții Făgărașului (România), cu relevanță pentru activitățile agrementale montane. Aspecte practice și metodologice.*** Vârfurile munților au stârnit interesul oamenilor din cele mai vechi timpuri. Drumul până acolo, dificultatea de a urca, priveliștea care se dezvăluia ochilor de acolo, erau provocări pentru oricine. Și aceste frământări, au generat, peste timp, o activitate aparte care viza vârfurile munților, muntenăria. Din momentul în care a fost cucerit Mont Blancul (Balmat, Paccard, 1786), apoi Everestul (Hillary, Tenzing, 1953), iubitorii muntelui își doresc neîncetat

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să ajungă pe vârfuri, pentru a se îmbăta cu un succes efemer şi a deveni cuceritori ai inutilului (Lionel Terray, 1961). Dar vârfurile, pe lângă faptul că sunt bastioane care trebuie asaltate, se disting şi prin abordări geomorfometrice, iar una dintre aceste abordări este proeminenţa, parametru care reprezintă diferenţa de nivel prin care un vârf saltă peste baza sa faţă de regiunile înconjurătoare. Prin urmare, cu cât acest salt este mai mare, cu atât vârful este mai important pentru muntenari şi cu atât mai mult trebuie inclus în palmares. În acest context, lucrarea de faţă îşi propune să analizeze şi să stabilească proeminenţa vârfurilor din cel mai râvnit masiv montan din Carpaţii Româneşti, respectiv Munţii Făgăraşului, scoţând în evidenţă şi o latură practică a problemei, materializată prin demersul metodologic inclus în cercetare.

Cuvinte-cheie: *proeminenţă montană, înşeuare-cheie, dominanţă orometrică, turism montan*

Introduction

Peaks, as geographical entities, can be defined from two perspectives:

1) As a position within a morphographic system: the peaks represent geomorphological structures located at the upper terminal part of a mountain (height) = the top of the mountain (fig. 1).

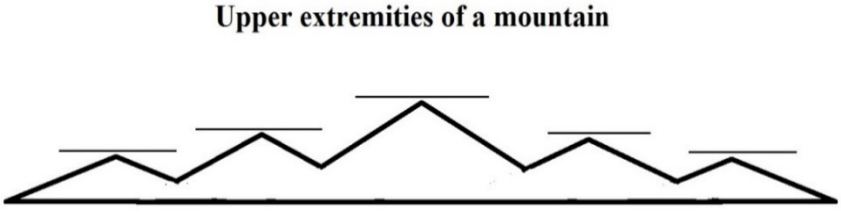

Fig.1. Peaks position on a mountain ridge

2) As geomorphology: the peaks represent prominences located in the plane of the ridges (rise), defined by specific morphographic elements (base, shape, flanks, upper extremity) and morphometric elements (altitude, inclination, and length of the flanks, level difference between base and upper extremity) (fig.2). As such, the prominence is the level difference between the base of a peak, called the "key saddle" or "key col", and its upper extremity (top).

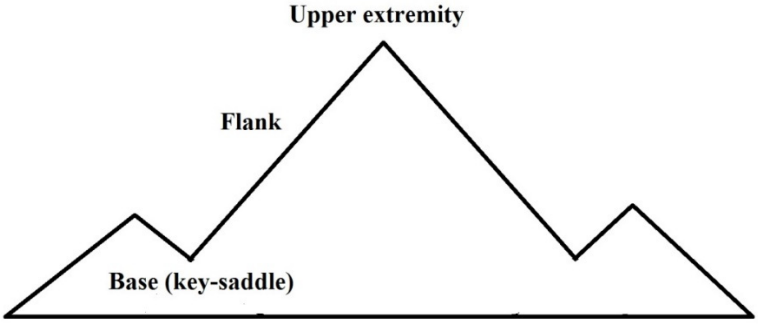

Fig. 2. The morphographic elements of a peak

These geomorphological structures appeared in the process of modeling mountain spaces, their detachment contributing to petrography (rock type), structural heritage (the position of geological bodies), hydro-atmospheric factors (precipitation, thermal variations, winds, ice), biogeographical factors (the action of vegetation, organisms) and anthropogenic factors (man and his activities).

For this reason, certain genetic (age), altimetric (height), and spatial (distance between peaks) ratios are established between the peaks located on a certain mountain ridge. The genetic point of view is very important in establishing prominence because the peaks differ from each other in rank. The highest peaks are considered "parent peaks", and the peaks below their altitude represent "sub-peaks", ranked in peaks of rank I, II, III, etc. In this context, the lower rank peaks are subordinated to the higher rank peaks, and their prominence is established about to them (fig.3). Finally, all sub-peaks are subordinated to the parent peak, in a so-called line of genetic descent (lineage).

For practical reasons, this article will address the peak as a geomorphological structure (landform), and the parameter that interests us, in connection with it, is the prominence (rise), which can be defined as the level difference between the base of the peak (key saddle), and its upper extremity (top).

The value of prominence is relevant in mountain recreational activities, as the peaks are attractions that must be escalated for several reasons:

-are the highest surfaces of the mountain, which attract attention and interest;

-provides viewpoints over the surrounding regions;

-involves special physical and mental demands to be achieved;

-constitutes targets with competitive sports connotations.

Because of this, the altitude and prominence of the peaks, along with the aesthetic component, induced by shape (conical, pyramidal, domed) and detailed relief of the flanks (slopes, steps, cliffs, ravines, ridges, glacial circuses, debris fields, etc.), are the most important reasons for practicing mountain recreational activities.

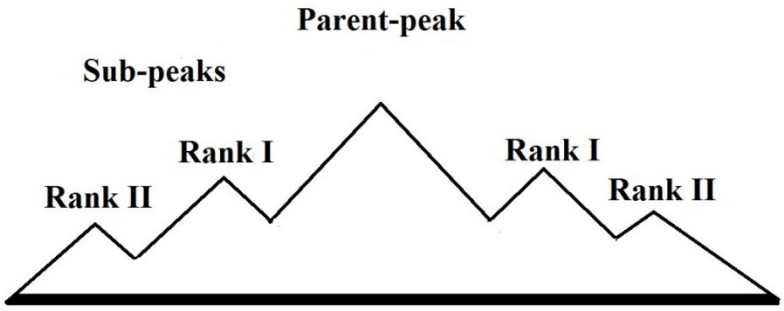

Fig. 3. The ranks of the peaks

Literature review

Concerns about establishing topographic prominence began in Britain in the late 19th century, when attempts were made to establish geomorphological structures with "mountain" status in England, Wales, and Ireland (Nuttall, Nuttall, 1989, 1990); Dawson, 1992; Dewey, 1995; Dawson, 1997a; Dawson, 1997b; Bearhop, 1997, Jackson, 2009). For this, the altitude of the structures and the minimum prominence of the peaks were taken into account.

Thus, the structures that had an altitude over 600 m and the minimum prominence over 15 m (30, 55, 150 m) were considered mountains. In 1991, Richard Goedeke set the minimum prominence of a peak of importance for mountaineering, at 30 m, as the classic length of rope for mountaineering, a value also adopted by the UIAA in 1994. In the US, the minimum value of the prominence of an important peak is 91 m. For the Alps, the works of Höhne (1993), Grimm and Mattmüller (2004), Helman (2005), and Goedeke (2006) can be mentioned. At a general and methodological level, the works of Schmidt and Stumme (2018), and Stubbemann et al. (2019) are recommended.

Study area

The Făgăraş Mountains are located in the Southern Carpathians (Făgăraş Group), between the Olt Valley (W), the Bârsa Groşetului-Dâmboviţa Valleys (E), the Făgăraş Depression (N) and the alignment of the Câmpulung, Brădetu, Arefu and Jiblea depressions (fig. 4). The present study considers the main ridge, developed sinuously, from west to east, on a length of 87 km, between Olt Valley (360 m) and Curmătura Foii Saddle (1350 m), within which are the highest peaks and a spectacular relief, with glacial and periglacial forms (glacial circuses, glacial valleys, moraine mounds, cusps, cliffs, peaks, chimneys, ravines, lathes, and rubble) modeled on metamorphic rocks (crystalline shales) (fig. 5).

Fig. 4. Geographical position of Făgăraş Mountains in Romanian Carpathians (source: ro.Wikipedia.org-with changes)

Fig. 5. Longitudinal profile of Făgăraş Mountains (source: MapMyHike.com-with changes)

Methodologies

For the elaboration of this article, several methodological steps were followed, as follows:

a) Analysis of the topographic map and extraction of the peaks from the main ridge (table 2).

- for this operation, the online topographic map of Romania was used, with a scale of 1: 25000, the equidistance of the main level curves of 50 m, from the website of the Military Topographic Directorate: (https://portal.geomil.ro/portal/home/ web map / viewer.html).

b) Elaboration of the diagram of the peaks on the main ridge, according to the data from table 2 (fig.6).

- for this operation the Paint program was used, where on a millimeter sheet the axis of the altitudes from 100 to 100 m was drawn, at a distance of 2 cm, then the altitudes of the peaks and saddles between them were scored.

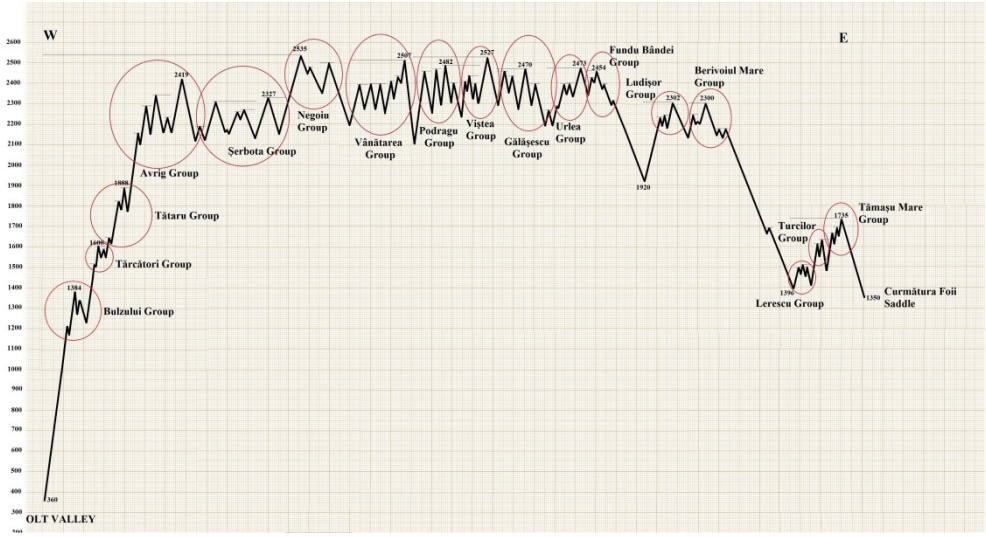

Fig. 6. The diagram of the peaks of the main ridge in Făgăraș Mountains (source: Topographic Map of Romania, 1: 25 000)

c) Grouping the peaks based on the subordination relations between them:

- in the modeling process of the main ridge several peaks resulted, between which there are certain relations of genetic, spatial, and altimetric subordination (fig.6);

- Negoiu (2535 m), and Viştea Mare (2527 m) - Moldoveanu (2544 m) duet can be considered as parent-peaks;

- the other peaks on the main ridge were grouped, on the same subordination criteria, around first-order peaks, as follows (table 1).

Table 1. Grouping the peaks on the main ridge of the Făgăraş Mountains, according to their order

Main group	**Main peaks/First order**	**Subordinated peaks/Second and third order**
Avrig	Bulz	Drăghicioaia, Bulz, Repezoi
	Tărcători	Strâmbaru, Tărcători
	Tătaru	Prislop, Tătaru
	Avrig	Suru Mic, Suru Mare, Budislavu, Vârtoapele, Gârbova
Negoiu	Şerbota	Gârbova, Scara, Puha, Scărişoara, Scăriceaua
	Negoiu	Portiţei, Călţun, Curmăturii
Vânătarea lui Buteanu	Vânătarea lui Buteanu	Lăiţel, Laiţa, Paltinu, Capra, Văiuga
Viştea-Moldoveanu	Podragu	Vârtop, Arpaşu Mare, Tărâţa
	Ucea	Corabia, Ucişoara
	Gălăşescu Mare	Hârtopu Ursului, Galbenele, Gălăşescu Mic, Slănina
Urlea	Mogoş	Slănina, Colţul Bălăceni, Cheia Bândei
	Fundu Bândei	Iezer, Geamăna, Leaota
Ludişoru	Ludişor	Zîrna, Langa
	Berivoiul Mare	Pietrele Popii, Belia, Laptele, Luţele, Cornişu Mic
Tămaşu Mare	Lerescu	Rudăriţa, Lerescu Mare, Lerescu Mic
	Turcilor	Piscul Mănăstirii
	Tămaşu Mare	Ciocinea, Răchita Mare

d) Establishing key saddles and topographic prominences:

- for this operation, the graph of the peaks on the main ridge was analyzed and the subordination relations between them were established, after which the key saddles were established for each peak (fig.6);

- based on these key saddles, the prominence of each peak was calculated by the following formula:

Pp= Pa-KSa, where Pp = peak prominence, Pa = peak altitude, and KSa = key saddle altitude (table 1)

e) Establishing the orographic dominance:

- after calculating the prominences, the orographic dominance of each peak was calculated, based on the formula Od = Pp / Pa x100, where Od = orometric dominance, Pp = peak prominence, and Pa = peak altitude;

- the orometric dominance shows us the importance of the respective peak in the orographic system of the Făgăraş Mountains and within the main ridge;

- the smaller the difference between the value of the prominence and the altitude of the peak, the higher the orometric dominance / the higher the prominence, the higher the orometric dominance;

- the peaks with high prominence are also distinguished by high values of orometric dominance;

- the most prominent and dominant peaks are Negoiu, Vişţea Mare, and Moldoveanu (table 2).

Results and discussions

Based on the Topographic Map, scale 1:25 000, published in 1984 by the Military Topographic Directorate, we established within the main ridge of the Făgăraş Mountains 69 peaks, between 1200 m and 2544 m. Of these, four peaks have the altitude of 2500 m (Moldoveanu, 2544 m; Negoiu, 2535 m; Vişţea Mare, 2527 m; Vânătoarea lui Buteanu, 2507 m).

The parent peaks on this ridge are Negoiu (2535 m) and the Vişţea Mare-Moldoveanu duet (2527-2544 m), which are testimonies about the altitude and the initial configuration of the mountainous terrain. Peaks below these altitudes are considered sub-peaks and are grouped based on genetic, altimetric, and spatial subordination ratios, which facilitate the establishment of key saddles and the value of the prominences. Based on the methodology presented above, the following values of orometric prominences and dominances were obtained (table 2).

Table 2. Topographic parameters of the peaks on the main ridge of the Făgăraş Mountains

Crt no.	Peak	Elevation m	Key saddle m	Proeminence m	Orometric dominance m	Status
1	Drăghicioaia	1210	1170	40	3.30	Peak
2	Bulzului	1384	1240	114	8.23	Peak
3	Repezoi	1341	1270	71	5.29	Peak
4	Strâmbaru	1511	1490	21	1.38	Summit
5	Tărcători	1600	1550	50	3.12	Peak
6	Comarnic	1587	1550	37	2.33	Peak
7	Prislopul Mic	1640	1620	20	1.21	Summit
8	Prislop	1820	1780	40	2.19	Peak
9	Tătaru	1888	1770	118	6.25	Peak
10	Suru Mic	2153	2100	53	2.46	Peak
11	Suru Mare	2283	2150	133	5.82	Peak
12	Budislavu	2343	2160	183	7.81	Peak
13	Vârtoapele	2233	2160	73	3.26	Peak
14	Avrig	2419	2120	299	12.3	Peak
15	Gârbova	2188	2120	68	3.10	Peak
16	Scara	2306	2160	166	7.19	Peak
17	Puha	2176	2150	26	1.19	Summit
18	Scărişoara	2261	2220	91	4.02	Peak
19	Scăriceaua	2270	2130	140	6.16	Peak
20	Şerbota	2327	2150	177	7.60	Peak
21	Negoiu	2535	360	2175	85.79	Peak
22	Portiţei	2476	2350	282	11.38	Peak
23	Călţun	2500	2300	200	8	Peak
24	Curmăturii	2210	2194	16	0.72	Summit
25	Lăiţel	2391	2270	121	5.06	Peak
26	Laiţa	2399	2270	110	4.58	Peak
27	Paltinul	2399	2250	149	6.21	Peak
28	Capra	2410	2320	90	3.73	Peak
29	Văiugii	2430	2400	30	1.23	Peak
30	Vânătarea	2507	2194	313	12.48	Peak
31	Vârtop	2460	2250	210	8.53	Peak
32	Arpaşul Mare	2468	2290	178	7.21	Peak
33	Podragu	2482	2300	182	7.33	Peak
34	Tărâţa	2400	2300	100	4.16	Peak
35	Corabia	2406	2360	46	1.91	Peak
36	Ucea Mare	2434	2300	134	5.50	Peak
37	Ucişoara	2399	2320	79	3.29	Peak
38	Viştea Mare-Moldoveanu	2527-2544	360	2167-2184	85.75-85.84	Peaks
39	Hârtopul Ursului	2454	2290	164	6.68	Peak
40	Galbena	2436	2350	86	3.53	Peak

Crt no.	Peak	Elevation m	Key saddle m	Proeminence m	Orometric dominance m	Status
41	Gălășescu	2470	2290	180	7.28	Peak
42	Gălășescu Mic	2398	2290	108	4.50	Peak
43	Slănina	2268	2190	78	3.43	Peak
44	Colțu Bălăceni	2286	2280	6	0.26	Summit
45	Cheia Bândei	2381	2340	41	1.72	Peak
46	Mogoș	2398	2330	68	2.83	Peak
47	Urlea	2473	2190	283	11.44	Peak
48	Iezer	2429	2400	29	1.19	Peak
49	Fundu Bândei	2454	2336	118	4.80	Peak
50	Geamăna	2386	2370	16	0.67	Summit
51	Leaota	2312	2290	22	0.95	Summit
52	Zârna	2231	2190	41	1.83	Peak
53	Langa	2242	2180	62	2.76	Peak
54	Ludișoru	2302	1920	382	16.59	Peak
55	Pietrele Popii	2247	2200	47	2.09	Peak
56	Belia	2212	2200	12	0.54	Summit
57	Berivoiul Mare	2300	2125	175	7.60	Peak
58	Laptele	2171	2140	31	1.42	Peak
59	Luțele	2176	2130	46	2.11	Peak
60	Cornișu Mic	1690	1660	30	1.77	Peak
61	Rudărița	1494	1460	34	2.27	Peak
62	Lerescu Mare	1503	1407	96	6.38	Peak
63	Lerescu Mic	1499	1450	51	3.40	Peak
64	Piscul Mănăstirii	1613	1550	63	3.90	Peak
65	Turcilor	1631	1484	147	9.01	Peak
66	Ciocinea	1652	1610	42	2.54	Peak
67	Răchita Mare	1682	1650	32	1,90	Peak
68	Tămașu Mare	1735	1396	339	19.53	Peak

Geomorphological structures that are distinguished by prominences over 30 m were considered peaks, and those below this value were declared heights (summits).

Regarding the orometric dominance of the peaks, as a ratio between Pp and Pa (Od = Pp / Pa x100), the following aspects emerged:

- the higher the peaks prominences (Pp), the higher the orometric dominances (Od);

- Pp depends on the altitude of the key saddle (the deeper the key saddle, so it has a higher value, the higher the Pp, and the higher the orometric dominance);

- if the key saddle is deep, it means that erosion has been strong, which is observed in high prominence and high orometric dominance;

- usually, the peaks with major Od group around them are peaks of lower rank.

Based on the results obtained, the following orometric classes were established:

1) Class 0-3: Curmăturii (0.72), Puha (1.19), Prislopul Mic (1.21), Prislop (2.19), Luţele (2.11), Comarnic (2.33), Tărcători (3.12), Drăghicioaia (3.30) etc.;

2) Class 4-6: Scărişoara (4.02), Tărîţa (4.16), Gălăşescu Mic (4.50), Laiţa (4.58), Fundu Bândei (4,80), Lăiţel (5,06), Repezoi (5,29), Ucea Mare (5,50), Suru Mare (5,82), Scăriceaua (6.16), Paltinu (6.21), Tătaru (6.25), Lerescu Mare (6.38), Hârtopul Ursului (6.68);

3) Class 7-9: Scara (7.19), Arpaşu Mare (7.21), Gălăşescu (7.28), Podragu (7.33), Şerbota (7.60), Berivoiul Mare (7.60), Budislavu (7.81), Călţun (8), Bulzului (8.23), Vârtop (8.53), Turcilor (9.01);

4) Class 11-12: Portiţei (11.38), Urlea (11.44), Gârbova (12.3), Vânătarea (12.48);

5) Class 16-19: Ludişoru (16.59), Tămaşu Mare (19.53);

6) Class 85 (parent-peaks): Viştea Mare (85.75), Negoiu (85.79), Moldoveanu (85.84).

Conclusions

The present study established the geomorphometric status of the peaks on the main ridge of the Făgăraş Mountains, the most coveted mountain massif in Romania. Thus, peaks with prominences over 30 m can be considered peaks proper, and those below this value represent only heights (summits), which is included in a certain hierarchy of preferences for mountaineers.

Through its genesis, altitude, shape, detailed relief, and prominence, the peaks of the Făgăraş Mountains represent landmarks that must be reached by those who carry out recreational activities on the mountain. In this context, the peaks have a double meaning: a sports-leisure significance (the last alignment, a finish line) and a psychological significance (challenge, record).

Regarding the importance of the peaks of the main ridge in the Făgăraş Mountains for mountain leisure activities, they are distinguished by:

1) Scenic relevance:

- tops are viewpoints;

2) Cultural relevance:

- tops have mythical connotations;

3) Sports relevance:

- high points that must be climbed through physical and mental performance;
- high points that launch challenges;

4) Strategic relevance:

- natural boundaries between administrative units;

5) Ecological relevance:
- the peaks preserve components of the environment (relief, plants, animals);

6) Psychological relevance:
- an obstacle to be overcome;
- challenge to be accepted;
- objective that must be included in the record.

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