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The Effects of Plyometric Training On the Running Speed in Soccer

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ABSTRACT

The plyometric method can be referred to as specific neuromuscular training, which may be used to optimize soccer players' functional status and physical fitness levels. The development of functional strength, which can be repeatedly used under game conditions, is decisive for success in the games themselves. The paper aims to extend knowledge about the effects of plyometric training on running speed among soccer players. Twelve U19 soccer players from the MFK Ružomberok soccer club participated in the experiment. The soccer players performed 10-m, 30-m, and 50-m running tests and an agility T-test. From the viewpoint of determining the efficiency of the plyometric method, the testing also included tests aimed to assess ankle mobility and jump tests with and without countermovement performed with the use of Optogait. The soccer players participated in a 9-week intervention program that included two 30-minute training sessions per week. As regards the effects of plyometric training on running speed, soccer players improved their running speed levels in both acceleration speed and running speed with changes of direction. The results show that these changes are determined by ankle mobility and lower-body explosive power levels..

Keywords: soccer; physical conditioning; running; speed; sports games

INTRODUCTION

Soccer performance requires a diversity of physical attributes and biomotor abilities. In-season training focus is often based on metabolic conditioning activities such as small-sided games, tactical and technical football drills and traditional running drills in order to further develop and maintain aerobic and anaerobic capacity. However, this often comes at the expense of strength training, which may be compromised for additional time on the pitch. Collectively, the literature suggests

that strength and power maintenance can be achieved with one strength session per week for soccer players. However, it is important for strength and conditioning coaches to continue the development of strength and power characteristics during in season (Yu, Altieri, Bird, Corcoran & Jiuxiang, 2021). The incorporation of plyometrics into training is essential, and this principle is often referred to as jump training. Takeoff and especially landing (muscle lengthening), amortization transitional phase and subsequent transition into takeoff play a crucial role in learning and perfecting selected exercises (Baechle & Earle, 2000; Bompa & Buzzichelli, 2021). The primary purpose of this method is to create specific conditions for the fastest possible muscle contraction. These conditions include the toning (pretension) of the muscle, which precedes its own active movement. The pretension can be achieved by jumping from a certain height. In the landing phase, an eccentric contraction is activated, due to which muscle tension accumulates, and at the same time, the stretching reflex of the muscle is activated. From this state, the subsequent isokinetic contraction can occur much faster than without previous toning (Havel & Hnízdil, 2009). From the viewpoint of incorporating it into soccer training, the mechanical principle of the plyometric method appears to determine the transfer to specific game skills. Incorporating this method into the training process also depends on joint health and adequate muscle flexibility levels. From the viewpoint of practical application, the most frequent exercises include drop jumps and landings, horizontal and vertical jumps, thrusting and throwing with emphasis on countermovement (Boyle, 2016; Brewer, 2017). By performing these exercises, players may improve their ability to use the elastic energy of the stretch reflex and more effectively stimulate the nervous factors determining the speed of force production. Player performances can be distinguished according to the playing and the movements that can be considered performance-determining in terms of acceleration and deceleration. Acceleration from standing or running, usually associated with a sudden change of direction, is an extreme load on the player's musculoskeletal system, and without targeted intervention and adaptation to such an overload, players are more susceptible to injuries. Terje Ingebrigtsen, Ettema, Hjelde, & Wisløff (2016) found that accelerations contributed to 7–10% of the total player load for all player positions, whereas decelerations contributed to 5–7%. The mean total distance covered over the period of the whole match by all players independent of positional groups is approximately 11 km (Di Salvo et al., 2007; Bradley, Di Mascio, Peart, Olsen, & Sheldon, 2010). When making this statement, it is necessary to consider a significant variance, which depends on the playing style, the quality of the opponent, the current match score and other determining factors. It is also necessary to consider alternating low-intensity activities, such as walking, with high-intensity running and repeated sprints. Together with these activities, it is needed to focus on the game specifics, while placing emphasis on game skills. Hipp (2014) has found that as the quality level of the competition increases, players cover a greater total distance during the match at high to maximum speeds and perform a higher number of sprints. At the same time, players cover a smaller distance by walking and slow jogging. Eliáš and Ligday (2022) found that the higher the performance level of the players, the higher the demands on their preparation before the match during the warmup. The purpose of a specific warmup should be aimed at increasing neuromuscular activity along with the simulation of game skills and physical conditioning requirements during a soccer game (Eliáš, 2021). Boyle (2016) emphasizes the need to learn the proper landing and takeoff technique while considering

the athlete's somatic parameters and stage of physical development. Plyometrics may be defined as jumping exercises that involve a rapid deceleration of body mass followed immediately by the rapid acceleration of that body mass in an opposing direction. As the transition phase should be as fast as possible, athletes should devote more training to landing and jumping acquisition exercises. The application of the stretch-shortening cycle requires a transition (amortization) phase from 150 to 200 milliseconds. A longer transition phase leads to elastic energy loss (Bílý, Cacek, Kalina, & Sunday, 2017).

METHOD

The purpose of the study was to determine the effects of a 9-week plyometric training on running speed and lower-body explosive power among soccer players. The sample consisted of U19 soccer players included 4 defenders, 4 midfielders, 4 attackers and 1 goalkeeper from the MFK Ružomberok soccer club, which is in the 1st league for the U19 age category. Sample characteristics are presented in Table 1.

Table 1. Sample characteristics

MFK Rižomberok	**n**	**Age** *(years)*		**BH** *(cm)*		**BW** *(kg)*		**Muscle mass** *(kg)*		**Fat mass** *(kg)*	
		M	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
	12	17.3	0.6	179	6.2	71.1	6.1	36.3	3.2	7.9	1.9

Note. n – sample size; BH – body height; BW – body weight; *M* – arithmetic mean; *SD* – standard deviation

Players participated in the experimental study during the fall part of the season between September 2022 and December 2022. The assessment included body composition analysis with the use of InBody 230. We analyzed body composition using the direct segmental multi-frequency bioelectrical impedance analysis. The parameters measured and assessed included body weight (BW), 2. body fat mass (BFM), 3. skeletal muscle mass (SMM). Players performed physical fitness tests that assessed: 1. ankle mobility (dorsiflexion against a wall), 2. lower-body explosive power using the Optogait device. The Optogait tests included the countermovement jump (CMJ), squat jump (SJ), and 10-second vertical jump test requiring plantar flexion. The parameters recorded during the jump tests included the ground contact time (GCT), flight time (FT), jump height (JH) and jump power (P), 3. running speed tested by 10-m, 30-m, and 50-m dash and agility T-test, which included running forward, rearward, and sideward. The players covered a running distance of 9.14 m (distance between the start line and first cone when sprinting forwards) and 4.57 m (distance between the middle cone and lateral cones when shuffling to the left or right). The Witty Kit 4 photocells were used to measure time.

The intervention program consisted of three parts: 1. 3-week mesocycle consisting of preparatory and landing exercises, 2. 3-week mesocycle consisting of follow-up jump exercises, 3. 3-week mesocycle consisting of combined landing and jump exercises with accessory unilateral and rotational movements. The intervention program scheme is displayed in Figure 1.

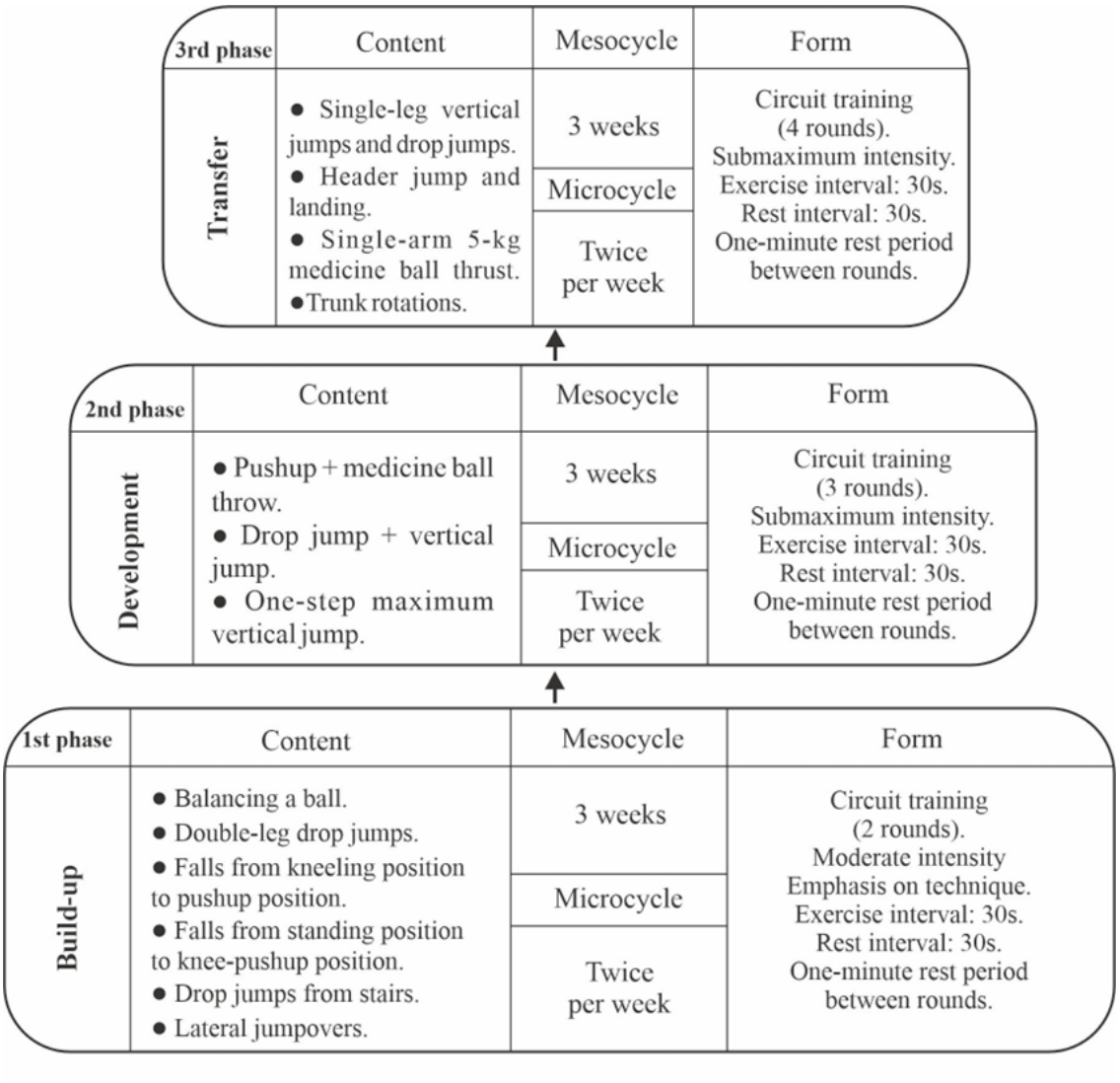


Figure 1. Intervention program

RESULTS

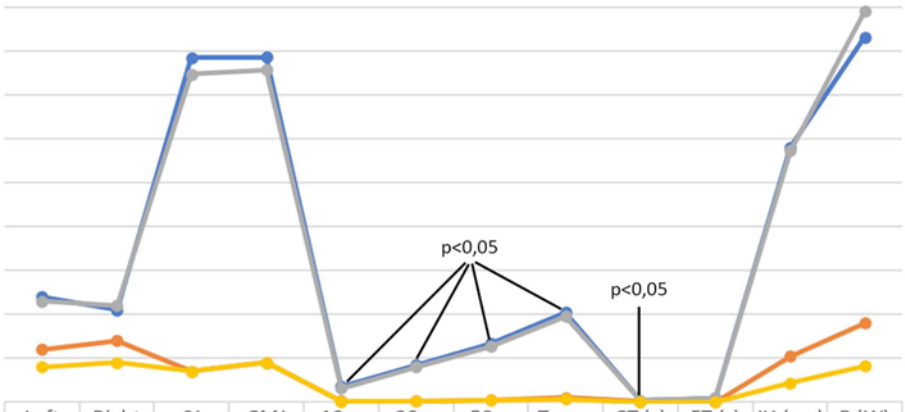
Correlation analysis was applied for the used test items to identify factors that probably have an influence on running speed. Table 2 shows the degrees of relationships between the variables that comprised the content of the test battery. Only statistically significant correlations at $p < 0.05$ are presented. Test battery variables can be divided into three groups with emphasis to ankle mobility, lower-body explosive power, and running speed.

Table 2. Correlation coefficients

	1	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**11**
1. Left ankle mobility *(cm)*	1.00									
2. Right ankle mobility *(cm)*	**.88**	1.00								
3. Squat jump *(cm)*			1.00							
4. CMJ *(cm)*			**.81**	1.00						
5. 10-m dash *(s)*				**-.66**	1.00					
6. 30-m dash *(s)*					**.71**	1.00				
7. 50-m dash *(s)*				**-.63**		**.88**	1.00			
9. VJ 10 second *(Contact time)*		**.63**					**.65**	1.00		
10. VJ 10 second *(Flight time)*									1.00	
11. VJ 10 second *(Jump height)*									**.99**	1.00
12. VJ 10 second Power *(W)*							**-.73**	**-.80**	**.65**	**.70**

Note. CMJ – countermovement jump; VJ – vertical jump; s – seconds; W - watts

A very strong relationship between the left and right ankle mobility, or repeated jumps, squat jump and countermovement jump, or 30 and 50 meters running speed is logically expected. On the other hand, ankle mobility seems to contribute to take off and running speed optimization. There was a relationship between the time interval for fast takeoffs during the repeated vertical jumps relying on plantar flexion and right ankle mobility and 50-meter running speed. Fast repeated takeoffs also determine the 50-meter dash performance. As for the acceleration during the 10-meter dash, its relationship with the countermovement jump may be considered a factor underlying the gradual acceleration up to 50 meters. The 50-meter distance may be viewed as borderline, which the players are able to cover during the game. On the other hand, correlational analysis has not shown any relationships between the agility T-test and other presented variables. The test scores achieved by the players at the pretest and posttest have shown statistically significant improvements ($p < .05$) in running speed tests (figure 2). Players most significantly improved in the agility T-test with changes of direction, as confirmed by the median decrease by 0.45 s. The speed of repeated takeoffs with the shortest ground contact time (GCT) possible should be one of the basic factors underlying the acquisition of plyometric movements. The results showed that the intervention program had an effect on this factor because there were significant changes in the GCT. Even though the ground contact time decreased only by 0.01 s, and the GCT median at the pretest was 0.18 s, it is highly demanding to optimize such a time interval. On the other hand, the graph in Figure 2 shows the jump height. When comparing pretest and posttest measurements after the end of the intervention, we see a decrease in the squat jump by 1.9 cm and in the countermovement test by 1.45 cm.



	Left	Right	SJ	CMJ	10m	30m	50m	T-run	CT (s)	FT (s)	JH (cm)	P (W)
	Ankle mobility (cm)		Opto gait (cm)		Running tests (s)				Opto gait (VJ)			
Pretest Median	12.00	10.50	39.30	39.35	1.82	4.25	6.71	10.25	0.18	0.49	29.10	41.65
Pretest Quartile deviation	6.00	7.00	3.55	4.50	0.12	0.13	0.23	0.53	0.07	0.05	5.25	9.05
Posttest Median	11.50	11.00	37.40	37.90	1.60	4.02	6.35	9.80	0.17	0.50	28.70	44.60
Posttest Quartile deviation	4.00	4.50	3.50	4.55	0.10	0.16	0.26	0.36	0.01	0.02	2.20	4.15

Note. SJ – squat jump; CMJ – countermovement jump; VJ – vertical jump; CT- contact time; FT – flight time; JH – jump height; P – power; W – watts; cm – centimeters; s – seconds; m – meters.

Figure 2. Comparison of pretest and posttest in experimental group

The results showed that the acceleration of the ground contact time reduced the jump height. In more extensive research, it will be necessary to find out whether it is possible to eliminate the decreasing level of jump height by strength training. The present study points to that the intervention program is designed to drill and improve plyometric movements divided into 3 phases (build-up, development and transfer) which are a determining factor in relation to periodization of training process. In the preparation of soccer players, it is important to apply resistance training, which in combination with plyometric exercises can be classified as contrasting methods of developing strength ability.

DISCUSSION

In soccer players, a positive correlation is reported between strength, power and acceleration. Multijoint dynamic tests of strength (squat 1RM and power clean 1RM), expressed relative to body mass, are most closely correlated with countermovement jump performance. These results suggest that increasing maximal strength relative to body mass can improve performance in explosive lower body movements. The squat and power clean, used in a concurrent strength and power training program, are recommended for optimizing lower body power (Nuzzo, McBride, Cormie, & McCaulley, 2008). A performance attribute for players is to perform sprints repeatedly, therefore it is important to optimize the content of strength training during the season. Through plyometric training, it is possible to develop high forces and maintain high levels of stiffness in muscles. Higher stiffness levels of lower limb muscles during plyometric exercises increase the amount of stored and reused elastic energy. According to Turner and Jeffreys (2010), the primary

and key places of storage and subsequent release of elastic energy are tendons. While the stiffness of a tendon is constant, the stiffness of a muscle is variable and depends on the forces exerted. The relevance of plyometric training is determined by two basic requirements, i.e. eccentric strength development necessary to tolerate high demands during fast movement deceleration and accumulation of potential elastic energy with the intention of reactive strength improvement as a faster response to the stretch during the muscle shortening phase (Vanderka, 2006). It can be concluded that during the season, it is necessary to include strength resistance exercises in addition to plyometric training, with which we can eliminate the decrease in the performance of the explosive power of the lower limbs, with emphasis on squat jump and countermovement jump. According to Čaprić et al. (2022), the intervention duration, which plays a key role, should last 2 to 4 weeks. The optimal intervention duration is 6 weeks two to three times per week. An intervention longer than 10 weeks is suitable for improving agility and specific fitness among soccer players. The best results are achieved when plyometric exercises with weights equaling 20% to 30% of the one-repetition maximum are used (Grasgruber & Cacek, 2008). The amount of weight depends on athletes' physical fitness levels. The increasing weight causes longer contact time while exerting a significant load on joints and tendons. Also, plyometric training is to be combined with strength exercises with weights equaling 90% of the one-repetition maximum. Studies have shown that this type of strength exercise is enough to include in a training microcycle once a week during the season. Boyle (2016) has found that the optimum number of jumps during a training session varies from 25 to 100 performed two to four times a week. When performed four times a week, it is necessary to distinguish between linear and multidirectional jumping exercises. The usability of plyometric exercises in soccer training is important from the viewpoint of movement stereotypes optimization in relation to the functional status of the musculoskeletal system. According to Shamshuddin, Hasan, Azli, Mohamed, and Razak (2020), an intervention consisting of plyometric training significantly prevents injury among soccer players. This may be optimized through blood flow restriction training, which improves the rate of strength gains with positive effects on explosive power development (Cook, Kilduff, & Beaven, 2014). Also previous research of authors Abe et al. (2005) point to improvements in acceleration and sprinting characteristics due to blood flow restriction training in team sport athletes. Another option is the application of contrast strength training to the process of football players. According to Hammami, Gaamouri, Shephard, and Chelly (2019), in summary, most athletic performance measures in male soccer players were enhanced after contrast strength training and plyometric training. However, the improvement of physical performance was better with 8 weeks of contrast strength training than with plyometric training. Storen, Helgerud, Stoa, and Hoff (2008) established that maximal strength training has a positive effect on running economy as well as maintaining maximal oxygen uptake (VO2max). The results demonstrated that well-trained athletes significantly improved their one repetition maximum by 33.2%, rate of force development by 26.0%, running economy by 5.0%, and time to exhaustion at maximal aerobic speed 21.3%, following eight weeks of strength training.

CONCLUSION

Incorporating intervention program into training has to meet the criteria based on the schedule and specific requirements of the in-season. As the plyometric method aims to improve the relationship between maximum and explosive power, it is necessary to incorporate these interventions during the winter pre-season period after the strength training period, followed by transfer to fast and explosive movements. The transitional - amortization phase of the movement seems to have a decisive effect on the running speed determined by ankle mobility. Following the intervention, players showed significantly improved levels of running speed in all tests. The results highlight the importance of the transition phase during fast takeoff movements, which was a determining factor during the intervention program. At this age, the development of lower-body explosive power relies heavily on the maximum strength potential, which may be enhanced by targeted intervention during the pre-season. In practice, this development need not be based on demanding exercises with emphasis on resistance training approaching 90% of the repetition maximum. Blood flow restriction training is one of the alternatives that significantly save a player's musculoskeletal system during resistance training with 20 to 40% of the repetition maximum. Strength training is part of in-season soccer training. Its methodological sophistication determines the importance of transfer to specific running activities and is an important factor in injury prevention.

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Nutrition Periodization in Recreational Endurance Athletes During Training Camp – Case Study

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ABSTRACT

Both training and dietary practices used by athletes greatly vary. Current sports nutrition guidelines promote dietary manipulation of energy-yielding nutrients specific to the period of training. The study explores the ad libitum nutrition practices of four healthy adult recreational athletes during a 2-week cycling training camp (~100 km·d^{-1}, ~240 min·d^{-1}) with particular attention to the current sports nutrition recommendations. Based on evidence-based guidelines, peri-exercise carbohydrate (CHO) and protein (PRO) intake periodization cut-off levels were set for athletes. Training days were categorized as hard (HARD, two training units/day), middle (MID, one training unit/day), and easy (LOW, no training). Fourteen-day diet records were used and analyzed by nutritional software for energy intake (EI), carbohydrate (CHO), and protein (PRO) intake. The 2-week mean daily energy intake (EI) was 1.3× higher than the predicted total daily energy expenditure, irrespective of the training day category, resulting in ~500 kcal·d^{-1} energy surplus. Daily EI intakes exceeds total daily energy expenditure in male participants during all training days, but not in female (modest negative energy balance in HARD and MID days), in contrast to female athlete Sufficient daily CHO (> 6 g·kg) were met by all participants independent of the training day. In the 2h post-exercise period, PRO intake exceeded the current recommendations 4.6-fold, and CHO intake was significantly lower after a second training session on HARD days (0.7 g·kg·h^{-1}) than a recommendation (1.2 g·kg·h^{-1}). Mean in-exercise CHO intake (~11.5 g·h^{-1}) was significantly under the moderate 30 g·h^{-1} recommendation. In conclusion, recreational athletes' dietary behaviours are inconsistent with current sports nutrition periodization guidelines. Gender differences were observed in maintaining high exercise-based energy demands by proper nutrition, especially during training days. Daily or during and post-exercise CHO and PRO intakes were not adjusted to the training sessions' volume, intensity, or duration.

Keywords: nutrient timing; nutritional strategy; energy intake; carbohydrates

INTRODUCTION

Athletes preparing for the main part of the training season frequently undertake training camps with high volumes of endurance training to improve performance. Consequently, energy intake monitoring should be prioritized to avoid low energy availability (LEA). Each acute training session should be periodized to reach the desired adaptation or performance during the training camp within the training program. Periodized nutrition manipulation with macronutrient availability allows the coordinated inclusion of sports nutrition for a given training phase into an athlete's program (Mujika, Halson, Burke, Balagué & Farrow, 2018).

New findings of recent years show the benefits of commencing of a training session with intentionally reduced endogenous and exogenous CHO availability to promote muscle adaptation (Burke, 2010). In line with matching the fuel availability with actual muscle needs, the area of sports nutrition periodization can be extended and scientifically defined (Burke et al., 2018).

The attempts of intentional manipulation with CHO availability in elite athletes with regular, systematic endurance training to promote adaptation in coordinance with the novel findings were described elsewhere (Heikura, Burke, Mero, Uusitalo & Stellingwerff, 2017; Marquet et al., 2016; Heikura, Stellingwerff, Mero, Uusitalo & Burke, 2017; Gejl et al., 2017). Practical models of CHO periodization are likely to be highly individualized according to the training structure as well as the athlete's specific training goals (Impey et al., 2018). The variable volume and intensity of cycling training create nutritional challenges regarding athletes' energy availability status and macronutrient intake (Burke, 2001; Drenowatz, Eisenmann, Carlson, Pfeiffer & Pivarnik, 2012).

Current dietary guidelines acknowledge differences in the nutrient requirements and goals for different sessions or phases of training. Recommendations targeted especially on total energy and fuel availability as well as on sufficient energy availability in accordance with carbohydrate (CHO) and protein (PRO) intake in the proximity to exercise (Thomas, Erdman, & Burke, 2016). Current understanding, however, perceives manipulation of carbohydrate availability as the primary means of periodizing sports nutrition (Stellingwerff, Morton & Burke, 2019in support of training periodization there has been an emergence around the concept of nutritional periodization. Within athletics (track and field; Impey et al., 2018; Burke et al., 2018).

Therefore, the periodization of sports nutrition is a strictly planned process in which the primary task of sports nutrition is to support the athlete's training outcomes (Jeukendrup, 2017). Each athlete must adapt to an individual nutrition plan that suits their performance or recovery needs. It was shown that the sub-elite athletes tend to reduced CHO intakes even as training loads increase, contrary to evidence-based guidelines (Kopetschny, Rowlands, Popovich & Thomson, 2018). To what extent sub-elite, recreational athletes are familiar with and follow the current sport nutrition guidelines focusing on meso- (e.g. within training camp), and micro- (within training day) macronutrient and energy periodization is less known, in contrast to the practices of elite-level athletes (Heikura, Stellingwerff & Burke, 2018).

Therefore, the study aims to explore the nutrition practices of recreational athletes during 14-days cycling training camp with attention to the periodization of Sports nutrition evidence-based guidelines.

METHODS

Subject characteristics

The characteristics of the participants are outlined in Table 1. All athletes perform regular cycling training (5-8000 km per year) with the purpose to compete and all may be classified as trained/developmental category according to McKay et al. (2022). .Each athlete undertook a 14-days training camp in Tuscany, Italy in 2019. Each athlete approved and provided written permission for this publication.

Table 1. Subject characteristics

Athlete (gender)	Age (y)	Body weight (kg)	BMI ($kg \cdot m^{-2}$)	VO_{2max} ($ml \cdot kg \cdot min$)	Body fat (%)	$Heart\ rate_{rest}$ (bpm)
1 (M)	29	76.1	23.5	61.4	11.7	50
2 (M)	53	76.3	22.8	68.2	14.0	40
3 (M)	21	65.3	20.2	69.0	8.8	49
4 (F)	27	69.9	22.6	60.0	13.3	42

Note. Body composition measured via bioelectric impedance analysis

Training assessment

All participants kept detailed training logs, including information on duration and volume (min and km) and intensity (HR). The intensity for each session was monitored via Garmin sports watch with a chest belt. The number of training units per day was chosen as a criterion for differentiating the variability in training load as this corresponds with a significant difference in the duration of the training sessions (p=0.009). As such we categorize the training days as hard (HARD, two training units/day), middle (MID, one training unit/day) and easy (LOW, no training) training days.

Heart rate reserve (HRR) calculated for each particular training session revealed that all training sessions were of the same relative intensity, as confirmed by the non-significant difference when adjusted for HARD (26 training units, ~ 52-65 % HRR) and MID (18 training units, ~55–66 % HRR) training days. (Table 2).

A total of 26 and 18 training days with HARD and MID training volume were analyzed for nutritional habits (Table 5). There were three days without training (LOW) for each athlete. The training consisted only of road or bike cycling sessions.

Table 2. Training characteristics during the cycling camp (data expressed as Mean±SD)

Athlete	Training day category (n)	Training			
		Intensity (% HRR)	Distance (km)	Duration (min)	$EE_{exercise}$ (kcal·kg·min^{-1})
1	HARD (7)	65.0±6.3	110.6±14.7	270.4±38.5	0.12±0.01
	MID (4)	66.1±11.2	98.7±13.2	214.0±31.5	0.12±0.024
2	HARD (8)	56.1±7.0	115.8±13.1	292.6±24.8	0.08±0.01
	MID (3)	55.9±4.9	101.0±15.1	227.0±44.5	0.06±0.007
3	HARD (4)	52.4±6.8	82.5±8.7	265.3±36.4	0.09±0.004
	MID (7)	56.7±5.1	79.4±30.2	211.7±43.0	0.10±0.009
4	HARD (7)	61.1±3.5	92.4±19.4	242.0±32.7	0.14±0.008
	MID (4)	58.5±2.3	107.6±7.5	234.3±23.6	0.13±0.012

Nutritional analyses

Fourteen-day diet records were used to assess food intake. The food of the cyclists was either chosen by the riders themselves or was prepared by a dietitian. Professional dietitians prepared the main meals served before and after the training sessions (correspond to breakfast, lunch, dinner, and second dinner). Meals were served collectively in a dining room, but individuals followed intake ad libitum without control. The known weight (from labels) of food used to prepare meals by dietitian was either recorded or was directly weight using digital kitchen scales (Sencor SKS 5020WH; Accuracy 1 g). The researchers educated each participant on how to record the food intake and participants were given a printed record sheet with a predefined set of grammage of food weight possibilities (e.g. spoon, plate, package, portion). A total of 56 whole-day food records were analyzed for energy intake (EI) and macronutrient composition using online dietary software *kaloricketabulky.cz*. Nutrition information not listed in the software database gathered from the packaging and dietary supplement labels were entered manually into the software program.

INDIVIDUALIZED ENERGY, CHO AND PRO INTAKE DURING TRAINING CAMP

Energy balance

Basal metabolic rate (BMR) was predicted using a Cunningham formula (Cunningham, 1980) Data from heart rate monitors (GARMIN Edge 830) were used to determine the exercise energy expenditure ($EE_{exercise}$). The total daily energy expenditure (TDEE) (kcal·kg-1), was then predicted from the BMR and physical activity level (PAL) multiples. The formula TDEE = BMR × PAL was used for LOW days, and PAL was set as 1,4. For MID and HARD training days TDEE = (BMR × PAL) + $EE_{exercise}$ was used with PAL set as 1,5 (Rodriguez, Di Marco & Langley, 2009; Thomas et al., 2016). Energy availability (EA) was calculated individually for each training day (MID and HARD) from heart-rate based $EE_{exercise}$, EI (14-day diet records) and bioelectric-impedance analysis based fat-free mass (IN Body 230) (Loucks, Kiens & Wright, 2011).

Nutrient intake periodization

To assess adherence to the sports nutrition guidelines, we set numeric cut off levels of CHO and PRO intake in the proximity of exercise to objectively determine the relevance of the nutrient intake

within the given training load. The rationale for setting the nutrients and energy is introduced in Table 3. The particular cut-off levels match current evidence-based pre-exercise, during and post-exercise nutrient intake guidelines that optimise performance and recovery (Kerksick et al., 2017; Thomas et al., 2016).

Table 3. Nutrient intake periodization cut-off levels during HARD and MID training days

HARD (2 training sessions/day)[1]			MID (1 training session/day)		
Periodization	**CHO**	**PRO**	**Periodization**	**CHO**	**PRO**
2 h Pre-Ex I	2 g·kg^{-1}	-	2 h Pre-Ex	2 g·kg^{-1}	-
Dur-Ex I	30 g·h^{-1}		Dur-Ex	30 g·h^{-1}	-
Between-Ex I-II	1.5 g·kg·h^{-1}	0.3 g·kg^{-1}	3 h Post-Ex	1.2 g·kg^{-1}	0.3 g·kg^{-1}
Dur-Ex II	30 g·h^{-1}	-	-		
3 h Post-Ex II	1.2 g·kg·h^{-1}	0.3 g·kg^{-1}			

Note. [1]in HARD days (two training sessions, morning session = Ex I and afternoon session = Ex II) the period between Ex I and Ex II training session represents ± 2 h period.

Statistical analysis

All data were managed in the Excell software. Statistical analyses were conducted using software Statistica (StatSoft CR s.r.o., Czech Republic). To show absolute athlete-specific nutritional data and along with the heterogeneity of the sample, descriptive statistics were used with data presented as mean ± standard deviation (SD). To compare the group data, Pre- and Post-Ex CHO and PRO intakes for all athletes, daily energy balance data (e.g. energy intake, energy expenditure, energy availability, CHO, and PRO intakes) were presented relative to the body weight (e.g. g·kg^{-1}, g·kg·h^{-1}, kcal·kg·min^{-1}). A coefficient of variance (CV) was used to assess inter-variable changes.

RESULTS

The relative daily CHO and PRO intakes interindividualy differ. However, mean relative daily energy, CHO, and PRO intakes were not different between the HARD, MID and LOW training days (Tab. 4). Mean CV_{energy} in HARD and MID days was 12,2 % and 17,8 %, respectively.

Table 4. Energy, CHO and PRO intakes during the cycling camp (data expressed as Mean±SD)

Athlete	**Training day category (n)[1]**	**Nutrition**			
		CHO (g·kg·d^{-1})	**PRO (g·kg·d^{-1})**	**EI (kcal·kg·d^{-1})**	**CV_{energy} (%)**
1	HARD (7)	9.8±2.5	3.7±0.9	88.5±15.4	17.4
	MID (4)	10.2±2.5	3.7±0.2	90.4±16.8	18.6
	LOW (3)	9.8±3.3	3.7±1	87.1±22.7	26.1
2	HARD (8)	9.4±1.2	3.2±0.4	84.4±8.1	10.8
	MID (3)	7.1±1.8	3.0±0.3	69.8±13.1	23.1
	LOW (3)	7.7±2.4	3.0±0.4	71.5.3±13.2	14.6

3	HARD (4)	9.5±1.4	2.8±0.2	75.2±7.9	10.5
	MID (7)	8.2±2.1	3.4±0.5	74.5±8.9	11.9
	LOW (3)	10±1.1	3.2±0.5	85.8±3.7	4.3
4	HARD (7)	7.5±0.7	3.1±0.4	73.4±7.5	10.2
	MID (4)	6.6±0.9	3.2±0.3	65.8±11.8	17.9
	LOW (3)	6.1±1.4	2.8±0.4	64.3±9.4	14.6

Note. [1] n = total number of training days in the given category included in the analysis

Absolute TDEE (kcal) was higher in HARD and MID days compared to the LOW days in all athletes. Contrary to male athletes, no difference was observed between HARD and MID days in female athlete, despite twice the training units per day (Tab. 5). Significant positive energy balance (EI:TDEE ~1.73) was reported in LOW days, however, positive energy balance was found in MID and HARD days as well (~1.13 and ~1.12 ratio, respectively).

Table 5. Individual energy balance data during the training camp (data expressed as Mean±SD)

Training day category	**Athlete**	**EI (kcal)**	**$EE_{exercise}$ (kcal)**	**TDEE (kcal)**	**Energy balance (kcal)**	**EI:TDEE ratio**
HARD	1	6188.1±1079.4	2442.4±152.4	5410.0±152.4	+ 778.1±1052.6	1.14
	2	5899.6±565.6	1796.4±308.2	4711.2±308.2	+ 1188.5±475.9	1.25
	3	4912.3±517.5	1648.5±285.5	4563.3±285.5	+ 349.0±418.6	1.07
	4	5133.1±521	2454.9±353.9	5204.7±353.9	- 71.5±525.7	0.98
MID	1	6318.0±1177.5	2011.5±575.6	4979.1±575.6	+ 1338.9±1447.5	1.26
	2	4998.0±819.6	1133.3±341.1	4048.1±341.1	+ 949.9±1098.6	1.23
	3	4862.9±580.8	1305.7±366.4	4220.5±366.4	+ 642.3±556.4	1.15
	4	4600.3±826.9	2352.3±381.3	5102.1±381.3	- 501.8±898.2	0.90
LOW	1	6089.7±1584.6	-	3137.4±520.0	+ 2952.2±1803.7	1.97
	2	4994.3±922.9		3463.3±270.5	+ 1713.9±653.1	1.44
	3	5600.3±238.4		3086.8±22.9	+ 2513.5±216.2	1.81
	4	4491.0±657.1		2658.8±130.6	+ 1832.2±653.2	1.68

Overall, due to the surplus in energy intake, EA sufficiently meets the optimum levels of 45 kcal·kg FFM^{-1}. Interestingly the EA was not different during the HARD (~59kcal·kg FFM^{-1}) in comparison to the MID (~56kcal·kg FFM^{-1}) training days in men being over the 45 kcal·kg FFM^{-1}in men (athletes 1-3), but not women (37,1 and 44,2 kcal·kg FFM^{-1} in MID and HARD days, respectively) (athlete 4). Importantly, EA in HARD days was ≥ 44 kcal·kg FFM^{-1} in all athletes (Fig.1).

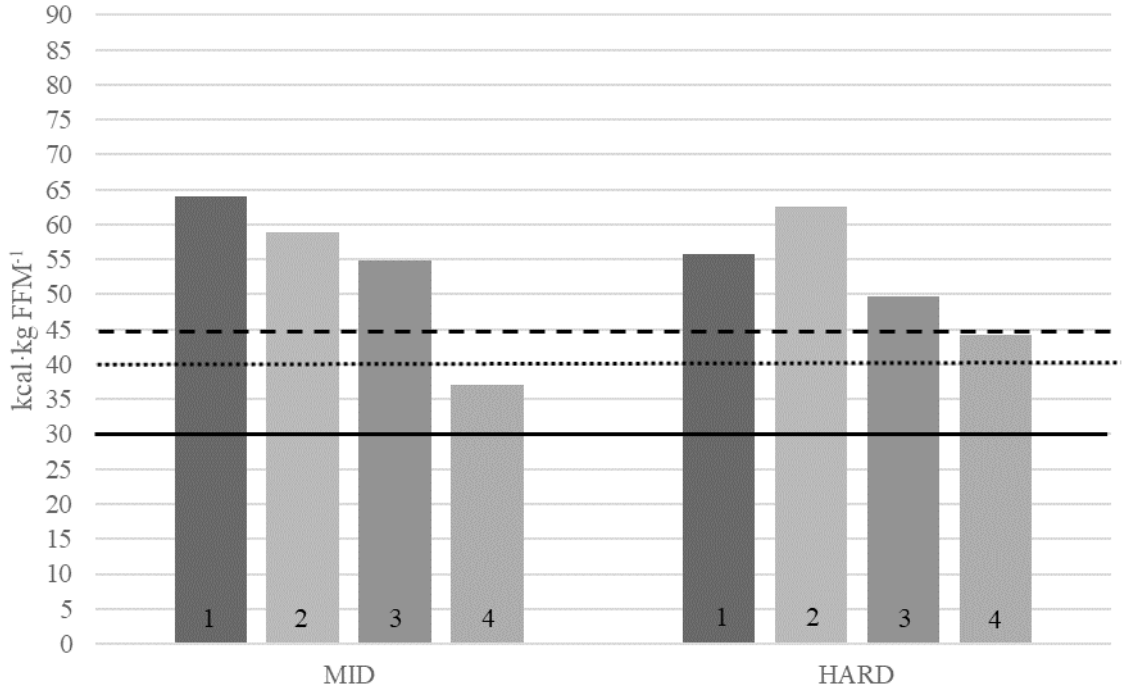

Figure 1. Mean energy availability in MID and HARD days for individual athletes (1-4)

Note. Dashed line and dotted line depict the optimal EA for women (45 kcal·kg FFM^{-1}) and men (40 kcal·kg FFM^{-1}); full line depicts the level considered to be low energy availability in both males and females

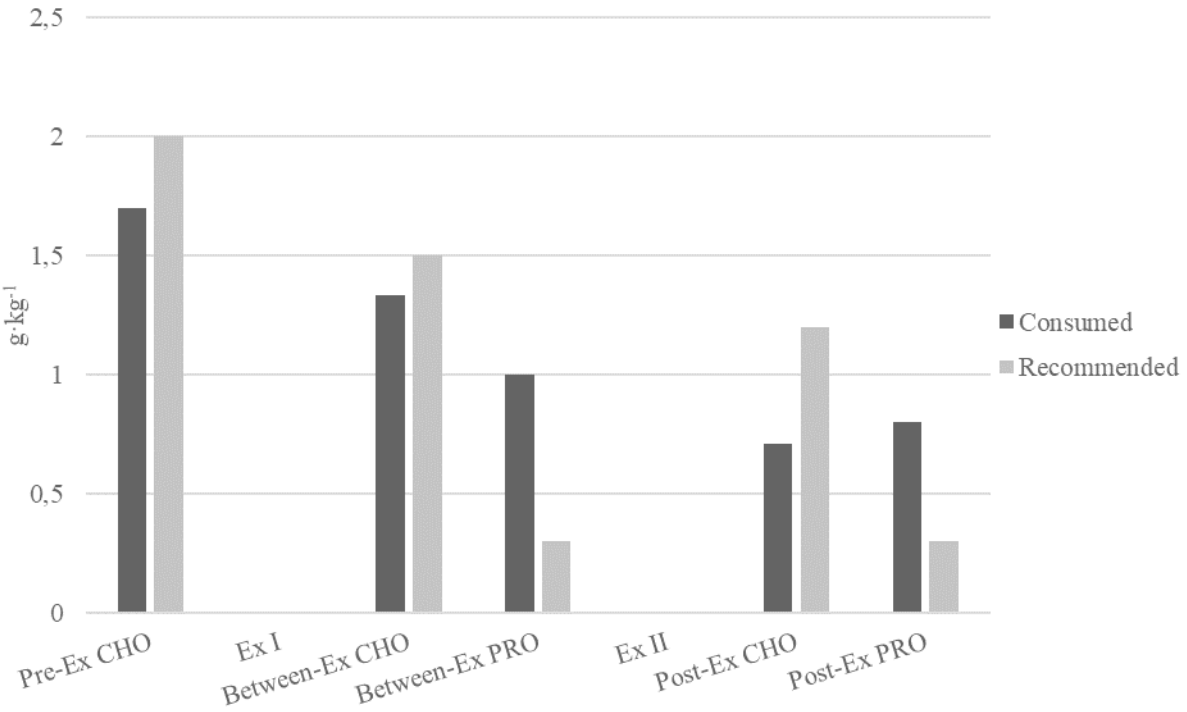

Figure 2. Pre- and Post-exercise nutrient periodization in HARD days

Note. Illustrates the difference between "consumed" (mean peri-exercise nutrient amounts for all training units meals) and "recommended" (described in Table 3; Post-Ex CHO is expressed in g·kg·h^{-1}

The mean CHO intake in HARD days after the second training session (~ 0.7 g·kg·h^{-1}) was nearly two times lower than recommended (1.2 g·kg·h^{-1}). In contrast, protein intake was higher than recommendations (0.3 g·kg^{-1}) in both post-Ex time periods in HARD (Between - Ex PRO, 0.8 g·kg^{-1} and Post-ExPRO, 1 g·kg^{-1}) and MID days (1.3 g·kg^{-1} (Fig. 2,3).

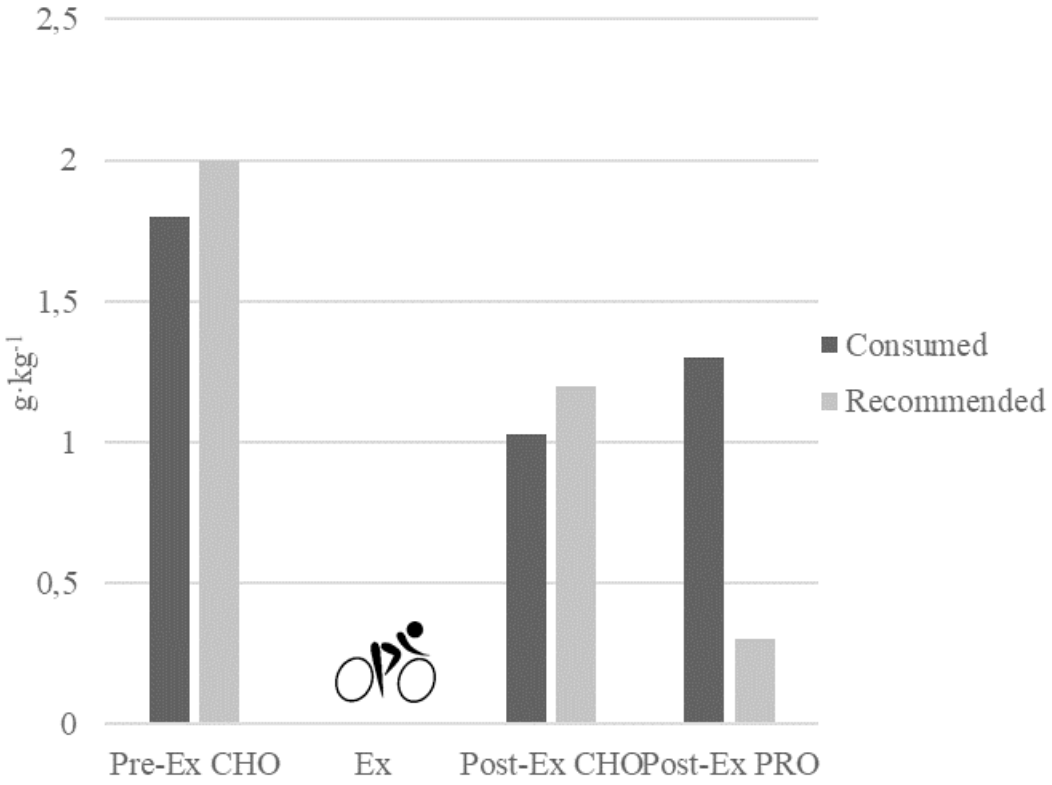

Figure 3. Pre- and Post-exercise nutrient periodization in MID days

Note. Illustrates the difference between "consumed" (mean peri-exercise nutrient amounts for all training units meals) and "recommended" (described in Table 3; Post-Ex CHO is expressed in g·kg·h^{-1}

In overall, CHO intake during exercise was significantly lower than elementary recommendations (30 g·h^{-1}). The CHO intake level was independent of the training day category and did not significantly differ (Fig. 4).

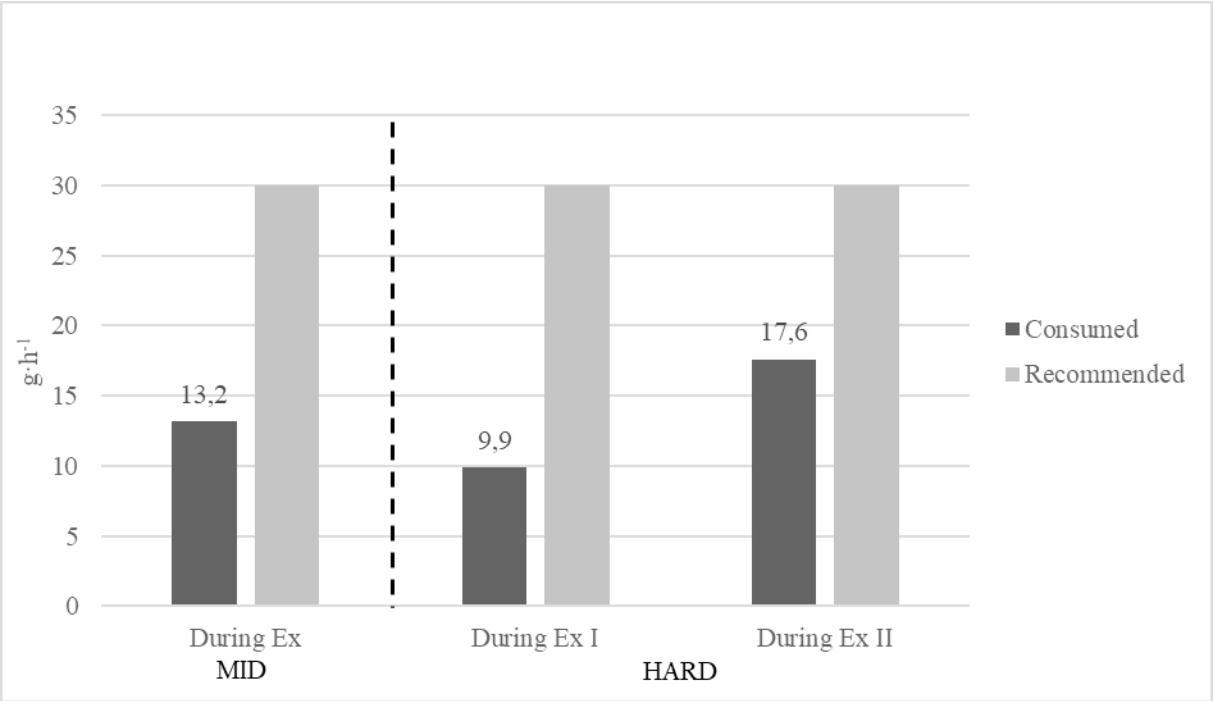

Figure 4. Carbohydrate intake during exercise in HARD and MID days

Note. Illustrates the difference between "consumed" (mean CHO intake during all training units) and "recommended" (described in Table 3)

DISCUSSION

The case study aimed to explore the area of sports nutrition periodization according to the current evidence-based guidelines. The current study describes the nutritional habits of 4 recreational athletes during the high-volume cycling training camp with particular attention to the achievement of current sports nutrition periodization guidelines (Burke et al., 2018; Jeukendrup, 2017). More specifically, the study aimed to associate athlete's CHO, PRO and energy intake within training camp with the variability in daily training load.

We found that the athletes' total energy and CHO intakes during the training camp meet and exceed the current guidelines for optimizing performance and recovery. However, we found that energy and CHO intake were independent of the training load, suggesting an inability to periodize the nutrition effectively.

The predicted training intensity based on HRR was below 60 % VO_{2max} for most training units, irrespective of the training phase and overall daily training volume (one or two training units/day). Therefore, to differentiate the variability in daily training load, we categorize the days as HARD (two training units/day), MID (one training unit/day) and LOW (no training). The participants' training program was not periodized as the calculated mean exercise intensity (% HRR) for HARD and MID days was the same (58.7±4.8 % and 59.3±4 % of HRR, respectively) (Tab 2).

It has been demonstrated that implementing a nutrition-training intervention involving individual periodized CHO availability requires careful planning and the expertise of a sports dietitian

(Stellingwerf, 2012). However, athletes seemed to be well aware of guidelines that emphasize optimal CHO availability around high-intensity training sessions (Vogt et al., 2005; Heikura et al., 2018). Even though strategically manipulating CHO availability before, during or after exercise has been found to provoke a beneficial adaptive response (Impey et al., 2018), we found no signs of deliberate lowering CHO availability within the microcycle or particular training session.

Energy intake

The most interesting observation was that the daily energy intake was higher than expenditure irrespective of the total daily training volume leading to a significant mean positive energy balance during the camp (~ 1060 kcal·d^{-1}), with a substantial daily surplus of ~ 2200 kcal and ~ 500 kcal in non-training and training days, respectively (Tab. 5). Elite athletes and recreational athletes are vulnerable to LEA (Vanata & Steed, 2013), and sports nutrition knowledge is also reduced (Trakman, Forsyth, Devlin, & Belski, 2016). The EA for training days exceeds the 45 kcal·kg FFM^{-1} limits (Loucks, Kiens, & Wright, 2011), reaching 53.0±9.5and 53.7±15.1 for HARD and MID days, respectively. This can be explained by the rigid relative daily energy intake of ~73-78 kcal·kg^{-1} irrespective to the training day category, however, with gender differences (3 males and 1 female athlete ~EI 80,8 and 67 kcal·kg^{-1}, respectively). This translates in lower EA in MID days in female athlete (~37 kcal·kg^{-1}), but still within an acceptable range (Areta et al., 2021). Furthrmore, significant daily energy intake inconsistency was observed in HARD days (-71 kcal), MID days (-500 kcal) and LOW days (+1800 kcal) in the female athlete but not in males. This suggests gender differences in the ability to adjust energy intake with total energy expenditureSignificant interindividual differences were observed for EA during HARD (44-62 kcal·kg FFM^{-1}) and MID (37-64 kcal·kg FFM^{-1}) days. Analysis of reported daily EI revealed no 'under-reporting' in all athletes as an EI:BMR ratio was < 1.5. However 'over-reporting' behavior where EI:BMR ratio exceeds >2.5 may be expected for LOW days or MID and HARD days, respectively. In particular, over-reporting was identified in 69.6 % of all training days in which reported PRO intake was high (~3 g·kg^{-1}). This corresponds with PRO being the most often misreported nutrient (Magkos & Yannakoulia, 2003) including retrospective (diet recall, food-frequency questionnaire, and diet history. The energy intake coefficient of variation in LOW days interindividually ranges from 4,2–26,1 %, reflecting poor ability to periodize energy intake. Unfortunately, we did not record body weight to show if this extreme energy dysbalance led to body weight gain.

It must be noted that - firstly, athletes in our sample were not familiar with nutrition periodization and secondly, an experienced sports dietitian, who also prepared meals, was present during the camp. On the one side, we believe dietitian presence allows controlling for proper food choices and nutrient composition of food consumed, therefore eliminating interindividual differences in options for food delivery. On the other side, it may indirectly promote the ad libitum athlete's food consumption during the camp, especially with the impact on non-training days. Therefore, it may be questioned to what extent the presence of the chef may have affected the ad libitum intake and adherence to guidelines (author's own recognition). It may be speculated that if there would be a strategically planned nutritional program, a professional dietitian may assist in controlling specific nutrient intake, which is in line with current guidelines (Thomas et al., 2016).

Carbohydrate intake

The CHO intake during the training camp interindividually ranges from 6-10 g·kg·d^{-1}which is in line with practices of endurance-based disciplines. However, when considering the variability in daily training volume, there was no significant difference between the mean CHO intake for HARD and MID and even LOW days, 8.9±0.8, 7.8±1.0, 8.2±1.5 g·kg·d^{-1}, respectively. Only one participant (female) reduced CHO intake markedly in non-training days. However, her intake reached sufficient levels of 6.1 g·kg·d^{-1} (Burke, 2001).

Periodization of nutrients

Current guidelines around PRO intake for all types of athletes promote the regular intake of modest amounts (~ 25 g) (Schoenfeld & Aragon, 2018) of high-quality PRO over the day, including soon after the completion of key training sessions (i.e., sessions of high intensity and/or high duration (>90 min) (Jäger et al., 2017). The post-exercise per-meal PRO intake recommendation adjusted for body weight (~ 0.3 g·kg^{-1}) was 4,6 times higher for MID (1,4 g·kg^{-}1) and similarly high for a first and second exercise session in HARD days (1.0 g·kg^{-1} and 1.2 g·kg^{-1}). All athletes exceeded the recommendation in all training sessions. We hypothesized that this resulted from high postexercise energy intake rather than PRO target intention as the daily PRO intake exceeded 3 g·kg^{-1} independently of the training day category.

Three hours post-exercise, the PRO intake in MID days accounted for 39.3 % of daily PRO intake. Similarly, on HARD days, the post-exercise PRO intake accounted for nearly 60 % (32.2 % for Ex 1 and 25.8 % for Ex 2) of total daily PRO.

Post-exercise CHO intake in HARD accounted for 15.5 and 8.4 % of daily CHO intake after Ex 1 and Ex 2, respectively. In MID, CHO intake accounted for 17.5 % of daily CHO intake. Athletes generally aimed to achieve high CHO availability with no signs of intentional manipulation. The CHO intake before exercise reached 90 % of the recommendation for 2h time frame period before exercise in MID and 85 % in HARD days (in both cases 1.8 g·kg^{-1} vs. 2.0 g·kg^{-1}). However, CHO intake during exercise was significantly lower (more then two-fold) than moderate 30 g·h^{-1} recommendations. We found the in-exercise CHO intake fulfilment to be 55 % of the recommendation in MID, 33.7, and 67 % in HARD for Ex 1 and 2, respectively. This may not limit the endogenous CHO availability and performance as athletes generally follow high CHO intake. All training sessions reported by athletes and included in the analysis lasted more than 120 min. This justifies the promotion of high CHO availability, as glycogen levels limit exercise capacity (Impey et al., 2018)compete high' paradigm. Despite this fact, CHO were not ingested in 36 % of all training sessions. Furthermore, even high-intensity training sessions expressed as % HRR not correlated with higher CHO intake (r = 0.19) (Fig. 5).

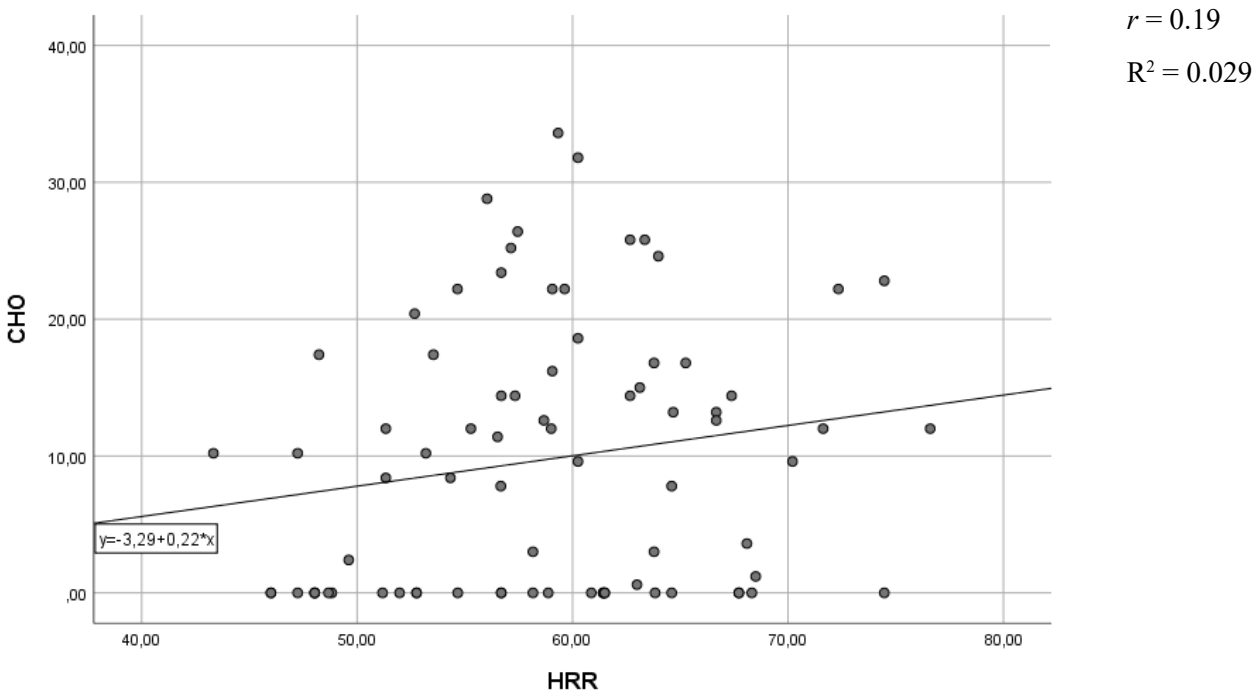

Figure 5. Carbohydrate intake during all training sessions in relation to the intensity (% HRR)

We believe that any form of sports nutrition periodization in recreational athletes should be coordinated with a trainer or educated dietitian and may hardly result from experience and ad libitum food intake. We show a positive energy balance, high CHO and PRO intake irrespective of training volume. This supports that athletes follow sports nutrition guidelines without considering new findings. Moreover, we found that gender differences in applying recommendations to practice should be considered and carefully interpreted as there is still limited understanding on this topic (Areta et al., 2022).

CONCLUSIONS

The case study revealed that the recreational athletes, rather than strategically manipulating nutrient delivery outside the training, focus on the total daily energy intake to compensate for the energy expenditure, which led to a significant positive energy balance (~ 500 kcal). No signs of deliberate CHO and PRO intake distribution to meet current sport nutrition guidelines were identified. Although daily CHO intakes meet current CHO guidelines promoting high endogenous CHO availability, daily or post-exercise CHO intakes were independent of the number of training sessions, intensity or duration and gender-different.

What the study brings new

Recreational athletes are not able to follow scheduled eating patterns. Moreover, recreational athletes do not adjust energy and nutrient delivery to the training program. Sports dietitian plays an essential role in assisting athletes to fulfil current sports nutrition periodization guidelines.

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The Effect of Suspension Training on Some Factors Related to the Shoulder Injuries in Athletes with Scapular Dyskinesis

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ABSTRACT

This study aimed to examine the effect of suspension training on some factors related to the shoulder injuries in athletes with scapular dyskinesis. The present study employed a semi-experimental pre-test and post-test design. Thirty male athletes with scapular dyskinesis were randomly allocated into either the training or control group, with 15 individuals in each. Identification of scapular dyskinesis was conducted through the utilization of a lateral scapular slide test. During the pre-test stage, the shoulder joint muscles strength, proprioception and functional stability, were assessed via manual dynamometer, upper body functional balance test, and imaging methods, respectively. Subsequently, the training group participated in an 8-week suspension training, with three sessions per week. Following the 8-week intervention period, all participants underwent the same measurements administered during the pre-test stage. Statistical analysis was conducted using a two-way analysis of variance at a significance level of $P \leq 0.05$ to analyze the research findings. The findings from the two-way analysis of variance indicated that, during the post-test stage, the experimental group showed significant enhancements in muscle strength, functional stability, and accuracy of shoulder joint proprioception in comparison to the control group. The study's results suggest that suspension training used in this study can be employed to enhance shoulder muscle strength, functional stability, and accuracy of shoulder joint proprioception, which may assist in ameliorating disorders resulting from scapular dyskinesis. Furthermore, the findings imply that incorporating these exercises into training regimens could help prevent shoulder joint injuries.

Keywords: Scapular dyskinesis; suspension training; Shoulder; Injury; Prevention

INTRODUCTION

Scapular dyskinesis is a condition that involves dysfunction in the positioning of the scapula bone (Saini, Shah, & Curtis, 2020). This condition can affect the alignment and movement of the shoulder joint, potentially leading to reduced performance, particularly in overhead sports (Asker et al., 2018). Early identification and management of scapular dyskinesis can help prevent further damage to the shoulder girdle and reduce the risk of injury (Saini, et al., 2020).

Previous studies have demonstrated that scapular dyskinesis can lead to impairments in strength (Bullock et al., 2021; Moghadam, Rahnama, Dehkordi, & Abdollahi, 2020), range of motion (Moghadam, et al., 2020; Naderifar & Ghanbari, 2022), activation and timing of the shoulder muscles (Gonçalves et al., 2022; Petviset, Sakulsriprasert, Vongsirinavarat, & Wattananon, 2021), shoulder girdle function (Huang, Weng, Chang, Tsai, & Lin, 2023) and proprioception (Sayaca et al., 2021; Zarei, Eshghi, & Hosseinzadeh, 2021). These variables are critical for optimal shoulder function and performance. Impairments in muscle strength and joint stability are two critical risk factors that can significantly increase the likelihood of injury in athletes who participate in overhead sports (Bullock, et al., 2021). Athletes with scapular dyskinesis exhibit a decrease in the strength of the infraspinatus and supraspinatus muscles (Merolla, De Santis, Campi, Paladini, & Porcellini, 2010). This is while the results have shown the rotator cuff muscles generate compressive force that helps to stabilize the humerus against the glenoid cavity, resulting in improved stability of the shoulder joint (Seitz, McClelland, Jones, Jean, & Kardouni, 2015). Seitz et al. found that athletes with scapular dyskinesis exhibit weakness in the lower and middle trapezius muscles, as compared to those without any signs of dyskinesis (Seitz, et al., 2015). There is a direct relationship between strength and stability in the shoulder joint. Therefore, impairment in strength can lead to a reduction in functional stability of the shoulder and finally an increase in likelihood of shoulder injuries (Bullock, et al., 2021).

On the other hand, changes in scapular position have been found to have a significant impact on the proprioceptive function of the shoulder joint, potentially leading to disruptions in the neuromuscular reflexes responsible for joint protection (Seitz, et al., 2015). This can lead to increased pressure on the joint, instability, and a heightened risk of injury (Sayaca, et al., 2021). This highlights the importance of maintaining proper scapular position to ensure optimal shoulder joint function. These findings align with previous research on the role of proprioception in joint stability and injury prevention (Zarei, et al., 2021). As such, paying close attention to proprioceptive accuracy in athletes with scapular dyskinesis is of utmost importance.

Academic literatures highlights the importance of selecting appropriate strategies for athletes with scapular dyskinesis to address the various variables affected by this condition (Giuseppe et al., 2020; Moghadam, et al., 2020). It is crucial to use non-invasive and cost-effective interventions that not only target these variables but also enhance performance and prevent injury. Suspension training has gained popularity in the sports community in recent years. The prominent feature of this training method is the use of body muscles in a suspended environment, which not only targets the intended muscles but also promotes muscular strength development and coordination between the kinetic chains by creating cohesive contractions along the closed kinetic chain

(Khorjahani, Mirmoezzi, Bagheri, & Kalantariyan, 2021). In addition, the functional nature of this training method and its emphasis on utilizing the core stabilizer muscles of the body in most of the movements have been noted (Karabay, Emük, & Kaya, 2019; Khorjahani, et al., 2021). It has been demonstrated that there is a direct correlation between core stability and upper limb injury occurrence (Zarei, et al., 2021).

Hence, it is hypothesized that suspension training, with the aforementioned characteristics, could be a viable option for improving factors related to the shoulder injuries in athletes with scapular dyskinesis. Therefore, the objective of this study is to examine the effectiveness of suspension training on functional stability, muscle strength, and proprioceptive accuracy of the shoulder joint in athletes with scapular dyskinesis.

METHODS

Study design

The current study employs a quasi-experimental research methodology utilizing a pretest-posttest design with two distinct groups.

Study population and selection of samples

The study population of the present research includes all male university athletes in overhead sports such as volleyball, handball, and basketball in the city of Rasht. The sample of this study consists of 30 individuals from the study population aged between 20 and 30 years who met the criteria for participation in the study. Before the study began, all subjects were notified of the potential risks and benefits of participating in the research. All subjects signed a consent letter to participate in the project. The sample size for the study was determined using an appropriate statistical formula based on previous studies with similar characteristics (Khorjahani, et al., 2021). A confidence interval of 0.95 and a test power of 80% were established, with an effect size of 0.7. Consequently, the sample size for each group was calculated as 13 individuals. However, to account for potential sample dropout during the study, the sample size was increased to 15 individuals for each group. To ensure homogeneity between the groups, each group was comprised of 5 volleyball players, 5 basketball players, and 5 handball players. The inclusion criteria for the study were being male, participating in university-level volleyball, basketball, or handball, and having scapular dyskinesis. The exclusion criteria were a history of injuries such as dislocation or fracture in any of the shoulder girdle bones, complete tear of the shoulder girdle muscles, adhesive capsulitis in the shoulder joint (diagnosed by a physician), any atrophy in the shoulder girdle muscles, skeletal muscle disorders in the upper limb, including forward head posture, protracted scapula, kyphosis, scoliosis (any physical abnormality affecting the study process, diagnosed by a physician), dissatisfaction to continue participation in the study, absence from two consecutive sessions or more than 3 sessions of training. The study followed the Helsinki Declaration recommendations of Human Ethics in Research.

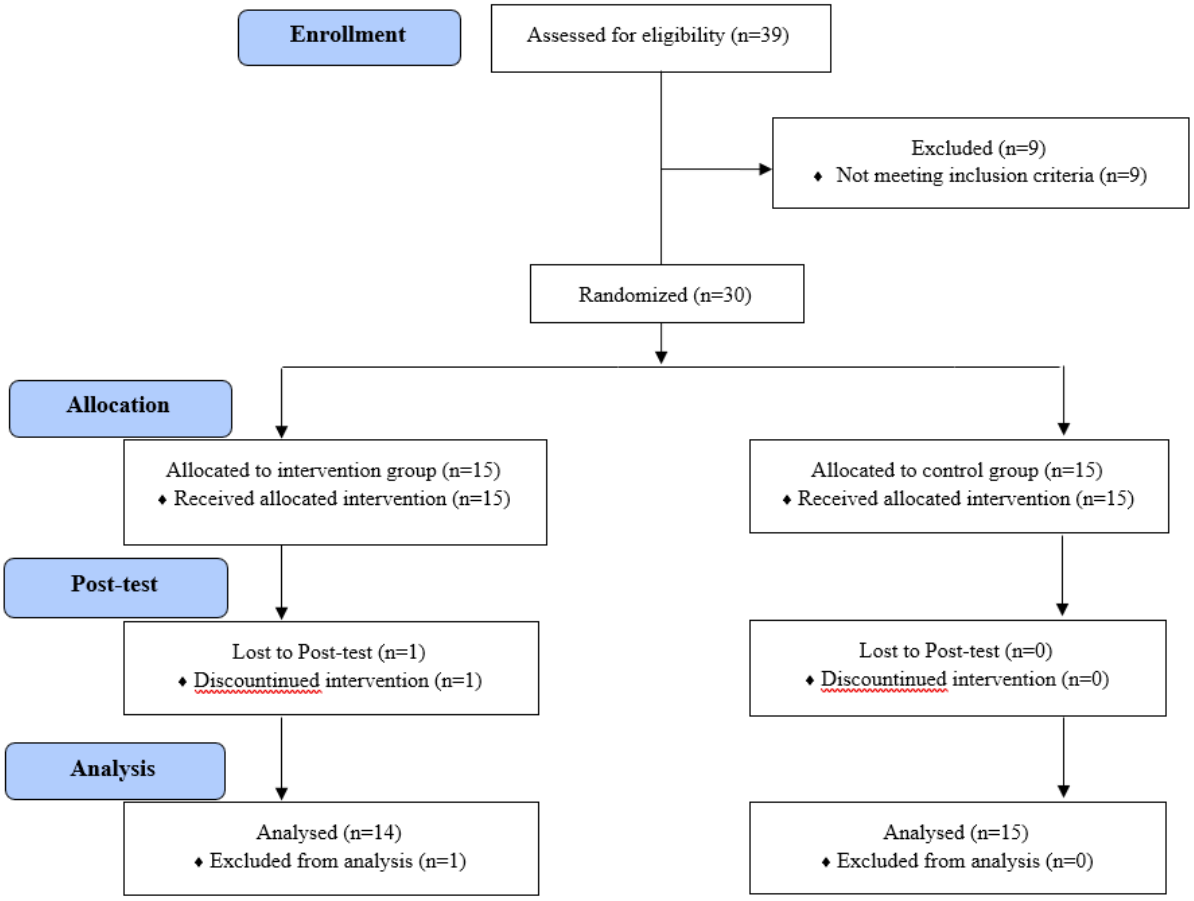

Figure 1. CONSORT flow chart of samples enrollment, allocation, post-test and analysis.

Preparation

The process of conducting the research was as follows: after issuing a call for participation in the research project on virtual platforms, individuals who expressed their interest in participating in the study were invited to attend a predetermined location in the laboratory for initial examinations and to assess their eligibility for inclusion or exclusion from the study based on the inclusion and exclusion criteria. Upon arrival at the laboratory, a detailed explanation of the study objectives and participation requirements was provided to the individual. Then, the informed consent form and personal information form were completed by the individual. Afterward, initial measurements were taken, including anthropometric measurements and assessment of shoulder movement disorders to determine the presence or absence of scapular dyskinesis.

Evaluation of scapular dyskinesis

To assess scapular dyskinesis, the lateral scapular slide test (LSST) developed by Kibler was used. The validity of this test is high in the neutral position and low in two other positions (45 and 90 degrees), and its intergroup reliability is high (0.87-0.94) as well as its intragroup reliability (0.63–0.79) (Kibler, Sciascia, & Wilkes, 2012). In this test, the inferior angle of the scapula was marked on the skin with a marker, and the distance between it and the adjacent vertebra was measured in three standing positions: 1- hands by the sides of the body, 2- hands on the lower back with the palm facing backward and the four fingers facing forward, and 3- arms in 90 degrees of abduction

with the palm facing downward. The measurement was repeated three times on each side, and if there was a difference of 1.5 cm or more between the two sides, the test was considered positive, and the individual was identified as having scapular dyskinesis (r = 0.90) (Kibler, et al., 2012).

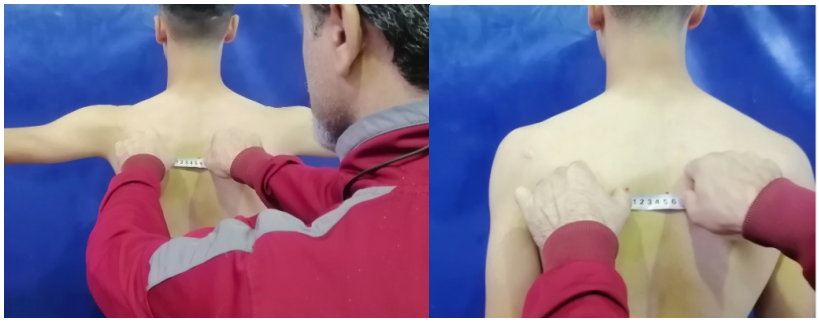

Figure 2. Evaluation of scapular dyskinesis

Evaluation of muscle strength

To measure the maximum isometric strength of internal and external rotator muscles of the shoulder joint, a handheld dynamometer model CASE-01163 manufactured by Lafayette Instrument Company, USA was utilized. To do this, the individual was placed in a supine position on a flat surface, and the shoulder was abducted to 90 degrees, with the elbow flexed to 90 degrees and hanging from the surface (angles were measured with a standard goniometer). The handheld dynamometer was placed on the anterior surface of the forearm just above the wrist for internal rotation and on the posterior surface for external rotation. A folded towel was placed under the arm to maintain humeral adduction. Then, the individual was instructed to exert maximum force for 2 seconds, without moving the arm, in the direction of internal and external rotation, respectively, against the handheld dynamometer. The maximum isometric force exerted by the individual was recorded on the digital display of the device (ICC = 0.88-0.96) (Hannah, Scibek, & Carcia, 2017).

Evaluation of functional stability

To assess the functional stability of the shoulder joint, the Y balance test was used. To perform this test, the individual stood on their hands and toes, keeping their spine and lower limbs in a straight line. The dominant hand was chosen as the support. The position of the hand was marked by a designated line, and the feet were separated by the width of the shoulders. In this position, the individual was asked to reach as far as possible in the medial, inferior-lateral, and superior-lateral directions with their free hand while maintaining the position of the supporting hand, torso, and lower limbs. To enable comparisons between individuals, the reach distances along the upper limb (the distance from the seventh cervical vertebra to the end of the longest finger in 90 degrees of shoulder abduction and elbow extension, wrist and finger extension) were normalized. The reaching task was performed continuously in all three directions without rest, and the individual was allowed to rest their free hand on the ground after each trial. This process was repeated three times, and the average of the three correct trials in all three directions was recorded as the composite score of the individual in the functional stability test. The intra-tester reliability of this test was reported as good to excellent (0.80-0.90) (Gorman, Butler, Plisky, & Kiesel, 2012; Zarei, et al., 2021).

Figure 3. Evaluation of functional stability

Evaluation of proprioception

To evaluate the accuracy of the proprioceptive sense of the shoulder joint during 90 degrees of abduction, digital camera imaging was used. First, the individual's shoulder girdle was marked, and a single shoulder abduction movement was reconstructed at a 90-degree angle. To perform the test, the individual was seated on a chair and asked to raise their shoulder to 90 degrees of abduction in a trial manner, during which the tester commanded them to remember this angle. Then, the main test was performed, and the tester was asked to reconstruct the 90-degree abduction movement. When they reached the target angle, they said "reached," and the tester immediately took a picture from the back view. Then, the photos were analyzed using Kinovea software to determine the accuracy of shoulder joint proprioception during abduction movement. It should be noted that to emphasize the accurate evaluation of proprioceptive sense, the movement was performed with eyes closed. The average of three correct trials was considered as the reconstruction angle of the proprioceptive sense of the shoulder joint. The reliability of this method was reported as 0.87–0.96 (Elrahim, Embaby, Ali, & Kamel, 2016; Herrington, Horsley, Whitaker, & Rolf, 2008).

Figure 4. Evaluation of proprioception

Training protocol

After conducting the pre-test assessments, the participants in the training group performed 8 weeks of suspension training. During this period, all participants were asked to perform their normal daily activities and refrain from exercises that emphasized the upper limb muscles and could affect the study results. The control group was asked not to perform any sports activity during the study period. The first researcher fully monitored and supervised all the training sessions. The suspension trainings were performed using for 8 weeks in 24 training sessions that lasted 25–30 minutes for each session by the subjects of suspension training group. The suspension progressive

exercises were designed to increase the intensity of the exercises each week relative to the previous week by adjusting the exercise duration, level and/or type so that they most closely resemble the common functional movements in volleyball, basketball and handball in the final week. All exercises performed were based on the books and papers published in the field of suspension trainings (Dawes, 2017; Melrose & Dawes, 2015; Mohamed, 2016). The first Researcher possessed the suspension coaching degree (grade I) with a 3 years experience. Following the training period, all factors were reassessed using the same procedure as the pretest.

Table 1. suspension training protocol

Week	Exercises	Set- Reps- Rest
1–2	Standing push-up plus, Chest press, standing overhead triceps extension, Scapular retraction, Inverted row, Supine iron cross, Elbow plank, Supine plank, Dual-arm external rotation	3-10-20
3–4	Standing push-up plus, Inverted row, Rear deltoid row, Biceps curl, Dual-arm external rotation, Dual-arm internal rotation, Standing overhead triceps extension, Reverse biceps curl, side plank, rotation plank	3-12-15
5–6	Scapular retraction, Field goal, Sprinter chest press, Push-up plus, Rear deltoid row to Y, Dual-arm external rotation, Dual-arm internal rotation, Reverse Crunch, rotation plank	3-10-10
7–8	Low row, I- Y- T exercise, T fly, Single-arm inverted row, Off-center chest press, kneeling overhead triceps extension, Dual-arm external rotation Inverted	3-12-10

Statistical analysis

To assess normality, the Shapiro-Wilk statistical test was conducted on the data. A Two-Way analysis of variance with repeated measures was then used to examine intergroup differences in the post-test stage of the study. All statistical analyses were performed using SPSS software (23.0; IBM SPSS Inc., Chicago, IL, USA), and the significance level was set at 0.05.

RESULTS

Table 2 presents demographic information for the subjects, categorized by group. Based on the results of the independent t-test, no significant differences were found in the demographic variables of the research subjects between the two groups.

Table 2. Demographic characteristics of research subjects in two groups (mean ± standard deviation)

Group Variable	Control	Intervention	P
Age (Year)	27.19±4.7	26.48±6.2	0.319
Heigh t(Cm)	185.01±5.1	184.85±8.3	0.227
Weight (Kg)	88.14±6.1	86.43±5.6	0.412
BMI ($kg.m^2$)	23.72±4.7	23.48±3.6	0.288

A Two-Way analysis of variance with repeated measures was conducted to investigate the effect of 8 weeks of suspension training on internal and external rotator muscle strength, functional stability, and shoulder joint proprioception accuracy. The results of the analysis revealed a significant interaction effect between time (pre-test to post-test) and group (control vs. experimental) on internal rotator muscle strength (η=0.263, P=0.001, F=12.04), external rotator muscle strength (η=0.167, P=0.001, F=9.22), functional stability (η=0.319, P=0.001, F=14.01), and shoulder joint proprioception accuracy (η=0.211, P=0.001, F=8.68).

Additionally, the results revealed significant main effects of time and training intervention on internal rotator muscle strength, with significant effects of time (η=0.281, P=0.005, F=8.23) and training intervention (η=0.194, P=0.021, F=6.79). Similarly, there were significant main effects of time and training intervention on external rotator muscle strength, with significant effects of time (η=0.207, P=0.003, F=10.61) and training intervention (η=0.155, P=0.009, F=8.38). Further, there were significant main effects of time and training intervention on functional stability, with significant effects of time (η=0.313, P=0.001, F=12.52) and training intervention (η=0.199, P=0.001, F=9.85). Finally, significant main effects of time and training intervention were observed on shoulder joint proprioception accuracy, with significant effects of time (η=0.242, P=0.001, F=11.36) and training intervention (η=0.213, P=0.001, F=9.79).

According to the results of the Two-Way analysis of variance, the suspension training had a significant positive impact on internal and external rotator muscle strength, functional stability, and shoulder joint proprioception accuracy in the experimental group when compared to the control group (P≤0.05).

Table 3. Comparison of muscle strength, functional stability, and proprioceptive accuracy between pre-test and post-test stages in the two groups

Variable	Group	Pre-test mean ± std	Post-test mean ± std	Confidence Interval
Internal Rotator Muscle Strength (N.m^2)	Intervention	13.3±3.6	17.3±4.1	-1.37_-2.62
	Control	13.7±2.9	13.4±2.7	-2.71_1.84
External Rotator Muscle Strength (N.m^2)	Intervention	11.6±4.5	16.9±3.4	-2.05_-2.38
	Control	12.2±3.1	12.8±2.6	-4.11_2.64
Functional Stability (Cm)	Intervention	63.2±7.8	77.3±9.4	-3.53_-1.28
	Control	64.8±8.8	66.4±10.7	-1.69_3.83
Proprioception (Degree)	Intervention	-5.8±0.9	-2.1±0.4	-5.84_-1.26
	Control	-6.1±1.1	-7.3±1.8	-3.19_3.54

DISCUSSION

The objective of this study was to investigate the effects of an 8-week suspension training on some factors related to the shoulder joint injuries such as functional stability, muscle strength,

and proprioceptive accuracy in athletes with scapular dyskinesis. Two-Way analysis of variance demonstrated a significant improvement in functional stability, as well as an increase in internal and external rotator muscle strength and proprioceptive accuracy of the shoulder joint following the intervention. These findings suggest that the suspension training may serve as an effective intervention for enhancing functional stability, muscle strength, and proprioceptive accuracy among this population.

The findings of this study are consistent with previous research conducted by Mohamed (Mohamed, 2016), Linek et al. (Linek, Saulicz, Myśliwiec, Wójtowicz, & Wolny, 2016), and Goullet et al. (Goulet & Rogowski, 2018), which respectively reported improvements in the strength of the shoulder joint muscles of swimmers, volleyball players, and professional tennis players following suspension training. However, our results differ from those of Hibberd et al. (Hibberd, Oyama, Spang, Prentice, & Myers, 2012) and Swanik et al. (Swanik, Swanik, Lephart, & Huxel, 2002), who did not observe significant changes in shoulder muscle strength following 6 weeks of strengthening exercises. The disparity in results between our study and those of Hibberd et al. (2012) may be attributed to the shorter duration of the training protocol in their study compared to ours. Additionally, the inconsistency may be attributed to differences in the protocol for measuring muscle strength. Hibberd et al. evaluated the strength of flexor and abductor muscles of the shoulder joint, whereas in our study, we assessed the strength of the rotator muscles of the shoulder joint.

The findings of this study suggest that suspension training may enhance the function of muscle spindle receptors and improve the accuracy of afferent messages from the shoulder joint to the nervous system, potentially leading to more precise feedback mechanisms (Khorjahani, et al., 2021). This improvement in feedback may contribute to enhanced motor control and stability in the shoulder joint (Moghadam, et al., 2020). As a result of improving the accuracy of nerve messages, more coherent and efficient movement commands can be sent to the muscles, which can lead to better performance of the shoulder joint muscles and ultimately improve functional stability (Zarei, et al., 2021). This improvement in functional stability may reduce the likelihood of shoulder injuries, particularly in athletes with scapular dyskinesis.

Merolla et al. (2010) found a reduction in supraspinatus and infraspinatus muscle strength in athletes with scapular dyskinesis. In their study, participants underwent a 6-month rehabilitation program. The results showed a significant improvement in the strength of both supraspinatus and infraspinatus muscles (Merolla, et al., 2010). Based on these findings, researchers concluded that an imbalance in the strength of the shoulder muscle structure leads to acquired scapular dyskinesis. This imbalance disrupts the length-tension relationship of the rotator cuff muscles, resulting in secondary weakness of the supraspinatus and infraspinatus muscles (Merolla, et al., 2010). Previous studies have shown that rehabilitation programs focused on restoring the balance of shoulder stabilizing muscles can improve rotator cuff strength in overhead athletes (Goulet & Rogowski, 2018). The results of the current study are consistent with these findings, indicating that 8 weeks of suspension training have improved the strength of the shoulder rotator muscles and functional stability in athletes with scapular dyskinesis.

Enhanced functional stability observed among the training group in this study, as a protective mechanism, can prevent unintended movements and injuries in the shoulder joint, which is

widely recognized as the most mobile and unstable joint in the body (Zarei, et al., 2021). This is particularly important as previous research has demonstrated a direct relationship between functional stability and proprioceptive accuracy of the shoulder joint (Sayaca, et al., 2021; Zarei, et al., 2021). Previous studies have reported that athletes with higher proprioceptive accuracy in their shoulder joint perform better in upper body functional stability tests, which may significantly reduce the risk of shoulder joint injuries (Jin-Ho, Ki-Jae, Mu-Yeop, Bang-Sub, & Jae-Keun, 2020; Zarei, et al., 2021). Based on the findings of this study and the opinion of Jin-Ho et al. (2020) it can be argued that improved awareness of shoulder position leads to improved performance of afferent and efferent neurons and motor control (Jin-Ho, et al., 2020). Complex movement pattern exercises such as suspension exercises, which are performed in multiple planes and levels of movement and involve multiple joints, may have a double effect on afferent inputs and improve proprioception (Khorjahani, et al., 2021).

The results of the current study demonstrate the positive impact of suspension training on the strength, functional stability, and proprioception of the shoulder joint in athletes with scapular dyskinesis. Given these findings, suspension training can be suggested as a preventative approach to shoulder joint injuries in athletes with scapular dyskinesis. Future research should explore other variables such as kinematics and activation of shoulder girdle muscles after implementing the training protocols used in this study. It is worth noting that the present study had a potential limitation in that it only involved male athletes. Additionally, conducting this research during the COVID-19 pandemic presented challenges in terms of subject recruitment and access to facilities.

CONCLUSION

The findings of this study indicate that suspension training have a favorable impact on variables associated with injury occurrence in athletes with scapular dyskinesis. Consequently, coaches and overhead athletes are advised to incorporate these exercises into their training regimen as a preventative measure against shoulder girdle injuries.

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Security Concerns and Conflict Experience of Physically Disabled People In the Czech Republic

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ABSTRACT

People with disabilities are more vulnerable to violence than their non-disabled counterparts. The fear of crime increases with the experience of victimization. There are many attempts to enhance the confidence of being outside alone or decrease the fear of crime through self-defense courses. The aim of the present study is to determine the level of security concerns in people with physical disabilities and to identify the most frequent crime they are facing. 77 physically disabled people (aged 15 and more; 45 women, 32 men; 5 elementary, 44 secondary, 28 higher educated) participated in the research. 49 participants use mechanic or electric wheelchair, 19 participants use other compensatory aids, 9 participants do not use any compensatory aids. 35 participants use the assistant service, 42 do not. Data was collected via a questionnaire of four parts, in which participants expressed their security concerns, confidence, or vulnerability in given situations through a 6point scale. Each part of the questionnaire is supplemented by an open question encouraging participants to express their experience. People with disabilities have a slight fear of possible conflict situations. This fear increases in conditions with a greater chance of a potential conflict situation or areas that cannot be left immediately. The results suggest a slight sense of helplessness in verbal conflict situations or a developing conflict that can still be de-escalated. We can assume that people with disabilities feel very vulnerable when it comes to direct physical assault.

Keywords: fear of crime; violence; disability; hate crime; abuse

INTRODUCTION

Violence and disability make up an extensive area with a high level of latency, especially in the field of domestic violence (Andrews & Veronen, 1993; European Commission & Directorate-General for Justice, 2008; Hughes et al., 2012). Crime experience increases fear of crime and a risk

of developing psychological problems, which is more likely to happen to disabled people (Dembo et al., 2018). There are many attempts to enhance the confidence of being outside alone or decrease the fear of crime through self-defense courses, which have developed from a theory to evidence-based approaches (Čihounková et al., 2015; Reguli, 2018). However, these courses must be based on the specific needs of clients. Therefore, even before planning self-defense courses, it is necessary to know their security concerns and the situations they more or less often face (Kohoutková et al., 2015). Many studies highlight hate crime that people with disabilities have to face (Healy & Dray, 2022; McClimens & Brewster, 2019; McGowan & Elliott, 2019; Ralph et al., 2016).

The research follows a series of projects focused on the self-defense of specific groups, which were solved at the Faculty of Sports Studies of Masaryk University in Brno. The aim of the present study is to determine the level of security concerns in people with physical disabilities and to identify the most frequent crime they are facing. The research also carefully touches on domestic violence to contribute to the gradual de-tabooing of this topic.

METHOD

Participants

77 physically disabled people volunteered for the research. There were two including criteria. The age of more than 15, which is the limit of criminal liability in The Czech Republic, and physical disability as defined by applicable legislation.

- 45 women, 32 men;
- 5 elementary, 44 secondary, 28 higher educated
- 11 participants use crutches or other compensatory aids, 10 participants do not use any compensatory aid. 60 participants use mechanic or electric wheelchair or combination of wheelchair and other compensatory aids
- 35 participants use the assistant service, 42 do not.

Procedures

Data was collected via a questionnaire „Security concerns „of four parts, in which participants expressed their security concerns, confidence, or vulnerability.

A six-point Likert scale was used in the first part of the questionnaire to express how respondents would feel in situations where there is a greater possibility of encountering a conflict situation. Still, they are not directly threatened by conflict. This part consists of ten statements, and respondents express their expected confidence level in given situations. The number one represents "I would keep surely absolutely calm" and number six "I would be very nervous". This part was ended by an open question encouraging respondents to describe a similar situation they were personally encountered.

The second part of the research tool used the six-point Likert scale, and it investigates how vulnerable respondents would feel in situations where they are a part of a conflict situation. Number one expresses "I would feel confident and know how to respond", and number six "I would feel helpless and do not know what to do". Eleven questions were assigned to this thematic area. This set of questions was supplemented by an open question where respondents were encouraged to describe similar situations they have personally encountered as well as in the first part.

The questions and the statements for the first and the second part of the questionnaire were built on the basis of the previous research in the area of self-defense for people with special needs (Cihounkova et al., 2016a; Cihounkova et al., 2016b; Šenkýř et al., 2015)whether in the form of providing services, improving mobility in public areas and the creation of jobs. A person with disabilities using a wheelchair has the opportunity to attend many public places, events and institutions for improving personal social life. In contrast, however, victimization and vulnerability is higher for people with disabilities. This fact inevitably results in a specificity and difficulties in a sel–defence situation. The aim of this paper is to inform about the project of the Faculty of Sport Studies „Evaluation of methodology of self – defence for people with physical disability using wheelchair", number ROZV/20/FSpS/05/2015. The methodology is based on theory of conflict, and it is focused on the initial stages of conflict resolution (i.e. pre conflict phase and verbal communication.

The third part of the questionnaire investigated what conflict situations people with physical disabilities can get into because of their disability. Respondents were asked if they had ever been in a conflicting or unpleasant situation because of their disability. If so, they were asked to describe the problem.

In the fourth part of the questionnaire, respondents answered whether they had ever encountered a person with a physical disability becoming a victim from an assistant or family member. They were asked to describe the situation in case of a positive response. Due to the sensitivity of the surveyed area, respondents could choose „I do not want to answer".

The data was collected in the last quarter of 2020. Because of the unpleasant epidemic situation, only a few questionnaires could be filled in the presence of the researcher. Other data was collected by interviewing in writing, an online questionnaire, and a printed version of the questionnaire, which was transmitted to the respondents indirectly. The questionnaires were distributed mainly via the Internet. Facebook groups associating people with physical disabilities as well as groups of people caring for the disabled were addressed (44 questionnaires).

Eighteen centers that associate or care for the disabled in The Czech Republic were asked to help with the distribution of the questionnaire. Three centers answered, and two of them were willing to help.

Statistical Analysis

Data was processed by MS Excel. Descriptive statistics and a Cohen D calculator were used for the first and second parts of the questionnaire to evaluate the level of security concerns.

Data from open questions was processed according to the thematic field by mind mapping.

RESULTS

THE FEAR OF POSSIBLE CONFLICT

People with disabilities, in general, have a slight fear of possible conflict situations (mean 3,66 with standard deviation 1,63). This fear increases in conditions with a greater chance of a potential conflict situation (in the night) or areas that cannot be left immediately (such as public transport). See Table 1.

Table 1. Results of all groups, fear of possible conflict

Situation	Mean	SD
1.1 I have to wait at a stop where there is a group of noisy people	2,73	1,35
1.2 At night, I have to get through a dark alley	3,96	1,64
1.3 I'm on public transport at night, and a visibly drunk person gets in	3,82	1,64
1.4 At night I have to get home by myself	3,78	1,73
1.5 At the concert, people become more drunk and aggressive	3,90	1,60
1.6 At night, on the way home, a stranger follows me on the street	4,44	1,45
1.7 I have to get around a group of vulgarly shouting at each other	4,00	1,46
1.8 In the park a short distance from me, a homeless man in torn clothes is lying and begins to wake up	3,13	1,57
1.9 I find myself in a dense crowd of people trying to get somewhere	3,70	1,56
1.10 I am outside with my family and an aggressive dog starts barking behind a low fence	3,12	1,65

SD=standard deviation

The fear of possible conflict situations is higher in women (Cohen D 0,48): The most significant difference was detected in the situation 1.2 (Cohen D 0,7) and 1.6 (Cohen D 0,78).

The fear of possible conflict situations is higher in people who walk without any supportive aids than in people who use crutches or other compensatory walking aids (Cohen D 0,35). The biggest difference was found in situation 1.1.(Cohen D 0,57) and 1.3 (Cohen D 0,64).

The differences between the other groups were not significant. For more details see Table 3 at the end of the text showing the level of fear of possible conflict in particular situation according to every subgroups.

Seventeen respondents mentioned another situation in which they felt fear, but they were not directly under attack. Most of them are related to transport, such as car crashes, aggressive drivers, slippery sidewalks, or pedestrian crosses. The oft-mentioned fears were related to drunk people and people under the influence of drugs. Unpleasant for people with physical disabilities are also encountering with a barking dog without a leash, getting lost and problems that a person with a physical disability cannot solve on their own. They are also afraid of hate violence.

Confidence in a threatening situation

The second part of the questionnaire examined how vulnerable respondents would feel in situations where they are a part of a conflict situation, both verbal and physical (mean of total 3,89 with standard deviation 1,82).

The results suggest a slight sense of helplessness in verbal conflict situations or a developing conflict that can still be de-escalated. We can assume that people with disabilities feel very vulnerable when it comes to direct physical assault. See Table 2.

Table 2. Results of all groups, confidence in a threatening situation

Situation	Mean	SD
2.1 Someone covers my eyes and starts dragging me somewhere	4,49	1,59
2.2 The drunk begins to scold me and approach me	4,06	1,80
2.3 A stranger on the sidewalk starts asking me for money	3,16	1,69

2.4 Someone starts harassing me at night on the street	3,34	1,80
2.5 The young men at the bus stop start shouting at me in a derogatory way	3,27	1,80
2.6 Someone suddenly throws me to the ground	4,91	1,62
2.7 At a party, someone starts shoving me and shouting „what is your problem"	3,81	1,64
2.8 Someone starts a tug-of-war with me over my purse/backpack	4,51	1,77
2.9 Suddenly I feel someone touching my pocket	4,16	1,74
2.10 Someone starts bothering a member of my family	3,61	1,91
2.11 I'm in the park with my family and a barking dog without a leash runs out of somewhere	3,51	1,82

SD = standard deviation

The feeling of helplessness is higher in women (Cohen D 0,36), with the most significant differences in situation 2.4 (Cohen D 0,89).

Like in the first part of the questionnaire, people who walk without any aids feel less comfortable in conflict situations than people using supportive aids for walking. The biggest difference was found in situation 2.2 (Cohen D 0,61), 2.5 (Cohen D 0,58), 2.7 (Cohen D 0,87), 2.8 (Cohen D 0,61) and 2.9 (Cohen D 1,16).

The differences between the other groups were not significant. For more details see Table 3 at the end of the text showing the level of fear of possible conflict in particular situation according to every subgroups.

Conflict situations due to disability

48 respondents stated that they never got into a conflict situation precisely because of their disability. Four respondents reported a non-conflict situation related to wheelchair failure or barrier. Three respondents got into a conflict situation due to his disability but did not specify this situation further.

The situations encountered by the remaining 22 respondents can be classified into the following categories:

- *Verbal* attacks – *most frequent: in public transport, drunks, when favoring a person with physical disabilities in the queue (for example, in the doctor's waiting room)*
- *Hate verbal violence insults due to differences* which were most often aimed at their visible differences, such as different walking patterns or physical disability. The second most frequently mentioned and, as reported, very severe attack gives a sad picture of contemporary society, which, despite the democratic regime, is not nearly as tolerant and inclusive towards the handicaps as humanist approaches would like.
- *Offer of assistance and subsequent robbing*
- *Excessive efforts to help from drunks*
- *Defending another person with physical disabilities*

For verbal conflicts and insults, respondents often stated that they were addressing the situation by not responding to these attacks and, if possible, by leaving the site.

Results of the third part of the questionnaire correspond with the results of the open question in its first part, where drunks and conflicts with them were reported as well as fear of hate crime were the two most resonant topics.

Violence by assistants or family members

68 respondents stated that they had not encountered violence against people with disabilities from assistants or family members. None of the respondents used the „I don‘t want to answer“ option.

Five respondents encountered violence from an assistant or family member but did not specify the situation further. One respondent experienced violence, but it was „reasonable to the situation and would be the same against a person without a disability.“

The responses of the remaining three respondents described the following violent situations:

- Physical and psychological violence, emotional blackmail and refusal of assistant help from family members, throwing against the floor, kicking and beating all over the body.
- Strangulation from foster parents, strangulation from social services worker
- Childhood abuse, that has not been fully coped with until now.

DISCUSSION

Most of the findings correspond with the theory of self-defense (Čihounková et al., 2015; Reguli, 2018) and we can assume, that physically disabled people appropriately evaluated a real threat of given situations.

Also, a higher fear of crime in women is often mentioned, especially in the situation of sexual assault threat, which corresponds with the special self-defense need of this group (Ballan & Freyer, 2012; Stanko, 1995). On the other hand, Vaccaro et al. (2011) remind us that men are more likely not to confess the fear openly.

The often mentioned fear of hate crime is alarming and suggests that disabled people face this verbal and physical violence too often (Edwards & Maxwell, 2021; Ralph et al., 2016). Rand and Harrell (2009) warn that nearly 1 in 5 violent crime victims with a disability believed that they became victims because of their disability.

The higher fear of crime and possible conflict in people who do not use compensatory aids was entirely surprising. They may feel more unsure when going out of balance by the attacker because of the knowledge that they cannot lean on anything.

Victims with a disability perceived offenders to be under the influence of either alcohol or drugs in about a third of all violent crimes against them (Rand & Harrell, 2009). Also our results confirm increased security concerns in the presence of people under the influence of either alcohol or drugs.

Despite the fact that Sobsey and Doe (1991) warn that dependence on care reduces a victim‘s willingness to report abuse, it is worthy to open this topic as often as possible.

CONCLUSION

Physically disabled people appropriately evaluated a real threat of given situations. In general, they have a slight fear of possible conflict situations. This fear increases in conditions with a greater chance of a potential conflict situation or areas that cannot be left immediately. Because they face offensive remarks and hateful verbal attacks very often, they should be educated on how to

internally process these experiences, which could be very painful in the long term. Knowing the security concerns of people with special needs is crucial for develompent of selfdefense courses for these groups of people.

Table 3. Mean and standard deviation in each group and question

QUESTION	GENDER		HELP OF AN ASSISTANT	
	Men	**Women**	**Yes**	**no**
1.1	2,28 (1,35)	3,04 (1,25)	2,69 (1,26)	2,76 (1,41)
1.2	3,25 (1,60)	4,47 (1,45)	4,14 (1,55)	3,81 (1,68)
1.3	3,19 (1,76)	4,27 (1,36)	4,00 (1,57)	3,67 (1,66)
1.4	3,22 (1,76)	4,18 (1,57)	4,29 (1,60)	3,36 (1,70)
1.5	3,38 (1,65)	4,27 (1,44)	4,00 (1,60)	3,81 (1,58)
1.6	3,88 (1,47)	4,84 (1,26)	4,63 (1,24)	4,29 (1,56)
1.7	3,59 (1,48)	4,29 (1,36)	4,23 (1,37)	3,81 (1,48)
1.8	2,63 (1,49)	3,49 (1,50)	3,31 (1,39)	2,98 (1,67)
1.9	3,53 (1,41)	3,82 (1,64)	3,77 (1,55)	3,64 (1,56)
1.10	3,16 (1,72)	3,09 (1,59)	3,26 (1,66)	3,00 (1,62)
2.1	4,06 (1,39)	4,80 (1,63)	4,74 (1,50)	4,29 (1,61)
2.2	3,59 (1,71)	4,40 (1,77)	4,23 (1,74)	3,93 (1,82)
2.3	2,91 (1,77)	3,33 (1,59)	3,43 (1,74)	2,93 (1,59)
2.4	2,47 (1,27)	3,96 (1,85)	3,17 (1,68)	3,48 (1,87)
2.5	3,00 (1,68)	3,47 (1,85)	3,23 (1,69)	3,31 (1,87)
2.6	4,47 (1,77)	5,22 (1,41)	5,31 (1,26)	4,57 (1,79)
2.7	3,22 (1,52)	4,22 (1,58)	3,83 (1,44)	3,79 (1,77)
2.8	4,19 (1,83)	4,73 (1,67)	5,00 (1,39)	4,10 (1,91)
2.9	3,75 (1,77)	4,44 (1,64)	4,51 (1,44)	3,86 (1,88)
2.10	3,44 (2,01)	3,73 (1,81)	3,89 (1,85)	3,38 (1,91)
2.11	3,41 (1,90)	3,58 (1,73)	3,71 (1,75)	3,33 (1,83)

QUESTION	EDUCATION				
	Basic	**High school (study sheet)**	**high school (baccalaureate)**	**Higher professional**	**University**
1.1	3,40 (1,50)	2,82 (1,65)	2,41 (1,19)	3,00 (1,41)	2,84 (1,12)
1.2	4,80 (1,17)	4,53 (1,65)	3,67 (1,52)	3,00 (0,82)	3,84 (1,71)
1.3	4,00 (1,26)	4,41 (1,68)	3,48 (1,62)	4,67 (1,25)	3,64 (1,55)
1.4	4,80 (0,98)	4,59 (1,85)	3,44 (1,57)	2,00 (1,41)	3,60 (1,57)
1.5	4,60 (1,50)	4,65 (1,49)	3,67 (1,41)	4,33 (1,25)	3,44 (1,65)
1.6	4,80 (1,60)	4,71 (1,27)	4,15 (1,48)	3,67 (1,70)	4,60 (1,33)
1.7	4,40 (1,50)	4,35 (1,53)	3,85 (1,48)	2,67 (0,47)	4,00 (1,30)
1.8	2,80 (1,72)	3,53 (1,75)	3,04 (1,35)	1,33 (0,47)	3,24 (1,50)
1.9	4,60 (1,20)	3,71 (1,93)	3,78 (1,26)	2,00 (0,82)	3,64 (1,52)
1.10	3,40 (1,85)	3,18 (1,92)	2,81 (1,42)	1,00 (0)	3,60 (1,44)
2.1	4,40 (1,02)	4,71 (1,23)	4,44 (1,57)	3,67 (2,05)	4,52 (1,77)

2.2	4,40 (1,74)	4,35 (1,78)	3,81 (1,89)	4,67 (1,25)	4,00 (1,70)
2.3	3,00 (1,79)	4,24 (1,55)	2,89 (1,45)	1,67 (0,47)	2,92 (1,72)
2.4	3,80 (2,32)	3,94 (1,51)	3,19 (1,61)	2,33 (1,89)	3,12 (1,88)
2.5	3,80 (1,60)	4,06 (1,66)	3,26 (1,67)	2,00 (1,41)	2,80 (1,83)
2.6	5,60 (0,80)	5,53 (0,98)	4,44 (1,89)	4,00 (2,16)	4,96 (1,46)
2.7	3,60 (1,36)	4,41 (1,33)	3,70 (1,74)	3,00 (2,16)	3,64 (1,55)
2.8	4,80 (1,47)	5,06 (1,21)	4,15 (1,88)	2,67 (1,70)	4,68 (1,76)
2.9	4,00 (1,26)	4,65 (1,45)	3,78 (1,87)	3,67 (1,70)	4,32 (1,71)
2.10	3,80 (1,72)	4,24 (1,73)	3,37 (2,00)	1,67 (0,47)	3,64 (1,83)
2.11	3,20 (1,94)	3,76 (1,77)	3,22 (1,83)	2,00 (0,82)	3,88 (1,70)

COMPENSATORY AIDS

	None	**Crutches /Canes/ Ortheses**	**Combination**	**Wheelchair**
1.1	3,33 (1,33)	3,29 (1,67)	2,58 (1,50)	2,57 (1,20)
1.2	4,22 (1,31)	4,57 (1,76)	3,42 (1,71)	3,96 (1,60)
1.3	4,67 (1,05)	3,86 (1,81)	3,00 (1,78)	3,86 (1,55)
1.4	3,67 (0,94)	3,86 (2,23)	3,17 (1,67)	3,94 (1,72)
1.5	4,33 (1,25)	4,57 (1,50)	3,08 (1,93)	3,92 (1,48)
1.6	4,89 (1,45)	4,71 (1,48)	4,33 (1,65)	4,35 (1,35)
1.7	4,11 (0,99)	4,57 (1,50)	3,67 (1,89)	3,98 (1,36)
1.8	3,33 (1,49)	3,71 (2,19)	2,75 (1,42)	3,10 (1,46)
1.9	3,89 (1,37)	4,00 (1,31)	3,42 (1,55)	3,69 (1,61)
1.10	2,89 (1,59)	3,29 (1,91)	2,67 (1,70)	3,24 (1,57)
2.1	5,00 (1,33)	3,14 (1,46)	4,92 (1,55)	4,49 (1,53)
2.2	4,22 (1,87)	3,00 (1,60)	4,25 (1,88)	4,14 (1,73)
2.3	2,78 (1,81)	2,14 (1,12)	2,75 (1,83)	3,47 (1,59)
2.4	3,67 (2,21)	2,43 (1,40)	3,08 (1,80)	3,47 (1,70)
2.5	3,22 (2,15)	2,00 (1,41)	3,00 (2,08)	3,53 (1,59)
2.6	4,78 (1,40)	4,43 (1,92)	4,00 (2,08)	5,22 (1,34)
2.7	4,56 (1,57)	2,71 (1,28)	3,50 (2,25)	3,90 (1,39)
2.8	4,56 (1,95)	3,43 (1,59)	3,75 (2,17)	4,84 (1,49)
2.9	4,67 (1,15)	2,14 (0,83)	3,50 (2,06)	4,51 (1,57)
2.10	3,22 (1,81)	1,86 (0,99)	2,92 (2,10)	4,10 (1,74)
2.11	3,11 (1,85)	2,57 (1,29)	3,08 (2,02)	3,82 (1,72)

AGE

	15-24	**25-34**	**35-44**	**45-55**	**55+**
1.1	2,83 (0,90)	2,48 (1,43)	2,77 (1,12)	2,73 (1,53)	2,91 (1,31)
1.2	4,50 (0,76)	4,14 (1,55)	4,00 (1,24)	3,47 (1,82)	3,95 (1,85)
1.3	4,83 (0,69)	4,05 (1,59)	3,62 (1,60)	3,53 (1,82)	3,64 (1,58)
1.4	4,17 (1,07)	3,95 (1,62)	3,69 (1,59)	3,47 (1,89)	3,77 (1,86)

1.5	4,50 (0,76)	4,14 (1,39)	3,69 (1,68)	3,73 (1,57)	3,73 (1,81)
1.6	5,00 (0,82)	4,38 (1,36)	4,54 (1,34)	3,93 (1,53)	4,64 (1,52)
1.7	4,67 (0,47)	3,81 (1,37)	3,69 (1,32)	3,73 (1,69)	4,36 (1,46)
1.8	3,50 (0,96)	2,95 (1,53)	3,23 (1,37)	3,07 (1,69)	3,18 (1,70)
1.9	3,50 (0,96)	3,52 (1,79)	3,38 (1,44)	4,07 (1,29)	3,86 (1,60)
1.10	3,50 (0,76)	2,90 (1,77)	2,92 (1,90)	3,00 (1,46)	3,41 (1,59)
2.1	4,67 (1,60)	3,95 (1,79)	4,92 (1,14)	4,67 (1,19)	4,59 (1,67)
2.2	3,67 (1,49)	3,71 (1,83)	4,08 (1,82)	4,20 (1,80)	4,41 (1,72)
2.3	3,00 (1,53)	2,71 (1,67)	2,85 (1,87)	3,47 (1,50)	3,59 (1,59)
2.4	3,83 (1,46)	2,95 (1,73)	3,46 (2,06)	3,13 (1,78)	3,64 (1,67)
2.5	2,83 (1,34)	3,00 (1,66)	3,15 (2,07)	3,53 (1,86)	3,55 (1,72)
2.6	4,67 (1,60)	4,76 (1,54)	4,46 (1,60)	5,07 (1,65)	5,27 (1,57)
2.7	3,50 (1,38)	3,57 (1,47)	3,92 (1,82)	4,00 (1,83)	3,91 (1,53)
2.8	3,67 (1,80)	4,48 (1,76)	4,08 (1,82)	4,73 (1,84)	4,86 (1,49)
2.9	3,50 (1,26)	4,05 (1,68)	4,38 (1,69)	4,07 (1,84)	4,36 (1,77)
2.10	3,50 (1,61)	3,43 (1,65)	3,00 (1,96)	3,93 (2,08)	3,95 (1,92)
2.11	3,67 (1,49)	3,19 (1,79)	3,38 (1,94)	3,47 (1,78)	3,86 (1,77)

	EMPLOYMENT			
	Employed	**Unemployed**	**Pensioner**	**Student**
1.1	2,40 (1,20)	2,73 (1,26)	4,25 (1,48)	2,36 (0,98)
1.2	3,44 (1,50)	4,21 (1,63)	5,00 (1,50)	3,64 (1,49)
1.3	3,56 (1,70)	3,88 (1,45)	4,25 (1,79)	3,91 (1,73)
1.4	3,32 (1,57)	3,88 (1,81)	4,38 (1,80)	4,09 (1,44)
1.5	3,72 (1,48)	3,91 (1,60)	4,88 (1,69)	3,55 (1,44)
1.6	4,16 (1,41)	4,39 (1,50)	5,38 (1,32)	4,55 (1,08)
1.7	3,60 (1,41)	4,09 (1,42)	5,00 (1,50)	3,91 (1,16)
1.8	3,00 (1,47)	2,94 (1,63)	4,38 (1,58)	3,09 (1,00)
1.9	3,52 (1,30)	3,61 (1,56)	4,25 (1,92)	4,00 (1,65)
1.10	3,12 (1,61)	2,85 (1,60)	3,38 (2,06)	3,73 (1,29)
2.1	4,24 (1,70)	4,45 (1,56)	4,75 (1,20)	5,00 (1,41)
2.2	3,84 (1,69)	4,27 (1,88)	4,00 (2,00)	4,00 (1,48)
2.3	2,68 (1,46)	3,39 (1,79)	4,25 (1,64)	2,73 (1,29)
2.4	2,96 (1,82)	3,61 (1,82)	4,13 (1,45)	2,82 (1,47)
2.5	3,16 (1,74)	3,30 (1,87)	4,63 (1,32)	2,45 (1,37)
2.6	4,52 (1,77)	5,21 (1,41)	5,38 (1,32)	4,55 (1,72)
2.7	3,76 (1,70)	3,91 (1,58)	4,50 (1,41)	3,09 (1,44)
2.8	4,24 (1,77)	4,70 (1,71)	5,00 (1,32)	4,18 (1,95)
2.9	4,08 (1,72)	4,24 (1,79)	4,13 (1,54)	4,09 (1,68)
2.10	3,28 (1,87)	4,06 (1,95)	3,25 (1,79)	3,27 (1,60)
2.11	3,32 (1,71)	3,76 (1,84)	2,88 (2,03)	3,64 (1,55)

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The Position of the Warm-Up In School Physical Education Lessons

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ABSTRACT

The essence of the presented research is to analyze the length, position, content and the process of the warm-up part within physical education (PE) lessons at lower secondary schools. The research study has a descriptive character and combines quantitatively and qualitatively oriented aspects of the analysis. The research method used was video-based observation. The research participants were selected from lower secondary schools in the Zlín Region – Czech Republic. Through 15 PE teachers, 35 video recordings were captured. For the analysis of video recordings, the deductive approach (system of categories) was used.

Based on the data analysis, the following information was discovered. The actual length of a PE lesson was on average 36 minutes and 30 seconds. The warm-up recorded to be on average 6 minutes and 22 seconds of the entire PE lesson. A total of 15 lessons were led by teachers and 14 lessons were led by the learning students. Mobilization (dynamic) exercises and static stretching were the most common focuses of the warm-up. The teacher's main priority was to point out mistakes that students made during lessons. The teachers also had to give the students verbal instructions (except for the residual category "other"). The most common form of organization of warm-ups was the so-called "free in space".

From the research, it is determined that the warm-up has an important impact on the PE lessons. This research could be appropriate for PE teachers' education as well as for individual teachers when preparing the PE lessons and/or reflecting on them.

Keywords: parts of Physical Education lesson; Physical Education; video study, warm-up

INTRODUCTION

„What seems so hard now will someday be your warm-up"
– unknown

There are various reasons why warm-up activities are essential in education. As the quotation used as the motto of this paper suggests, in the early stages of learning, the warm-up is critical for improving skills, knowledge, and understanding. However, the crucial role of warm-up activities within education is often overlooked or underestimated.

In Physical Education lessons, warm-up exercises are an integral part of the introductory phase. Their importance lies in preparing the cardiovascular and musculoskeletal systems for increased physical stress (Martens, 2004), thereby reducing the risk of injuries (citation needed). By increasing heart rate and blood flow to the muscles, warm-up exercises enhance overall body temperature and improve joint and muscle flexibility (citation needed). They also contribute to enhancing coordination, balance, and psychological readiness for physical exertion. This means that the goal of the warm-up is to prepare the body for the activities that will follow (cf. Tilinger 2009, Jebavý 2014, Dvořáková & Engelthale 2017). For example, in a gymnastics lesson, the warm-up should include toning exercises aimed at adjusting the muscle tone of the most stressed muscle groups of the body. In a sports game, it is advisable to focus the warm-up on a dynamic warm-up that matches the nature of the sports game. If the main part of the lesson focuses on the development of joint mobility, it is desirable to emphasize it during the warm-up. There is no exact recommendation regarding the duration of warm-ups – it depends on the specific situation and the professional judgment of the PE teacher or coach.

Within the PE lesson, the warm-up is an essential part. Therefore, it is necessary to consider its position and its relation to other parts of the lesson. The lesson's structure is discussed in Czech professional literature dealing with general didactics (Najvar, Najvarová & Janík, 2009) and the didactics of PE, where the warm-up is regarded as an important part of PE lessons. However, a detailed analysis of the position of the warm-up within the PE lesson is lacking or presented briefly (Dobrý 1997, Jebavý, Hojka & Kaplan 2014, Rychtecký & Fialová 1998, Sliacky 2015).

Regarding the actors involved in warming-up activities, the teacher is predominantly responsible for leading the exercises in traditional PE lessons. However, in non-traditional, student-centred PE lessons, the warm-ups are often assigned to the students (for the Czech context, see Sliacky 2015).

To sum up, it is important to analyse not only the function of warm-ups within PE lessons and their content but also the connection between the warm-up and the main part of the lesson and the specific activities that teachers and students engage in during warm-ups. This is the focus of our study. We believe that this information could be relevant for PE teacher education as well as for individual teachers when preparing PE lessons and reflecting on them.

RESEARCH AIMS AND METHODS

The presented research study is a part of the wider research project, which aims are divided into three levels:

- The aim on the theoretical level is to analyse and subsequently synthesize existing Czech and foreign knowledge on the issue of the warm-up in PE lessons.
- On the research level, the aim is to use video study to analyse the length, position, content and process of the warm-up part within PE lessons at the lower secondary schools (in the Zlín region – Czech Republic).
- The aim on the practical level is to clarify the function of warm-up activities and their connections with other parts of the PE lessons. Also, how the individual teachers are preparing and reflecting the PE lessons.

These aims were reflected in the construction of the presented research study. It focuses on the research level of the whole project. Our ambition here is not to generalize the results obtained by our research; we will show on our sample of video recordings of PE lessons, how warm-ups look in practice. We hope to use the relevance of our findings for PE teacher education and individual teachers in practice.

Sampling and data collection

The research sample was selected from lower secondary schools in the Zlín Region – Czech Republic. There were 128 fully organized basic schools (including primary and lower secondary level) on September 15, 2019, the sampling procedure started.

Schools were contacted through their principals. They received an online questionnaire designed by the author of this study. The aim was to capture how many PE teachers work at basic schools in the Zlín Region and how many of them have PE qualifications.

Eighty-seven principals replied to a total of 128 questionnaires – the return rate was 69.2%. One questionnaire was not included in the analysis due to incorrect data. We continued to work with 86 responses from the principals. They showed that a total of 234 PE teachers were working at the lower secondary school at the time of data collection, of which 105 were women and 129 were men.

Based on the obtained data, at the beginning of the 2020/2021[1] school year, teachers were recruited to participate in a video study of PE instruction. The observed teachers were selected based on availability due to the COVID-19 pandemic. The data collection took place from September to 2 October 2020. During the video recording, teachers were asked to keep the lesson as standard as possible. The data was recorded on one camcorder (GoPro Hero 8). The camera in the observed lessons was operated by all the same persons (the main researcher of the project), so there was no need to train more people. The camera was not static, but it moved in space so that the PE teacher was in the picture. The teachers did not have a microphone. The sum of 35 video recordings of PE lessons was acquired (thirty-two 45 minutes long, three 90 minutes long). They serve as the basis for various analyses.

1 Video data collection has been delayed due to the COVID-19 pandemic. The planned number of video recordings was higher, however other teachers were not contacted due to new wave of the pandemic.

The research sample – for the video study – consist of 15 teachers (8 women, 7 men). 11 teachers work in city schools and 4 in village schools. Surprisingly, only 6 teachers (from 15) are PE qualified. The average length of their teaching experience is 12 years. The shortest length of teaching experience is 1 year, which is the case for 3 teachers. The longest teaching experience of 36 years was for 1 teacher (Table 1).

Table 1. Characteristics of the research sample – according to gender, PE qualification, length of practice

Teachers			
Respondent designation	**Gender**	**PE qualification**	**Length of practice**
A_ZL_TV2020	M	no	28 years
B_ZL_TV2020	M	no	29 years
C_ZL_TV2020	W	no	12 years
D_ZL_TV2020	M	yes	16 years
E_ZL_TV2020	W	yes	12 years
F_ZL_TV2020	M	yes	6 years
G_ZL_TV2020	M	yes	1 year
H_ZL_TV2020	W	no	1 year
I_ZL_TV2020	W	no	1 year
J_ZL_TV2020	W	no	2 years
K_ZL_TV2020	W	yes	2 years
L_ZL_TV2020	M	yes	24 years
M_ZL_TV2020	W	no	6 years
N_ZL_TV2020	M	no	36 years
O_ZL_TV2020	W	no	6 years

As this research study focuses on the warm-up, it is necessary to describe the nature of PE lessons within which the warm-up analysis was performed (Table 2, 3).

In Table 2 we present a summary overview of recorded PE lessons, where we add the years (grades) in which the PE lessons were taught. In Table 3 we present the typology of lessons according to the content focus.

Table 2. Lesson typology – general information

Thirty-five physical education lessons from it...	
12 girls	
14 boys	
9 coeducational	
22 in the gym	
13 on the outdoor playground	
3x 5th year	4x 9th year
7x 6th year	1x 6th + 7th year
12x 7th year	1x 6th – 9th year
7x 8th year	

Table 3. Typology of lessons according to content focus

Gymnastic	2
Athletic	9
Game	15
Unconventional	1
Fitness	3
Combat sport	0
Mixed	5
TOTAL	**35**

Tables 2 and 3 show that most of the video recordings were boys' lessons, in the gym and that the most common were game lessons.

The highest number of recordings (12) was conducted in the lessons of 7th-grade students. In 2 cases, it was a combination of several grades, due to the low number of students. In one city school, girls from the 6th and 7th grades were combined, and in one village school, all girls from the 2nd grade (6th – 9th grade).

The research data was obtained with the support of an internal project of the Faculty of Sports Studies of Masaryk University with registration number MUNI / 51/06/2020. As this was a video study, all steps had to be taken in accordance with ethical principles and the GDPR. The school principal has always agreed to the participation of a third party. Teachers had signed the informed consent of the research participant. All research data was handled with confidence.

Data analysis

The research study has a descriptive character, it combines quantitatively and qualitatively oriented aspects of the analysis. Following the video study approach, the research method was observation mediated by video recordings of classroom instruction.

For the video analysis of the warm-up, it was necessary to create a categorical system. We used a categorical system for our design, which was inspired by Janík and Miková (2006) and other authors focused on PE didactics (Dobrý, 1997; Rychtecký & Fialová, 1998; Sliacky , 2019).

In the categorical systems (Table 4), the following aspects (categories) were covered and defined: (1) lesson structure (dividing the lesson in parts), (2) Acting warmups, (3) content of warm-up (traditional), (4) Content of warm-up (non-traditional), (5) teacher activities during warm-up. They were processed in a way that subcategories for the main category were defined, and the description (definition) was provided to clarify. The given subcategory code is what the researcher should use. In case, the observed phenomenon cannot be included in any given subcategory, it should be included in the subcategory "other".

The advantage of using the categorical system within video analysis lies in the possibility to observe one phenomenon multiple times and from multiple perspectives.

Table 4. Categorial system for analysing warm-up in PE lessons

Category	Subcategory	Content definition
Structure of the PE lesson (into parts)	Introduction	Organization (typically a gathering) to present information about the lesson, checking attendance, motivation (acquainting with the aim of the lesson).
	Pulse-raising activities	Pulse-raising aerobic activities to preparate the cardiovascular system and warm the muscles of the body.
	Warm-up	Mobility exercises to prepare the joints and stretches to prepare the muscles and their associated ligaments and connective tissue.
	Main part	Main activity of the lesson.
	Cool- down	Activities assist the body in returning to its normal resting state.
	Organization	For example, preparing tools, time between the parts etc.
	Other	It refers to sequences that cannot be classified into any of the above subcategories.
Actors of warm-up	Teacher – direct instruction	The teacher demonstrates the exercises.
	Teacher – indirect instruction	Pictures, sketches, photos, and videos.
	Student	One student demonstrates the exercises.
	Students – pair, threesome	Two or more students demonstrates the exercise.
	Students	Each student in the group demonstrates one exercise.
	Other	It refers to sequences that cannot be classified into any of the above subcategories.
Content of warm-up (traditional)	Mobilization	Activities which prepare the joints for main activity.
	Dynamic stretching	Stretching exercises that are performed with movement.
	Static stretching	Stretching exercises that are performed without movement - the stretch position and holding the stretch for a specific amount of time.
	Work out	Strengthening exercises, e.g., muscles with a tendency to weaken.
	Specific warm-up	Warm-up that connects with the main activity.
	Missing warm-up	Warm-up is skipped.
	Other	It refers to sequences that cannot be classified into any of the above subcategories.
Content of warm-up (non-traditional)	Warm-up with the music	Warm-up is done to the music.
	Warm-up games	For example, imitating animals, using non-traditional tools…
	Other	It refers to sequences that cannot be classified into any of the above subcategories.

Category	Subcategory	Content definition
Teacher activities during warm-up	Practice (demonstrate exercise)	Teacher demonstrates exercise and gives verbal instructions.
	Verbal instructions	Teacher gives verbal instructions, counts repetitions of exercises etc.
	Observation	Teacher does not demonstrate exercise neither gives verbal instruction, teacher just observe students during warm-up.
	Refer to mistakes	Teacher refers to mistakes without correction of exercise.
	Correction	Teacher refers to mistakes and demonstrate or describe correct execution.
	Evaluation	Teacher evaluates the students.
	Motivation	Teacher motivates the students.
	Other	It refers to sequences that cannot be classified into any of the above subcategories.

For data analysis deductive approach was used. It's principle is that (sub)categories (codes) were used for capturing phenomena observation in video recordings then are used in a form of the categorical system. For coding and data analysis, the Videograph software (Rimmele 2002, see Figure 1) was used. Microsoft Excel was utilised for statistics.

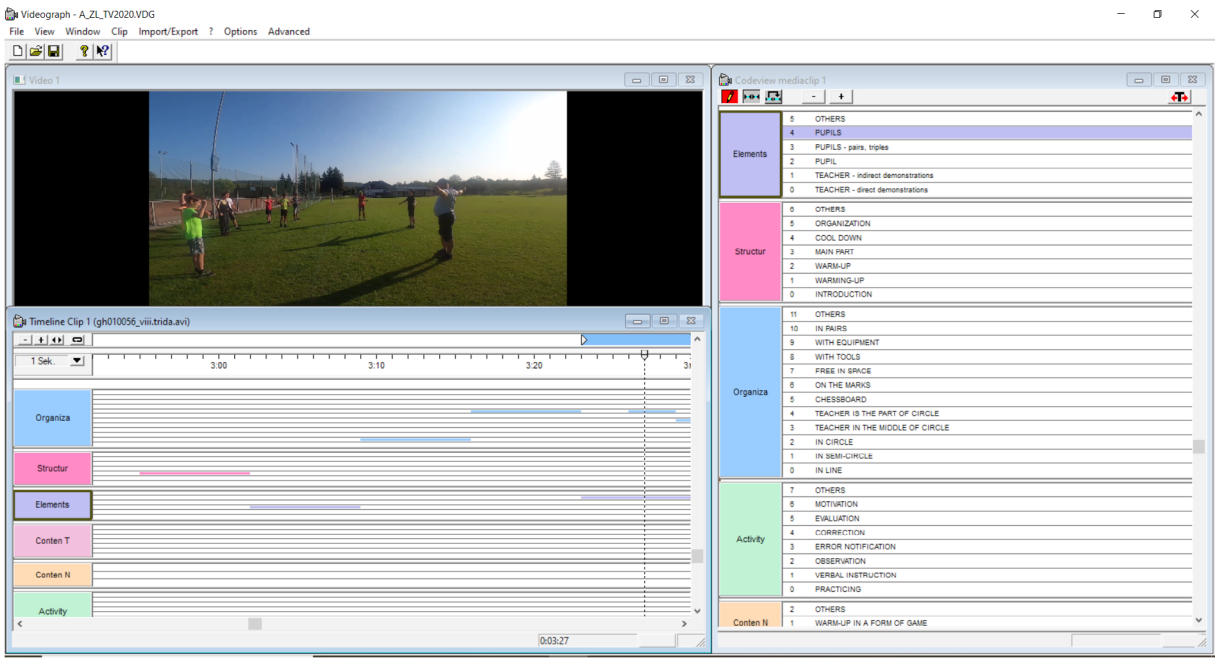

Figure 1. Videograph

The criteria for determining the length of the whole lesson were the following:

- The lesson length was measured from the time the teacher made it clear that the lesson was beginning (in most cases associated with the start of the students) until the teacher verbally finished the lesson (typically with the words "split up", "let's get change your clothes" etc.).

The criteria for determining the length of the warm-up were the following:

- The signal for measuring the start of the warm-up part was that the teacher verbally encouraged the students to do one of the activities related to the warm-up, using, e.g. the words "let's warm-up", "let's stretch", and "find a place". The signal for the end of the warm-up part was again a verbal instruction from the teacher, for example: "let's move on", "so we stretched", etc.

RESULTS

The research sample includes 32 lessons of PE with 45 minutes and three lessons of PE with 90 minutes. To sum up, 21 hours, 17 minutes and 16 seconds of PE lessons were observed. The warm-up lasted 3 hours, 42 minutes and 56 seconds for all analysed lessons. The average duration of a PE lesson was 36 minutes and 30 seconds. The average length of the warm-up time was 6 minutes and 22 seconds (the standard deviation was 2 minutes and 37 seconds, and the median was 5 minutes and 33 seconds).

Physical education classes are typically measured in minutes rather than percentages because time is a more straightforward and universal way of measuring duration. Minutes provide a more tangible way for students and educators to plan and execute a class schedule while percentages can be more abstract and difficult to visualize.

Additionally, minutes allow for a more precise way of measuring physical activity, which is often measured in minutes per day or week to meet recommended levels of exercise. It is also easier to calculate grades, attendance, and overall performance based on minutes spent in physical education class than it would be using percentages.

Overall, although percentages can be useful in some contexts, minutes remain the standard unit of measure for physical education classes.

PE lessons and warm-up: composition and content

Regarding the content of the warm-up, it is essential to consider what will be focus on in the main activity. For this reason, we analysed the role it plays in warm-ups in relation to the main activity. First, we roughly analysed the overall content focus of the examined lessons (see Figure 2). Most lessons were focused on games (15 lessons), followed by athletics (9 lessons). In contrast, we did not find any combat sport-oriented lessons.

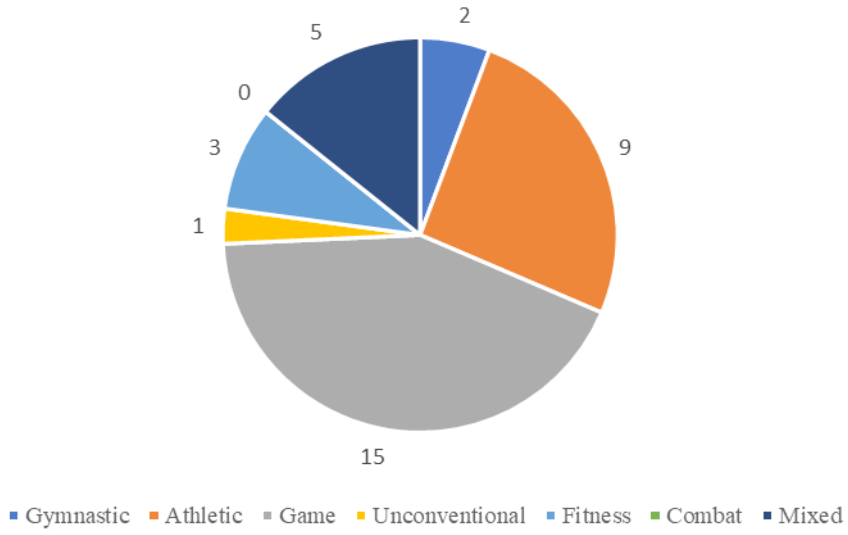

Figure 2. Typology of lessons according to content

Then we performed a detailed analysis of the lessons recorded and found (based on the study of the warm-up exercises and the objectives of the main part) that in most of the PE lessons, there is a connection (correspondence) between the content of the warm-up and the main part of PE lessons.

In athletic lessons, the mobilization (dynamic part) was most often used on the spot in combination with static stretching of the lower limbs. In four lessons, the teachers also included an ABC running drill during the warm-up. Three teachers did not include a comprehensive ABC running drill in the warm-up, but only some of its leg extension and butt-kicking elements. In two warm-ups (led by the student, and the second time by the teacher) the elements of cool-down were included at the beginning of the warm-up after the pulse-raising activities.

In the two observed gymnastics lessons, the mobilization (dynamic) part on the spot and the mobilization of the head were included most frequently. There was employed static stretching or pulse-raising activities of the lower limbs while standing and sitting.

In the fifteen recorded game lessons, the mobilization (dynamic) part, the mobilization of the head and the static stretching of the lower limbs while standing were employed most frequently. Compared to other types of lessons, strength training, such as squats, push-ups, and V-Ups, was included in the warm-up. As in athletic classes, the warm-up was initiated by a cool-down.

During fitness lessons, the warm-up was devoted to the mobilization (dynamic) part, stretching the lower limbs while standing and sitting and stretching the upper limbs while sitting.

In one non-traditional lesson, elements of mobilization, static stretching, and "jumping-jacks" were used in the warm-up.

In mixed classes (with boys and girls together), the warm-up ABC running drill was also part of the warm-up due to the fact, that the first part was devoted to athletics (running techniques) and the second to games ("king" and football).

During the warm-up, we noticed some unusual elements in the recorded lessons (due to the exercises that preceded and followed them in the warm-up), which were so-called "completely out of context" to the content of the warm-up, but also the main part:

- Elements of yoga appeared in two warm-ups.
- Jogging was included in two warm-ups.
- Sprints were included in two warm-ups.
- Students crawled once at the end of the warm-up.

Further analysis of the obtained data showed that the two warm-ups were directly related to the content (topic) of the main activity. This is because the teachers used the same tools, which they used during the main part. In one warm-up, there was use of a basketball ball, to help increase the skill when playing the sport in the main part. The second warm-up also included a ball however this time it was a volleyball. The topic of main part of this observed PE lesson was the basics of sports games. In both the warm-up and the main part, the teacher used the same equipment, so he did not waste time returning or exchanging tools, but especially the student perceived natural continuity from the beginning of the PE lesson.

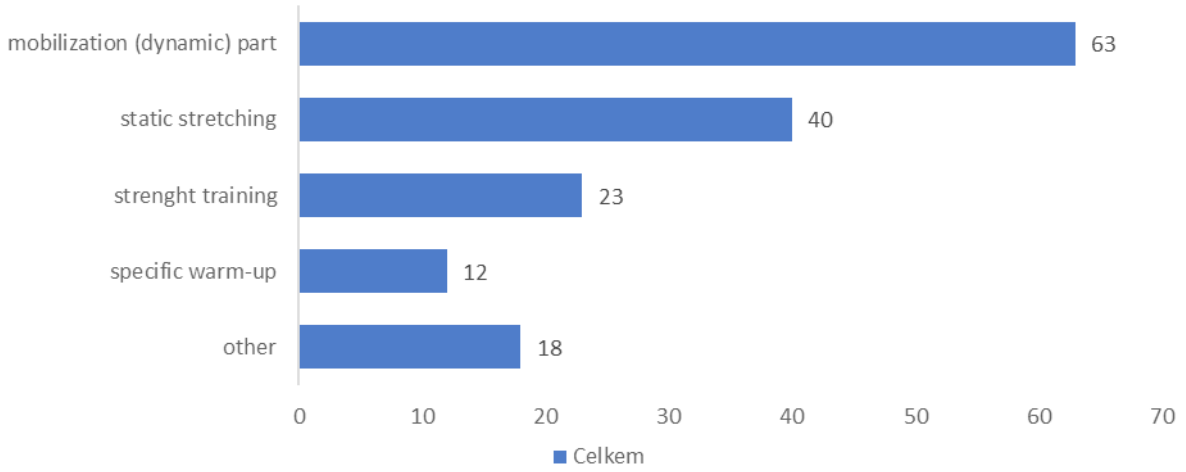

Figure 3. Content of warm-up in PE lessons

In one lesson of physical education, a tool (skipping rope) was used in the warm-up, which was not related to the content of the main part. Specifically, it was an athletic lesson (preparation for the long jump).

In the warm-up (see Figure 3), the mobilization (dynamic) part was the most common (63x) In neither case was it a dynamic part in motion. The second most represented content of the warm-up (40 times in total) was static stretching. It occurred in different forms and other parts of the warm-up. In lessons led by a teacher, a student or two students, static stretching exercises were used, both standing and sitting. A total of 23 strength training sessions appeared during the warm-up, most often squats and push-ups. In two lessons there were V-Ups, sit-ups and plank. The specific warm-up most often presented the ABC running drill or the application of its elements. In specific cases (see category "others"), the warm-up was about exhaling, jogging, sprinting, jumping jacks and crawling.

Teacher activity during warm-up and its' organisation

The teacher is responsible for the content of the warm-up. The teacher should choose activities during the warm-up related to the correct execution of exercises that connect to the following

activities. Therefore, we created a categorical system that covers the teacher's activities during the warm-up (see Figure 4).

During the warmup the teacher pointed out mistakes (30 times in total), however, in most cases, it was resolved by simple instructions. The next most common task (also 30x) was activities from the category "other", which included organizational matters. Such as"let's make a place" (12x), questions such as "what we haven't stretched yet", or questions about health status (5x), preparing tools, which means that the teacher did not even observe the warm-up, but was preparing tools for the next part of the lesson (5x), 3x the teacher "moralize" the students, 2x provided the feedback, 2x the teacher exercise together with the students, in one case the teacher asked the students what was done in the last PE lessons, also in one case the teacher check the attendance and once the teacher whistled a change of direction at the exercise.

The next most represented category (23x) was verbal instructions. This means that the teachers no longer performed the exercises but only described them verbally. The teachers used vocabulary that the students knew well.

When the warm-up was led by a student/students, in twenty-one cases, the teacher only watched them and did not interfere in the exercises in any way.

During the demonstration of exercises (16 times), the teacher was the only leader no students were involved. During the demonstration of exercises, the teacher most often accompanied the activity verbally or counted the number of repetitions.

The category of motivation (16x) was more of a brief short phrase. E.g. "hold on", "go, go", "let's still go", "girls, let's go", etc. An example of longer motivation is "whoever can't, can practice at home".

The least represented categories were evaluation (12x) and comparison (11x).

In the evaluation case, it was a brief reaction to conducting a warm-up or performing an exercise – e.g., "excellent", "very nice", "great", "super", etc.

For correction, teachers usually approached the students individually and corrected the exercises manually. Or they told the students that variant B would be better than variant A.

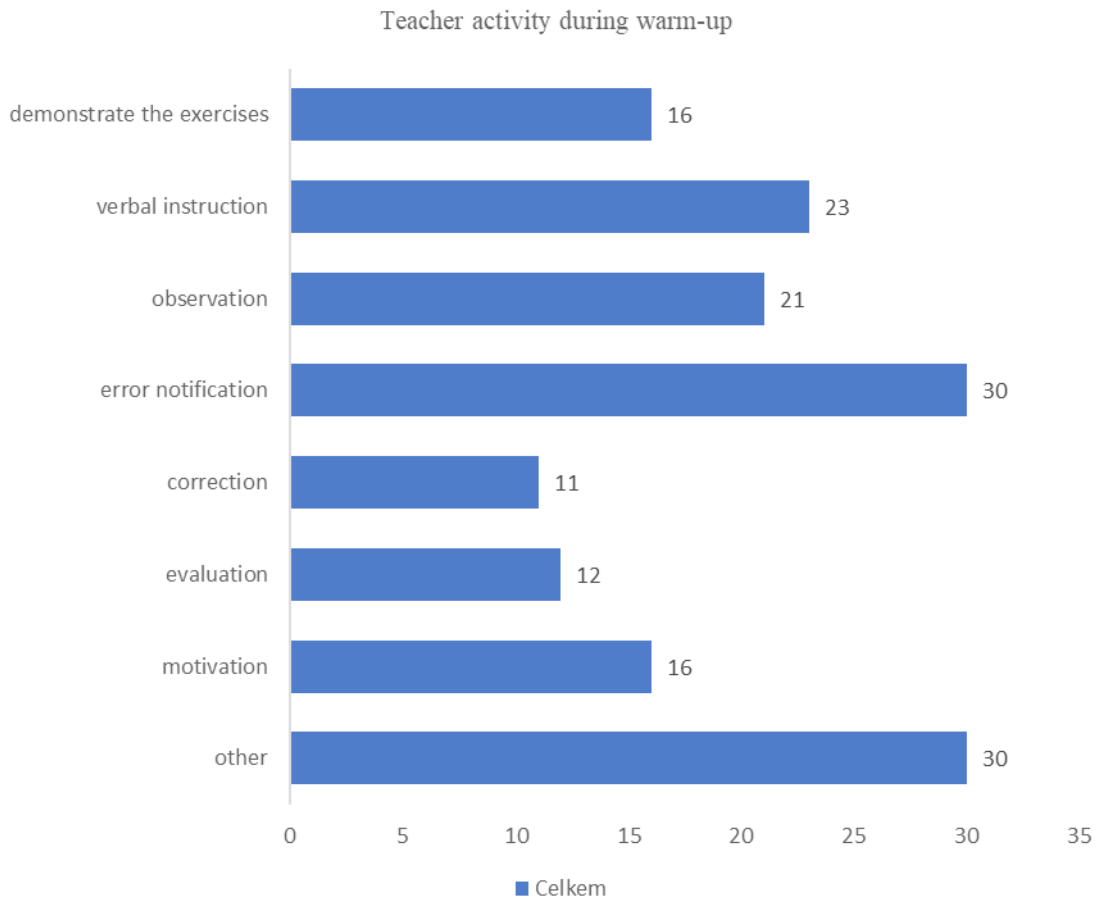

Figure 4. Teacher activity during warm-up

DISCUSSION AND CONCLUSION

When studying the literature, the challenge of defining the "warm-up" in PE lessons occurred. Some authors (Albrechtová, 2006; Buzková, 2006; Ramík, 2010; Stackeová, 2014; Ramsay, 2014) use the word "stretching" instead of "warm-up". From the content definition and from the context of including stretching in the "movement lesson", it may seem that it could be a synonym. However, it should be noted that these authors publish mainly in the field of fitness and exercise programs for coaches and the public, so their goal is not to define the "preparatory part", which is included in the literature of PE didactics.

A positive finding was that warm-up was included in each of the analysed lessons. The average duration of the warm-up was 6 minutes and 8 seconds for the regular 45-minute lessons and 8 minutes and 50 seconds for the 90-minute lessons. This time also corresponds to the time reported in the literature, e.g. Škop (2000) sets the length of the warm-up at six to ten minutes. We also agree with Škop (2000), that he separates the time for warm-up from the time for pulse-raising activities, and, of course, the other parts are clearly defined in time.

In the lessons we studied, the connection between the warm-up and the main part was observed. For example, the warm-up, which closely corresponded to the athletic lesson, was analysed in four PE sessions. Specifically, it was about the inclusion of the ABC running drill in the warm-up.

Three teachers included elements of the ABC running drill in the warm-up. In two PE lessons, the connection of the warm-up with the main part was due to the use of equipment during warm-up. In both cases, it was a ball. One lesson was focused on the basketball game, the other on the basics of sports games. It is important to say that the content of the warm-up (the selection of exercises) should correspond to the given physical activities used in the main part. Jebavý (2014) mentions that the teacher should include general and then special exercises in the warm-up.

A positive finding is that teachers often pointed out errors in the lessons. According to Klimtová (2010), not correcting mistakes is a common shortcoming that teachers make. Sometimes the student does not even notice the poor exercise. The students need to know when they are doing something wrong because then they can improve and know what to work on. Especially if, for example, poor exercise could be fixed, which could harm the body rather than a benefit in the future. Dvořáková (2012) emphasizes that the teacher should explain the importance of the exercise. However, we rarely met with that in the analysed lessons. Another issue is the form in which the student learns that he has made a mistake. In PE, there is often not enough space for long explanations allocated; short commands are frequently used.

The evaluation of the observed warm-ups in relation to their correctness, structure, content, and leadership, as per the recommendations of academic publications, yielded notable results. The warm-ups generally demonstrated a commendable level of accuracy, with a well-structured format and appropriate content that adhered to established guidelines. However, occasional shortcomings were noted in terms of the structure and content, indicating room for improvement. Nonetheless, the leadership exhibited during the warm-ups was effective, demonstrating proficiency in guiding participants through the exercises. Overall, these findings highlight the successful implementation of warm-up strategies that align with best practices in the field, while also suggesting areas for further refinement.

As we mentioned in the Introduction, this research study could serve as inspiration, especially for PE teachers. Based on our findings, suggestions on how to think about warm-ups when preparing PE lessons could be provided – for example: to be aware of the physiological effects of individual exercise, to find correct (safe) space for students, to use correct vocabulary, point to out possible mistakes, to communicate correct performance, etc.

However, it is crucial to keep in mind the limiting factors that influence the choice of warm-up exercises – for example the environment, the age of the students, and the variability of the warm-up.

We see the following research option in the analysis of the cool-down part of PE lessons. During our previous observation and analysis, we noticed, that the cool-down part is also devoted to a minimum of time and its' position is probably not clear within PE lessons. However, the next analysis is needed to highlight this phenomenon.

ACKNOWLEDGEMENT

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"Football Did Not Make Me a World Champion, But It Did Help My Wellbeing": A Qualitative Study of Study-Sport Balance Based On Fung Ka Ki

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ABSTRACT

Managing the balance of academic and athletic responsibilities at university is a serious challenge for student athletes. This phenomenological case study illuminates how one individual successfully managed his study-sport balance at university, and how such experiences shaped his life. Through two semi-structured interviews, the participant Fung Ka Ki, a former student athlete turned international footballer, made sense of his lived experiences at university and achievements post-university. Interpretative phenomenological analysis (IPA) was employed for the qualitative analysis. Two themes were derived: 1) Deploying athletic wisdom to inform life coping strategies, 2) Wellbeing through intellect and body developing together as a system. The findings provide insights into how mental and physical discipline may complement each other to create deep existential wellbeing. The study contributes to the on-going debate on whether high performance athletes should further their studies at university, and indicates ways sports and wellbeing practitioners may support student athletes more effectively.

Keywords: Interpretative Phenomenological Analysis; qualitative research; sport; student athlete; wellbeing

INTRODUCTION

This paper presents a qualitative case study of Fung Ka Ki (FKK), a public figure in Hong Kong (HK), known for being its first professional footballer with a Master's degree. Single case studies have been applied successfully to a wide range of disciplines, including education, social work,

sport, and psychology (Kazdin, 2011). This study aimed to explore in detail how a former student athlete, who excelled in both academic and athletic domains, makes sense of his lived experiences as an elite university student athlete. In particular, it addressed two under-researched areas: 1) How the student athlete copes with balancing academic study with elite level competing in sport, and 2) How this lived experience may influence the quality of post-university life.

On the issue of study-sport balance, recent findings based on nearly 7,000 undergraduate and postgraduate students from British institutions showed that "too busy with studies" was the biggest barrier to gym and sports participation – over three-quarters of the sample experienced this barrier (UKactive Research Institute, 2020). Thus, academic demands may be considered a significant source of demotivation for students to be physically active. Nevertheless, committed student athletes, because of their dual roles, must remain active in their sports despite demanding curricular schedules. Qualitative studies have highlighted some challenges of combining study and athletics at university. Adler and Adler (1985) conducted a participant-observation study on 38 players from an American university's basketball team over a 4-year period. They reported that although student athletes entered the university with an optimistic attitude, the intense sporting demands and expectations were debasing of their academic personas (within the first two semesters, many players claimed that they were detached from their academic work). McKenna and Dunstan-Lewis' (2004) action research with 10 student athletes from a British university found that participants experienced confusion and frustration with priorities. For example, some expressed feeling clueless whether the priority should be competing or graduating, and that being a student athlete prevented the normal life that other students enjoyed. The latter finding was supported by Rothschild-Checroune et al.'s (2012) phenomenological study of 12 first year student athletes from a Canadian university. Their participants felt they did not have enough time for the chores of daily living after fulfilling their academic and athletic responsibilities. Based on 27 student athletes from four American universities, Martin et al.'s (2010) phenomenological study showed how traveling for competitions affected study schedules. Their findings revealed that although the concept of team study sessions (students from the same team using the time in between team practices to study together) was introduced in some universities, most of the student athletes experienced such sessions as unproductive, as they were often distracted by their teammates' tendencies to joke and play around.

Despite the documented difficulties of study-sport balance, relatively little research has paid attention to how successful student athletes cope and excel at university (Cosh & Tully, 2015). On the other hand, it is argued that student athletes lack the coping skills to manage their challenging, divided lives (Papanikolaou, et al., 2003). Through thematic analysis, Cosh and Tully's (2015) study of 20 student athletes at an Australian university attempted to explore both their participants' stressors and their coping strategies. Their findings showed a number of stressors faced by student athletes, such as schedule clashes, fatigue from sport and study, and unreasonable expectations from the coach. This study highlighted that when facing such stressors, the students described having very few problem-focused coping strategies. Most of them relied on emotional support from other people, and some reported using avoidance strategies (e.g., settling for lower grades, skipping classes, and switching to part-time study). Cosh and Tully's (2015) findings converge with

previous research indicating that student athletes would rather step away from their studies, than maintain a balance between their sport and studies while at university (Fortes et al., 2010). They are also consistent with Papanikolaou et al. (2003) that university student athletes generally lacked effective coping strategies for engaging simultaneously with sport and academia. These findings are unsettling for at least two reasons. First, avoidance is generally considered an unhealthy way to cope with stress – it may lead to mental health problems and burnout (Azizi, 2011; Ben-Zur ,2009). Second, both sports performance and emotional wellbeing may be compromised by poor coping (Nicholls & Polman, 2007). Hence, research which enquires into student athletes' lived experiences of coping with their dual roles at university may illuminate the foundations of future remedial work.

FKK was recruited to provide a detailed case study for this purpose. As a student, he completed a Master of Science in Business Management at the University of Warwick (UoW), and subsequently received a full tuition scholarship to study at the University of Hong Kong (HKU). As an athlete, he represented the HK national football team in both Under-23 and senior levels. He was instrumental to HKU's football club becoming champions of the Jackie Chan Challenge Cup (an annual inter-collegiate tournament in HK), and he was awarded Sportsman of the Year by the University Sports Federation of Hong Kong (USFHK). These suggest that he managed a successful balance between academic studies and sports participation. It is relevant that Hanton et al.'s (2008) quantitative study of 217 athletes (national level or above) found that older and more experienced athletes tended to cope better with sports-related stressors, and were less likely to use avoidance strategies. FKK competed at national level as a mature student. These provide further justification of his potential to illuminate the phenomenon under enquiry.

On the question of the impact of being a successful student athlete on post-university life, Gallup (2016) compared life outcomes between former university student athletes (N = 1,670) and their non-athlete counterparts (N = 22,813) from the same intuitions. Results showed that former athletes were more likely to 1) be thriving socially (54% versus 45%), and physically (41% versus 33%), 2) have a sense of purpose (56% versus 48%), and 3) be employed at their desired level (82% versus 78%). More recently, focusing on 3,702 alumni from the same university, Stracciolini et al. (2018) found that those who were student athletes (44% of the sample) showed superior later-life health outcomes. For example, they were: 1) more likely to consider themselves in either good or great health (91% versus 85%) and exercise at least three times per week (62% versus 50%), and 2) less likely to smoke (14% versus 25%). While the long-term benefits of having been a student athlete at university are evident in the quantitative comparisons reviewed above, former student athletes' own understandings of the impacts on their post-university life are less well researched. According to Holmberg and colleagues (2015), understanding lived experiences, more so than statistical information, can provide valuable insights on people's motivation and decision-making in relation to their own health. FKK's decision to continue playing football at both intercollegiate and professional level, where many decide to quit (Hassan et al., 2017), presents a special opportunity to reflect on their impact on later life and career.

METHOD

Background of the participant

After graduating from high school, FKK started both his career as a professional footballer and his post-secondary education studying a diploma in Tourism Management at the Hong Kong Institute of Vocational Education (IVE). He played for the HK national football team in the Asian Games. After completing the diploma, he was sponsored by the Hong Kong Football Association's former president to study a Master's degree in Business Management at UoW. He stopped playing football professionally, but continued as a student athlete for UoW's football club. After graduating from UoW, he signed a professional player contract with Kitchee, making him HK's first professional footballer with a Master's degree. He continued life as a student athlete accepting HKU's sports scholarship to study Sports Science and Leisure Management. Post-university, he accepted a position as Financial Director of Birmingham City Football Club in the UK and then as the Chief Executive Officer of Lee Man Football Club in HK. At the time of writing, FKK is 41 years old, married with one child, and Director of Sky Kids, a consulting company for sports, travel, and education.

Procedure

The study was approved by the University of Edinburgh's Philosophy, Psychology and Language Sciences Research Ethics Committee. Initial contact with the participant was made through a mutual acquaintance. Two interviews were agreed at the outset. For the first interview in June 2019, he was asked to read the Information Sheet and sign the Consent Form. For the purpose of ethics, he was made aware that he would be identifiable in any publications resulting from the research. He was offered the option of being interviewed in either Cantonese or English. He chose the former, and code-switched between Cantonese and English throughout the interview. The initial interview enquired into three areas. First, his background and general reflections on being a student athlete (e.g., "What made you like football?", "What were your strengths and weaknesses as a footballer?", "What were your strengths and weaknesses as a student?"). Second, his experiences of being an international student athlete in England (e.g., "How did you make the decision to leave for England to start your Master's?", "How did you balance studying and football during your Master's?", and "How did being a university student athlete at UoW influence your post-university life?"). Third, we enquired into his experiences of returning to HK as a student athlete after a year-long sojourn in the UK (e.g., "How did you feel about entering HKU as HK's first professional footballer with a Master's degree?", "How did you prioritise between football and your studies at HKU?", "How did being a student athlete in HK influence your post-university life?"). A short break was offered between parts of the interview. Probe questions (e.g., "Can you elaborate?") were asked throughout the interview.

A clarification meeting was held in July 2019 (14 days after the interview). This allowed for reflections on the interview transcript and voicing of possibilities for the second interview. The participant was encouraged to elaborate on experiences that were important. The initial interview and clarification meeting, conducted in a private clubhouse suggested by the participant, were

in-depth and thorough (over 4 hours in total). The participant was invited to read his English-translated transcript for accuracy and any misinterpretations. He signed an additional form to indicate agreement with the translation from Cantonese to English.

Data analysis

The transcript was analysed according to the method of Interpretative Phenomenological Analysis (IPA) (Smith et al., 2009), and adapting case study guidelines, from Bramley and Eatough (2005) and Horrocks et al. (2016). The transcript was read and reread several times to enable thorough familiarisation with the content and "entering the participant's world" (Smith et al., 2009, p.82). Language considered interesting, rich, or allusive was highlighted, and the author's observations and thoughts were noted alongside. Based on these highlights and notes, initial themes which best captured the essentials of the participant's lived experiences were identified. Themes that seemed connected psychologically were grouped together and given headings. Interview extracts were selected to exemplify the themes and to check the internal coherence of the interpretation. The second author acted as a "critical friend" in a review of the themes generated and discussion of the data. Member checking was also employed – the participant was invited to read the preliminary analysis of his interview transcript.

RESULTS AND DISCUSSION

Three main themes were identified from the interviews: 1) Deploying athletic wisdom to inform life coping strategies, 2) Wellbeing through intellect and body developing together as a system, and 3) Living between cultures through bicultural identity. The first theme reflected how football-specific wisdom played an important role in coping with the challenges at different stages of his student athlete life. The second theme captured the different possibilities of wellbeing he experienced through the combination of sport and scholarship, including possibilities that occurred during and after university. The third theme reflected his understanding of the cultural differences between being a student athlete in the UK and in HK. Due to space restrictions, only the first two themes, relevant to study-sport balance, are analysed in this paper.

THEME 1: Deploying athletic wisdom to inform life coping strategies

Deploying athletic wisdom, the theme analysed in this section, refers to knowledge and experience FKK gained in the sporting arena that he extrapolated as a coping resource for life more generally. This theme is constituted of the two subthemes: *Making life-changing decisions* and *Man-marking academically*. The concept of sport as a microcosm and crucible of personality development was put forward by Chan and Lee (2020), in an interpretative phenomenological study of how badminton players made sense of their personalities and lived experiences on court. The players identified, cultivated, or refined in the sporting arena, a psychological or developmental need that paralleled their challenges in broader life. Figure 1 provides a representation of this process.

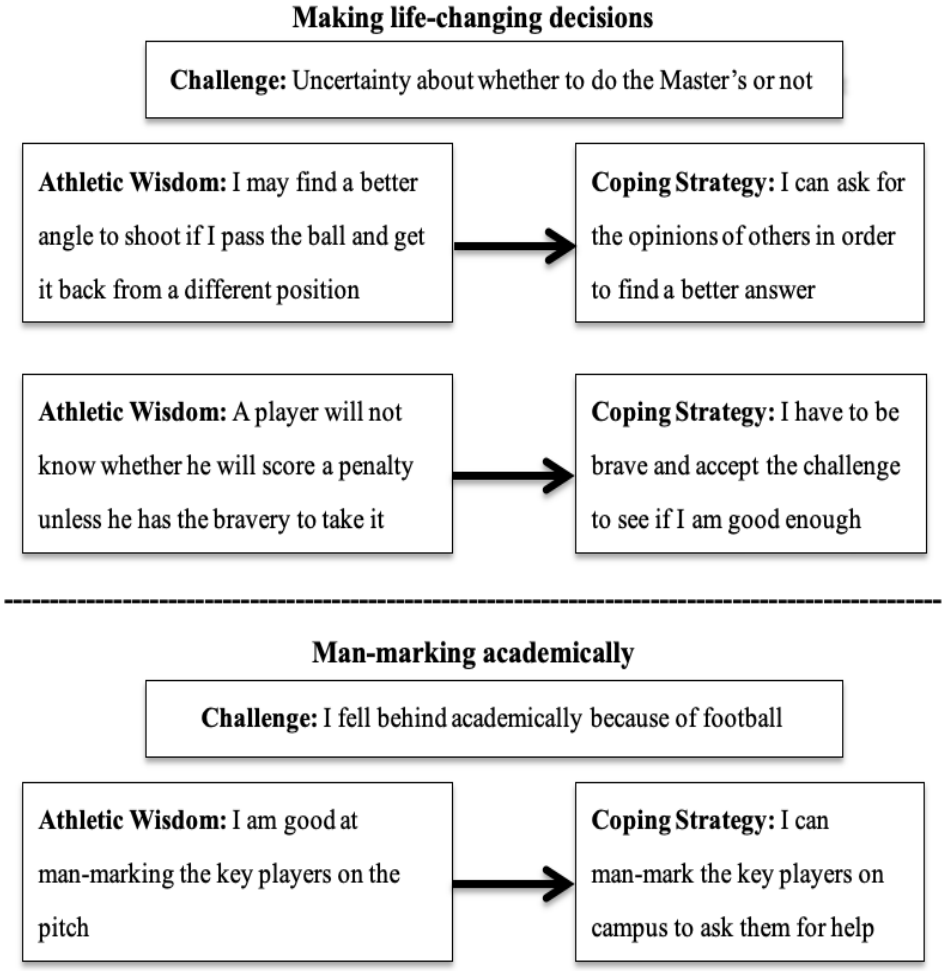

Figure 1. Fung Ka Ki's experiences of coping

Making life-changing decisions

Choosing to accept the offer from UoW to do a Master's degree was a potentially life changing and difficult decision. FKK was already a professional footballer in HK at the time and would need to quit the salaried position to study abroad. He recounts how made the life-changing decision:

> "I did enjoy sharing my stuff with my friends. I would tell them that I wanted to hear their thoughts about something, or I might ask them if my solutions to a problem made sense to them. I think such interactions were kind of like playing football. Sometimes, I might not be able to find the right angle to take a shot, but if I passed the ball to someone else and moved to a different position to receive the ball back, then I might find myself a better angle to shoot […] You need to pass the ball around, to hear what others think, and subsequently you might be able to find the answer more easily."

One of the teammates he "passed the ball to" was Tam Siu Wai, a senior player whom he looked up to:

> "Tam Siu Wai, one of my former teammates, taught me a simple lesson, 'You will never know whether you're good enough to do something unless you are willing to give it a try', that was such a powerful quote for me […] It was back in the days when I had

> to decide whether to go to Warwick or not. The conversation happened after a training session. It was a rainy day, and he was nice enough to give me a lift. I told him that a British university, one of the top four, accepted me to do a Master's degree. However, I was still a full-time professional footballer back then, and my coach, he was not very supportive. The coach told me not to go, he said that I would probably not be smart enough to do a Master's, and that I should just stay in HK and focus on my football career. I was feeling uncertain what to do. So, I asked Tam Siu Wai for his thoughts. His response? 'Are you crazy? Of course you should go and do the Master's! That coach also said that I would not be good enough to take penalties - did that stop me from taking penalties? No! I wouldn't know the result unless I was brave enough to take it!' […] The way he used a football example to answer my question of whether I should go and do the Master's, was exactly what I needed."

In these two extracts we can see FKK deploying metaphors from football to help in making life choices. He had learned through his footballing experiences that if he could not find a clean opportunity to shoot for goal, he needed to pass the ball to a teammate and receive it back for a different perspective. This informed his decision-making: "the offer or not" became the ball, which he passed to his teammate to find a better "angle" and response. The second extract offers a further metaphor which he generalised as a life lesson. Here, a player cannot know if he is good enough to take a penalty unless he tries it. Taking the penalty was the Master's degree: he would not know whether he was "smart enough" unless he embarked upon it. Building on Heidegger's (1962) concept of being-in-the-world, which emphasises the inextricable link between a self and its world, Dale (1996) argued that when analysing an athlete's experiences, researchers and practitioners could not talk about an athlete without implying their lifeworld. He notes "the two [athlete and world] do not exist apart from each other, and each individual and his or her world are said to co-constitute one another" (Dale, 1996, p.309). Further examination of FKK's lifeworld offers opportunities for a deeper analysis. At that time in HK no other professional footballer had completed a Master's degree, and this may illuminate layers of his conflict and uncertainty in accepting the scholarship offer. His coach, who advised him to stay in HK, exacerbates his self-doubt by questioning his ability to study. We can see from other parts of the transcript his propensity to listen to his coach. We also know from another part of the interview he did not do well at A-level and failed to get into university. The opportunity to study in "one of the top four" universities in England, only three years later after his diploma at IVE, may have seemed like a prize beyond his reach.

The clash in his lifeworld was mitigated by others willing to listen sympathetically. The account of his conversation with Tam Siu Wai allowed him to devise the life lesson of "passing the ball" to garner multiple perspectives on his difficulty. It is noteworthy that he remembers the small details of the exchange, including the timing (after a training session) and the weather (rainy) on the day. This testifies to how the conversation did not only help him with the answer he needed at the time, it was pivotal to literally changing his world – to a world where he eventually became HK's first professional footballer with a Master's degree, a title that would continue to pave new paths and opportunities for years to come.

Man-marking academically

FKK's ability to remain focused, meant he was "frequently asked to 'man-mark' the key player of the opposing team". In a game between the HK Under-23 and Japan Under-23, the coach gave him the challenging task of man-marking Shunsuke Nakamura, who later played for Celtic Football Club and was awarded the "Scotland Premiership Player of the Year" award (Macpherson, 2017). In the following, he shares how the metaphor of man-marking helped him academically:

> "I had plenty of games for my club back then. As a consequence, I had to skip my lectures. It was difficult for me, because when you missed them, you're lost, you couldn't really follow, like other students were a few chapters ahead of you […] I was quite outgoing, I won't just stay in my room and cry […] If I missed this and this chapter, then I would 'man-mark' my classmate, and ask him if he could lend me some of his notes."

He would also "man-mark" his lecturer:

> "I would also man-mark my lecturer and ask him questions. I suppose nowadays, the students may be afraid to ask their lecturer questions […] I was not afraid, because I only missed the lecture for an actual football match, I did not miss it because I went to sing karaoke or play snooker. I actually wanted to be there. So, I did nothing wrong. Luckily, my lecturer was quite reasonable, he would be willing to help me out and give me advice on how to do my revision."

He claims being forced to skip lectures due to football commitments was "difficult" and made him feel "lost". In this scenario, the concept of man-marking, something he excelled at in football, enabled him to approach his lecturer and classmate and to recruit them as a study resource. According to Galvin and Todres (2011), when wellbeing is experienced deeply in the domain of identity, there is a sense of "I am" (sense of self backed-up by the continuous histories and contexts that fit with who one is), coupled with a sense of "I can" (sense of being able to). This account fits with FKK's coping experience. For the former, his sense of himself as "outgoing" is supported by a history as a proactive student whom: 1) would not "just stay in my room and cry", 2) "was not afraid" to ask for help, and 3) "wanted to hear" other people's thoughts. Regarding the latter, his sense of "I can" was apparent from being able to get the help he needed from his lecturer, something he, unlike other students, was "not afraid" to do.

FKK's lived experiences of handling his difficulties on and off the pitch helps to inform and flesh out the concept of problem-focused coping, a strategy that university student athletes tended to lack when balancing sport and study (Cosh & Tully, 2015; Papanikolaou et al., 2003). Focusing on this particular stressor, he did not devalue his studies or student role, as in Adler and Adler (1985), or rely on emotional support and avoidance strategies, as in Cosh and Tully (2015). Instead, his focus was to minimise the effect of the stressor (being left behind and feeling lost) through active coping (employing his lecturer and classmate as supports). Building on Lazarus and Folkman's (1984) distinction between emotion-focused and problem-focused coping, Gaudreau and Blondin (2004) have proposed a threefold structure: task-orientated, distraction-oriented, and disengagement-oriented coping, which is frequently used in the sport psychology literature (e.g., Kaiseler et al., 2019).

In the foregoing analysis, FKK's coping style may be interpreted as task-oriented – concentrating on how to solve the problem, rather than switching to other issues (distraction-oriented) or lowering his expectations (disengagement-oriented). His sense of self as outgoing helps to flesh-out the observed statistical correlation between extraversion and task-oriented coping already established in the literature (e.g., Kaiseler et al., 2012; Kaiseler et al., 2019). Barker et al. (2011) have encouraged practitioners of sport psychology to employ case studies in developing interventions for athletes. Previous research indicates stress management is considered an area where student athletes require interventions (Cosh & Tully, 2015; Papanikolaou et al., 2003). FKK's lived experiences of managing his challenges may inform such interventions, such as those that promote problem-focused and action-oriented coping. Both are healthier than avoidance-focused coping and are more in-keeping with the high levels of energy and focus of student athletes (Azizi, 2011; Ben-Zur, 2009).

THEME 2: Wellbeing through intellect and body developing together as a system

A recurring theme of the interviews was how the unity of academic study and physical sports enhanced the possibilities for living well. This main theme of the intellect and body developing together as a system, is constituted of three subthemes: Temporal self; Embodied self; and Professional self. Figure 2 represents the possibilities experienced through his different senses of self.

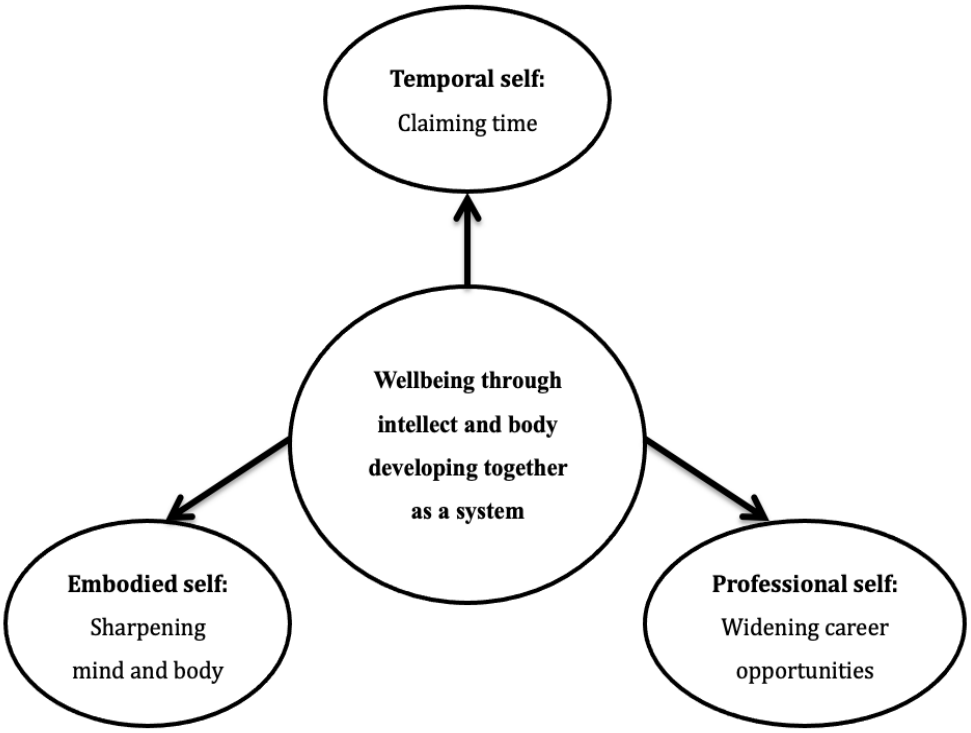

Figure 2. Fung Ka Ki's wellbeing based on his temporal self, embodied self, and professional self

Temporal self: Claiming time

The discipline of a rigorous timetable was paramount in FKK's use of time:

> "I would go to class or do my schoolwork between 7am to 3:30pm. I would then go to training between 4 to 7pm. Between 7 to 10pm, I would be having my dinner and doing

> my revision. Pretty much like that. The schedule worked well for me. […] The key was always just about self-discipline. Say if it was already 4pm, then mentally I would not think about what happened earlier during the day in my studies. I would remind myself I should only focus on my training. During my training between 4 to 7pm, I had to avoid thinking about things related to my modules."

The time discipline was vital to physical health as well as mental wellbeing:

> "Following a timetable was vital. And sometimes you needed to break it down a bit as well, say for example within the 3 hours of training, what you would want to focus on. The same for revision, like which chapters you needed to focus on. As a student athlete, I felt like I was in control, I felt well prepared, and that helped my wellbeing too […] People in my course, as we were doing Sports Science after all, we were all quite physically active, I mean like most of us played at least one sport. I had a part-time job to do for my professional football club, whereas some of them had to work part-time as personal trainers or yoga instructors. So, we all had to follow a schedule. In contrast, there were people in my hall who studied quantitative finance or mathematics, they were younger than me for like 5 years, as I had already finished my Master's and they had only just started their undergraduate degree. But they looked much older, as if they could be my uncles. I think it was because they did not exercise at all. They spent most of their time studying in the student accommodation. They rarely left their room."

We can see how FKK took ownership of lived time, as displayed through a rigour towards temporal boundaries between sport and study. In *Being and Time*, Heidegger (1962) characterised Dasein as temporality. He argued from phenomenology, that time is derived from nature, experienced first-hand as the diurnal cycle of day and night, and the perennial cycle of the seasons, and in ageing and decay – these give Dasein's sense of duration and 'lived time', and allowing the projection of a future. FKK's experiences highlight that in order to be "in control" of his life and destiny, he had to claim and apportion his time rigorously to specific purposes. As a student athlete, he followed his timetable not just physically, but also mentally: he would remind himself to avoid ruminating about his modules during time reserved for training, and he stressed the importance of knowing "what to focus on" prior to the session. This temporal sense-making recalls a previous finding on runners and boxers that "psychological preparation for the training session ahead is vital" (Allen-Collinson & Owton, 2015, p.256). He even accounts for his perception of aging and of physical differences between himself and inactive students, through his hold on lived time.

Embodied self: Sharpening mind and body

FKK recalls how maintaining balance between exercising and studying helped to keep both body and mind active:

> "If you don't exercise, you may need actual medicine, like pills or things like that. But if you do exercise regularly, you probably don't need any of that. I think that was an important lesson I learned through my experiences as a student athlete. Maybe football did not make me a world champion, but it did help my wellbeing. Not just physically, but

> also psychologically, you know. I think wellbeing is probably the most important thing for people in general. I think even if you're not earning a lot of money, but you're both physically and psychologically well, then you'll be fine […] I didn't want pills, so I just had to keep playing football, you know. I was like, I couldn't handle liquid medicine at all! Oh, and I hated Panadol too. So yeah, that was pretty much why I needed sport. As for my studies, I was aware of the importance of knowledge. I knew that I had to know more. It was not just about going to the library to read a book, but also about being able to digest, analyse, and apply the things you learned."

He elaborates on the irreplaceabilities of knowledge and exercise according to his lived experience:

> "For human beings in general, the need for knowledge and the need to exercise are equally important. Both are irreplaceable. You need both in your life, regardless of whether you're a student athlete or not! The need for knowledge keeps your brain active. It enhances your ability to analyse, be critical, and think about the cause of something. Exercise, on the other hand, trains the rest of your body and keeps you well through the various ways I mentioned earlier. Yeah, I think that's how I reflect on my experiences as a student athlete […] Even though I am a director now, I still attend workshops regularly, just to make sure that my knowledge is up to date. Even though I am no longer playing the game competitively, I still try to go for a run at around 5pm every other day, because I know that's what my body needs."

He claims that studying made him analytical, critical, and thoughtful, while playing football helped him feel well and kept him away from medicine. The account is reminiscent of Merleau-Ponty's (1962, p.203) "our own body is in the world as the heart is in the organism, it keeps the visible spectacle constantly alive, it breathes life into it and sustains it inwardly, and with it forms a system". Merleau-Ponty was attempting to explicate an understanding of the world, as it appears to us, as inseparable from our bodily insertion into it – he says they "form a system". Thus, the human being is a body-mind system where both co-create being-in-the-world in productive ways. When FKK says "I think for human beings in general, the need for knowledge and the need to exercise are equally important", he shows how maintaining both body and mind, for him, has reciprocal ramifications for their functioning as a system, that manifests as wellbeing. The training of the body that is not accompanied by a mind developing knowledge is like a body without a heart or a vehicle without navigation. Similarly, studying and acquiring knowledge without physical expression is like a heart without a body, unable to express its ardour though accomplishments in the world. As a student athlete, the mutual discipline of the mind and body were key to his wellbeing. He continued to sustain their symbiosis through his professional life, running and participating in continuing professional development to the present day.

Professional self: Widening career opportunity

FKK's status as an athlete and as a postgraduate were pivotal for his post-university career:

> "When I was studying in Warwick, I thought, once I got my Master's, I should have no problem getting a decent job. And as expected, when I eventually came back to HK with the Master's, I felt that the degree was very useful, very useful indeed […] I mean, that was probably why Cable TV invited me to be a football commentator. They were like, 'You got this Master's, your communication skills should be good enough', so they could count on me to do a good job commentating. Cable TV was very popular at that time, so I was proud to get the job."

After being hired as a football commentator in HK for Cable TV came an opportunity at Birmingham City Football Club:

> "The degree helped me significantly – it gave me the permit to work as a financial director at Birmingham City […] I felt like because of my study-sport balance, I had two different tools. Metaphorically, it was like I had a screwdriver and I also had a spanner, so yeah, two different things, both very useful. The guy who hired me to work as the financial director wanted someone with both tools. On the one hand, he needed someone with knowledge in business management, which was what my Master's was about. On the other hand, he also wanted a football person, and I think I could call myself a football person thanks to my experiences as a player. After all, we're talking about a football club."

He claims his experiences of playing the game alongside his communication skills and business knowledge made him the best candidate as a football commentator on live television and as a financial director of a football club. It is relevant to draw from two other parts of his transcript for further interpretation. First, he mentions that during the start of his career as a footballer, people in HK tended to think that "footballers represented people who were not educated". Second, despite his achievement as HK's first professional footballer with a Master's degree and his directorial job offers, he describes himself as "nothing special" and "just an ordinary guy". These show both dwelling and mobility are present in his sense of identity: A continuous sense of I can, coupled with a strong sense of I am – an ordinary guy who happened to be in the industry (Galvin & Todres, 2011).

Ryan and Deci's (2000) self-determination theory (SDT) offers a framework for further discussion of study-sport balance. SDT proposes that one's motivation to engage in a goal-directed behaviour is influenced by the degree to which three universal psychological needs are fulfilled: 1) autonomy (freedom of choice), 2) competence (ability to control the outcome), and 3) relatedness (a sense of shared experience). Individuals experiencing higher levels of satisfaction of these three needs are more likely to be self-determined and self-motivated (Ryan & Deci, 2000). Applying SDT, FKK's experience of autonomy, competence, and relatedness all contributed to his success in managing a balance between study and sport. It was his own choice to keep studying and playing football as a university student (autonomy). He was not coerced in either studies or sports, and emphasised a need for both in his life. This might not always be the case for student athletes, as David (2005) reports, the decision to engage in elite level sport or continue studies was more often taken by coaches or parents. In relation to competence, FKK believed in his own ability, in particular, to remain focused on a demanding schedule on a daily basis. According to Martin et al. (2010), some

student athletes may lack this discipline, becoming distracted by teammates during study sessions. In terms of relatedness, he felt connected to the people involved in both contexts: in his footballing world through deep connections with teammates, and in the academic world through classmates on a similarly tight schedule.

Taken together, FKK's understanding of his life during and after university helps to disclose how former student athletes are in position to enjoy good later-life outcomes, including perceived health, exercise adherence, and employability (Gallup, 2016; Stracciolini et al., 2018). This case study also contributes to the debate on whether high performance athletes (HPAs) should only focus on their sport, or continue in education as a dual career athlete. This question was raised in Pavlidis and Gargalianos' (2014) review of experts' opinions, focus group discussions, and case documentation. Those arguing for the former believed that: 1) winning should be the sole focus for HPAs; 2) pausing school should help HPAs focus more thoroughly on their sport; and 3) it would be very difficult for HPAs to find the time and energy to study amidst the frequent and intensive training required (Athletes to Business, 2011). Those arguing for the latter pointed out that: 1) HPAs should not focus solely on their sport, as injury or loss of form could put an end to their athletic careers prematurely; 2) retired HPAs experienced difficulty in finding work to support themselves financially due to lack of academic qualifications; and 3) education could guide HPAs into different occupations and enhance opportunities for maturation during and after an athletic career (Aquilina & Henry, 2010). FKK opted for the latter and this case study challenges the assumption that full-time education is too much for HPAs. His reflections on his work as football commentator for Cable TV and financial director for Birmingham City Football Club endorse the role of education in helping secure the future employability of HPAs.

CONCLUSION

Through in-depth analysis of data collected from semi-structured interviews, this study is the first to understand phenomenologically a former student athlete's lived experiences of elite level sport and academia. The analysis of FKK's lived experiences provides some illuminating insights into the integration of physical and mental wellbeing during university life and reflect on how these helped him chart a successful career.

A strength of this study is the richness of the interviews drawing from lived experience. The in-depth interpretative analysis offers a detailed, insider's view of the challenges of high level sport and study internationally in HK and the UK. There is little existing qualitative research of this kind, and it was made possible by commonalities between the first author and the participant. According to Palmer et al. (2010), the quality of the interview hinges on the degree of shared experience between the researcher and participant. The first author grew up in HK, and studied as a local student in HK and as an international student in the UK. He completed a postgraduate degree and played for a university sports team in the UK, worked in HK's football industry, and is bilingual in Cantonese and English. These facilitated rapport throughout the interviews. As for the limitations, this is a single case study and thus generalisation is limited, and readers may judge for themselves

the wider psychological import of the idiographic study. Further, the findings are the result of personal meaning-making of the participant and of the researchers, as appropriate to qualitative, phenomenological methodology, and thus do not indicate cause-and-effect relationships.

Finally, according to Stokoe et al. (2013), current university students tend to play down their achievements. This may possibly explain the relative lack of in-depth, successful experiences of coping in previous research on sports participation while at university. Given the findings from this study, future qualitative research may profitably seek to understand the lived experiences of other former student athletes in different sports and cultures, especially in terms of how they make sense of their wellbeing and achievements, both physical and intellectual, in different areas of their lives.

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Sport as Part of a Good Life: Investigating the Debate

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ABSTRACT

This paper is concerned with the question "What is the role of sport in a good life?". My aim is to highlight the key approaches and core positions in the philosophical debate on the role of sport in a good life. I argue that these approaches can be divided into three general categories: (1) negative: sport does not belong to the realm of a good life); (2) differentiated: sport contributes to living a good life, but it is not the main domain; and (3) affirmative: sport significantly contributes to living a good life. I want to point to those aspects of sport to which the identified positions refer and some interesting arguments that these positions offer. The originality of this research lies in clarifying the main approaches (i.e., describing their general content and structure) and making their arguments explicit. This article is of theoretical nature and uses tools that are standardly used when dealing with these types of research questions, with the most important ones being description, demonstration of relevant thoughts, comparison, evaluation, and interpretation.

Keywords: philosophy of sport; good life; sports ethics; wellbeing, flourishing

INTRODUCTION

The problem of living well in relation to the potential role of sport in it has been discussed quite extensively among philosophers of sport (Suits, 2014, originally 1978; Pisk, 2006; Morgan, 2010; Feezell, 2013; Breivik, 2022). This is understandable since the debate on what a good life consists in presents one of the main topics in the history of thought. My intention here is to focus on the question "What is the role of sport in a good life?".

The goal of this paper is to point out the key positions in a debate on the role of sport in a good life. My ambition is therefore not to map the debate in detail nor to offer an exhaustive list of all the existing approaches since this would be a task for a comprehensive monograph. I also won't

attempt to evaluate all the pros and cons of particular positions to defend the one I subscribe to. As the discussions in the scholarly literature are quite extensive and sophisticated, my task here will be to look at them from a certain distance to see the overall picture of their structure. My intention is to offer a philosophical perspective on the relation between sport and a good life. In doing so, I focus on the core approaches that, in my opinion, represent the basis for the philosophical investigation of the aforementioned question. References used in this text are meant to be illustrative, not exhaustive. Based on my readings I divide the main approaches into three general categories:

- Negative (sport does not belong to the realm of a good life);
- Differentiated (sport contributes to living a good life, but it is not the main domain); and
- Affirmative (sport significantly contributes to living a good life).

I want to highlight those aspects of sport to which the identified positions refer and some general arguments that these positions offer. I work not only with approaches that directly speak about sport in relation to a good life, but I also include those lines of thought that represent an implicit argumentative basis of these positions, although they do not directly refer to sport or a good life. The importance and originality of this essay lies in clarifying the main approaches (i.e., describing their general content and structure) and making their arguments explicit. This "mapping of the terrain" is valuable because it helps us to understand better what the debate on the role of sport in a good life is about. It also helps one to see what lines of thought are worthy of a detailed future investigation.

An important specification concerns the term "sport". I take (modern) sport to be "an institutionalised, rule-governed, structurally game and play-like (non-necessary, non-ordinary, arbitrary, and gratuitous) encounter in various tests and contests of human physical skills" (Mareš and Novotný, 2023, p. 43). Although the word "sport" first appeared in the 15th century (McClelland, 2017, p. 83) and its etymology reaches back to the 12th century (Olivová, 1988, p. 8), the cluster of activities that the concept of sport represents is rather old and already traceable before the invention of the word, for example in the ancient Greek culture.[1] I do not intend to simplify a rather complex history and meaning of various physical activities by simply calling them "sports". Not everything we call sports are in fact sports. On the contrary, some activities that are not called sports might actually be sports. When I refer to sport in this article, I mean the type of activity described above. When appropriate, I also refer to other types of human activities that are similar to sport (e.g., physical exercises – techné gymnastiké, or games). The fact that a particular activity is not inherently a sport does not mean that the theses about it cannot apply to sport by analogy. The quoted authors usually have their own notion of what sport is. Since they share a common point of reference, I leave the details of their conceptions aside and focus only on their arguments regarding the value of sporting activity.

1 The use of the term sport in the context of ancient Greece is problematic, given its linguistic origins and modern usage. Although the physical and competitive activities of the ancient Greeks had strong ritual, religious, and philosophical overtones, I consider it possible to describe many of them as "sporting", given the intrinsic aspects of the activities in question. However, this designation should be taken with a grain of salt. In many ways, physical encounters meant something different from what they mean today. It is also problematic to draw a line between sports, physical exercises, and the various games that were practised in ancient Greece.

Another important specification concerns the term "good life". I approach this concept only through the discussed positions. In particular, I briefly specify what conception of a good life is preferred or presupposed by the relevant authors. Detailed analysis of the content of these positions must be left for another occasion.

Sport as Part of a Good Life

Conceptualizing sport within the domain of a good life is a theoretical project. However, it is also tightly linked to a more practical concern, namely how shall we live our lives and to which activities shall we devote our limited time. Is it reasonable to devote our lives to sport? If yes, on what rational basis can we do that? On the contrary, what are the arguments that speak against such a devotion? What is the precise point of reference of these arguments? Philosophers discussing sport have provided interesting (implicit or explicit) answers to these questions. I will now address the main positions in the debate on the role of sport in a good life which will be discussed in the following order: negative, differentiated, and affirmative.

Negative positions

In general, negative positions refer to certain defects of particular sporting forms or occurrences (predominantly highly competitive or professional sport and Olympic sport), or point to sport's little value in comparison with the more important pursuits. In case of the former, authors especially criticize excessive performance connected with a strong emphasis on results, material prizes, and winning at any cost. This emphasis represents a challenge for modern highly competitive and professional result-oriented sports, but it is already tracible in the context of ancient Greek sport (Pisk, 2006, p. 68). Jirásek (2005, pp. 141-142) states that sport contains traditional and authentic values and opportunities (fair play, performance, victory, or sportsmanship), but it is also exposed to risks of immoral attitudes (cheating to win), instrumentalization of human body (depersonalisation), commercialisation, and politization (ideological manipulation, indoctrination). This position is further developed by Feezell (2013) who claims:

"Certain critics are disturbed by the moral atmosphere of sports and the way they encourage the inevitable side effects of competition: aggression, violence, alienation, and a lack of civility. As highly commercialized competitive activities, sports often highlight greed, crass materialism, egotism, and, at least every four years, jingoistic nationalism." (p. 190)

Feezell points to the Olympic sport which is criticized also by other authors. Kreft (2019) formulates his criticism of the Olympic sport as follows: "[Sport] initially was and still is organised based on the aristocratic and elitists distribution of power, which allows elite associations and elite Olympic movement… to rule over sport and athletes." (p. 257) A radical leftist critique of modern Olympism is offered by Simonović (2004, pp. 9-11). Olympic games are described as the instrument for integrating people into the spiritual orbit of capitalism. Simonović presents Olympism as an aggressive totalitarian ideology that promotes, among other things, sex segregation, abuse of children, turning sportsmen into modern slaves, and drug abuse. Considerably less radical critique is offered by Suits (1988, p. 9) who maintains that in the Olympics there is a kind of compulsion to win which turns a game that could be play into something that is not play, i.e., the valuable play potential of sport is not realised.

It is important to note that these critiques (whether or not we accept their adequacy is a separate issue) do not refer to sport as a type of activity, but rather highlight certain negative features of particular sporting forms and events situated in a given historical and cultural context. They are mainly concerned with professional sport and often they point to some wider cultural problems of which sport is a certain mirror (e.g., materialism, emphasis on results, or wasting resources especially in case of sports mega events).[2] The critique is therefore cultural or sociological, not primarily conceptual (i.e., does not refer to sport as a type of activity). This cultural critique does not deny the positive potential of the Olympic sport. As Loland (2012) notes: "If practiced in sound and responsible ways, Olympic sport can be an exponent of admirable forms of human excellence with validity not only in sport but in society at large." (p. 163) Stronger critique would deny this potential and point to the fundamental problems in the concept of the Olympic sport as such. Simonović seems to go in this direction.

The critique presented so far implicitly rejects the inclusion of sport into the context of a good life on the basis of sport's defective forms. It does not tell us explicitly what a good life consists in, but only suggests what is not desirable in life. An overemphasis on performance and results together with economic or power-oriented instrumentalization of sport generally stand out as undesirable elements that obscure the playful (autotelic) and developmental potential of sport.

The latter critique of sport attempts to show sport's little value with respect to potentially more valuable activities. Already in the late 6th and early 5th century BC, philosopher Xenophanes (Fragments DK 21 B2) mocks the importance of physical strength and athletic achievements. He suggests that these qualities do not make the polis better nor do they stand higher that the pursuit of wisdom. Modern representative of this critique is Chomsky (2014) who characterizes (professional) sport as an "…area which has no meaning and probably thrives because it has no meaning…" Chomsky argues that there are different areas that really matter to human life. Focusing on sport is compared to living in a fantasy world without paying attention to the real issues: "One of the functions that things like professional sports play, in our society and others, is to offer an area to deflect people's attention from things that matter…"[3] Presented thesis is a glimpse of a larger objection against the role of sport in a good life, namely that sport is either worthless, dangerous, and even despicable (Feezell, 2013, p. 189), or at least not as important as other areas. This latter part of the objection can be explicit (as in the case of Xenophanes or Chomsky), or implicit (as in the case of conceptions that do not exclude sport but highlight different ways of living, e.g., contemplative, religious, or political). Such critique goes deeper than the former (pointing to some defects of some instances of sport) as it refuses to ascribe positive value to sport in general. Instead, it interprets sport and its defining properties (e.g., competition with others) as something undesirable, even harmful.

A detailed critique of competing with others is formulated by Luper (1986) who argues against the position of Competitivism.[4] The central distinction of such view is between competitive and non-competitive properties. The second group of properties involves the examples of roundness,

2 Oborný (in our private correspondence) claimed that a good life and the professional sport are incompatible categories. According to Oborný, this form of sport is too cultural and unnatural for human beings.

3 The question remains whether this criticism applies exclusively to sport or whether it can be extended to other "non-productive" activities, e.g., fine arts (painting, sculpture, music, or poetry).

4 Luper (1986, p. 167) presents Competitivism as a type of Perfectionism. This theory holds that excellence is either essential to a good life or at least intrinsically good.

redness, or having a friend. These properties are not competitive in a way that having one does not imply that others won't have the given property. Competitive properties, on the other hand, require rivalry and certain polarization. Luper offers the following example (1986):

"… we might say that a good sprinter is one who can sprint faster than the average sprinter, that a good swimmer is one who can outswim the average swimmer, etc. The property of being able to outrun the average racehorse has a characteristic in common with being able to outswim the average swimmer: in order to have either, an item must compete successfully with other items of the same type. Such properties are the offspring of rivalry, and can aptly be termed 'competitivist'." (p. 167)

The author then extends this model to the concept of living a good life (1986):

"Just as a good racehorse must have the competitive property of being faster than average, the thought goes, so a good live must possess various properties to a degree that exceeds the average… a good X is one that has certain properties to a greater degree than the average X." (p. 168)

According to Luper, the claim that competitive properties are essential to a good life is a tragic error generated by the absurd view that a worthwhile life is like a contest won. One of the problems of such view is that it precludes a plurality of good lives ("if to be good is to score higher than the average life, then some lives must be average or below, and hence not good"). Luper (1986, 170) concludes that competitive properties cannot be essential to the goodness of life.

The critique of Competitivism as applied to sport could be formulated in the following syllogism: (a): Good life does not involve competitive properties (i.e., trying to be better than others); (b): Sport involves competing with others and a commitment to excel in a contest; therefore (c): Sport is not part of a good life. Although the conclusion follows from the premises, both premises could be problematized. For example, one could say that the second premise does not apply to all instances of sport, but only to its competitive, performance-oriented variants, which consider the main purpose of sport to be outdoing others and winning the competition. It is also possible to problematize the first premise, i.e., that competition with others is purely negative.[5]

In contrast to the first line of criticism, the second critique is more explicit about what a good life consists in and what types of activities are worth pursuing in life. These include the pursuit of wisdom and an active interest in solving social and political issues (Xenophanes, Chomsky) or building good interpersonal relationships (Luper).[6] Sport is interpreted as an activity that does not significantly contribute to these valuable endeavours, and thus does not belong to the sphere of a good life.

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5 Some philosophers of sport (among others Hyland, Simon, or Nguyen) have attempted to demonstrate that competition is not necessarily something negative. It could be conceptualized as a cooperative enterprise. The intention then is not to beat or destroy the opponent, but rather to strive together and approach the other as an important element in the process. Under this view, although someone wins and the others lose, everyone can benefit from participating in a contest.

6 Luper (1986, p. 174) suggests that a crucial element of a good life (and a universal intrinsic good) is being in a certain sort of non-competitive relationships with others. My impression is that Luper does not deny the value of excelling in something (even in sports), but only point to the negative aspects of extreme dedication and strong competition with others.

Differentiated positions

The common ground of the differentiated positions is that they ascribe some positive value to sport, but also add that sport's value is limited, conditional, and that sport is not the main domain towards which (all) humans should focus their attention. Representatives of this position are ancient Greek thinkers Plato and Aristotle, who acknowledge educational role of sporting and sport-like activities (techné gymnastiké) in the context of living a good life. In Plato's Republic, physical training and sporting activities are presented as part of a rigorous, yet balanced educational programme which prepares certain classes (guardians, rulers) of the polis for a good community service. These activities are important, but not exclusive means for cultivating the goodness of character (Cooper, 1997, 410b–412b). Reid (2007) summarizes their role as follows: "In Plato's Republic sport serves the educational objectives of personal virtue, intellectual achievement, and political harmony." (p. 160)[7]

Similarly, Aristotle understood physical cultivation as a way to acquire virtues (specifically fortitude, andreia, see Barnes 1995, 1337b, 20–30), health, and beauty (i.e., external goods and conditions for happiness, eudaimonia), but the activities that best fulfil the purpose of human beings are of a different sort, namely intellectual activities, specifically contemplation (Barnes, 1995, 1177a, 10–20). Reid (2020, 69) in the context of Aristotle's conception further specifies that athletic training can only contribute to virtue when it is complemented by an effort to understand what is good and beautiful. Moreover, such sporting practices must be well-balanced and must avoid excesses (Barnes, 1995, 1338b, 40-1339a, 5). Therefore, sport's overall value in the context of a good life is limited and conditional. Sport is valued as an instrument for reaching higher goals and as a platform for personal cultivation if it meets certain standards and criteria. Hurka (1993) summarizes Aristotelian position on the value of physical activities as follows:

"Most of us are not outstanding athletes and cannot achieve the highest physical perfection. Still, we can preserve our basic health and pursue whatever mild athletics are compatible with our main projects. We have instrumental reasons to do both these things. Physical activity keeps us alert and can be the medium for some exercise of rationality. If Aristotelian perfectionism is correct, however, this activity is also a modest intrinsic good, as the development of our physical nature." (p. 39)

Under the discussed "differentiated" view, sport could also be interpreted as a form of compensation. It not only helps us to develop our physical nature, but also to distract ourselves from the workaday concerns and to regain physical and mental strength for pursuing projects of higher value. Sport is then seen as a type of relaxation after work.

Moreover, sport is approached as an instrument for developing healthy cooperation between people. This notion is apparent in the modern Olympic movement. The aim and purpose of the new Olympic Games, captured in the Olympic Charter (2021), is an educational ideal of human development (Jirásek, 2018). The second fundamental principle of Olympism states: "The goal of Olympism is to place sport at the service of the harmonious development of humankind, with a view to promoting a peaceful society concerned with the preservation of human dignity." Sporting competition is intended to build not only individual character, but also human community through

7 Sporting activities in ancient Greece were closely connected with military preparations and were meant to produce soldiers that will protect the polis. This is apparent not only in Sparta, but also in Athenian gymnasia (Olivová, 1988, pp. 100, 106).

fostering bonds of friendship between people and a sense for belonging (Jirásek, 2005, p. 277).[8] However, to what extent is this goal actually being realised remains to be a question and a potential subject for criticism.

The aforementioned examples of the differentiated positions see sport as a potentially valuable instrument for cultivating the goodness of character, enabling individuals to pursue projects of higher value, and promoting interpersonal relationships. Sport in a sense of active participation is part of a good life, but only to a certain extent. These positions highlight that there are other more important things in life that one should pay attention to, namely public service (Plato), contemplation (Aristotle), production (capitalism), or peaceful cooperation between nations (Coubertin).

Differentiated positions also calculate with individual/personal perspectives and subjective preferences. Fry (2004, p. 41) in this respect states that a well-played sport is an intrinsically valuable activity (insofar as it exemplifies fairness, decency, teamwork, and a quest for excellence), but a passionate participation in sport is not a norm for humans in general. One does not have to be an excellent athlete to live a good life. However, Fry adds that for some individuals, the challenges posed by sports are especially meaningful, because the goods that are realizable through sports (e.g., the felt quality of the sport experience) are not readily available through other avenues. This conception shifts our attention from sport to a sporting individual. Here, sport is part of a good life for those individuals (or communities) that have a personal relation to it, but those who don't may pursue different quests that will be important for them.

Affirmative positions

Positions that conceptualize sport within the domain of a good life highlight internal qualities of sport together with its positive impact on human wellbeing and flourishing. Classical representative is Bernard Suits who considers playing games and sports to be the essence of his Utopian vision and constituent of the ideal of existence (2014, pp. 189, 194).[9] Throughout his body of work Suits provides various reasons why these activities are so important. He considers sport to be a type of intrinsic good that, along with many other things, makes up the class of goals to which we ascribe primary seriousness (1973, p. 19). Due to its inner structure (specific rules, goals, and means how to reach these goals), game playing (and arguably sport) "… makes it possible to retain enough effort in Utopia to make a life worth living" (2014, p. 189).[10]

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8 In the Czech context it is worth mentioning the figure of Miroslav Tyrš who regarded physical exercise as a means for achieving national goals, the establishment of democracy, and catalyst to Slavonic cooperation and mutuality. Tyrš was an opponent of competitive sport. He championed harmony and kalokagathia (Platonic teaching based on a philosophy of corporeal, moral and spiritual whole), aesthetics and ethics in physical activity (Jirásek and Hopsicker, 2010, p. 257).

9 Utopia represents a state of affairs where all of the instrumental activities, economical and interpersonal problems are eliminated and where all of the basic goods are easily accessible. Suits then looks for activities that his Utopians would pursue and identifies game playing as the most suitable candidate (Suits, 2014, pp. 182-189). Suits positively values both games and sports. In his main text (The Grasshopper), he does not offer a clear distinction between the value of playing games and the value of participating in sports, i.e., both types of activities are of a similar importance.

10 Suits offers a detailed conceptual analysis of play, game, and sport. His well know definition of game playing states (Suits, 2014): "To play a game is to attempt to achieve a specific state of affairs (pre-lusory goal), using

The significance of games and sports is based not only on ontology (the nature of the activities in question), but also on philosophical anthropology (human nature).The reason why Suits paid such a high attention to games and sports is partly because they enable to realize human potential in a unique way: "People play games so that they can realize in themselves capacities not realizable (or not readily so) in the pursuit of their ordinary activities." (1973, p. 14) Playing games thus resonate deeply with what does it mean to be a human being. Suits here seems to advocate a certain kind of perfectionism about wellbeing (Fletcher 2016). He asserts that humans have a specific set of capacities that derive from human nature and whose exercise and development is good for humans. Lopez Frías (2022) describes Suits' anthropology in relation to his theory of gameplay as follows:

"… for Suits, the defining marks of human nature are the struggle to overcome obstacles and the exercise of autonomy… human beings fulfil their nature when they manage to arrange their lives to give themselves obstacles of their choosing to exercise and develop the capacities from which they derive the highest level of satisfaction." (p. 129)

Sports, although not the sole constituents of a good life, possess qualities that significantly contribute to human flourishing. For Suits, sports are important platforms for exercising and developing human capacities whose exercise and development is an important element of living a good life.[11]

Another account of a good life that involves sporting practices is presented by Morgan (2010). Good life is conceptualized as one in which wholehearted engagement in the social practices that human agents take up is the significant feature. Sport is presented as a sector in which such engagement is the norm rather than the exception. Morgan (2010) specifies that being truly engaged is dependent on recognizing sports' internal value and sports' internal goods: "… in order to engage fully in a practice like sport one must be motivated principally by, and committed foremost and utmost to, its internal goods." (pp. 249-250) Sport may bring about external goods such as money, fame, or power, but the true value of sport comes from its inner structure and the standards of excellence it embodies. Similarly, Breivik (2022, p. 28) states that by taking part in sport people can experience the intrinsic values and meanings that come with such participation.

The value of engagement in sports and games is also based on the assertion that they allow us to carve out new ways of being and even confront the absurdity of our existence. This point is developed by Ryall (2021) in her reaction to Nguyen (2020):

"The best games are those which allow us to stretch our abilities but also our imagination. Games allow us to carve out new ways of being and experiment with the consequences. The fact that I can play and replay a game in a way that is not afforded in other aspects of life, or even with

only means permitted by rules (lusory means), where the rules prohibit use of more efficient in favor of less efficient means (constitutive rules), and where the rules are accepted just because they make possible such activity (lusory attitude)." (p. 43) The shorter definition has this form: "Playing a game is the voluntary attempt to overcome unnecessary obstacles." (p. 43) According to Suits, games and sports are more sophisticated than play and due to their inner nature more valuable. For more details on the relation between play, game, and sport see Suits (1988). The author who defends the value of play is the classic Huizinga (see his opus magnum Homo ludens), according to whom play and playfulness are the symbol of a good life.

11 Suits (1974) further argues that there is not a single proper function that human beings should perform. Instead, he advocates that there is virtually an uncountable number of functions that are proper for human beings. He formulates this claim as an argument against Aristotle's conception of human nature and its proper function.

other forms of art, gives it a special value. In this sense, it portrays the ultimate existential value: I can create and recreate myself infinitely… games may also force us to confront the absurdity of our lives in a way that other activities do not, since we are aware that the goal towards which we are striving is a temporary one that we may choose to ignore." (Ryall, 2021, p. 434)[12]

Ryall here bases the value of playing games on the possibility of repetition which allows one to re-create oneself in the process of playing. The goal of this process is "only" temporal and somehow unforced (arbitrary). It reminds an individual of the temporality of her existence and encourages one to explore the new ways of being that open up in the process of playing. For Ryall, games (and also sports) thus emerge as an existential category. On a general level, they represent a specific possibility of coming to terms with the world. They are meaningful ways of grappling with the fate of a finite, inscrutable and in some ways absurd existence.

These and other affirmative positions refer to sport as a type of activity involving various positive qualities internal to it. Such qualities (e.g., a difficult framework that allows a person to act in the new modes of action) are presented as ones that contribute significantly to individual and social wellbeing and flourishing.[13] The good life in these conceptions means active immersion in activities that bring pleasure to a person, allowing him to realize and develop his ludic nature, motor skills, specific capacities, and modes of action. What matters is living with a passion for movement, play, and the quality of experiencing the present moment.

AN OVERVIEW OF THE MAIN THESES OF THE PRESENTED POSITIONS

Negative positions

- **Critique of particular forms of sporting practices:** *There are many problems associated with the specific forms of sporting practice (especially with professional sport), such as overemphasis on performance, one-sided obsession with results, exploitation of athletes, instrumentalization of the human body, corruption, cheating, or aggressive behaviour of athletes (or fans).*
- **Critique of the value of the activity***: Sport is generally not a valuable activity. There are more valuable activities and areas in human life that one should be interested in.*
- **Critique of Competitivism:** *Competition with others involves certain problems, e.g., polarizing people into categories of winners and losers, and is therefore undesirable.*

12 A radical view related to the absurdity of our existence would question whether there is such a thing as a good life. However, even under such view, sport (due to its inner qualities) could still be conceptualized as a certain antidote to a meaningless existence.

13 Jirásek (in our private correspondence) problematizes the idea that the goodness of sport is constituted by the structure of the activity and its internal qualities (e.g., specific goals related to the framework of testing various physical skills). He advocates that this level is insufficient and emphasizes the role of values that are represented by the activity. My intention here is to point to the internal qualities of sport that are highlighted in the scholarly literature. I agree that a comprehensive discussion on the goodness of sport and its role in a good life would have to include values and specific contexts of their manifestation. For a comprehensive discussion on a good sport see Mareš (2023).

Differentiated positions

- **Sphere of upbringing and education:** *Sport is one of those areas of physical culture in which a person is specifically educated for life. Sport contributes significantly to the development of physical fitness and character of a person, i.e., to the acquisition and strengthening of certain virtues (e.g., bravery, endurance, or discipline).*
- **Sphere of compensation:** *Through sport, people can regain energy after strenuous work tasks. Sporting encounter is a form of rest and recharging for the pursuit of worthwhile human activities.*
- **Sphere of interpersonal relationships***: Sport helps to build healthy interpersonal (personal and societal) relationships based on cooperation, mutual respect, and respect for shared rules.*
- **Sphere of individual interests:** *Sport is a meaningful and valuable activity for selected individuals, namely those who are interested in it and enjoy their participation, but participating in sport is not the "norm" for all.*

Affirmative positions

- **Sphere of activity:** *Sport involves the goods inherent for this type of human practice. It is an activity with inherent qualities worth pursuing, i.e., an area of intrinsic value. This value relates primarily to the performance of physical (movement) skills.*
- **Sphere of human engagement:** *Sport contributes significantly to human flourishing by the way it engages people physically and experientially, and through the modes of action to which an athlete is exposed. Sport enables an individual to develop his/her natural (especially physical) capacities. It also brings joy, satisfaction, and a range of other valuable experiences.*
- **Existential sphere:** *Sport significantly enters into the life situation of a person. It allows to create new ways of being and specific confrontation (or coping) with the finality and possible absurdity of human existence.*

CONCLUSION

Presented list of positions shows that in their critique or support of the role of sport in a good life, authors focus on different aspects of sporting practices. Negative positions point to certain defects of particular sporting forms and occurrences. In doing so, they do not necessarily criticise sport as a type of activity, but rather they argue against some ways of how sport is being practiced. This critique could be interpreted as cultural since sport mirrors certain general features and values of a particular culture. However, some of these positions refer to sports' little value in comparison with other types of activities. Sport is then presented as an area that serves no valuable purpose and that is undesirable, even harmful. Differentiated positions acknowledge sports' positive features, but they try to frame them into a larger context of what a good life consists in. Here, sport is not the main domain, but it may be a valuable part of education (in a broad sense) that aims at some higher goals (e.g., political leadership, intellectual achievements, peaceful coexistence between nations, and production) or it may be valuable for some people, but not for everyone. Affirmative

positions highlight sports' internal qualities, i.e., its intrinsic value together with the unique forms of agency and experiences connected with this type of human practice. Their focus is on debunking the nature of sport to demonstrate its relevance in a good life.

So how does sport stand in the context of a good life? Contemporary sport is clearly not without its problems. Various literature on sport ethics (e.g., Kreft, 2019; Zurc, 2019; Pérez Triviño, 2013) reminds us of the challenges that the contemporary sport faces. Moreover, despite its potential inner qualities, sport (and virtually any other type of human conduct) is arguably not the sole occupation in the context of living a good life. When we put too much emphasis on one good (i.e., sport or play), it will be at the cost of some other goods. Therefore, it will lead to disbalance which represents a threat to a good life. Luper (1986) in this respect says:

"To excel at something requires an inordinate amount of attention to one limited area, and the neglect of equally important concerns. For example, training schedule required to be the best swimmer would impose an inordinate sacrifice on one's education and social life. Skewing our activities toward one goal would lead us to neglect other projects and the needs of our spouses, children and friends." (p. 173)[14] Whether or not sport belongs to the realm of a good life is not determined solely by the sport itself (i.e., by its form and its desired properties) but also by the preferred notion of a good life. Here I only wish to suggest that considering sport and taking its positive qualities seriously may open up space for a more holistic notions of a good life. Such considerations may enrich our thinking about the human nature, its capacities, and the types of conduct that will promote human flourishing. Moreover, sport brings into light topics that are often neglected in a wider philosophical debate on a good life, such as corporeality (i.e., human physical skills), game, play, and "positive" encountering (with rules, other people, ourselves, nature, and the surrounding environment). Taking sport seriously may challenge some traditional, more rationally based conceptions of living a good life and stimulate us to look at the traditional philosophical questions such as "Who we are?" and "Why are we here?" from a different perspective. Therefore, I conclude that the future philosophical debates on a good life will benefit greatly from considering this area of human practice and the spheres it thematizes.

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Home Advantage In the Top Czech Hockey League

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ABSTRACT

Home advantage in sport has long been established as an important factor in determining the outcome of a match. According to this phenomenon, the home team should win more games and score more goals than the away team. Home advantage is a very complex phenomenon that is influenced by many different factors. One possible explanation is that the home crowd supports the home team's performance and also causes the referee to be under pressure and favor the home team. The aim of this paper is to quantify the home advantage in the Czech top hockey league. Using statistical analysis, the number of points scored, goals scored, shots taken, penalties awarded and penalty minutes in the 2019/20 season were compared. A total of 364 matches were analysed. The results showed the existence of a home advantage in the Czech top hockey league in the 2019/20 season. Implications for sport practice and possible directions for future research are discussed.

Keywords: sport; ice hockey; home advantage; spectators; Mann-Whitney test

INTRODUCTION

The phenomenon of home advantage has been studied in sport for many years. The influence of the venue on the outcome of a sporting match is a phenomenon that has been discussed quite frequently in the literature (Bray and Carron, 1993; Koning, 2005; Koning, 2011; Balmer et al., 2005; Balmer, et al., 2003). In most cases, bookmakers place emphasis on the venue of the match (i.e., home or away) when setting odds. According to this phenomenon, athletes or sports teams are expected to perform better at home and achieve better overall results. The home advantage has been studied for more than four decades, yet the exact causes and mode of action are still unknown. According to

most authors (e.g. Pollard, 2006; Pollard, 2008; Carron et al., 2005; Courneya and Carron, 1992), the home advantage is mainly due to the influence of fans, travel, familiarity with the pitch, referee bias, psychological factors and tactics, and a host of other aspects.

The first authors to address the home-field advantage were Schwartz and Barsky (1977), who suggested that home fans exert an encouraging and motivating influence on their players. Schwartz and Barsky (1977) examined the influence of the home environment in various sports, most notably American League baseball, Major League Soccer, and ice hockey. The research revealed a positive influence of the home environment on sport performance. However, the degree of influence of the home environment varied across sports. Balmer et al. (2001) further add that the home advantage differs between team and individual disciplines. The home advantage has been demonstrated in most professional sports. Jamieson (2010) demonstrated the home advantage in 10 different sports, and like Schwartz and Barsky (1977) found that the extent of this advantage varies between sports. He found that the home advantage is highest in football compared to all other sports examined. Schwartz and Barsky (1977) consider the proximity of the fans and their cheering and chanting to be a crucial factor in the emergence of home advantage, which leads the home players to exert more effort and ultimately win the game. Similar to Schwartz and Barsky (1977), other research (Anderson et al., 2012; Smith, 2005; Wolfson et al., 2005) has shown that fans are the main reason for the emergence of home advantage. Furthermore, some studies have examined the dependence of home advantage on crowd size (Nevill et al., 1996), crowd density and intensity (Pollard, 1986; Nevill et al., 2002), or the distance of the sports venue from the crowd (Armatas and Pollard, 2012; Dohmen, 2008; Pollard and Armatas, 2017).

On the other hand, some authors (Courneya and Carron, 1992; Nevill and Holder, 1999) are rather sceptical and suggest that the home advantage has less impact than expected. For example, van de Ven (2011) concluded that audience support is not necessary for the emergence of home advantage (HA). Agnew and Carron (1994) found very little effect of fans and their size on home advantage. Pollard (1986) even found no effect of fans on home-field advantage. Pollard and Pollard (2005) report that home advantage in ice hockey, basketball and football in England has declined over the last two decades. These trends and changes provide some evidence that travel and familiarity with the pitch contribute more to home advantage, but fans in the stands have little influence.

Another frequently cited factor that can cause a home advantage is the influence of fans on the referees. Dosseville et al. (2016) report that referees tend to make more decisions in favour of the home team. This phenomenon has been addressed in many studies (Goumas, 2014; Nevill et al., 2002; Boyko et al., 2007; Nevill and Holder, 1999; Pollard, 1986; Sutter and Kocher, 2004; Garicano et al., 2005). The aforementioned studies have confirmed the assumption that referees tend to make decisions more in favor of the home team and that they are highly susceptible to social influence. The role of referees is very demanding and they unconsciously rely on cues from the crowd to make decisions.

A literature review revealed that there is an extensive literature on home advanteage in individual and team sports. However, most attention was paid to football. According to Pollard (2008) and Jamieson (2010), the home advantage is highest in football compared to all other sports. Other

sports have not received as much attention in the literature. E.g. rugby (Morton, 2006), ice hockey (Agnew and Carron, 1994; Dennis and Carron, 1999; Pollard and Pollard, 2005), basketball (Moore and Brylinsky, 1995; Watson and Krantz, 2003). A major limitation of the above research is that it has not yet been possible to examine matches without home spectators over very long periods of time. The only exception is the period 2020 and 2021 as a result of the Covid-19 disease pandemic. For this reason, spectator presence has been cited as the main factor responsible for the emergence of the home advantage phenomenon (Pollard and Pollard, 2005). However, the available analyses are not consistent regarding the effect of spectators on home advantage. A possible reason for the divergent results may be that research has not accounted for a number of other important factors. This factor may be the playing style of the team, which probably determines its chances of scoring goals and thus the probability of winning. Another factor may be the difficulty of the match schedule in terms of the opponents it faces. The quality of the opponents a team faces is an indicator of its probability of winning (Peeters and van Ours, 2020). More experienced teams may rely less on the support of their spectators than their less experienced opponents. It is also evident from the above that most of the literature focuses primarily on the field of football. Hockey competitions do not receive as much attention in the available literature. Czech hockey in general and the Czech top hockey league in particular do not receive any attention in the literature. The aim of this research is to find out whether there is a home advantage in the Czech hockey league. The presented research uses statistical methods to investigate the differences between the values of selected sports statistics in home and away matches. Empirically, the statistical methods are applied to the Czech top hockey competition (i.e. Tipsport Extraliga) in the 2019/20 season.

METHODS AND DATA

Data

The subject of the analysis was the Czech top hockey league called Tipsport Extraliga. The research focused only on matches in the regular season. Play-off matches were excluded from the research. Tipsport Extraliga was examined based on sports data from the 2019/20 season. 14 teams participated in the Tipsport Extraliga in the 2019/20 season. Namely: Sparta Praha (SPA), Kometa Brno (KOM), Bílí Tygři Liberec (LIB), Mladá Boleslav (MLB), Dynamo Pardubice (PCE), Mountfield Hradec Králové (MHK), Verva Litvínov (LIT), Vítkovice Ridera (VIT), Oceláři Třinec (TRI), Rytíři Kladno (KLA), Škoda Plzeň (PLZ), Olomouc (OLO), Berani Zlín (ZLN) and Energie Karlovy Vary (KVA). The Tipsport Extraliga was played in a four-round system. Each team played 52 games (26 at home and 26 on the opponent's field). This league structure allows an unbiased method for quantifying home games throughout the season. 364 matches were played during the 52 rounds. Tipsport Extraliga managed to play the entire regular season (i.e. 52 rounds) with spectators in the 2019/20 season. It was also the season with the highest average spectator attendance since the 1992/93 season, according to BPA statistics (BPA sport marketing a.s., 2023). The average attendance was 80,142 spectators. The play-offs were cancelled for the 2019/20 season due to the outbreak of the Covid-19 disease pandemic. For this reason, the play-offs are also not included in the research presented.

The data on individual hockey matches was obtained from data on the website of the top hockey competition Tipsport Extraliga, in the database on the Hokej.cz website operated by (BPA sport marketing a.s., 2023; eSports.cz, s.r.o., 2023) and on the Livesport.cz website. This data includes the number of points scored per game (3 points for a win, 2 points for a win in overtime, 1 point for a loss in overtime and 0 points for a loss), the number of goals scored, the number of shots on target, the number of penalties and the number of penalty minutes awarded.

Statistical Analysis

Shapiro-Wilk test and two-sample Mann-Whitney U test and two-sample t-test were used to evaluate the obtained data. The Shapiro-Wilk test was used to test the normality of the sports data examined. The Shapiro-Wilk test is the preferred test of normality due to its good performance compared to a number of alternative tests (Shapiro et al., 1968). The Shapiro-Wilk test is used to test the hypothesis that a random sample of size n (X_1, X_2, ... X_n) comes from a normal distribution with unspecified parameters μ and σ^2, $N(\mu, \sigma^2)$. The null hypothesis H_0 states that the data sample belongs to a normal distribution. The alternative hypothesis H_1 states that the data sample does not belong to a normal distribution. The test statistic to assess the normality of the data is the W statistic, which according to (Budíková et al., 2010) is given by (1). The test statistic W reaches the value of 1 if the data shows a perfect fit to the normal distribution. If the value of the test statistic W is statistically significantly less than 1, the null hypothesis of a fit to the normal distribution can be rejected and the alternative hypothesis accepted.

$$W = \frac{b^2}{S^2} = \frac{\left(\sum_{i=1}^{k} a_{n-i+1}(y_{n-i+1} - y_i)\right)^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2} \quad (1)$$

In the present research, the non-parametric two-sample Wilcoxon test was also applied to the sports data; in some publications (Nachar, 2008) it is also called the Mann Whitney U test. The non-parametric two-sample test is used when the assumption of normality of the data is not met. The Mann Whitney U test is a non-parametric analogue of the test of the identity of the means of two independent random sets (X_1, X_2, ... X_m) and (Y_1, Y_2, ... Y_n) with different numbers of elements. The null hypothesis H_0 states that the data samples have identical means (medians). The alternative hypothesis H_1 states that the data samples do not have identical means (medians). The null hypothesis H_0 can be written as $\mu_1 = \mu_2$. The alternative hypothesis H_1 can be written as $\mu_1 \neq \mu_2$. The test assumes that (X_1, X_2, … X_n) is a random selection from some continuous distribution and (Y_1, Y_2, ... Y_n) is an independent random selection from the same continuous distribution that is shifted by a constant δ with respect to the former. Thus, the random variables (X_1, X_2, ... X_m) and (Y_1 - δ, ... Y_n - δ) have the same distribution. The test statistic for the Mann Whitney U test is denoted U and is the smaller of U_1 and U_2, defined below (2). In relation (2), R_1 is the sum of the ranks for group 1 and R_2 sum of the ranks for group 2.

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$
$$U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2 \quad (2)$$

The second test used was a t-test for two samples. This is a basic test for comparing the means of two independent samples. This test belongs to parametric tests. The null hypothesis H_0 states that the data samples have identical means. The alternative hypothesis H_1 states that the data samples do not have identical means. The null hypothesis H_0 can be written as $\mu_1 = \mu_2$. The alternative hypothesis H_1 can be written as $\mu_1 \neq \mu_2$. The test statistic (3) below is used to test these hypotheses in the case of small sample size (< 30).

$$t = \frac{\overline{X_1} - \overline{X_2}}{S_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \sim t(n_1 + n_2 - 2) \quad (3)$$

The Shapiro-Wilk test and subsequently the Mann Whitney U and t-test, which served as the basis for the outcomes reported in this research, were conducted at the 5% significance level. All analyses were conducted using SPSS statistical software (IBM, 2023).

RESEARCH RESULTS

This part of the paper is devoted to the results of empirical research in which, in addition to descriptive statistics, the above tests of means were used. The subject of the research was individual matches of the highest Czech hockey competition Tipsport Extraliga in the 2019/20 season.

Descriptive statistics

Table 1 shows descriptive statistics for all 364 games regardless of team. It is well known that home advantage is substantial in professional hockey. Table 1 shows that in all of the games reviewed in the 2019/20 season, 47.53% ended with a home win, 12.64% with a home win in overtime, 9.34% with an away win in overtime, and 30.49% with an away win. This pattern was also reflected in the average difference in points, goals and shots between the home and away teams. On average, hockey teams scored more points in home games than away games. The difference was 0.544 points per game; the median was one point. Home teams scored more goals on average than away teams. The difference in the sample studied was 0.588 goals per game and had a median value of one. Teams also averaged more shots on target and off goal at home than during away matches. The difference in the sample studied averaged 3.368 shots on target and 2.431 shots off target per game and had a median value of equal to four and three shots, respectively. Table 1 also shows the statistics for penalties. On average, there were 3.984 penalties per game at home, which is 0.723

fewer penalties than in away games. On average, all teams playing at home in the analysed sample were given approximately 1.173 fewer penalty minutes than in away games. Fewer penalties for the team playing at home provides better opportunities to score goals, which is also reflected in the statistics described above.

Table 1. Summary statistics over hockey matches, 2019/20

	Mean	St. Dev.	Min.	Median	Max.
number of points (home)	1.772	1.320	0	2	3
number of goals (home)	3.168	1.847	0	3	9
number of shots on target (home)	31.984	6.963	12	32	55
number of shots off target (home)	13.019	4.341	2	13	28
number of penalties (home)	3.984	2.000	0	4	13
number of penalty minutes (home)	9.755	7.912	0	8	51
number of points (away)	1.228	1.320	0	1	3
number of goals (away)	2.580	1.664	0	2	8
number of shots on target (away)	28.615	6.671	12	28	55
number of shots off target (away)	10.588	3.935	2	10	23
number of penalties (away)	4.706	2.043	1	4	15
number of penalty minutes (away)	10.929	7.393	2	10	59
points difference	0.544	0	0	1	0
goal difference	0.588	0.184	0	1	1
shots on target difference	3.368	0.292	0	4	0
shots of target difference	2.431	0.406	0	3	5
difference of penalties	-0.723	-0.043	-1	0	-2
penalty minutes difference	-1.173	0.519	-2	-2	-8
number of home wins			173 (47.53%)		
number of home wins in overtime			46 (12.64%)		
number of away wins in overtime			34 (9.34%)		
number of away wins			111 (30.49%)		

All hockey teams scored on average more points in home games than away games, see Table 2. The biggest average difference of 1.385 points was recorded by HC Škoda Plzeň in the 2019/20 season. Almost one point average difference was for the team HC Rytíři Kladno. Thus, in terms of average points scored, the 2019/20 season saw a difference between whether a team played at home or away. On the other hand, the smallest average difference of 0.038 points was captured by HC Olomouc. Furthermore, a difference of 0.077 points was recorded for HC Dynamo Pardubice. In terms of the number of points scored, there was almost no difference between whether these teams played at home or away. In terms of the number of goals scored, each team scored more goals on average at home, with the exception of HC Olomouc. The largest average difference of 1.385 goals scored was found for HC Škoda Plzeň. BK Mladá Boleslav scored more than one goal on average at home in the 2019/20 season. On the other hand, only HC Olomouc scored 0.423 more goals on average in away games. All teams took more shots on target and shots off target during home games. The difference within each team was the biggest for Mountfield HK (5.731 more shots on target during home games). The smallest difference in the number of shots on target

in home and away matches in the 2019/20 season was recorded by HC Sparta Praha (only 0.231). The differences in the number of shots off target were not significant for individual teams, with the exception of HC Vítkovice Ridera, HC Škoda Plzeň and HC Verva Litvínov. These teams took on average three or more shots off target during home games than during away games.

Table 2 also shows the statistics for penalties for each team. On average, all teams except HC Dynamo Pardubice were awarded fewer penalties in home games. The biggest difference was observed for HC Energie Karlovy Vary and HC Rytíři Kladno. These teams were awarded an average of 1.308 (KVA) and 1.269 (KLA) fewer penalties during home games. The opposite was true for HC Dynamo Pardubice, who were awarded an average of 0.346 more penalties in home games. In terms of the number of penalty minutes awarded, the results are different. HC Berani Zlín, HC Bílí Tygři Liberec, HC Dynamo Pardubice and BK Mladá Boleslav were awarded more penalty minutes on average during home games. The other teams were awarded fewer penalty minutes during home games. The biggest difference was observed for HC Olomouc (3.577 fewer penalty minutes on average during home games).

Table 2. Average difference of selected statistics for each team, 2019/20

	points difference	**goal difference**	**shots on target difference**	**shots of target difference**	**difference of penalties**	**penalty minutes difference**
ZLN	0.231	0.346	2.962	1.962	-0.423	0.962
LIB	0.769	0.423	3.077	0.577	-0.231	0.731
PCE	0.077	0.423	4.308	2.231	0.346	1.423
KVA	0.269	0.385	5.346	1.808	-1.308	-0.346
KOM	0.808	0.423	0.269	1.462	-1.192	-3.154
MLB	0.846	1.038	3.538	0.731	-0.423	1.038
MHK	0.154	0.615	5.731	2.615	-0.769	-0.615
TRI	0.500	0.962	2.000	1.615	-1.000	-3.308
OLO	0.038	-0.423	2.115	1.692	-0.923	-3.577
KLA	0.923	0.615	3.962	0.846	-1.269	-2.462
SPA	0.615	0.846	0.231	1.769	-1.000	-2.808
PLZ	1.385	1.385	4.385	5.000	-0.077	-0.885
LIT	0.654	0.885	4.692	3.538	-1.077	-2.269
VIT	0.346	0.308	4.538	8.192	-0.769	-1.154

Table 3 shows the median values of selected statistics for each hockey team. The median values, like the mean values, are more favorable for home games or there is no difference according to the median. In terms of points scored and goals scored, the only exception is the HC Olomouc team, which, according to the median for these statistics, was better in away games.

Table 3. Median of differences in selected statistics for each team, 2019/20

	points difference	goal difference	shots on target difference	shots of target difference	difference of penalties	penalty minutes difference
ZLN	0.5	1	4	1.5	0	0
LIB	1	1	5	0	0	0
PCE	0	0.5	3.5	4	0	0
KVA	1.5	0	4.5	3	-1.5	-2
KOM	2	0	0	1.5	-2	-4
MLB	2	2	2	1	-1	-2
MHK	0.5	0	6.5	3.5	-0.5	-2
TRI	1.5	1.5	4.5	1.5	-1	-2
OLO	-0.5	-0.5	2	2	-1	-2
KLA	1.5	0.5	2	0	-1.5	-3
SPA	0	1	2	2	-1	-2
PLZ	2.5	1,5	3.5	3.5	-1	-2
LIT	1	0.5	5.5	3.5	-1	-3
VIT	1	1	6	8.5	-0.5	-2

Dependency testing

The first objective of the research was to determine if there were statistically significant differences between the selected sports statistics during 182 home games (selection H) and 182 away games (selection A). Since the Shapiro-Wilk test showed that all selected sports statistics did not have a normal distribution, a non-parametric two-sample Mann-Whitney U test was used to test the hypothesis. The Mann-Whitney U test determines whether two samples have the same median. The statistical program SPSS (IBM, 2023) was used for testing. The null hypothesis assumes that there are no significant differences between the values of the sports statistics of the two samples ($\mu\_H=\mu\_A$). The null hypothesis was tested with a significance level of 0.05. One-sided and two-sided tests were conducted to distinguish between the alternative hypothesis. In case of rejection of the null hypothesis, either $\mu\_H\neq\mu\_A$, or $\mu\_H>\mu\_A$ (resp. $\mu\_H<\mu\_A$). Table 4 shows the results of the two-sample Mann-Whitney U test for the selected sport statistics. From the data in Table 4, it can be seen that statistically significant differences were observed for all the selected statistics.

Table 4. Results of Mann-Whitney U test for all matches, 2019/20

	Results			
Compared game statistics	**Difference**	**Test statistic U**	**P-Value**	**H_1**
number of points	**Yes**	80492	**< 0.00001**	$\mu\_H>\mu\_A$
number of goals	**Yes**	78336	**< 0.00001**	$\mu\_H>\mu\_A$
number of shots on target	**Yes**	85316	**< 0.00001**	$\mu\_H>\mu\_A$
number of shots off target	**Yes**	87193	**< 0.00001**	$\mu\_H>\mu\_A$
number of penalties	**Yes**	51442	**< 0.00001**	$\mu\_H<\mu\_A$
number of penalty minutes	**Yes**	53134	**< 0.00001**	$\mu\_H<\mu\_A$

Another objective of the research was to determine whether there are statistically significant differences between selected sports statistics within individual hockey teams. Within each team, 26 home games (selection H) and 26 away games (selection A) were always compared. The null hypothesis assumes that there are no significant differences between the values of the sports statistics of the two selections (μ_H=μ_A). The null hypothesis was tested with a significance level of 0.05. One-sided and two-sided tests were conducted to distinguish between the alternative hypothesis. In case of rejection of the null hypothesis, either μ_H≠μ_A, or μ_H>μ_A (resp. μ_H<μ_A). The first indicator evaluated was the number of points obtained. This sport statistic did not have a normal distribution and the non-parametric Mann-Whitney U test was used to test the hypothesis. From the data in Table 5, it can be seen that only some teams had statistically significant differences. A statistically significant difference in the number of points scored in home and away matches was confirmed for HC Bílí Tygři Liberec, HC Kometa Brno, BK Mladá Boleslav, HC Rytíři Kladno and HC Škoda Plzeň. These teams can thus be said to have scored more points during home matches. For the other teams, there was no evidence that the number of points scored at home was different from the number of points scored in away matches.

Table 5. Results of two-sample non-parametric Mann-Whitney U test (number of points)

	number of points		
	Diff.	**P-Value**	**H_1**
ZLN	No	0.321	μ_H≠μ_A
LIB	**Yes**	**0.026**	μ_H>μ_A
PCE	No	0.593	μ_H≠μ_A
KVA	No	0.770	μ_H≠μ_A
KOM	**Yes**	**0.027**	μ_H>μ_A
MLB	**Yes**	**0.008**	μ_H>μ_A
MHK	No	0.359	μ_H≠μ_A
TRI	No	0.117	μ_H≠μ_A
OLO	No	0.430	μ_H≠μ_A
KLA	**Yes**	**0.005**	μ_H>μ_A
SPA	No	0.066	μ_H≠μ_A
PLZ	**Yes**	**< 0.001**	μ_H>μ_A
LIT	No	0.070	μ_H≠μ_A
VIT	No	0.142	μ_H≠μ_A

Other indicators were the number of goals, shots on target and shots off target. These sport statistics had different distributions and the parametric t-test and non-parametric Mann-Whitney U test were used to test the hypothesis. From the data in Table 6, it can be seen that only some teams had statistically significant differences. A statistically significant difference in the number of goals scored in home and away matches was confirmed for BK Mladá Boleslav, HC Oceláři Třinec, HC Rytíři Kladno, HC Škoda Plzeň and HC Verva Litvínov. These teams can thus be said to have scored more goals during home matches. More than half of the teams (9 in total) had a statistically significant difference in the number of shots on target during home matches. Seven teams were found to have a statistically significant difference in the number of shots off target during home matches.

Table 6. Results of two-sample non-parametric U test and parametric t-test (goals and shots)

	number of goals				number of shots on target				number of shots off target			
	test	**diff.**	**P-Value**	**H_1**	**test**	**diff.**	**P-Value**	**H_1**	**test**	**diff.**	**P-Value**	**H_1**
ZLN	U	No	0.218	μ_H≠μ_A	t	No	0.111	μ_H≠μ_A	t	**Yes**	**0.039**	μ_H>μ_A
LIB	t	No	0.212	μ_H≠μ_A	t	**Yes**	**0.036**	μ_H>μ_A	U	No	0.323	μ_H≠μ_A
PCE	*U*	No	0.853	μ_H≠μ_A	t	**Yes**	**0.016**	μ_H>μ_A	t	**Yes**	**0.029**	μ_H>μ_A
KVA	U	No	0.368	μ_H≠μ_A	t	**Yes**	**< 0.001**	μ_H>μ_A	U	**Yes**	**0.045**	μ_H>μ_A
KOM	U	No	0.316	μ_H≠μ_A	t	No	0,431	μ_H≠μ_A	t	No	0.073	μ_H≠μ_A
MLB	U	**Yes**	0.007	μ_H>μ_A	t	**Yes**	**0.019**	μ_H>μ_A	t	No	0.230	μ_H≠μ_A
MHK	t	No	0.095	μ_H≠μ_A	U	**Yes**	**0.002**	μ_H>μ_A	*U*	Yes	0.018	μ_H>μ_A
TRI	U	**Yes**	**0.033**	μ_H>μ_A	U	No	0.082	μ_H≠μ_A	t	No	0.055	μ_H≠μ_A
OLO	U	No	0.845	μ_H≠μ_A	U	No	0.085	μ_H≠μ_A	t	No	0.086	μ_H≠μ_A
KLA	U	**Yes**	**0.036**	μ_H>μ_A	U	**Yes**	**0.042**	μ_H>μ_A	t	No	0.194	μ_H≠μ_A
SPA	t	No	0.052	μ_H≠μ_A	U	No	0.456	μ_H≠μ_A	t	No	0.064	μ_H≠μ_A
PLZ	U	**Yes**	**0.003**	μ_H>μ_A	t	**Yes**	**0.016**	μ_H>μ_A	t	**Yes**	**< 0.001**	μ_H>μ_A
LIT	U	**Yes**	**0.044**	μ_H>μ_A	t	**Yes**	**0.003**	μ_H>μ_A	t	**Yes**	**0.004**	μ_H>μ_A
VIT	U	No	0.272	μ_H≠μ_A	t	**Yes**	**0.003**	μ_H>μ_A	t	**Yes**	**< 0.001**	μ_H>μ_A

The last group of indicators was the number of penalties and penalty minutes awarded. These sport statistics had different distributions and the parametric t-test and the non-parametric Mann-Whitney U test were used to test the hypothesis. It can be seen from the data in Table 7 that only some teams had statistically significant differences. A statistically significant difference in the number of penalties awarded in home and away matches was confirmed for HC Energie Karlovy Vary, HC Kometa Brno, HC Oceláři Třinec, HC Olomouc, HC Rytíři Kladno and HC Verva Litvínov. These teams can thus be said to have received fewer penalties during home games. In terms of the number of penalty minutes awarded, the results are almost identical. Statistically significant differences were found for HC Kometa Brno, HC Oceláři Třinec, HC Olomouc, HC Rytíři Kladno and HC Verva Litvínov. These teams can be said to have been awarded fewer penalty minutes during home games.

Table 7. Results of two-sample non-parametric U test and parametric t-test (penalties)

	number of penalties				number of penalty minutes			
	test	**diff.**	**P-Value**	**H_1**	**test**	**diff.**	**P-Value**	**H_1**
ZLN	U	No	0.136	μ_H≠μ_A	U	No	0.122	μ_H≠μ_A
LIB	U	No	0.276	μ_H≠μ_A	U	No	0.427	μ_H≠μ_A
PCE	U	No	0.750	μ_H≠μ_A	U	No	0.656	μ_H≠μ_A
KVA	t	**Yes**	**0.009**	μ_H<μ_A	U	No	0.208	μ_H≠μ_A
KOM	U	**Yes**	**0.012**	μ_H<μ_A	U	**Yes**	**0.016**	μ_H<μ_A
MLB	*U*	No	0.504	μ_H≠μ_A	U	No	0.198	μ_H≠μ_A
MHK	t	No	0.127	μ_H≠μ_A	U	No	0.287	μ_H≠μ_A
TRI	U	**Yes**	**0.013**	μ_H<μ_A	U	**Yes**	**0.010**	μ_H<μ_A
OLO	t	**Yes**	**0.016**	μ_H<μ_A	U	**Yes**	**0.014**	μ_H<μ_A
KLA	U	**Yes**	**0.008**	μ_H<μ_A	*U*	**Yes**	**0.011**	μ_H<μ_A
SPA	U	No	0.072	μ_H≠μ_A	U	No	0.071	μ_H≠μ_A
PLZ	U	No	0.504	μ_H≠μ_A	U	No	0.370	μ_H≠μ_A
LIT	U	**Yes**	**0.049**	μ_H<μ_A	U	**Yes**	**0.048**	μ_H<μ_A
VIT	U	No	0.067	μ_H≠μ_A	U	No	0.054	μ_H≠μ_A

DISCUSSION

The statistical analysis showed the existence of statistically significant differences between home and away games in the Czech top hockey league and was consistent with similar analyses from hockey leagues in the USA. For example, Agnew and Carron (1994) examined 15 teams over two hockey seasons. A significant home advantage was found when all games were included (58.7%) and when ties were excluded from the analyses (61.6%). Pollard and Pollard (2005) examined the National Hockey League (NHL) from 1917 to 2003. In the first seven seasons, home advantage was very high, reaching 75.0% in 1922/23. As the NHL expanded, the home advantage gradually began to decline. By the 1930s it had stabilised at an average of around 60%, which was maintained until the mid-1970s. Since then, there has been a further decline, which has stabilised at around 55% since the mid-1990s. The present research on the Czech top hockey league has not yet followed the development over such a long period of time. Thus, the results cannot be compared with Pollard and Pollard (2005) and other similar research at this time. The findings from the Czech hockey league are also in line with the findings of Bray (1999) who found an average home winning percentage of 52%. The findings from the Czech hockey league, on the other hand, contradict the findings of Szabó (2022) who found that there is no significant difference in the number of penalties and goals scored in home and away games in the American National Hockey League.

The presented empirical research on the Czech hockey environment also found statistically significant differences between home and away environments for some hockey teams. A similar conclusion was reached by Bray (1999), who examined individual NHL teams. Bray (1999) found that the vast majority of NHL teams won 17.3% more games at home than away. Further research is needed to clarify the reasons for the differences within individual teams in the Czech hockey league. A higher home advantage was found for the teams HC Verva Litvínov and HC Rytíři Kladno. A statistically significant difference was found for five of the six selected sport statistics. This is in line with previous studies (Clarke and Norman, 1995; Pollard and Gómez, 2009) that present similar findings for teams from geographically isolated locations or smaller cities. At the same time, these are hockey clubs with a rich hockey history and a strong hockey community in both cities. A higher home advantage in terms of points scored and shooting activity was found for HC Škoda Plzeň. Thus, it can be concluded that HC Škoda Plzeň hockey players have a higher shooting activity on their home court. For the teams HC Karlovy Vary, HC Kometa Brno, BK Mladá Boleslav and HC Oceláři Třinec, statistically significant differences were found for half of the selected sports statistics. For the teams HC Kometa Brno, HC Oceláři Třinec, the main statistically significant differences were in penalties and penalty minutes. The research presented here suggests that the teams in question receive fewer penalties when playing at home. Thus, these findings add to existing scientific evidence supporting the involvement of referees in the home advantage (Scoppa, 2021; Sors et al., 2020) and reinforce the existence of this phenomenon in elite hockey. This phenomenon could manifest itself to a different degree at critical moments such as the playoffs. It would be relevant to assess this in future research. A rather lower home advantage was found for HC Bílí Tygři Liberec, HC Dynamo Pardubice, Mountfield KH, HC Olomouc, HC Ridera Vítkovice and HC Berani Zlín. For these teams, statistically significant differences were

found in only two of the six sports statistics evaluated. A surprising result was achieved by HC Sparta Praha, which did not show a significant difference between home and away matches in any of the statistics. This finding is consistent with research by (Clarke and Norman, 1995; Pollard and Gómez, 2009). Given that capital cities are typically cosmopolitan places, a reduced sense of territorial protection might be expected to play a role in the consistently lower home advantage also found in this research. Empirical research on the Czech hockey league did not find evidence of a home disadvantage for any of the teams evaluated. Which is contrary to the finding of Bray (1999) according to which a small percentage of teams always show a home disadvantage in the regular season.

Other factors that may have influenced each team's home advantage, such as unusual home stadium characteristics, were not considered in this analysis. However, any home advantage found for HC Sparta Praha playing in a large stadium suggests that the capacity of the home stadium could be taken into account in future research on differences between teams. The presented research is limited to Tipsport Extraliga matches, which means that other matches in lower hockey leagues may behave differently. There is an assumption that different results can be expected from lower hockey leagues with lower spectator attendances. The research presented here is limited to the top hockey league in one season and further research needs to be conducted in other seasons and other leagues or countries so that the findings can be generalised to the wider population of ice hockey teams.

CONCLUSION

The aim of this research was to find out whether there is a home advantage in the Czech hockey league. Using parametric and non-parametric two-sample tests, the present research examines the differences between the number of points scored per game, goals scored, shots on and off target, penalties and penalty minutes awarded during home and away matches. The results of the research presented suggest that home and away matches played with spectators differed significantly in the 2019/20 season. The analysis of penalties and penalty minutes also suggests that referees favoured the home team more in matches played with spectators during the 2019/20 season.

The analysis of the individual hockey teams revealed that the home advantage is manifested to different degrees for each team. The home advantage was more pronounced for teams from smaller and traditional hockey cities such as Litvínov and Kladno. Conversely, the home advantage was generally very low in the capital city of Prague. Here, there was no statistically significant difference in any of the statistics examined.

The home field advantage in hockey is one of the less explored areas. According to many authors, the influence of the home environment is much smaller compared to football. Hockey players are isolated from the crowd by boundaries. The pitches also tend to be similar, at least in terms of temperature and ice quality. Hockey is one of the most unpredictable sports, and the outcome can be influenced by chance. Still, there are very many reasons why the home advantage in hockey is important to watch. One of them is the betting odds. The home advantage in hockey is something that every bettor should consider before placing a bet. We must not forget the hockey rules, which give the home team several significant advantages (substitutions, face-offs and shootouts).

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Developmental Trend Of Talented Pupils' Performance in Orienteering – Longitudinal Research 1997–2020 in the East Bohemia Region of the Czech Republic

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ABSTRACT

The article presents the findings of a longitudinal testing of talented youth in orienteering in the Czech Republic. Young talented orienteers participate in the testing of motor skills by standardized tests. The results and conclusions of the 3 km and 5 km cross-country running measurements (according to age category) point to a regressive state of endurance abilities in young athletes between 1997 and 2020, describe possible reasons and suggest possible remedies. A total of 300 girls and 445 boys aged 12-14 years participated in the research investigation in the East Bohemian Region of the Czech Republic, who are divided into performance categories HD12 and HD14 in the context of organised Czech orienteering competition. The aim of the evaluation of the longitudinal testing was to determine the trends in performance in endurance cross-country running as a key performance parameter of talented orienteering athletes over the period 1997 to 2020. The resulting data indicate that performance in all the studied categories in the given field test has a consistently decreasing trend. The results are also related to the conclusions of foreign and domestic observations of the state of motor fitness of children and youth of the corresponding period and indicate that the level of aerobic ability of young talented runners generally follows the current state of the level of endurance ability found in the national testing of school youth under the auspices of the Czech School Inspectorate (CSI, 2023), and thus the alarming society-wide situation in the field of motor fitness of children and youth in the Czech Republic.

Keywords: motor testing, talented children and youth, longitudinal research, orienteering, aerobic fitness

INTRODUCTION

Lehnert et al. (2014, p. 13) define talent as "a complex of aptitudes covering the requirements placed on an athlete to achieve high sport performance." The identification of talent is an integral part of organized sports, especially in the process of sports training for children and youth. The process of talent identification should ideally start at the very beginning of a sport career on the basis of the child's discovered movement abilities in the family or in the process of school physical education (Bailey & Morley, 2006). The complex process of identification is closely linked to the requirements of a specific sports discipline and also includes monitoring the potential for the development of relevant motor skills (Agricola et al, 2022). One of the possible ways of talent identification is the use of motor testing as a means of mapping the current state of the given prerequisites of young athletes, while the results of repeated measurements allow to predict with a certain degree of caution the possible development of performance growth of a young athlete (Perič, & Suchý, 2010; Morrow et al., 2023). The process typically takes place during the specialized training (depending on the sector, from about the age of 11) and lasts for several years. In this stage of child and youth development, individuals are closely monitored, and sport and motor performance tends to be assessed based on regular testing and measurement of relevant predictors.

Orienteering is a sport that combines self-movement with orientation in unfamiliar terrain. Competitors move under their own power through arbitrary terrain with the aim of completing a designated race course using a map and a compass in the shortest possible time (CSOS, 2018). Soulek (1991, p. 5) discusses that "...performance is limited by a certain percentage of special running endurance and a certain percentage of orienteering qualities...and is assumed to vary with age, with the proportion of running performance in overall performance being predominant in elite runners." Langer's (1991) structure of performance in adult athletes consists of 54% fitness, 24% somatotype and running technique, 12% orienteering technique, 8% load capacity and 2% are other factors, clearly indicating that endurance ability demonstrated in running performance has the greatest influence on orienteering performance. According to Hnízdil and Kirchner (2005), performance in the schoolchildren's categories, running performance still determines 30% running performance and 70% orienteering technique. However, in the younger age group (12-14 years) this ratio is balanced to 50:50 and gradually the role of running fitness becomes more and more pronounced in experienced competitors (up to 70:30).

The relationship between endurance level, running technique and competitive performance in orienteering has been studied abroad by Saltin (1972), Adams & Saltin (1980), Ranucci, Grassi & Miserocchi (1986), Kolb, Sobotka & Werner (1987), Fach (1989), Moser et al. (1995), Jensen, Johansen & Kärkkäinen (1999), Larsson et al. (2002), Millet et al. (2010) and others. Then, Batista et al. (2020), by analysing 469 studies, demonstrated that the main physiological requirement required for performance in orienteering is a high level of fitness in alternating aerobic and anaerobic loaded terrain running. Thus, it supports the findings of Soulek (1991) directly targeting the young orienteering category, who demonstrated that there are significant differences in the level of physical fitness in orienteering athletes at the age of 15 years, which in practice underlines the need for systematic cross-country training of young orienteers before the age of 15 years.

Thus, monitoring the parameter of running performance rightly has a prominent place in the identification and work with young talent in orienteering. The area of support for talented pupils in orienteering in the Czech Republic has been dealt with by a number of authors (Soulek & Škop, 1975; Weber, 1981; Růžička, 2009; Cahel, Košárek & Novotný, 2015) and the selection of talents has long been implemented within individual clubs, training centres and regions. In the East Bohemian region, the process involves the annual entrance testing of young athletes, which defines the membership base of the Youth Training Center. Athletes aged 12-14 who placed in the top 10 in the overall annual ranking races of the previous season are nominated for testing. This applies to both DH12 (girls and boys up to 12 years) and DH14 (up to 14 years) categories. The process includes tests of motor readiness in selected areas of motor skills, a key part of the testing of young talented orienteers is a test of special physical readiness, which is running in forest terrain called cross-country running.

METHODS

The aim of our research was to determine the developmental trend of performance in young talented orienteers from the East Bohemian region of the Czech Republic based on the results of longitudinal motor testing conducted between 1997 and 2020. A total of 745 young orienteers (300 girls and 445 boys) from the East Bohemian region aged 12-14 years participated in the research. The survey does not include data from 2001, when the testing did not take place. The results of this testing present a long-term trend in the level of physical preparedness in the area of endurance skills, which is dominantly related to the quality of competitive performance of orienteers. The monitored item is a key component of the performance of young talented orienteers - a test of special physical preparedness: cross-country running. The girls from the D12 and D14 categories and the boys from the H12 category will run a three-kilometre course, while the oldest boys' category, H14, will run a five-kilometre course. Cross-country testing is conducted annually in Hradec Králové near the Biřička pond in the local part of Nový Hradec Králové on a consistent one-kilometer circuit, partially along forest paths and partially in open terrain with an elevation gain of 20 meters. The test is performed after thorough warm-up and always under the supervision of trained regional coaches dedicated to the activities of the Youth Training Center and assistants from the ranks of coaches of selected clubs in the named region. The measurement is carried out by hand stopwatches with accuracy to the second.

Statistical data was processed and evaluated in MS Excel 2016 using descriptive method with arithmetic mean, percentage values and standard deviation which shows us the average deviation from the mean of the category. To optimize the evaluation, we normalize the observed performance results into "standard scores" that show us by how many standard deviations a test result is better or worse than the arithmetic mean

$$z = \frac{x - \overline{X}}{s}$$

and convert to T-scores

$$T = 50 + 10z$$

Legend:

X - total arithmetic average

x - tested result

s - standard deviation

T - values of arithmetic averages of individual years converted to T-scores

where the average performance corresponds to 50 points and the standard deviation equals 10 points (Měkota & Blahuš, 1983).

$$T = 60 - 10*z$$

The results are presented using a graphical method employing line graphs that depict the linear trend, along with logical methods for interpretation and drawing conclusions.

RESULTS

The presented results of special physical fitness testing (cross-country) utilize values of arithmetic averages for each year, recalculated to T-scores based on the specified age categories, along with indicating the linear performance trend in the respective running test.

Results of category boys H12 and girls D12

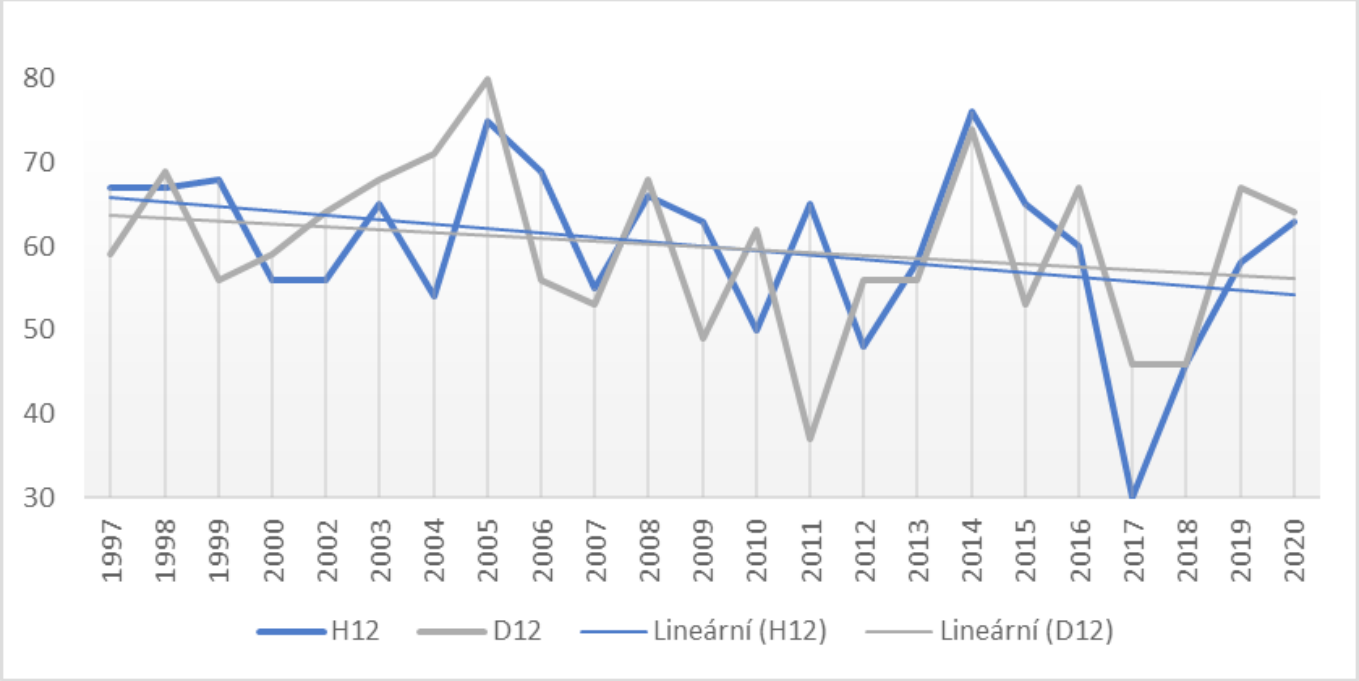

Figure 1. Values of performance in the cross-country running test for the categories of girls D12 and boys H12 (both cat. 3 km) in T-scores in the observed period 1997-2020 with expressed linear trend of performance.

Results of boys H14 and girls D14

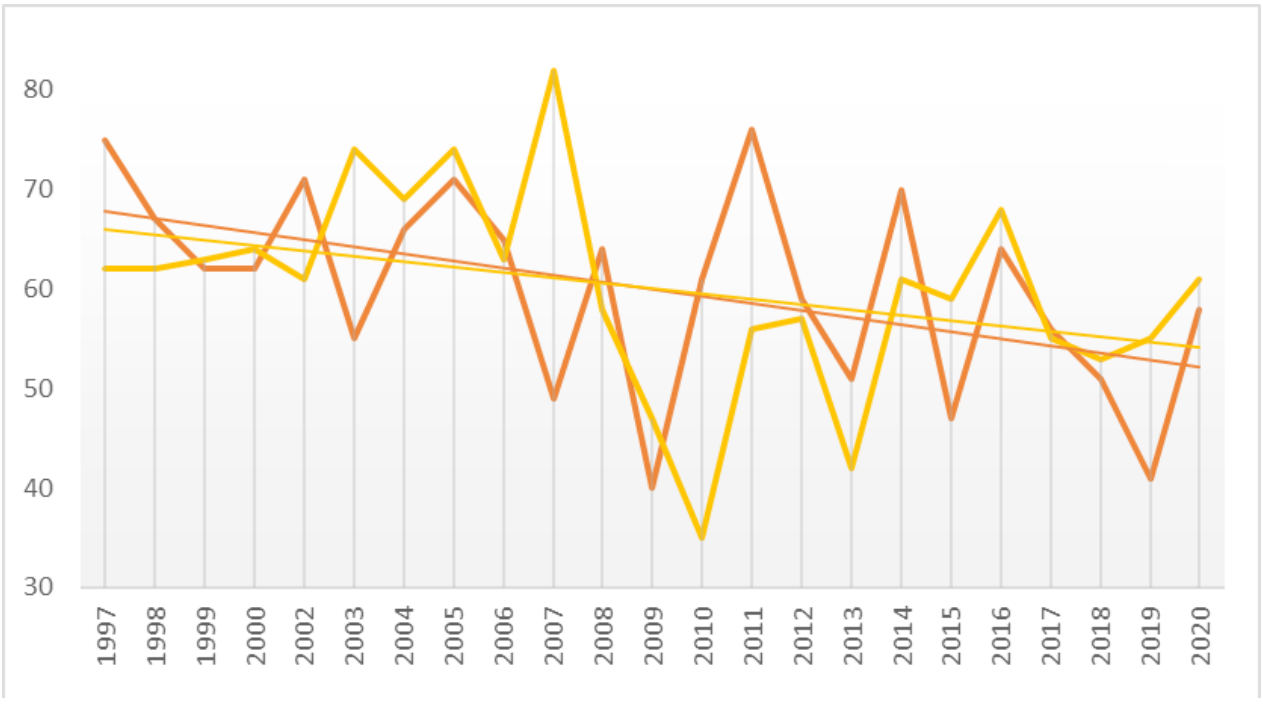

Figure 2. Performance values in the cross-country running test for the categories girls D14 (3 km) and boys H14 (5 km) in T-scores in the period 1997-2020 with a linear trend in performance.

DISCUSSION

The results of special physical fitness (cross) testing of young talented orienteers in all categories of orienteering tracked between 1997 and 2020 indicate a gradual deterioration in endurance performance. The regression of this key predictor of quality performance in orienteering is presented by linear trend graphics for the younger boy H12 and girl D12 categories tested and both older categories H14 and D14, with the most pronounced regression for the oldest categories tested. The results of our study indicate the longitudinal nature of the observed negative linear trend. Although there are differences in the average performances from year to year, using the expression of the linear trend we can clearly observe the unfavourable state of the long-term development of the level of endurance abilities of young athletes. This fact confirms the continuously alarming general regression of the state of these motor prerequisites in children and youth manifested in the world since the mid-1970s (Tomkinson, 2007). It also adds topicality to the results of long-term observations of physical fitness levels in children and youth based on research in 27 countries conducted on all continents between 1958 and 2003 (Tomkinson et al., 2003; Olds et al, 2006; et al.) Similar and important findings from international empirical or meta-analytic studies of the last decades include those of Tomkinson (2007, 2019), Aubert et al. (2022), and the very recent findings of the FitBack project (Ortega et al., 2023). These directly point to a trend of long-term decline in both strength abilities and, in particular, cardiorespiratory fitness (aerobic capacity) in children and young people. The alarming situation is consistent with the findings of a number of measurements conducted among school youth in the Czech Republic over the last 25 years, i.e. covering the same period as our evaluation (Bunc, 2000; Gajda & Měkota, 2000; Rubín et al., 2014; Suchomel & Rubín, 2017; Růžička et al., 2022, etc.). Thus, the results of our longitudinal monitoring and the identified negative performance trends complete the picture of the generally deteriorating situation in the level of physical fitness of children and youth in our country. Moreover, they draw attention to the fact that the given regression does not only affect school youth in general, but also affects the performance sphere, specifically the area of work with talented young orienteers.

One of the key reasons for the negative trend can be seen in the wrong exercise regime of children and youth in the Czech Republic, which is then reflected in the performance trends of young talents. As documented by Kalman et al. (2010), a large proportion of school children are insufficiently physically active. The decline in the fitness of boys and girls in grades 3 and 7 of primary school is evidenced by a 2013 study on a sample of primary schools in the Pilsen region, which targeted muscular performance as one of the components of fitness. The data present more than double the prevalence, with 74% of children classified as below average to significantly below average in 2013 compared to 31% in 1986 (Müllerová et al., 2015). In a pilot survey by the Czech School Inspectorate in the 2015/2016 school year (CSI, 2016), the decline in physical fitness of pupils in primary and secondary schools over the last 10 years was perceived by three-quarters of physical education teachers. A negative conclusion was also expressed when comparing the results of the measurement of school youth, which was carried out as part of the Sazka Olympic multi-sport project, with the results of a national survey from 1966 (Adamec, 2021). Gába et al. (2022) in the National Report on Physical Activity of Czech Children and Youth summarise by

concluding that Czech girls and especially boys are currently below average in terms of aerobic fitness levels compared to international standards. Finally, based on an assessment of trends based on our longitudinal monitoring, we can also draw a parallel with the picture that complements the results of the nationwide motor fitness testing of school youth (Agricola et al., 2020) in the autumn of 2022. The conclusions of the CSI (2023) demonstrate that girls and boys generally fall within the "critical zone" of fitness. The most pronounced deterioration in performance occurred in comparison to the mean of the Unifittest battery of test norms (Kovář & Měkota, 1995) specifically in the cardiorespiratory fitness test (endurance shuttle run), regardless of gender. The results for 7th grade elementary school students showed a 27% and 33% decline in performance between 1996 and 2022 for boys and girls, respectively, which is approximately equivalent to the normative Unifittest performance of 3rd grade elementary school students. Thus, even our tracking results dealing with talented pupils - that is, highly active performance-oriented and motivated individuals - do not break out of the negative societal trend in the area.

The evaluation methodology we have developed will allow us to process and interpret the results in future years and continue to monitor the long-term trend in the performance of talented pupils in orienteering as a basis for systematic work with children and youth. The given conclusions emphasize the need for increased attention of coaches of children and youth in the field of development of endurance abilities in orienteering. The results can also be used to compare the results of talented pupils in the area of endurance skills with other areas, talented youth centres or clubs. Alternatively, they may allow comparison of performance trends with international competitors, for individuals, the results can then predict the further development of sporting talent and its potential outcomes. Awareness of the identified negative trends in performance can significantly strengthen the need for coaches of children and youth to focus on effective fitness training of their trainees, especially in the area of endurance skills development as a key prerequisite for sport performance in orienteering. This corresponds to the current strong international emphasis on conditioning in orienteering already in the youth categories (Larsson et al., 2002; Türkmen & Biçer, 2022 and especially the meta-analytical study by Batista et al, 2020, etc.), in the Czech context agrees with the view of Cahela et al. (2015), Růžička (2009) and Soulek (1991), who, based on laboratory and field motor testing, recommended the provision of systematic endurance training before the age of 15.

CONCLUSION

The results of the longitudinal testing and its evaluation show that the performance of talented children and youth in orienteering in the East Bohemia region of the Czech Republic is deteriorating. The linear trend of performance in the discipline of cross-country running shows a negative tendency in all the studied categories of younger and older pupils/students in the period 1997-2020. The smallest degree of deterioration can be observed in the tested category D12, and the largest regression in the category H14. In general, both older categories DH14 show a steeper negative trend in performance, which may indicate a lack of attention of coaches of pupils in the field of development of endurance skills before this age. It also demonstrates some connection with

the society-wide regression of motor fitness of Czech children by comparing the findings of Kovář & Měkota (1995) and CSI (2023) affecting essentially the same period as our observation. The evaluated measurement data and conclusions can significantly contribute to the construction of systematic training of young talents in orienteering, which will adequately respond to the identified long-term negative trend, as well as the society-wide regression in the field of motor fitness level.

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STUDENT SECTION

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Establishment of Puck Control Standards for Ice Hockey Players Ages 6–15

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ABSTRACT

Expert judgment in skill assessment via observational methods can introduce bias based on the evaluator. In the field of ice hockey, the development of standards rooted in scientifically derived tests remains a challenge. Hence, this study aims to define precise standards for ice hockey players aged from 6 to 15 years. Given the diverse skill set required in ice hockey, our work focuses on one of the basic skills – puck control. Employing Rasch and Mokken analyses, we designed an assessment tool in the form of a Guttman scale, ranking item difficulty, to evaluate puck control abilities of ice hockey players. This paper delineates the standards for puck control in ice hockey, specifically for players aged from 6 to 15 years in the Czech Republic, rated on a scale from 1 to 17. The standards have been tailored for cohorts of players aged between 6 and 7 years, between 8 and 9 years, between 10 and 11 years, between 12 and 13 years, and between 14 and 15 years. The standards are set to 0, 2, 4, 6, and 9 items, respectively.

Keywords: Rasch model; Guttman scale; Mokken analysis; Items

INTRODUCTION

Producing competitive players necessitates a tailored approach to training. Essential to this is the provision of relevant feedback for effective training strategies. Evaluating individual skills requires the development of tests grounded in scientific principles (Chmelíř & Perič, 2018). These tests serve as benchmarks, enabling the establishment of comparative standards. Such an approach augments training methodologies, emphasizing the need for consistent implementation (Kostka, 1963). Subsequently, it allows for assessing players against scientifically derived standards.

Ice hockey comprises a large number of skills, among which we concentrate on one essential aspect – puck control. Puck control is acknowledged as a foundational skill in ice hockey (*Hockey Canada*, c2022; Pavliš et al., 2003; Pavliš et al., 2009; *USA Hockey*, c2023), hence stickhandling technique receives much attention in training discussion worldwide (Bukač, 2014).

Our objective is to devise and employ an assessment tool to define puck control standards in ice hockey for players aged from 6 to 15 years in the Czech Republic.

Defining these standards and structuring cohorts necessitates consideration of methodological guidance from ice hockey federations. Additionally, factors involving ontogenesis need to be taken into account. Anatomical, physiological, pedagogical, and psychological developmental variances alongside individual disparities also demand attention.

The maturation of the central nervous system plays a major role in this context (Vágnerová, 2012). Perič (2008) also highlights variations among players concerning their aptitude for learning movements and the quality of the movement execution.

Furthermore, establishing standards requires acknowledgment of motor learning patterns, where the mastery of a given motor skill undergoes continual changes during the learning process. Skill levels of players evolve over time and are influenced by their learning pace (Ghorbani & Bund, 2017).

METHOD

In defining the standards, we employed a newly devised assessment tool to evaluate puck control of ice hockey players, structured as a Guttman scale (*Český hokej*, c2017-2023). The development of the tool adhered to specific protocols, starting with a thorough literature review, confirming the lack of a similar tool in both Czech and foreign literature. Subsequently, experts were selected based on predefined criteria to compile an item bank.

Drawing from the literature review and expert consultations, a comprehensive item bank counting 74 items was created. Next, the item bank was calibrated, with a meticulous selection of experts according to given rules to evaluate the calibration, and 357 players were chosen to validate the items. Each participant underwent testing across all 74 items.

Following testing, data were collected and evaluated, utilizing Rasch and Mokken analysis techniques. Items inconsistent with the Rasch model were removed from the item bank in seven sequential rounds (de Ayala, 2009). After the removal rounds, a selection round was conducted to identify items for inclusion in the assessment tool. Following the selection, the items were once again analyzed, resulting in the elimination of one more item from the tool. Throughout each round, content validity was assessed, and reliability was calculated using Cronbach's alpha. Mokken analysis further supported the reliability values (Stochl et al., 2012). Outlined below is the developed assessment tool, comprising 17 items arranged in a Guttman scale based on item difficulty for practical use (*Český hokej*, c2017-2023) and correct execution[1]. To execute the items correctly (pass the item), players are required to skate as swiftly as possible. The cones used for practice must not exceed 5 cm in height.

1 In naming and describing the items, we aimed for simplicity and clarity, avoiding excessive use of coaching jargon to ensure accessibility for the general public, while considering language differences in English-speaking countries.

Item 1 – Narrow stickhandling, forehand fake (two-handed), stationary. This item involves narrow stickhandling with a forehand fake (reach) while maintaining stickhandling (twice stickhandling, one wide). Players execute a relaxed, continuous movement without stopping, performed three times in a row. The emphasis is on the sliding skills of the lower hand, focusing on fluidity rather than quantity of movements.

Item 2 – Skating forward, tight turn around cone to the left and to the right (twice, with four cones). Players begin with the puck, executing a tight turn around the cone to the left, moving swiftly to the next cone, then executing a tight turn to the right. This sequence is repeated twice, with players skating forward as fast as possible while handling the puck. For positioning of the cones, see Figure 1 – Cone layout.

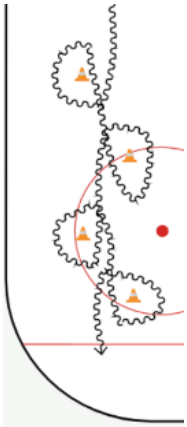

Figure 1. Cone layout

Item 3 – Forehand fake pass, backhand skating away. While stationary, players execute a fake pass on the forehand side, move the puck to the backhand side, and initiate skating away on the backhand side.

Item 4 – Narrow stickhandling, wide forehand (two-handed), skating forward. This item involves narrow stickhandling with a wide reach on the forehand side (only forehand) followed by back stickhandling (twice stickhandling, one wide). The emphasis is on relaxed, smooth, continuous movement without stopping, repeated three times consecutively; focusing on the sliding skills of the lower hand while skating forward.

Item 5 – Inside-edge forehand puck tuck between legs. While skating forward, players pass the puck from behind, through their legs, using an inside-edge kick of the skate to the stick.

Item 6 – Wide stickhandling, skating backward. While skating backward, players perform wide stickhandling (wider than shoulder width), maintaining smooth movement without stopping, repeated three times in a row as swiftly as possible.

Item 7 – Stickhandling behind the body, forward skating. Players execute stickhandling behind the body, extending to the side (forehand-backhand control), while moving straight forward, skating continuously.

Item 8 – Narrow stickhandling, lower-hand stick release to backhand, skating backward linear crossovers. While skating backward (linear crossovers), players perform narrow stickhandling, releasing the stick to one hand – the upper hand (twice stickhandling, one release). Emphasis is on

smooth, continuous movement, repeated three times in a row; focusing on the skill of releasing the lower hand, controlling the puck with one hand, and returning to both hands, all the while skating backward linear crossovers as swiftly as possible.

Item 9 – Leg slalom, forehand stickhandling slalom between cones alternate-side. Players navigate two rows of cones, one for legs and one for stickhandling, with five cones each, positioned approximately 2 m apart and 0.6 m wide. Players alternate skating slalom in the leg row and stickhandling slalom on the forehand side in the hand row, ensuring regular slaloming between legs and stickhandling while maintaining distinct rows for each. For cone layout, see Figure 2 – Alternate-side slalom.

Figure 2. Alternate-side slalom

Item 10 – Leg slalom, backhand stickhandling slalom between cones alternate-side. Players navigate two rows of cones, one for legs and one for stickhandling, with five cones each, positioned approximately 2 m apart and 0.6 m wide. Players maneuver in a slalom pattern in the leg row while executing stickhandling on the backhand side in the hand row. Players must not skate over to the hand row or perform stickhandling in the leg row. The task requires regular slaloming using feet and stickhandling using hands. For cone layout, see Figure 2 – Alternate-side slalom.

Item 11 – Stickhandling over lying stick (backhand to forehand, 1 out of 3 attempts). With a stick placed on the ice, players remain stationary and execute stickhandling (tossing the puck) over the lying stick from the backhand to forehand, maintaining control of the puck on the blade. Players must successfully complete this task at least once out of three attempts.

Item 12 – Leg slalom, forehand stickhandling slalom between cones same-side. Players navigate two rows of cones, one for legs and one for stickhandling, with five cones each, positioned approximately 2 m apart and 0.6 m wide. Players skate in a slalom pattern in the leg row while executing stickhandling on the forehand side in the hand row. Players must not skate over to the hand row or perform stickhandling in the leg row. This task demands consistent slaloming using feet and stickhandling using hands. For cone layout, see Figure 3 – Same-side slalom.

Figure 3. Same-side slalom

Item 13 – Leg slalom, backhand stickhandling slalom between cones, same-side. Players navigate two rows of cones, one for legs and one for stickhandling, with five cones each, positioned approximately 2 m apart and 0.6 m wide. Players skate in a slalom pattern in the leg row while executing stickhandling on the backhand side in the hand row. Players must not skate over to the hand row or perform stickhandling in the leg row. This task requires consistent slaloming using feet and stickhandling using hands. For cone layout, see Figure 3 – Same-side slalom.

Item 14 – Puck pickup with stick, catching by hand (1 out of 3 attempts). Players must pick up the puck from the ice solely with the stick and catch it. If the player fails to catch the puck due to glove interference (only hits the puck), it is considered a successful attempt. The player needs to achieve this successfully at least once out of three attempts.

Item 15 – Forward skating, fake move and pass, 360° turn, skating away on the other side, retaking the puck (three times). Players skate toward a cone, execute a fake move, pass the puck behind the cone, perform a 360° turn (simulating avoiding a defending player), skate to the other side of the cone, retrieve the puck, and continue to the next cone to repeat the sequence. This process is repeated three times. For cone layout and movement execution, see Figure 4 – Fake move 360°.

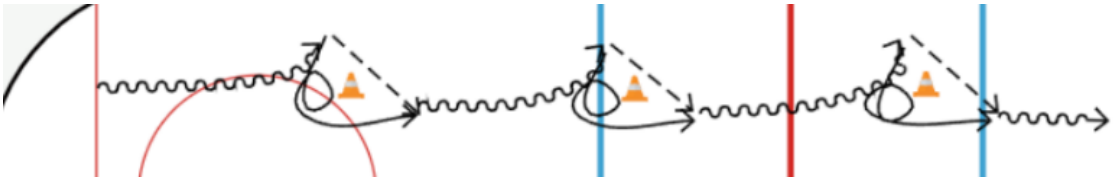

Figure 4. Fake move 360°

Item 16 – Varied leg and hand slalom on the forehand side. Players navigate two rows of cones, six for hands, five for legs, approximately 0.6 m wide. Players perform slalom skating in the leg row and stickhandling slalom on the forehand side in the hand row. Skating over to the hand row and stickhandling in the leg row are not allowed. This task necessitates consistent slaloming using legs and stickhandling using hands. For the irregular cone layout, see Figure 5 – Varied slalom.

Figure 5. Varied slalom

Item 17 – Varied leg and hand slalom on the backhand side. Players navigate two rows of cones, six for hands, five for legs, approximately 0.6 m wide. Players execute slalom skating in the leg row and stickhandling slalom on the backhand side in the hand row. Skating over to the hand row and stickhandling in the leg row are not allowed. This task necessitates consistent slaloming using legs and stickhandling using hands. For the irregular cone layout, see Figure 5 – Varied slalom.

In defining standards, it was essential to consider the recommendations provided by ice hockey associations and federations worldwide. These recommendations offer guidance regarding age groups and the commencement of skill acquisition, particularly in the field of puck control. These recommendations are globally remarkably similar, differing only in minor variations in terminology and the start of more intricate skill acquisition. Our standardization process in puck control for ice hockey players aged from 6 to 15 years took these global patterns into account.

Selecting appropriate hockey clubs for data collection was vital for our research. Only clubs encompassing all youth categories up to 16 years of age were included. Subsequently, players were chosen based on both calendar age and sport age criteria. Players had to meet both criteria, including an uninterrupted sport age in comparison to their peers, barring any major disruptions in regular training (except for common illnesses). Selected players adhered to training plans (length and number of training units per week, training content) according to the methodological materials recommended by the Czech Hockey Federation for the respective age cohort.

The age of selected players ranged from 6 to 15 years, following methodological recommendations. In keeping with these recommendations, organized training typically starts toward the end of preschool age or at the beginning of junior school age, aligning with skills acquired at the third stage of motor learning by the end of school age. Defining standards for cohorts within a two-year span appeared the most appropriate choice. Our goal was to include as many players as possible, evenly distributed across all age cohorts. Considering practical experience and application of the defined standards, age cohorts were established at two-year intervals, since players participate in official games as members of one team. Hence, standards were defined for players up to 7 years of age (U7), 9 years of age (U9), 11 years of age (U11), 13 years of age (U13), and 15 years of age (U15).

For statistical analysis, we employed MS Excel and basic descriptive statistics (mean, standard deviation, median).

RESULTS

Data were collected from 1,102 players aged from 6 to 15 years, evenly distributed across age categories with approximately 200 players per category.

Table 1. Standards

Completed items	Number of U7 players	Number of U9 players	Number of U11 players	Number of U13 players	Number of U15 players
0	92	47	22	8	1
1	33	54	36	21	5
2	40	73	31	20	8
3	7	31	25	18	13
4	1	25	34	20	4
5	7	6	11	11	3
6	0	8	35	31	12
7	0	4	14	10	9

8	0	1	20	29	26
9	0	3	23	29	38
10	0	0	2	5	13
11	0	1	8	14	31
12	0	0	2	2	11
13	0	0	1	3	1
14	0	0	2	0	5
15	0	0	0	0	1
16	0	0	0	0	1
17	0	0	0	0	0
Total players	180	253	266	221	182
Mean	0.96	2.15	4.56	5.73	8.2
Median	0	2	4	6	9
Standard deviation	1.25	1.9	3.24	3.3	3.25

These data constituted the basis for defining puck control standards among ice hockey players aged from 6 to 15 years in the Czech Republic.

DISCUSSION

Our study aimed to establish standards for puck control in ice hockey in the Czech Republic. The standards were set across age categories up to 7 years (U7), up to 9 years (U9), up to 11 years (U11), up to 13 years (U13) and up to 15 years (U15). Based on reviewed literature (Hockey Canada, c2022; USA Hockey, c2023) and practice requirements, the standards were not delineated for each individual year of age but rather for cohorts spanning two years, aligning with the common practice in youth competitions, where players might compete with those a year older (*Český hokej*, c2017-2023). The chosen two-year range of the cohorts adheres to global norms and methodological recommendations in ice hockey.

Furthermore, the practical differences in puck control mastery between players with a one-year age difference are relatively minimal, particularly in the early stages of systematic training. Their contribution to practice is deemed negligible. Hence, we believe that defining standards for cohorts with a two-year interval is appropriate for both our study and practical implementation. This approach can be recommended for further research with a similar focus.

We believe that a cohort size of approximately 200 players suffices for defining standards. Given that youth teams generally comprise 10 to 17 players (*Český hokej*, c2017-2023), our sample for standard definition encompasses more than ten teams with complete rosters. Teams typically commence with a player count closer to the minimum and expand thereafter. Therefore, we consider our sample to be adequate for establishing general standards.

Although our study aimed to define puck control standards, it is worth noting that publications on ice hockey standards often emphasize the health of players (Andrews et al., 2022; Ziadia et al.,

2023) or their physical abilities (Stastny et al., 2023; Vigh-Larsen et al., 2020) rather than specific skills. A similar trend is present in other sports as well. In the domain of motor learning, the focus is primarily on the methodology of setting standards (Lindsay et al., 2022; van Abswoude et al., 2021). This emphasis arises from the ease of data collection through standardized tests. In our view, it is therefore necessary to develop skill-based tests tailored to individual sports, particularly team sports, and utilize these scientifically based tests to establish standards suitable for evaluating athletes and providing relevant immediate feedback.

CONCLUSION

Based on data collected from 1,102 players aged from 6 to 15 years, we established puck control standards for each cohort. The cohorts comprised players aged from 6 to 7 years, from 8 to 9 years, from 10 to 11 years, from 12 to 13 years, and from 14 to 15 years, respectively. For each cohort, data were collected from approximately 200 players, ensuring comparable representation across all age groups.

The standards are set at 0, 2, 4, 6, and 9 completed items out of 17 in total for each cohort, arranged from the youngest to the oldest players.

The anticipated skill levels align with expectations for beginners as they start to play hockey and acquire foundational skills. A turning point occurs with the cohort ages from 10 to 11 years. According to conventional recommendations, the training of players up to the age of 11 years should emphasizes skating and the puck control. However, the progression remains steady, increasing by approximately two items per cohort, without a significant leap, persisting through the cohort of ages from 12 to 13 years.

Our findings suggest that the skill levels of players in both the cohort of ages from 12 to 13 years and particularly the cohort of ages from 14 to 15 years do not reach the anticipated levels. Despite the expectation that the oldest cohort would have mastered all puck control skills, our research indicates that their performance falls slightly below the mid-point of the scale, rather than approaching the highest skill level.

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The Influence of the HIIT and Aerobic Training Programs on Body Composition

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ABSTRACT

Purpose: According to studies, the increasing risk of obesity in the general population is mainly caused by insufficient physical activity. The main goal of this study was to compare the effect of two types of endurance training. High-intensity interval training (HIIT) and moderate-intensity continuous training and their effect on chosen aspects of body composition. Methods: This study included women (n = 14; 32 years old; height 166.3cm; weight 62.5kg) divided into two groups of seven participants. A deliberate selection of 7 participants selected the tested groups. The women trained three times a week for ten weeks. Pre-test and post-test were conducted in the week before the beginning and the end of these ten weeks using non-invasive techniques (anthropometric measurements, body composition analysis – bioimpedance analysis). Parameters were analyzed using the pair T-test. Factual significance was evaluated using Cohens d. Results: Despite the relatively small number of participants, it can be stated that the group that trained using the high-intensity interval training showed better results. However, the final data could not be used to compare the statistically relevant efficiency of the two methods in body fat loss. The changes in studied parameters were, therefore, marked as statistically insignificant. Conclusion: Despite the relevant results, the HIIT program showed better results. It is crucial to expand the testing group and consider the subjects' eating regimen, motivation, and readiness for testing to continue. High-intensity interval training is shown to be a promising training program for body composition alternation due to its variability and low time consumption.

Keywords: body composition; intensity; interval training; physical exercise; bioimpedance analysis.

INTRODUCTION

Most of the adult population does not achieve recommended levels of physical activity, which negatively contributes to the global epidemic of overweight/obesity and related cardiovascular diseases. Physical activity is essential to weight loss programs and is integral to obesity treatment. Endurance training has an irreplaceable place in sports training, especially in terms of body fat percentage. Physical activity has many health benefits, such as positive effects on weight loss and even breaking down body fat with the added benefit of retaining muscle mass and total body weight. (Bellicha et al., 2021). Moderate-intensity continuous training (MICT) is often recommended for its greater ability to break down fat storage and higher energy output compared to anaerobic training, as an example stated by Geliebter et al., already in 1997. Currently, it is recommended to train at least 150 minutes of medium-intensity exercise or 75 minutes of high-intensity exercise three days a week to achieve a positive change in the physical performance and overall health of an individual (Sultana et al., 2019). Doing this type of exercise can offer several health benefits, such as cardiorespiratory health, metabolic health, and musculoskeletal health (Scoubeau, 2022), which is closely tied to a decrease in body fat. Most exercises specifically targeting weight loss in adults and individuals suffering from adiposity are recommended to include continual medium-intensity training (Sultana et al., 2019). Not having enough time to exercise is considered to be a frequent reason for the lack of physical activity in the general population (Keating et al., 2014). High-intensity interval training (HIIT) could offer comparable health benefits more time-efficiently than regular aerobic exercise, more commonly referred to as MICT of published research abroad. Moreover, it is applicable to the general public. HIIT is characterized as an exercise alternating between intervals of high intensity and either low intensity or a complete rest. De Feo (2013) characterizes HIIT as a repetitive high-intensity exercise for 30 seconds to several minutes, separated by 1 to 5 min of recovery.

On the contrary, MICT, generally referred to as aerobic training, lasts for a longer time period. According to WHO (2020), aerobic activity can be defined as endurance activity improving cardiorespiratory ability. Walking, jogging, swimming, or cycling can be used as examples of such activity. Aerobic exercise contributes to clinically significant loss of fat and muscle gain and decreases the risk of cardiovascular diseases (de Oliveira, 2020). The study of Stevenson et al. (2009) defines aerobic training as a type of endurance training that gradually hastens metabolism and stimulates the body to burn fat intensively, similar to HIIT training. On the contrary, HIIT is an efficient tool for body weight decrease. It also improves endurance and, in some cases, even increases the amount of muscle mass. It can be considered one of the most efficient training methods, even though the exercise lasts a relatively short time. However, in contrast to other MICT and strength training activities, HIIT is not based on low intensity. As the name suggests, it is a type of interval in which high-intensity intervals follow low-intensity intervals. Recently, the general population became aware of these high-intensity educational programs. Despite the initial positive feedback, the realization of these programs is quite problematic due to the already-mentioned requirements of high intensity. The study by Amaro-Gahete (2019) states that HIIT is turning out to be a time-efficient strategy to improve body composition. It systematically describes

that medium-intensity training programs show similar results to HIIT programs, both leading to the decrease of body fat (FFM- fat-free mass) in individuals leading a sedentary lifestyle and individuals suffering from overweight/obesity. The difference is that HIIT shows the same results while saving about 40% of time invested in exercise weekly. It can be concluded that HIIT is a more time-efficient alternative to basic aerobic training. The study of Amaro-Gahete (2019) also mentions the positive but inconclusive results of HIIT's effects on body composition parameters in individuals with a wide age range and varied biological factors. Despite that, HIIT is still the most modern, time-effective method of exercise at the moment. There are other alternative programs to this type of exercise being developed constantly.

A wide range of medical examinations revealing shortcomings and possible health problems can be used to prevent obesity. InBody device is one of the technologies specializing in obesity diagnosis. This device can calculate the body composition using a tetrapolar arrangement of electrodes, which send electric signals through the human body. After determining body fat percentage, bioimpedance analysis is often used. The most common indicator of excess body weight is BMI (body mass index). According to Cacek et al. (2014), the amount of excess body fat is one of the most important aspects of obesity. It describes the health risks for the individual and informs about the physical state and performance.

This study focused on two types of endurance training: moderate-intensity continuous training (MICT) and High-intensity interval training (HIIT). The continual method is primarily used for the development of aerobic endurance during a continual strain of a cyclic character, otherwise known as a periodic exercise that lasts for a longer period (Máček et al., 2011). As a study by Novotný et al. (2008) states, aerobic training with a continuous load and low intensity is long-term slow movement training over a longer distance (Novotný, 2008). On the other hand, interval methods alternate between intervals of load and rest. During the rest phase, the heart rate and ventilation do not recover completely, which is characteristic of this type of method. This variable method progressively enhances the endurance of an individual (Bernacíková et al., 2017).

The main goal of this study was to compare the impact of the two types of training load, HIIT and MICT, and their effect on body composition in women by using a 10-week intervention program. Based on the previous studies, we assume that MICT will show lower effectiveness on body composition than HIIT.

METHODS

Participants

All participants were healthy female recreational athletes performing aerobic sports activity up to 150 minutes per week (n = 14; women; average: 32 years old; height 166.3cm; weight 62.5kg). Participants were selected through purposive sampling. Women must be pre-menopausal, have no injuries, not take any medication, and be non-smokers. They were randomly divided into two groups of seven subjects. Pre-test and post-test were conducted using non-invasive techniques (anthropometric measurements, body composition analysis - bioimpedance analysis).

Procedures

The MICT and HIIT training program lasted for ten weeks with a frequency of three times a week (30 training units total).

Training protocol

The intervention program (Table 1.) was composed of an exercise unit performed three times a week for 10 weeks. A 5-minute warmup was initiated in every unit. It finished with an individual stretching. The training sessions of the MICT group lasted for 60 minutes and took place on a treadmill. The maximum heart rate (HRmax) was determined to be around 60–75 % of an individual HRmax. Training sessions of HIIT groups were split into three times repetition short intervals (30 s bouts and 30 s rest) Both of the protocols. MTF was set to 85–95% HRmax. The equation for calculating HRmax = 208 – (0.7 × age) (Tanaka et al., 2001). Heart rate was monitored using a Polar Heart Rate monitor (Polar® RS800sd Kempele, Finland) and was recorded at the completion of each high-intensity interval, and reported as percentage of age-predicted HRmax.

Table 1. Training protocol of the MICT and HIIT groups

Group	Number of participants	Duration	Intervention including warm up and cool down	% HRmax
MICT	7 women	3x per week 10 weeks at all	65min walking/running motorized treadmill	60-75% HRmax
HIIT	7 women	3x per week 10 weeks at all	3x (30s running, whole-body exercise, 30s rest), 1:1 35min per session	85-95% HRmax

Anthropometric characteristics and body composition measurements

Complete body composition analysis was undertaken using Inbody720 (Biospace, South Korea) segmental Body Composition Analyzer. Body height (cm) was measured by a stadiometer with 0.1 cm precision. Participants stood upright and barefoot by a wall, wearing thin sports clothes. Heels, behind, and shoulder blades were touching the wall. Bioelectric impedance analysis InBody was used for measuring body fat, muscle mass, waist-to-hip ratio, area of visceral fat, and mass.

Methods of data collection, data processing, and evaluation

Basic theoretical and practical preparations were conducted, undesirable elements were removed, and personal analysis was performed. All the women from both intervention programs went through a complete body analysis (Inbody 720), both at the start and at the end of the whole program. Pre-test and post-test were conducted 6 days before and 6 days after the 10- week intervention at the Faculty of Sports Studies. On the day of testing and the day previously, they had not completed any training, and according to the set measurement schedule, they came on an empty stomach. Before starting the measurement by InBody, the participants were familiarized with the measurement procedure, and they were the examiner conditions for the accuracy of the measured values to be ensured. Changes in the body composition were acquired. The main goal was to study changes in body fat and muscle mass. The secondary parameters were body mass and body mass index (BMI). The range of the effect changes between the HIIT and MICT was assessed by pair testing – Cohen

d. The results were transferred into tables and graphs for better illustration. Statistical significance was defined as $p < 0,05$ and was tested using the Wilcoxon paired test.

RESULTS

From both of the study groups, 7 women finished the intervention program. The changes in body composition of the HIIT group are shown in Table 2. Values of body fat, muscle mass, body mass, body fat percentage, and BMI were compared.

Table 2. Personal characteristics of group HIIT, pre- and post-testing.

Woman	Weight (kg)		Body fat (kg)		Muscle Mass (kg)		Body fat percentage (%)		BMI (kg/m2)	
	pre	*post*	*pre*	*post*	*pre*	*post*	*pre*	*post*	*pre*	*post*
TW1	75.6	76.9	20.7	22.3	30.64	30.33	27.42	28.98	25.26	25.69
TW2	57.3	57.3	14.1	13	23.65	24,35	24.52	22.71	19.83	19.86
TW3	71.4	71	22.8	22.4	26.68	26.77	31.99	31.53	24.71	24.57
TW4	63.4	67.3	11.7	12.9	28.69	30.09	18.48	19.19	21.31	22.62
TW5	53.2	52.6	14.4	12.2	21.12	22.03	27.06	23.25	22.14	21.89
TW6	60	58.2	17.8	15.3	23.11	23.59	29.69	26.33	24.03	23.31
TW7	79.1	77.1	28.4	25.8	28.09	28.52	35.92	33.43	28.03	27.32

Legend:TW = Tested woman

The expected progress after the HIIT intervention was primarily in decreased stored body fat and increased muscle mass. The results show that the changes that took place mainly were individual. Five women (TW 2, 3, 5, 6, 7) both decreased their body fat percentage and increased their muscle mass. In these instances, either a drop or a constant value of total body weight was recorded. Despite regular exercise, a rise in both body fat percentage and total body weight was recorded in two cases (TW 1, 4).

As it is shown in Table 3., the results in these cases are incredibly different. Unlike in HIIT, the primary assumption was decreased total fat without increasing additional muscle mass. However, this occurred only in two cases (TW 5, 7). In two instances (TW 3, 6), both a decrease in total fat and an increase in muscle mass were recorded. The rest of the subjects (TW 1, 2, 4) showed an increase in muscle mass but also an increase in body fat.

Table 3. Personal characteristics of group MICT, pre-and post-testing.

Woman	Weight (kg)		Body fat (kg)		Muscle Mass (kg)		Body fat percentage (%)		BMI (kg/m2)	
	pre	*post*	*pre*	*post*	*pre*	*post*	*pre*	*post*	*pre*	*post*
TW1	71.6	73.3	21.7	23.1	28.04	28.22	30.25	31.45	27.28	27.93
TW2	63	65.3	16.7	17.2	25.64	26.53	26.46	26.33	22.32	23.14
TW3	60.9	61.4	14.1	14	25.99	26.35	23.16	22.82	21.07	21.25
TW4	67.8	69	22.9	24	24.61	24.77	33.85	34.84	24.6	25.04
TW5	75.8	75.2	24	23.8	28.55	28.37	31.72	31.7	25.62	25.42
TW6	51.5	51.4	15.3	13.9	19.44	20.15	29.66	26.98	21.16	21.12
TW7	72.9	72.2	24.6	24.4	26.67	26.48	33.69	33.76	26.14	25.89

Legend: TW = Tested woman

During Wilcoxon body fat testing, the significance value was $p < 0.5$ (Table 4.). Even though in 5 cases, there was a decrease in body fat recorded, we can conclude that the changes in the total body fat were insignificant. Regarding muscle mass (Table 5.), there was an increase recorded in 6 cases. Due to the fact that the studied group was small, the value of the increase in muscle mass was considered a statistically significant $p = 0.043$.

Table 4. Wilcoxon paired test for body fat - HIIT

Pair of Variables	Wilcoxon Matched Pairs Test (X1_Spreadsheet3) Marked tests are significant at p< .05			
	Valid N	T	Z	p-value
Fat before (kg)& Fat after (kg)	7	7	1.183	0.237

Table 5. Wilcoxon paired test for muscle mass – HIIT

Pair of Variables	Wilcoxon Matched Pairs Test (X1_Spreadsheet3) Marked tests are significant at p< .05			
	Valid N	T	Z	p-hodnota
Muscle mass before (kg)& Muscle mass after (kg)	7	2	2.023	0.043

When performing a statistical evaluation of MICT, the situation was similar to that of HIIT, as there were no significant changes in body fat in the tested subjects (Table 6). In this case, there were no statistically significant changes in the amount of skeletal muscle mass (Table 7).

Table 6. Wilcoxon paired test for body fat - MICT

Pair of Variables	Wilcoxon Matched Pairs Test (data) Marked tests are significant at p < .05			
	Valid (N)	T	Z	p-value
Body fat pre and post (kg)	7	12	0.338	0.735

Table 7. Wilcoxon paired test for muscle mass -MICT

Pair of Variables	Wilcoxon Matched Pairs Test (data) Marked tests are significant at p < .05			
	Valid (N)	T	Z	p-value
Body mass pre and post (kg)	7	6.5	1.268	0.205

The effect of both groups, MICT and HIIT (Table 8., Table 9.), on BMI is very small (d_{MICT}0.091; d_{HIIT}=0.003) as well as body weight (d_{MICT}0.073, d_{HIIT}=0.006) and body fat d_{MICT}=0.034, d_{HIIT}=0.150). A minimal effect was recorded on the body fat percentage in the MICT group (d_{MICT}=0.031), and a higher value was recorded in the HIIT group (d_{HIIT}=0.258). In both groups, there were small but positive changes (increase) in muscle mass (MM-kg) when comparing participants in the groups (d_{MICT}=0.095, d_{HIIT}=0.157).

Table 8. Group MICT – Comparison pre- and post-selected variables

	MICT		**Effect**
	M	**SD**	**Cohen´s d**
BMI_pre	24.03	2.53	0.091
BMI_post	24.26	2.53	
PBF_pre	29.83	3.89	0.031
PBF_post	29.70	4.40	
BW_pre	66.21	8.40	0.073
BW_post	66.83	8.32	
BF_pre	19.90	4.40	0.034
BF_post	20.06	4.84	
MM_pre	25.56	3.02	0.095
MM_post	25.84	2.79	

Legend: M- Mean, SD- standard deviation, BMI- Body Mass Index, PBF- Percentage of Body Fat, BW- Body Weight, BF- Body Fat, MM- Muscle Mass.

Table 9. Group HIIT- Comparison pre and post-selected variables

	HIIT		**Effect**
	M	**SD**	**Cohen´s d**
BMI_pre	23.62	2.49	0.003
BMI_post	23.61	2.49	
PBF_pre	27.87	5.56	0.258
PBF_post	26.49	5.13	
BW_pre	65.71	9.79	0.006
BW_post	65.77	9.87	
BF_pre	18.56	5.83	0.150
BF_post	17.7	5.63	
MM_pre	26	3.45	0.157
MM_post	26.53	3.29	

Legend: M- Mean, SD- standard deviation, BMI- Body Mass Index, PBF- Percentage of Body Fat, BW- Body Weight, BF- Body Fat, MM- Muscle Mass.

The difference between BMI in the groups (Table 10.) according to the type of exercise was minimal before the exercise (d=0.164). After exercise, the difference between the groups according to the type of exercise increased (d=0.258). The difference between MM in the groups according to the type of exercise was minimal before the exercise (d=0.134). There was a slight difference in the comparison before the start of the research in BF (d=0.260). The post-exercise MM difference between groups by type of exercise increased (d=0.225), as did BF (d=0.449). When comparing both groups' pre-and post-testing, the difference in BW values was evaluated as very small (dpre=0.055, dpost=0.116).

Table 10. Comparison of pre and post-testing groups MICT and HIIT.

	MICT x HIIT d
BMI_pre	0.164
BMI_post	0.260
PBF_pre	0.410
PBF_post	0.670
BW_pre	0.055
BW_post	0.116
BF_pre	0.260
BF_post	0.449
MM_pre	0.134
MM_post	0.225

Legend: d- Cohen´s d, BMI-Body Mass Index, PBF- Percentage of Body Fat, BW- Body Weight, BF- Body Fat, MM- Muscle Mass.

Physical activity had a significantly higher effect when comparing both training groups on the percentage of body fat (PBF) at the post-test, where the value of Cohen's d gives the difference in the type of exercise as a medium effect (d=0.672).

DISCUSSION

The study aimed to compare the effects of high-intensity interval training (HIIT) and moderate-intensity continuous training (MICT) on body composition in adult women active in sports. The results show that the changes that have occurred are mostly insignificant. The only exception showing statistically significant change was the amount of muscle mass in women participating in HIIT training. Even though the individual training units were physically quite demanding (especially in HIIT), it is interesting that in some cases, there was an increase in total body fat recorded, even though the opposite was expected. The predicted phenomenon of the HIIT intervention was the reduction of total body fat and adding skeletal muscles. This occurred in 5 of the seven tested subjects. In the case of MICT, there was a drop in total body fat without increasing muscle mass in two cases. In the other two cases, there was an increase in total muscle mass and loss of total body fat recorded.

Excess body weight and obesity have become a serious global threat to all generations. Optimal cardiovascular physical activity – fitness is considered a protective factor, decreasing the risk of chronic diseases, mainly cardiovascular illnesses. According to the American Global survey by the Fitness College of Sports Medicine Trendy 2019, which focused on High-intensity training, HIIT was the most significant fitness trend from 2014 to 2018 (Scoubeau et al., 2022). Studies indicate that a higher intensity of exercise could be an effective alternative to improving cardiorespiratory functions and body composition by decreasing the amount of stored body fat. Therefore, finding an effective means to motivate the general public to exercise is crucial. The general public tends to be less active and, therefore, is susceptible to diseases connected to having higher amounts of body fat (Alves et al., 2021). Rossi et al. (2021) claim their studies describe HIIT as a more effective means to reduce body fat storage compared to endurance training of medium intensity. Despite that, a recent

meta-analysis did not show any better results of HIIT on body fat reduction compared to medium-intensity continual training (Andreato et al., 2019; Keating et al., 2017; Sultana et al., 2019). Because of this, it is appropriate to continue to study and debate this topic. Including more variables that could impact body mass management in future studies, such as energy input and output, would be beneficial. Chao L. et al. (2022) also confirm changes in values of body composition. After the 8-week intervention program, there was an increase in muscle mass and a decrease in body fat percentage in both tested groups. A MICT group also showed positive changes in the amount of total fat and the visceral fat area. Our findings differ from the previous studies. The probable cause could be characteristics of the subjects. In the studies, a significant group of the subjects were untrained adults with excessive body weight or obesity. In our case, most subjects were already trained and used to frequent exercise. More studies are required to describe the mechanism. In his study, De Oliveira et al. (2020) stated that HIIT training protocols have similar effects on the human body as the MICT protocols in adults with sedentary lifestyles. In addition, the effects of HIIT rarely affect body composition or critical proteins related to muscle mass gain. Similar findings were described in the systematic overview and meta-analysis of Wewege et al. (2017), which studied the effects of a moderate-intensity continuous exercise program together with a high-intensity interval training program on fat mass in sedentary individuals, with the conclusion that both exercise programs have similar effects on fat mass. Likewise, a study by Keating S.E. et al. (2014) compared HIIT with MICT. During the first week, the intensity ranged from 30 minutes at 50% VO2 max. to 45 minutes at 65% VO2 max three times per week (total 108-114 minutes per week). After 12 weeks, there was no significant change in total weight ($p = 0.30$), but fat loss was statistically significant ($p < 0.05$) for both continuous training (-2.6%) and HIIT (-0.3%). Visceral fat loss was also highly significant ($p < 0,01$). On the other hand, the study of Heinrich, K.M. et al. (2014) did not register any effect of HIIT and MICT on BMI and body mass even after an 8-week intervention, which was carried out 3 times a week. An 8-week study was conducted in Iran, where the intervention group did MICT three times a week (50 minutes). The intensity was in the range of 60-85 % MTF (maximum heart rate). The final measurements and statistical analysis show that body fat and waist circumference decreased ($p < 0,05$). The control group, which did not train at all, showed no significant changes Rastegar et al. (2014). The research of Willis et al. (2012) laboratory compared three training groups, where one did aerobic training. There were both fat loss and body mass loss recorded in this group. D'aleva et al. (2023) state that HIIT and a combination of HIIT with MICT training improved anthropometry and cardiovascular parameters and the rate of fat oxidation to a similar extent. However, the combination of both the combined interval training and moderate-intensity continuous exercise was less intense than HIIT. Study has shown that the combination of low-volume HIIT with high-volume moderate-intensity training is an effective way to improve fat oxidation, metabolic rate, and body composition in obese individuals. In most cases, the authors agree on the positive effect of MICT and HIIT on fat loss. However, they do not concern themselves with increasing or maintaining muscle mass. In addition, HIIT can improve body composition and aerobic capacity (Adimi et al., 2022).

CONCLUSION

To conclude, comparing the effects of these types of training is quite relevant due to the achieved results. A limiting factor for the possibility of generalizing the results to a broader population is the small number of participants and their deliberate selection for this part of the research. Despite the small sample of women tested, better results were achieved in the HIIT intervention program, especially concerning body fat percentage (d=0,670). Here, the expected changes occurred in 5 subjects, in the MICT program, only in 4 subjects. An important argument for this statement is also the fact that there was an increase in body fat in three women attending the MICT program.

Intervention programs are known for their demands on the time of subjects, who, despite their busyness, try to regularly participate in the prepared program. However, from the data collected, it cannot be assessed if the positive impact of HIIT is more significant on body composition than MICT. In order to continue the research, it is necessary to obtain a more extensive test group and consider diet, preparation, and motivation, which could have influenced the results to an extent. It should be noted that although some individuals cannot or will not undergo this type of high-intensity exercise, the flexible nature of HIIT protocols (intensity, duration, effort, rest period, volume, modality, etc.) allows moderation of the training to their preferences and abilities. Due to the appropriate knowledge of this type of training, sports professionals who work with insufficiently active or overweight people can currently use HIIT modified with MICT aimed at fat loss, decreasing BMI, or improving energy balance.

According to the systematic reviews and meta-analyses (Andreato et al., 2019; Keating et al.; Rossi et al., 2022; Scoubeau et al., 2022; Sultana et al., 2019; Wewege et al., 2017;), it can be claimed that both MICT and HIIT improve body weight and body composition in adults, not only overweight or obese. Benefits of exercise include reduction of mass, weight, total body fat, and visceral fat tissue. Even though the effect on weight and fat loss is relatively small, reducing visceral fat is probably related to improving cardiometabolic health in these individuals. It is important to add that loss of visceral fat can occur even if the participants experience little or no weight loss. HIIT allows the general population to adapt to their abilities and preferences (Neves et al., 2023). Thus, we can argue that HIIT provides beneficial changes for public health.

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Predictive Model of the Risk of Fall Based on Physical Fitness Assessment in Older Adults

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ABSTRACT

Falls occurring during activities of daily living pose a major threat and are the third most common cause of death in seniors. In clinical evaluations, mostly single tests are used to assess the risk of fall. However, a complex set of tests would lead to a more comprehensive assessment of the risk of falls. The purpose of this study was to develop a predictive model of the risk of falls in older adults aimed to prevent injuries. This study involved 159 older adults (≥65, 77% women) who underwent laboratory testing consisting of questionnaires, physical tests and basic anthropometric data measurement. The data were processed by a statistical method of regression analysis, the Classification and Regression Tree. Based on the analysis a predictive model of the risk of fall for older adults was created. The most important variables for the predictive model were total % of body fat mass, Timed Up and Go Test and 2 minutes walking test. Based on the predictive model, we can design a targeted intervention program for elderly adults to prevent risk of falling, promoting well-being and increase quality of their life.

Keywords: TUG; physical tests; elderly, falling; prevention

INTRODUCTION

The older population is increasing dramatically and the number of people over 60 years is growing faster than any other age group. Quality of life in later years depends to a large degree on the ability to do the things we want to do without pain or limitations, for as long as possible. As we are living longer, it is becoming increasingly important to pay attention to our physical condition (Sherrington et al., 2017; Teng et al., 2020). Many older adults are functioning dangerously close to their maximum ability level during normal activities of daily living. Standing up from the chair, climbing stairs, are examples that often require near maximum efforts for older people who are not very physically active. On the other hand, much of the usual age-related decline in physical ability is preventable and even reversible through proper attention to our fitness levels and physical activity. Especially important is the early detection of physical daily living activities and decrease the risk of falls (Rikli, 2001).

Falls are the second leading cause of unintentional death worldwide (Gschwind et al. 2013). A fall is defined as "*an event which results in a person coming to rest inadvertently on the ground or floor or other lower level, excluding intentional change in position to rest to furniture, wall or other objects*" (WHO, 2007). The Word Health Organization (2007) claims age as a key risk factor for falls. Older adults have the highest risk of serious injury or death. This risk level may be in part due to the physical, sensory, and cognitive changes associated with ageing, in combination with environments that are not adapted for an ageing population. Falls (without or with injury) also carry a heavy quality of life impact. A growing number of older adult's fear falling and therefore limit their physical and social activities (NCOA, 2021). It may cause further physical decline, social isolation, or depression, which can lead to decreased quality of life (Salkeld et al., 2000). Many people think falls are a normal part of aging. The truth is, they're not. Most falls can be prevented—and everyone have the power to reduce the risk of falls (NCOA, 2021). Although there are recommendations to assess the risk of falls in the elderly, the tools currently used have not shown sufficiently high predictive validity in differentiation between high and low risk of falls. (Park, 2018).

Falls prevention programs based on physical activities (walking, balance training or strength training) are examples of effective strategies to offset declining strength and improve balance, thus reducing falls and promoting well-being (Senderovich & Tsai, 2020). There is robust evidence that exercise can reduce the rate of falls in older people. A systematic review from 88 trials indicates that exercise in community-dwelling older adults reduced the rate of falls by 21% (Sherrington et al., 2017). In praxis, mostly single tests related to falls risk are used. However, the complex set of tests would bring valuable variables, which lead to comprehensively assess the risk of falls. Therefore, it is crucial to develop a predictive model to identify older adults vulnerable to falls and then to design tailored preventive intervention program for the elderly.

METHOD

Based on validated studies on this topic, we have defined fitness parameters that are closely related to activities of daily living (ADL) and instrumental daily activities (IADL) (Schoene et al., 2013; Rosa et al., 2018). Tests were selected for a comprehensive assessment of physical condition, anthropometry, cognitive functions, and subjective assessment of the fear of falling.

The data used in this study were collected during an observational cross-sectional study. Participants (n=159) were tested and filled questionnaires at Faculty of Sports Studies, Masaryk University in Brno, The Czech Republic. The key was the sequence of tests. Participants started with filling three questionnaires (basic anamnesis, The Montreal Cognitive Assessment and Falls Efficacy Scale- International test) in a quiet environment to promote concentration. Physical tests took place in laboratories of Faculty. Participants started by assessing human body composition (BIA) followed balance (The Functional Reach test), mobility (Timed Up and Go Test), strength assessment (Hand grip and 30-Second Chair Stand Test) and finished with an endurance test (2-minute walking test).

The study was carried out according to the Declaration of Helsinki and was approved by Masaryk University (EKV-2021-102).

Participants Characteristics

The study involved 159 older adults (≥65,) who don´t suffer from acute or chronic diseases that would make it impossible to complete testing. Participants were recruited through snowball method specially in educational organizations for the elderly (e.g., the University of the Third Age or the Senior Academy) and in leaflets form in medical centres or homes for the elderly in Brno, Czech Republic, between February 2021 and December 2021. The Inclusion criteria were age ≥65 and self-sufficiency. The exclusion criteria were limitations for measurement o a bioimpedance device (e.g., pacemaker, epilepsy, or metal prothesis) and any health restriction which limits doing physical activities and cognitive tests. Prior to recruitment approval was obtained from an institutional research ethics committee. All participants provided written informed consent, approved by Masaryk University Faculty of Sports Studies in Brno.

Data Collection

Questionnaires

This research involved three questionnaires.

Basic anamnesis. This anamnesis contained personal information, demographic data, medication, socioeconomic status, level of physical activity and history of falls – number of falls during last year.

The Montreal Cognitive Assessment (MoCA) is a 10-minute cognitive screening tool which was validated as a highly sensitive tool for early detection of mild cognitive impairment (Nasreddine et al., 2019). MoCA accurately assesses the short-term memory, visuospatial abilities, multiple aspects of executive functions, Attention, concentration, and working memory, language and orientation to time and place (MOCA, 2022).

Falls Efficacy Scale – International (FES-I). The FES-I is a diagnostic tool for assessing the fear of falling in the elderly and consist of 16 questions participants' concerns about falling during normal day-to-day activities. The answers are evaluated in 1–4 points, where 1 means no fear of falling and, conversely, 4 points indicate great fear of falling during the implementation of the activity. Respondents can complete the FES-I themselves or with a researcher who must make sure that the respondents have a sufficient understanding of the meaning of the asked question. This diagnostic tool has been successfully translated into several languages using the methodology of Ten Step Translation Protocol. The valid translation of Falls Efficacy Scale – International for use in the Czech Republic was used for this research. (Reguli & Svobodová, 2011).

Assessment of body composition - BIA

Bioelectrical impedance analysis (BIA) is a practical and non-invasive method to assess human body composition. Initial applications of BIA at 50 kHz used whole-body measurements of resistance, derived by using surface electrodes placed on a hand and a foot (Shafer et al., 2009). For our research we used device Inbody 270 to estimate total body composition - weight, %fat mass, FM, and FFM.

Participants stood barefoot on the device's scale with the soles of their feet positioned on four metallic electrodes, held the handles in both hands making contact with metallic grip electrodes in contact with the palm and thumb, arms were fully extended and abducted approximately 20 degrees laterally., and the device collected weight. Participants waited until their weight stabilized, height, sex and age were entered into the Inbody software and participants stood still for the duration of the assessment (Brewer et al., 2021). Measurement on Inbody 270 (BIA) was conducted before physical assessments to minimize the effect of hydration status on measurements.

Assessment of physical fitness

The Functional Reach Test is used to assess balance and postural control. It is conducted using a wall meter at the height of a participant's shoulder. The participant stands so the top of the shoulder is perpendicular to the wall meter. With the participant's fist in line with the wall meter, the participant leans forward as far as possible without taking a step or losing balance. Measured is the distance of the fist between the starting point (measured when standing straight) and end point (measured when leaning forward) to give the total reach measurement. The result 25 cm and more indicates a low risk of falling (Greenberg, 2020); (Newton, 2001).

Timed Up and Go Test (TUG). Timed Up and Go test assess mobility. Result is the number of seconds required to get up from a chair, walk 2.5 meters, turn, return, and sit on the chair to the start position. The timed Up and Go Test is also a simple screening test that is a sensitive and specific measure of probability for falls among older adults. An older adult who takes ≥12 seconds to complete the TUG is at risk for falling (CDC, 2017). This test assesses the agility/dynamic balance important in tasks that needs fast movement such as getting off a bus, going to the bathroom, picking up a ringing phone and getting up to attend to something in the kitchen (Rikli, 2001).

Hand grip strength (HGS) is used for the diagnosis of frailty and sarcopenia (Sousa-Santos& Amaral, 2017). This test measured the maximum isometric strength of the hand and forearm muscles with the Takei 5401 dynamometer. Participants seated on a chair without armrests. Joints of the lower limb were approximately three-flex (90 ° -90 ° -90 °). Shoulders were in the neutral position and the elbow of the examined arm was flexed at an angle of 90 °. The opposite arm was loosely placed on the thigh (on the side of the examined arm). Hand grip strength is examined three times for each hand with a rest interval of 2 minutes between tests (a total of 6 minutes of rest and approximately 2 minutes for the testing). Non-dominant arm is tested first and then the dominant one. (Sousa-Santos& Amaral, 2017)

30-Second Chair Stand test. The Chair stand test is used for measurement of lower-body strength and endurance. The result of this test is the number of stands from a chair that can be completed in 30 seconds. Arm position is across the chest. It is needed for many tasks such as climbing stairs, standing up from a chair, getting out of a car etc. Increased ability in performing this exercise may reduce the chance of falling (Rikli, 2001). This test is used by Center for disease control and prevention as a tool which indicate a risk for falls (CDC, 2017).

2-minute walking test. The 2-minute walking test is used to assess aerobic capacity and endurance. The result is the number of full steps completed in 2 minutes. The height of raising each knee is a point between the patella and the top hip bone. The final score is the number of times the right knee reaches the right height. Usually, this test is used for assessment of aerobic endurance (Rikli, 2001).

Data Diagnostic

Mining analysis and applied non-parametric classification and regression trees (C&RT) with the „Fall" as the dependent variable was chosen for this study. The C&RT classifies the individual instances based on a simple criterion. All homogeneous instances are in precisely one leaf of the tree, while all the other instances are in a different leaf in such a way that the most homogeneous ones are together. The C&RT algorithm creates several classification trees and continuously calculates the importance of the individual variables so that the n-th observation is classified in the correct category in all trees. The result is an ordered list of variables that most often affect the correct classification, even though they might not always be present in the tree structure.

The advantage of classification trees is that no assumptions that place standard statistical methods on the data need to be met. Such as normality of data, homogeneity of variances, etc. The result is the classification of cases into individual nodes with a description of their typical predictors.

RESULTS

Characteristics of the study population

The sample consisted of 159 participants (37 men and 122 women) aged 65 to 101 years (mean age ± SD = 73.59 ± 7.39 years). 52 participants (32,70%) had experienced one or more falls in the preceding 12 months. The characteristics of the study population are shown in Table 1.

Table 1. Baseline characteristic of participants

	Participants (n=159)
Demographics	
mean age in years	73.59 (7.39)
women	122
men	37
% body fat mass	37.33 (8.37)
Mean body mass index in kg/m2	25.05 (5.96)
Falls history	
yes	52
no	107

Characteristics of analysed variables from physical fitness assessment and questionnaires

The variables selected for this study are shown in Table 2.

Table 2. Characteristic of variables from physical fitness assessment and questionnaires

	Mean	Median	Std. dev
% body fat mass	36.95	37.33	8.37
Functional Reach Test (cm)	36.27	38.20	12.68
Timed up and go test (TUG) (s)	7.51	5.50	7.34
Handgrip R (kg)	25.80	24.25	9.45
Handgrip L (kg)	24.34	23.15	8.59
Chair Stand Test (n)	13.69	14.00	4.73
2 minutes walking test (n)	77.89	85.00	32.43
MoCa test (points)	24.23	26.00	6.11
FES-I test (points)	21.78	19.00	7.01
Physical fitness (points)	6.40	7.00	1.91

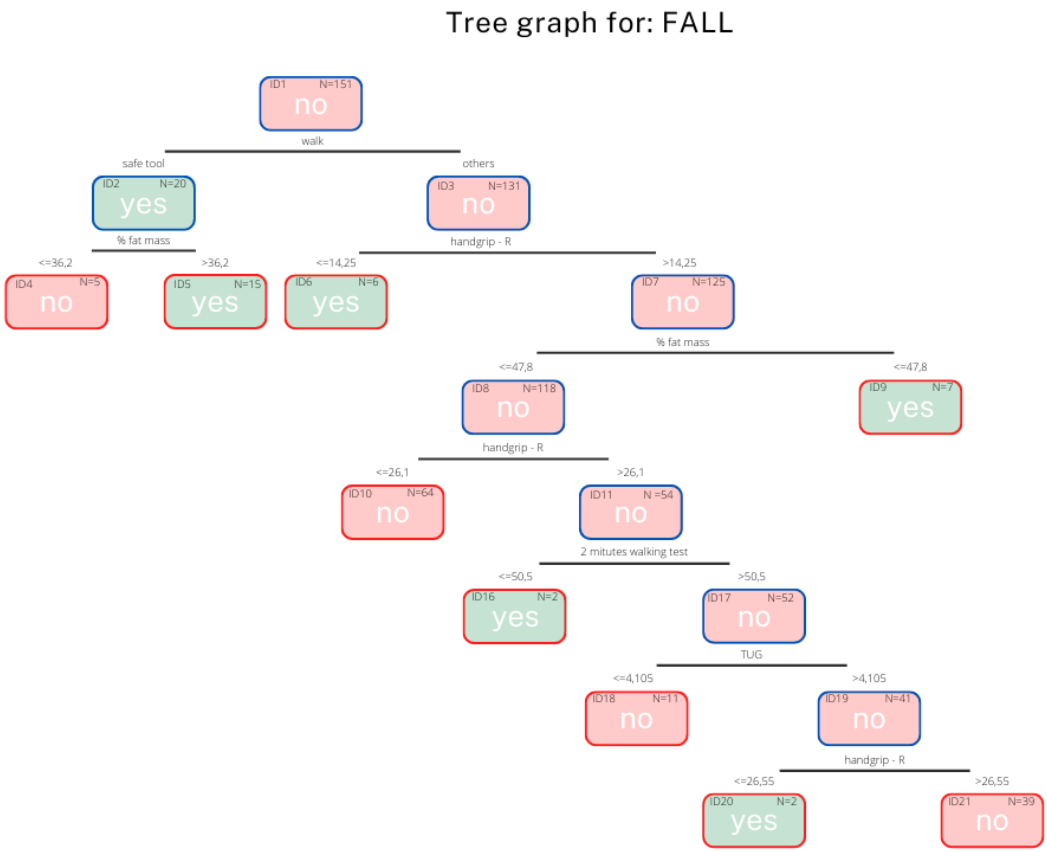

Figure 1. Resulting C&RT tree for variable fall

Results of tests are shown in Figure 1. The resulting C&RT tree describes the final division of individual cases into tree leaves. For the result, we can look at typical properties that predict the final dependent "Fall". How are the nodes where the number of falls is most characterized:

Node ID = 5: predominate in the classification "falling". There are 14 of them and it is typical for them that they walk safely with a wand, but they have a fat percentage> 36.2 % (specifically 45.5 %; which is above average)

Node ID = 6: predominate in the classification "falling". There are 5 of them and it is typical for them that they walk normally without a wand, but they have a handgrip R <47.8 (specifically 10.3, which is below average)

Predictor importants

The classification of falls is best determined by the variable "% fat" and then the test "Stand up and go" and "2 minutes walk". The variables gender, gait test and fitness do not enter the classification of falls / falls at all. Results for determined variables shows Table 3. It is a list of variables that were taken into account during the calculation of the final tree, although some of them were not ultimately included among the variables used to split the tree. Here we find the right determinants for the dependent variable - fall.

Table 3. Determined variables

	Variable rank	Importance
% body fat mass	100	1.000000
Timed up and go test (TUG	98	0.979894
2 minutes walking test	93	0.929633
Handgrip L	86	0.864965
Chair Stand Test	84	0.844345
Handgrip R	77	0.765213
Functional Reach Test	69	0.691745
Type of housing	56	0.557762
MoCa test	53	0.528888
FES-I test	39	0.390330

DISCUSSION

This an observational cross-sectional study aimed to develop a predictive model of falls prevention in older adults is based on multifactorial variables. Our findings demonstrated that the model which best predicted falls of participants comprised total body % fat mass, Timed Up and Go Test (TUG) and 2 minutes walking test**.**

Although falls can occur at any age, the frequency of falls increases with age. (CDC, 2021). The greater risk of falls in older adults is caused when changes occurring with aging (physical, perceptual and cognitive) are combined with unsuitable environment. (Palumbo et al., 2015). Cause of falls is multifactorial so for prediction of falls combination of assessment tools has to be used. A systematic review and meta-analysis by Park (2017) examined which tools for predicting the risk of falls in older adults are the best. The conclusion was that rather than a single measure, two or more assessment tools used together would better evaluate the characteristics of falls.

Study published by Palumbo et al. (2015) pointed out a predictive tool based on a small number of variables could be preferable, as their administration is generally shorter and easier. However, this objective can clash with the need to have good accuracy in prediction. The study suggests

that fall prediction is more accurate when based on multiple fall risk factors and indicators. Thus, screening tests from three to six variables are optimal in terms of predictive accuracy.

The importance of using the TUG test as a part tool for a predictive model confirm several studies (Alexandre et al., 2012; Möller & Jakobsson, 2012; Laessoe et al., 2007; Cella et al., 2020). Findings that % fat mass and 2 minutes walking test affect fall risk are innovative. Based on these tests are also defined an important fall risk factors – obesity, low level of endurance and low level of mobility. Variables such as sex, subjective assessment physical fitness, results from FES-I and MoCa questionnaires had low variable rank and importance for predictive model (Tab.2).

An important limitation of the present study was that we did not investigate the use of drugs. There is evidence that pharmaceutical interventions can lower fall risk in older adults with Parkinson disease and people with muscle weakness (Lord &Close, 2018). In addition, the limitation of this study concerns non-inclusion of measurements gait speed. Gait speed or adaptability were important predictor for fall risk in several studies (Palumbo et al., 2015; Lord &Close, 2018; Laessoeet al., 2007). Environmental variables could be seen as another limitation since it has been suggested as an important cause of falls. All measurements took place inside at Faculty of Sports studies but the influence of environmental factors and the difficulty in daily tasks performed have to be considered as well as the individual physiological factors, which is also pointed out by Brauer et al. (2000). The influence of environmental factors is captured by the questionnaire FES-I but in our predictive model reached low importance.

CONCLUSION

In conclusion, findings from this study indicate that a total body % fat mass, Timed Up and Go Test (TUG) and 2 minutes walking test are the key variables for a predictive model of risk of fall in older adults. Several studies confirm importance of TUG test as a part of predictive models. Innovative predictive variables for the risk of fall are body fat percentage and 2 minutes walking test. Based on predictive model we defined also crucial factors on risk of falls – obesity, low level of endurance and low level of mobility, which are an important for planning specific prevention or rehabilitation programs for older adults. The validity of this predictive model must be verified in future studies.

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Variables Influencing the Emotional Attachment of Adolescents in Prague Schools to Physical Education

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ABSTRACT

Background: Emotional attachment to any activity is a frequently discussed topic. Backgrounds speak of the importance of building emotional attachment since childhood, we agree with this statement and we see school Physical Education as one of the important sources that can significantly influence this attachment in the field of physical activities. The aim of the study is to define the variables that influence the emotional attachment between pupils and school Physical Education. **Method**: A questionnaire used by Antala for a similar investigation in Slovakia was chosen as the research tool. After assessing the normality of the data, we chose the Kruskal- Wallis test for statistical data processing. **Results**: Our research group contained 480 respondents from 22 primary schools in Prague. 38% of the pupils have a negative relationship with Physical Education. 41% of pupils have a neutral relationship with Physical Education. Emotional attachment also affects the state of health. In many cases sick students have a more positive relationship with physical education. **Conclusions**: Pupils who are not focused on performance perceive Physical Education more positively than pupils focused on achievement. Children's emotional attachment to physical activities is important, we recommend working on tools to better clarify this area.

Keywords: physical activity; Kruskal- Wallis test; education; performance

INTRODUCTION

Currently, health is a topic of discussion, the value of which many people have verified during the COVID-19 pandemic. During the pandemic, physical activities and the movement of people were restricted, which was reflected in all aspects of health for many people. At the present time, the situation around COVID-19 is more relaxed and society is returning to the time before the first wave of this pandemic broke out.

According to WHO (2002), adult lifestyle is influenced by childhood and adolescence. This is also supported by Malina (2004), who emphasizes that childhood and adolescence are key to the creation of a movement regime. In these periods, relationships and attitudes towards physical activities are formed. The task of parents and teachers is to create opportunities for regular activity and thus create a positive relationship to physical activity. Physical education serves as a tool for creating a regular exercise regime. A regular exercise regime in childhood and adolescence is the first prerequisite for its continuation in adulthood. Jeřábek and Tupý (2007) are of the opinion that educating children to actively develop and protect physical health and responsibility for it should be one of the top priorities of current educational trends in elementary education in the Czech Republic.

In advanced foreign educational systems, Physical Education has an important role and the conditions in the curriculum documents enable the fulfillment of the goals of school Physical Education. In the Norwegian education system, schools compensate children for physical activity on days when children do not have Physical Education in the schedule. Swedish curriculum programs are autonomous in the design of Physical Education, schools also choose the number of teaching hours. It is similar in the Spanish curriculum. The conditions for the realization of educational goals in the Czech curriculum system are not at such a level. These data are presented by the following authors in their studies: Habrdlová (2019), Vlček (2012), Lupač (2018) and Zoglowek (2012).

Lupač (2018) finds in Czech documents a certain discrepancy between the educational goals (strongly health-oriented) and the curriculum (movement-oriented). The goals of school Physical Education in the Czech educational system are comprehensively conceived. According to Fialová (2010), the main goal of Physical Education is to stimulate and develop movement regime, health prevention, movement abilities and skills. Furthermore, it is also necessary to develop the personal characteristics and positive attitudes of pupils towards physical activity. We perceive the last part of this definition as crucial, which states that it is important to develop positive attitudes of pupils towards physical activity, because physical activity is an important determinant contributing to the level of human health.

In the professional physical education community, many topics are discussed that affect this educational field and its impact on students. A very important topic is the assessment of pupils in Physical Education. Cihlář (2017) points out that a positive assessment affects the pupil's attitude towards Physical Education in the dimension related to performance, efficiency, and health, and it is also important to realize that the physical activity of the parents has an effect on the physical activity of the child. In our opinion, it is the motivation of pupils at the beginning of schooling and the subsequent evaluation of their activity that is a very important factor in building positive attitudes among pupils at all levels of education. The aim of the study is to assess the variables that can influence the emotional attachment of adolescents to physical activity.

METHOD

The chosen research tool was the questionnaire used by Antala for a similar investigation in Slovakia in 2012. In our study, we interpret scaled items from the first, second and third dimensions. In total, there were ten items assessing the emotional relationship to Physical Education. All items were rated points (1-5), the more points, the more positive the relationship. The first dimension contains six items and assesses the emotional relationship to Physical Education. In the study, we refer to it as the score of domain 1 – emotional relationship (hereafter referred to as emotional relationship). So, the respondent can get from 6 to 30 points. The remaining items delimited by the scale assessed the relationship to Physical Education. These items are contained in the second and third dimensions. These are two items in the second dimension and two items in the third dimension. The total score of the tool ranges from 10-50 points. The questionnaire also includes identification data. The tool did not pass standardization for the Czech population. From the psychometric data, we calculated the internal consistency using the Cronbach's alpha coefficient (0.7), this is a lower value, but sufficient according to Gurková (2011). Table 1 shows the division of probands into categories according to the number of points obtained.

Table 1. Evaluation of selected items

Total score	**Score - emotional relation**	
10-17 points	6-10 points	Very negative relationship
18–25 points	11-15 points	Negative relationship
26-34 points	16-20 points	Neutral relationship
35-42 points	21-25 points	Positive relationship
43-50 points	26-30 points	Very positive relationship

(Antala, 2012; Gurková, 2011)

Pupils from primary schools, grammar schools and high schools from Prague were included in the deliberately selected research group. The tool was distributed to pupils in the 9th grade of elementary schools and in the 1st grade of high schools. At grammar schools, the questionnaire was distributed in the first years of secondary education. The age of the group ranges from 14 to 16 years, which corresponds to the developmental period of middle adolescence (Macek, 2003).

The set was deliberately selected by students of FTVS UK (Faculty of Physical Education) as part of their internships in Prague. The total number of anonymous respondents was 589 from 22 schools. From this number, we included 480 questionnaires into the research. The conditions for exclusion from the research were set as follows. A respondent was excluded from the research if the questionnaire lacked identifying information (height, weight, age), if there were three or more unanswered items in the questionnaire, or if the open-ended answer was a nonsense. Failure to fill in an item or crossing it out was considered an unanswered item.

We divided the group according to identification data (health status, BMI, level of physical activity) into sub-sets, which were subsequently subjected to statistical analysis. By dividing, we have defined the variables that we believe will enter the relationship of adolescents to school

Physical Education. You can view the representation of individual types of schools and study programs in Table 2. As can be seen, grammar school students are the most represented ones, specifically the 8-year study program, on the contrary, high schools are the least represented. The composition of the partial sets can be seen in Table 3.

The criteria for division into individual groups were determined as follows. We divided the subsets according to BMI into three categories according to the percentile graphs into the categories "underweight", "optimal weight" and "overweight and obesity". Subsets divided according to the level of physical activity were divided according to the following criteria. If the respondent participates in competitions and is registered under the association, he falls into the category "do sports competitively". If the respondent engages in physical activities but is not registered under an association and does not participate in competitions, he falls into the category "play sports recreationally". If the respondent does not do sports, he falls into the "do not do sports" category. The division according to health status divided the respondents into the "healthy" category, which is made up of respondents who are sick once in the school year, the "occasionally sick" category is made up of respondents who are sick for two to three weeks during the school year. If the respondent is absent more often during the school year, he falls into the category "often sick". The criteria were clearly defined, and the respondents were able to assign themselves to individual categories.

Data collection took place in January and February 2020, just before the start of the first wave of the COVID-19 pandemic.

Table 2. Participants characteristics

Study program		Boys	Girls	Total
Upper primary	ISCED 2	48	51	99
8-year grammar school	ISCED 2	95	67	162
4-year grammar school	ISCED 2	52	83	135
High school	ISCED 3	27	57	84
Total		222	258	480

ISCED (International Standard Classification of Education)

Table 3. Dividing the group into individual sub-sets

Criterium	Category	n
Sport activity	I do sports competitively	216
	I do sports recreationally	210
	I do not do sports	54
Health	Healthy	182
	Occasionally sick	227
	Often sick	71
BMI	Underweight	154
	Normal weight	173
	Overweight and obesity	153

BMI (Body Mass Index)

For the results part, we worked with frequencies, percentages, descriptive statistics, and inferential statistics as part of the statistical analysis. Statistical data processing was performed in the R program. Descriptive statistics determined measures of central tendency and measures of variability. We used the Shapiro-Wilk test to determine normal distribution of the data (p= 0.00046), according to which the data are non-parametric. Statistical significance was determined using the Kruskal-Wallis test. We performed subsequent post hoc analysis using the Dunn-test with Bonferroni correction (Skutil, 2011; Sigmund, 2012).

RESULTS

From table 4, it can be read that the highest frequency of students is represented in the categories "neutral relationship" and "negative relationship". We can state this for the results of the 1st domain as well as for the overall score of our tool. On the contrary, the percentage of students with a positive and very positive relationship is very low.

Table 4. Participants results

Relationship	Frequency				Cumulative frequency			
	Emotional Relationship Score		Total Score		Emotional Relationship Score		Total Score	
	A.F.	R.F.	A.F.	R.F.	A.F.	R.F.	A.F.	R.F.
Very negative	52	10.9%	39	8.2%	52	10,.9%	39	8.2%
Negative	187	38.9%	197	41%	239	49.8%	236	49.2%
Neutral	199	41.4%	215	44.8%	438	91.2%	451	93.8%
Positive	36	7.5%	25	5.2%	474	98.7%	476	99.2%
Very positive	6	1.3%	4	0.8%	480	100%	480	100%

Legend (A.F. – absolute frequency; R.F. – relative frequency)

Tables 5 and 6 show the position measures and the variability measures. For the overall results as well as for the emotional relationship score, we point out that the medians of the individual subsets move around the center of the scale. However, an interesting finding is that the highest scores appear in the subset of non-sporting respondents and frequently ill respondents. On the contrary, the lowest values of the medians appear in competitive athletes and in healthy respondents.

Table 5. Results per total score

Set split criterion		**Average**	**Modus**	**Median**	**SD**
	Whole set	26	28	26	6
Sport	Competitive sport	24	21	24	5.2
	Recreational sport	27	28	27	5.3
	Non-sportsmen	28	30	28	7
Health	Healthy	25	23	24	6.2

	Sometimes sick	26	25	26	5.3
	Often sick	27	28	28	5.1
BMI	Underweight	26	23	26	5.1
	Normal weight	26	28	26	5.7
	Overweight and obesity	25	22	25	6.1

Legend (SD= Standard Deviance)

Table 6. Results per emotional relatedness scores

Setting the split criteria	Average	Modus	Median	SD
Whole set	16	15	16	4
Sport				
Competitive sport	14	13	14	3.6
Recreational sport	16	17	17	3.5
Non-sportsmen	18	20	17	5
Health				
Healthy	15	14	14	4.4
Sometimes sick	16	16	16	3.5
Often sick	16	15	17	3.5
BMI				
Underweight	16	15	15	3.5
Normal wight	16	16	16	3.8
Overweight and obesity	15	13	15	4.2

Legend (SD= Standard Deviance)

Tables 7 and 8 show the results of the Kruskal–Wallis test and subsequent post hoc analyses. Statistically significant values are highlighted. There is a statistically significant difference for the overall health score and physical activity level, and the same is true for the emotional relationship score. According to the post hoc analysis in Table No. 8, there is a difference in the category of athletes between the sets of non-athletes and competitive athletes in both the total score and the emotional relationship score. For health, there is often a statistically significant difference between the sick and healthy sets.

Table 7. Kruskal–Wallis test criteria

Comparison	p- value
Total score x health	***0.00627***
Total score x BMI	0.28873
Total score x sport	***0.00001***
Domain Score x health	***0.00870***
Domain Score x BMI	0.51840
Domain Score x sport	***0.00008***

Table 8. Post hoc analysis using Dunn-test with Bonferroni correction

Kruskal – Wallis	Sets compared	p- value
Domain Score x sport	Non-athletes x recreational athletes	0.49099
	Non-athletes x competitive athletes	***0.00002***
	Recreational athletes x competitive athletes	***0.00001***
Total score x sport	Non-athletes x recreational athletes	0.09546
	Non-athletes x competitive athletes	***0.00176***
	Recreational athletes x competitive athletes	***0.00026***
Domain Score x health	Sick x sometimes sick	0.14753
	Sick x healthy	***0.00687***
	Sometimes sick x healthy	0.32836
Total score x health	Sick x sometimes sick	0.09654
	Sick x healthy	***0.00456***
	Sometimes sick x healthy	0.37745

DISCUSSION

In the study, we reached the following results. Over 80% of pupils have a neutral or negative attitude towards school Physical Education, 10.9% have a very negative attitude. 9% of pupils have a positive and very positive relationship. Based on the statistical analysis, we can state that significance was demonstrated for the total score in the category classified according to the performance of physical activity. Post hoc analysis shows significance between competitive athletes and non-athletes (0.00002) and between competitive athletes and recreational athletes (0.00001). The same results appear for the emotional relationship score. Competitive athletes vs. non-athletes (0.00176) and competitive athletes vs. recreational athletes (0.0026).

According to Pereira (2020), increasing age affects the interest in Physical Education among girls, he claims that the interest in Physical Education among pupils in Portugal decreases with age. If we compare this study with Cruz's study (2021), we find that Filipino children maintain a positive attitude towards physical activity even after graduating from high school. These studies confirm the thesis that it is necessary to build children's relationship to physical activity from childhood.

In his experiment, Sigmund (2009) demonstrated an increase in motivation with varied and attractive content. This is confirmed by Adamcak (2020) who claims that the relationship to Physical Education can be improved with attractive content and new and unconventional games. The question remains, what is the importance of competitions and activities based on them. In his study, Gosset (2019) finds no difference between programs focused on competitive and non-competitive forms of Physical Education. This is confirmed by Bernstein (2011) who claims that educational programs based on competition and racing are not very popular among students. Coulter (2020) points at the importance of fun and variety over competition.

An important factor in the perception of this issue is the subjective perception of the lessons by the teachers themselves. Maciulevičiene (2016) looks about teachers' views on their Physical Education lessons, the research group consists of teachers and their pupils. In general, teachers tend

to rate the lessons more positively than their students, especially in the areas of content variety and modern features. Teachers are more likely to believe that the content of the lessons corresponds to the needs of the students, rather than the latter. In this study, only 20% of students report that the teaching meets their needs. This reduces the need for students to play sports and be physically active at school and after school, which is the main goal of the general PE program. This factor has a significant influence on building a relationship to physical activity.

The value of the BMI index does not have a statistically significant effect on the relationship to Physical Education classes. However, the level of physical activity in the domain assessing the emotional relationship also has a statistically significant effect on the students' attitude towards Physical Education classes and in the overall score.

Pupils who do not engage in physical activities in their free time or engage in them recreationally have more positive attitudes towards Physical Education lessons, on the contrary, pupils who engage in a certain sport competitively have a negative attitude towards Physical Education lessons. We believe that competitive athletes are not linked to school Physical Education, because they are used to the load from sports training, which is somewhat different from Physical Education. In addition, it is likely that children are not willing to engage in any sport other than their own.

Another variable that statistically significantly affects the attitude of students to Physical Education classes is their health status. Post hoc analysis showed that adolescents who fall into the category of often ill have a more positive attitude towards Physical Education than adolescents who fall into the category of healthy. This finding contradicts the research of Zeng (2016), according to which Chinese students consider Physical Education as an important part of a healthy lifestyle. The same can be said for primary school pupils in Ireland. Wang's study (2019) contains similar results, adding to them the finding that boys have a more positive attitude towards PE than girls.

CONCLUSION

The aim of the study was to evaluate the relationship of pupils to school Physical Education and to find the variables that influence this relationship. This statement is confirmed by Antala's research (2012), in which he concludes that primary school pupils have a negative attitude towards Physical Education. Pupils who are not focused on performance perceive Physical Education more positively than pupils focused on performance. The teacher has several tools at his disposal to improve pupils' relationship with physical education. Our recommendation is to prepare a variety of hours with attractive content. It was at the time of the COVID-19 pandemic that many teachers prepared colorful activities with different content for children. The aim of these activities was to provide children with physical activity despite the inconvenient situation in society.

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Examination of Resilience and Self-esteem Levels of Parents of Children with Disability

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ABSTRACT

In society's foundational structure, families play a crucial role in overall happiness. Parental influence on child health is pivotal. While health challenges bring social, economic, and psychological burdens, resilience emerges as key. Resilience engages with self-esteem, benefiting parental well-being and care for special needs children, offering a positive environment for both. This study aims to explore the relationship between psychological resilience and self-esteem levels of parents of children with special needs, suggesting a positive link between elevated psychological resilience and self-esteem in parents. The study employed a relational scale strategy to investigate psychological resilience and self-esteem among parents of children with special needs. The sample comprised 156 parents of children with mild to moderate intellectual disabilities in Ankara, Turkey. Measures included the "Short Psychological Resilience Scale (SPRS)" and the "Rosenberg Self-Esteem Scale (RSS)." Data analysis encompassed descriptive statistics, t-tests, one-way ANOVA, Pearson's correlation, and Multiple Linear Regression analysis ($p<.05$). In the study's results, the data demonstrated normal distribution. Employed parents demonstrated higher SPRS and RSS scores compared to unemployed parents. While parents with children engaged in sports displayed higher scores, the difference wasn't statistically significant ($p>.05$). Parents' education level played a significant role; bachelor's degree holders had notably higher scores. Positive correlation was observed between SPRS and RSS scores ($r=.411$). Regression analysis confirmed a robust predictive relationship ($R2=.169$) between self-esteem and resilience. Raising special needs children requires elevated self-esteem and resilience due to multifaceted caregiving responsibilities. Traumatic experiences may impact self-esteem and resilience, prompting the need for a positive outlook for parental caregiving.

Keywords: Resilience; self-esteem; special education; disability; parenting

INTRODUCTION

The family, being one of the fundamental building blocks of society, plays a pivotal role in the overall happiness of society. Amidst various factors contributing to people's happiness, physical and mental well-being take precedence. Ensuring the health of individuals extends to their family members, relatives, and even their children, underlining its significance.

Parents play a predominant role in ensuring their child's health within the family (Callahan, et al., 1980; Ilhan, 2009). While the ideal scenario for parents is to witness their child being born and growing up in good health, the opposite situation can bring about numerous social and economic challenges, as highlighted by Callahan et al. (1980) and Isikhan (2005). Moreover, when a child faces health issues, parents grapple with the task of sustaining their child's life, which poses not only social and economic struggles but also physical challenges (Akozlu & Ekim, 2020). Additionally, these circumstances give rise to psychological burdens, emphasizing the significance of psychological resilience. This resilience becomes crucial in alleviating the hardships experienced by both parents and children with special needs (Damiani, 1999; Isikhan, 2005).

Various definitions of the concept of psychological resilience can be found in the literature. According to Holahan and Moos (1985), it involves the process of adapting to life in the face of both physiological and psychological challenges. In simpler terms, it is characterized as a personality trait that enhances individuals' ability to maintain a positive outlook when confronted with stressful life circumstances (Cencirulo, 2001; Luthar, Cichetti & Becker, 2000) and empowers them to effectively cope with stressors (Atkinson, et al., 1999; Bartone, et al., 2008).

Psychological resilience refers to an individual's ability to adapt, cope, and bounce back from adverse situations, challenges, and stressors, demonstrating emotional strength and maintaining well-being despite facing difficulties. It involves the capacity to recover from setbacks and maintain a stable psychological state. Resilience is not about avoiding stress or experiencing no negative emotions, but rather about effectively managing and recovering from them (Rutter, 2012). Self-esteem, on the other hand, refers to an individual's overall evaluation of their own worth, value, and competence. It involves beliefs and attitudes about oneself, encompassing aspects such as self-confidence, self-acceptance, and self-respect (Baumeister, Campbell, Krueger, & Vohs, 2003).

The relationship between psychological resilience and self-esteem is complex and interconnected. While they are distinct concepts, they often influence each other. Research (Baumeister et al., 2003) suggests that individuals with higher self-esteem tend to exhibit greater psychological resilience. When a person possesses a positive view of themselves, they might approach challenges with a sense of confidence and belief in their ability to overcome difficulties (Luthar & Cicchetti, 2000). This self-assuredness can contribute to their ability to adapt and bounce back from setbacks. On the other hand, having strong psychological resilience can also contribute to the development of healthy self-esteem. Individuals who are adept at managing stressors and setbacks are more likely to view themselves as capable and worthy, thus enhancing their self-esteem.

The robust levels of psychological resilience and self-esteem among parents play a pivotal role in protecting not only their personal well-being but also in care for their children with special needs. This stirred concept encompasses multifaceted risk factors that can destabilize mental

equilibrium and protective factors that uphold stability (Baldwin, Baldwin, & Cole, 1990). Research by Masten (1994) demonstrates that low self-esteem aligns with risk factors, whereas high self-esteem is intertwined with protective factors, as observed in the studies by Masten and Coatsworth (1998). Consequently, an individual's self-esteem profoundly shapes their psychological resilience, a trait exemplified in the "I" statements they use to define themselves (Oner, 2019). The positivity or negativity of these self-perceptions intricately affects self-esteem, thus underscoring the critical nature of elevated self-esteem and psychological resilience in parents. This significance transcends their own well-being, extending its impact to the compassionate care they provide for their children with special needs, fostering an environment conducive to positive outcomes for both parties.

This study hypothesizes that among parents of children with special needs, higher levels of psychological resilience and self-esteem will be positively associated with favorable independent variables, including employment status, higher perceived income level, higher education level, and active sports participation status of their children. The study expects to find a significant relationship between these independent variables and the dependent variables, indicating that parents' personal characteristics and their children's engagement in sports contribute to enhanced psychological resilience and self-esteem. When parents see their disabled children engage in sports and achieve milestones, they, possible, might experience a sense of accomplishment. Witnessing their children overcome challenges and make progress can boost parents' self-esteem and resilience.

METHOD

Study Model

In this study, which investigates the levels of resilience and self-esteem among parents of children with special needs, the relational scale strategy, a descriptive method aiming to establish relationships between two or more variables, was employed (Karasar, 2020, pp. 48).

To gather data, the researcher reached out to 10 special education and rehabilitation centers located in Ankara, Turkey, during 2021. When parents came to pick up their children with intellectual disabilities, the researcher approached them and invited them to voluntarily participate in the study. The parents took part in the study in person, and the process of filling out the scales took approximately 10 minutes.

Ethical Procedure

Permission was obtained from Gazi University Ethics Committee (05.04.2021/08) to conduct the study. Parents ethical consensus were provided.

Participants

The research sample for this study consists of parents of children with mild to moderate intellectual disabilities in Ankara, Turkey. A total of 156 parents participated in the study, including 132 mothers and 24 fathers. The parents' ages ranged from 22 to 57 years old, while their children with intellectual disabilities were primarily aged between 3 and 32 years. The research was conducted during the global Covid-19 pandemic in 2021, leading to a restriction on the number of participants. Only one parent from each family was allowed to participate in the study. Parents

were categorized based on their educational level, economic status, employment status, and their disabled children's involvement in sports (Table 1).

Instruments

The researchers employed the "Personal Information Form" to collect demographic information from the participants. This included details such as their parental status, employment status, perceived income level, parents' education level, and the involvement of parents' children with special needs in sports.

To assess the participants' levels of psychological resilience, the "Short Psychological Resilience Scale (SPRS)" was employed. The scale was originally developed by Smith et al. (2008) and adapted into Turkish by Dogan (2015). It consists of a single sub-dimension and comprises a total of 6 items, following a 5-point Likert scale. Reverse coding was applied to the 2nd, 4th, and 6th items within the scale to ensure response consistency. The scale's potential scores range from 6 (minimum) to 30 (maximum). The Cronbach's alpha (α) value was .82.

To measure the participants' self-esteem levels, the "Rosenberg Self-Esteem Scale (RSS)" was employed, which was introduced by Rosenberg in 1963. Turkish reliability and validity studies were carried out by Cuhadaroglu (1986), as reported in Tukus (2010). The scale consists of 10 items and follows a 4-point Likert scale. Reverse coding was applied to the 6th, 7th, 8th, 9th, and 10th items within the scale to ensure response consistency. The scale's potential scores range from 10 (minimum) to 40 (maximum). The Cronbach's alpha (α) value was .83.

Analysis and Interpretation of the Data

Statistical analysis of the data extracted from the inventories was conducted using Microsoft Excel and the SPSS 22.0 computer program. For the statistical analysis of the collected data, descriptive statistics including measures such as maximum, minimum, median, mean, and standard deviation were employed. Additionally, the Skewness and Kurtosis values were utilized to assess the normal distribution of the data. The Skewness and Kurtosis values for the RSS were observed to fall between -0.37 and -0.18, while for the SPRS, they ranged between -0.22 and 0.08. These values indicate that the data adhere to a normal distribution, as outlined by Tabachnick and Fidell (2013). In order to compare paired groups of variables, the t-test was employed. Furthermore, for comparisons involving three or more groups, one-way ANOVA was used to evaluate whether a statistically significant difference exists among the group means. Post-Hoc Tukey tests were then utilized to discern specific differences among sub-groups. In addition, Pearson's Product-Moment Correlation analysis was employed to ascertain the associations between resilience, self-esteem, and age of disabled children, while Multiple Linear Regression analysis was utilized to assess the predictive capacity of the independent variable (self-esteem) on the dependent variable (Psychological Resilience). The significance value for each conducted test was established at $p<.05$.

RESULTS

Table 1. Descriptive statistics of participants

Variable	Groups	f (156)	%	SPRS $\bar{x}$±sd	RSS $\bar{x}$±sd
Parents	Mother	132	84.6	19.33±4.05	30.74±5.30
	Father	24	15.4	21.54±4.23	32.41±4.19
***Employment Status**	Employee	51	32.7	21.23±4.44	32.45±5.33
	Unemployed	105	67.3	18.91±3.78	30.29±4.97
Perceived Income Level	Low	37	23.7	18.94±4.11	30.48±5.60
	Medium	112	71.8	19.70±4.10	31.05±5.02
	High	7	4.5	23.00±3.82	32.85±5.58
****Level of Education**	Secondary school	47	30.1	19.19±4.00	30.65±5.13
	High School	51	32.7	18.78±3.29	30.09±5.09
	Two-year Degree	18	11.5	19.83±4.40	29.72±5.99
	Bachelor's	40	25.6	21.30±4.79	33.12±4.44
Sports Participation Status of Parents' Children with Disabilities	Yes	59	37.8	20.33±3.76	31.30±5.62
	No	97	62.2	19.26±4.32	30.81±4.90

f: frequency, SPRS: Short Psychological Resilience Scale, RSS: Rosenberg Self-Esteem Scale, sd: Standard deviation, *Currently employment status of the parents, **Parents' education level.

In table 1, it can be observed that 32.7% of the parents participating in the research are employed, while 67.3% are unemployed. Among the parents, 32.7% have a high school education, 30.1% have completed secondary school, 25.6% have a bachelor's degree, and 11.5% have a two-year degree. In terms of recreational activities, 37.8% of parents with special children participate for at least 5 hours a week, while 62.2% do not.

Table 2. SPRS and RSS scores of participants

	SPRS Scores*	RSS Scores**
Minimum	7	16
Maximum	30	40
Median	20	35
Mean	19.67	36
Standard deviation	4.14	5.17

*Short Psychological Resilience Scale,
**Rosenberg Self-Esteem Scale

The scores of parents of children with special needs who participated in the study ranged from 7 to 30 on the SPRS, with an average score of 19.67±4.14. The scores obtained by parents of children with special needs who participated in the study on the RSS ranged from 16 to 40, and the average score was found to be 36±5.17.

Table 3. Comparison of SPRS and RSS total scores in relation to parents' employment status

Scales	Groups	n	Mean	sd	t	p*
SPRS	Employee	51	32.45	5.33	2.481	0.014*
	Unemployed	105	30.29	4.97		
RSS	Employee	51	21.23	4.44	3.389	0.001*
	Unemployed	105	18.91	3.78		

*p<0,05, SPRS: Short Psychological Resilience Scale, RSS: Rosenberg Self-Esteem Scale, n: Sample size, sd: Standard deviation, t: t-value, p: Reliability co-efficient.

When the t-test was conducted based on the parents' employment status variable, as presented in Table 3, it was determined that working parents (n=51) scored higher than non-working parents (n=105) in terms of the total scores obtained from SPRS and RSS. This difference is statistically significant.

Table 4. Comparison of SPRS and RSS total scores in relation to children's sports participation status as perceived by parents

Scales	Children's Participation in Sport	n	Mean	sd	t	p
SPRS	Yes	59	31.30	5.62	0.573	0.568
	No	97	30.81	4.90		
RSS	Yes	59	20.33	3.76	1.572	0.118
	No	97	19.26	4.32		

SPRS: Short Psychological Resilience Scale, RSS: Rosenberg Self-Esteem Scale, n: Sample size, sd: Standard deviation, t: t-value, p: Reliability co-efficient.

Based on the variable of participation in sports as presented in table 4, a t-test was conducted to analyze the total scores of children with special needs obtained from SPRS and RSS. The results indicated that the total scores of parents (n=59) whose children with special needs engage in sports were higher than those whose children do not participate in sports (n=97), although this difference was not statistically significant.

Table 5. Comparison of SPRS and RSS total scores according to parents' education levels

Scales	Groups	n	Variance Source	Ss	df	Mean Square	F	p
SPRS	Secondary school	47	Intergroup	256.951	3	85.650	3.342	0.021*
	High school	51						
	Two-year degree	18	Intragroup	3895.049	152	25.625		
	Bachelor's	40						
RSS	Secondary school	47	Intergroup	157.523	3	52.508	3.184	0.026*
	High school	51						
	Two-year degree	18	Intragroup	2506.804	152	16.492		
	Bachelor's	40						

SPRS: Short Psychological Resilience Scale, RSS: Rosenberg Self-Esteem Scale, n: Sample size, Ss: Sum of squares, df: Degrees of freedom, F: F-test value, p: Reliability co-efficient.

The total scores obtained from SPRS and RSS, categorized by the parents' education level as presented in table 5, were analyzed using the One-way ANOVA test. The results revealed a significant difference between the groups. To identify the specific groups where the difference existed, the post-hoc Tukey test was employed, as indicated in table 6.

Table 6. Comparison of SPRS and RSS total scores according to parents' education levels

Scales	Groups	Mean	Mean Difference	Standard Error	p*
SPRS	High School	30.09	-2.515	0.857	0.02*
	Bachelor's	33.12			
RSS	High School	18.78	-3.026	1.069	0.027*
	Bachelor's	21.30			

*p<0,05, SPRS: Short Psychological Resilience Scale, RSS: Rosenberg Self-Esteem Scale, p: Reliability co-efficient.

Table 6 displays the results of the post-hoc Tukey test, which was utilized to investigate the groups exhibiting differences in the total scores obtained from SPRS and RSS based on the educational status of parents with children with special needs. The analysis revealed that the difference in total scores obtained from SPRS and RSS between the secondary education group (n=51) and the bachelor's degree group (n=40) favored parents with bachelor's degrees (p<0.05).

Table 7. Comparison of SPRS and RSS total scores according to parents' income levels

Scales	Groups	Variance Source	Ss	df	Mean Square	F	p
SPRS	Low Medium High	Intergroup	97.158	2	48.579	2.895	0.058
		Intragroup	2567.169	153	16.779		
RSS	Low Medium High	Intergroup	34.221	2	17.111	0.636	0.531
		Intragroup	4117.779	152	26.914		

SPRS: Short Psychological Resilience Scale, RSS: Rosenberg Self-Esteem Scale, Ss: Sum of squares, df: Degrees of freedom, F: F-test value, p: Reliability co-efficient.

Upon analyzing the total scores obtained from SPRS and RSS based on the income level variable of parents, as presented in table 7, the One-way ANOVA test was conducted. However, no significant difference was observed between the groups.

Table 8. Pearson correlation analysis

		SPRS	RSS	Children's age
SPRS	r	1	.411	.036
	p		.000*	.654
	n	156	.156	156
RSS	r	.411	1	.003
	p	.000*		.965
	n	.156	.156	.156
Children's age	r	.036	.003	1
	p	.654	.965	
	n	156	.156	156

*p>0,001, r: Correlation, n: Sample size, SPRS: Short Psychological Resilience Scale, RSS: Rosenberg Self-Esteem Scale

Table 8 displays the correlation analysis between the scores obtained from SPRS and RSS of parents with children with special needs who participated in the study. The correlation analysis revealed a moderately positive correlation between the scores obtained from both scales by the participants. However, it has been found that the age of disabled children is not correlated with psychological resilience and self-esteem.

Table 9. Investigation of the Prediction Power of Self-Esteem Levels of Parents with Children with Intellectual Disability in Psychological Resilience

Dependent Variable	Independent Variable	Beta	t	p	F	Model (p)	R^2
Psychological Resilience	**Stable**	9.474	5.122	.000	31.247	.000*	.169
	Self-esteem	.329	5.590	.000			

*p<0.001, t: t-value, F: F-test value, p: Reliability coefficient. R^2: Coefficient of determination.

Table 9 presents the results of the regression analysis conducted to ascertain the causal relationship between the psychological resilience and self-esteem levels of parents with children with special needs. The analysis revealed a statistically significant relationship (F=31.247; p<0.001). Additionally, it was observed that the predictive power of self-esteem on resilience is robust (R2=0.169). This implies that each unit increase in self-esteem is associated with a 0.329-unit change in resilience.

DISCUSSION

The correlation analysis yielded a positive association between the psychological resilience and self-esteem levels among parents of children with special needs. Therefore, the findings of this study align with existing literature (Hayter & Dorstyn, 2014; Karaman, 2018; Liu, et al., 2014; Marti, 2016).

The study revealed that the psychological resilience and self-esteem levels of working parents with special needs children were notably higher than those of non-working parents, and this difference exhibited statistical significance. The elevated levels of psychological resilience and self-esteem among working parents with special needs children can be attributed to the fact that their children are engaged in activities outside the home environment, even if only briefly, which can provide a respite from the demanding emotional and physical caregiving responsibilities. In this regard, it's worth noting that certain studies in the literature present opposing findings to the current research. In investigations conducted by Bildirici (2014) and Celebi (2021), it was deduced that the employment status of participants did not exert an influence on their levels of psychological resilience. These discrepancies emphasize the complexity of these relationships and signal the necessity for an exhaustive understanding of the multifaceted dynamics at play in the lives of parents navigating the realm of special needs caregiving.

The study's analysis of the income level variable revealed that there were no noteworthy differences in the overall scores of participants categorized by low-, middle-, and high-income levels concerning psychological resilience and self-esteem ($p>0.05$) within the context of parents with special needs children. Consequently, the research concluded that the income level of these parents did not exert a significant influence on their psychological resilience and self-esteem. This conclusion is substantiated by similar research conducted by Sayilan et al. (2020) and Yazicioglu & Uluagli (2020), which found no correlation between participants' income levels and self-esteem, as well as by Kimter's (2020) study, which also indicated that income level did not impact psychological resilience. However, it is worth noting that contrasting results exist in the literature, as studies like those by Bildirici (2014), Yilmaz, Esenturk, Ulas & Ilhan (2017), Yagmur & Turkmen (2017), Gunes (2020), and Kurt & Arslan (2020) identified significant discrepancies concerning income level's association with self-esteem and psychological resilience.

In relation to the education level variable, an investigation was carried out to determine whether the total scores of participants with primary, secondary, associate, undergraduate, and graduate education differed significantly in terms of SPRS and RSS. The analysis revealed that parents with bachelor's degrees had higher total scores (SPRS=21.30, RSS=33.12) compared to parents with a high school degree (SPRS=18.78, RSS=30.09), and this disparity was statistically significant. This outcome finds support in existing literature (Li, et al., 2014; Marti, 2016). In the study conducted by Kurt & Arslan (2020), it was observed that participants with higher education levels exhibited higher total psychological resilience scores than those with secondary and high school education levels, and this distinction was statistically significant. Yagmur & Turkmen (2017) discovered that individuals who received education beyond high school demonstrated higher levels of psychological resilience compared to those who halted their education after high school, and this variance was statistically significant. In Bildirici's study (2014), a significant difference in psychological resilience was noted concerning education levels. The heightened ability for accurate self-reflection and coping with stressful situations due to higher education levels may be factors contributing to the elevated levels of psychological resilience and self-esteem. Notably, studies by Karal & Bicer (2020), Kimter (2020), and Celebi (2021) established that the education level of participants did not influence their psychological resilience.

The total scores derived from the SPRS and RSS for parents whose children with special needs engage in sports are greater than those for parents whose children with special needs do not participate in sports. Nevertheless, this disparity lacks statistical significance. In the available literature, we could not identify any research that either supports or contradicts this finding. According to Ilhan (2010a), parents of children with special needs reported that their children's engagement in sports activities could potentially offer psychological solace to the parents. Conversely, parents whose children with special needs partake in sports might have elevated their levels of psychological resilience and self-esteem, given that their children's enjoyment and mental relaxation through sports participation could positively impact them. Parents often play a crucial role in supporting their children's sports participation. Seeing their children succeed and enjoy sports fosters a sense of shared success and achievement, leading to positive emotions and increased self-esteem. The involvement of disabled children in sports can empower parents as

they witness their children develop new skills and abilities. This empowerment extends to parents' belief in their own ability to handle challenges, enhancing their psychological resilience. Sports involvement can facilitate positive interactions between parents and their disabled children. These moments of connection and shared experiences contribute to emotional well-being, fostering resilience in parents. The joy and excitement of watching their children participate in sports can serve as a stress-relieving outlet for parents. Engaging in these activities provides a break from caregiving responsibilities and promotes relaxation.

Upon conducting a simple linear regression analysis to ascertain the extent to which parents' self-esteem levels predict resilience in parents of special needs children, it was revealed that indeed, parents' self-esteem levels are predictive of resilience. In other words, as parents of children with special needs experience an increase in their self-esteem levels, their psychological resilience also sees an uptick. This pattern aligns with similar findings from studies by Veselska et al. (2009) with adolescents and Sanci & Ucar (2021) with women in the textile sector. Karairmak & Cetinkaya (2011) investigated the effects of self-esteem and locus of control on psychological resilience in individuals who had experienced the Marmara earthquake in Turkey on August 17, 1999, known for its significant traumatic impact. Their research also mirrored our current study's results, indicating that higher self-esteem scores corresponded to higher psychological resilience levels. In parallel, Arslan (2015) likewise discovered a predictive link between self-esteem and psychological resilience. However, it's worth noting that there are also studies in the literature that have yielded opposing conclusions. For instance, Bompus (2014) examined the racial identity, psychological resilience, and self-esteem of participants, focusing on adopted Afro-American individuals. This research revealed a negative predictive relationship between self-esteem and psychological resilience.

During the data collection process, a parent of a child with special needs was observed making the following statement: "The parent, upon reading some of the items in the psychological resilience scale, began to answer the questions while vocalizing their thoughts. Upon completing the scales, they remarked, 'Naturally, I must maintain good psychological well-being in order to fulfill my child's needs. If it weren't for me, no one else would attend to my disabled child's requirements.' Based on the outcomes of the present study and this illustrative situation, it becomes evident that raising children with special needs necessitates parents to uphold elevated levels of self-esteem and psychological resilience, alongside sustaining their motivation. This is crucial, given that parents attend to every facet of their children's requirements, ranging from nourishment and healthcare to education and social interaction. By effectively managing these variables, parents can tend to their own needs in parallel with those of their children with special needs."

Considering the outcomes of these studies, it becomes evident that the self-esteem and psychological resilience of individuals who have undergone traumatic experiences could be impacted by such events, potentially diminishing their overall quality of life. The inherent drive within the human organism to maintain a state of psychological and physiological equilibrium compels us to seek solutions for returning to a sense of normalcy, irrespective of the consequences associated with the events encountered. Especially following impactful events that we have been exposed to, it remains imperative to uphold a positive outlook, both for our own well-being and

for effectively fulfilling our responsibilities toward those in our vicinity. In this regard, the reality that parents of children with intellectual disabilities assume the majority of caregiving duties necessitates the cultivation of psychological resilience.

CONCLUSION

This study involved parents of children with mild to moderate intellectual disabilities. By encompassing a diverse group of parents who care for individuals with varying degrees of physical, mental, and emotional differences, it becomes possible to ascertain the underlying motivations that drive parents in tending to their children with special needs. Furthermore, this approach allows for an exploration of the connections between their psychological resilience, self-esteem levels, and caregiving responsibilities.

The percentage of parents (n=97) whose children did not participate in sports in the current study is 62.2%. The significance of involving individuals with special needs in sports has been underscored in numerous studies (Darcy, Lock & Taylor, 2017; Kiuppis, 2016; Koparan, 2003; Ilhan, 2010b). Initiatives to promote the engagement of children with special needs in sports should be encouraged within special education and rehabilitation centers, as well as special education schools. The endeavor of children with special needs to enhance their communication with their parents through sports (Yarimkaya, Esenturk & Ilhan, 2020) and their determination to embrace life and adapt to society despite their unique circumstances can contribute to parents' increased selflessness and motivation in providing care for their children. It is crucial to investigate the factors that hinder the participation of children with special needs in sports and, if identified, take steps to eliminate these barriers. Efforts should be made to facilitate and maximize the involvement of children with special needs in sports activities.

The extensive responsibility that parents bear for the care of their children with special needs can lead to their limited participation in social and educational activities. To address this issue, providing substantial support from relevant institutions can enable parents to allocate time for personal growth through social and educational endeavors. Organizing training sessions for parents of individuals with special needs holds significance in helping them cope with these challenges psychologically and become more effective caregivers. Collaborative efforts between responsible organizations, including municipal initiatives, social institutions, universities, and government, can facilitate the implementation of such activities.

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