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ANALYSIS OF PEAK POWER OUTPUT, LOWER LIMB EXPLOSIVE STRENGTH AND BALANCE PERFORMANCE OF YOUNG FOOTBALL PLAYERS ACCORDING TO THEIR PLAYING POSITION: A PILOT STUDY

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Analiza szczytowej mocy wyjściowej, eksplozywnej siły kończyn dolnych i równowagi młodych piłkarzy w zależności od pozycji gry: badanie pilotażowe

Streszczenie

Promowanie wysokiego poziomu siły, mocy i kontroli postawy w określonych pozycjach gry ma kluczowe znaczenie w całej fazie dojrzewania u młodych piłkarzy. W badaniu tym zbadano moc szczytową, siłę eksplozywną kończyn dolnych i zachowanie równowagi wśród młodych piłkarzy na różnych pozycjach gry. W badaniu wzięło udział czterdziestu trzech młodych piłkarzy (wiek: 15,81 ±1,33 lat), podzielonych na cztery pozycje: 5 bramkarzy, 12 obrońców, 20 pomocników i 6 napastników. Zaobserwowano istotne różnice w szczytowej mocy wyjściowej pomiędzy grającymi na pozycjach ($p = 0,003$, $\eta^2 = 0,226$), z przewagą napastników nad pomocnikami ($p = 0,011$). Jednakże nie stwierdzono żadnych znaczących rozbieżności w charakterystyce skoku pionowego. Stwierdzono różnice w charakterystyce równowagi statycznej średniej prędkości środkowo-bocznej (AAPS) dla nogi niedominującej i dominującej ($p = 0,025$, $\eta^2 = 0,211$; $p = 0,033$, $\eta^2 = 0,198$),

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przy niższej prędkości kołysania u bramkarzy (p = 0,022) w porównaniu z napastnikami (p = 0,040). Jednakże badanie nie wykazało znaczących różnic w innych charakterystykach działania wagi statycznej ani równowagi dynamicznej. Podsumowując, badanie podkreśla znaczące różnice w szczytowej mocy wyjściowej w zależności od pozycji gracza, ale nie w przypadku siły eksplozywnej kończyn dolnych i zachowania równowagi pomiędzy grupami.

Słowa kluczowe: moc szczytowa, skok pionowy, równowaga statyczna i dynamiczna, piłka nożna.

Abstract

Promoting a high level of strength, power, and postural control in specific playing positions is crucial throughout the puberty phase in young football players. This study explored peak power, lower limb explosive strength, and balance performance among youth football players across their playing positions. Forty-three young male football players (age: 15.81±1.33 years) participated, categorized into four positions: 5 goalkeepers, 12 defenders, 20 midfielders, and 6 forwards. Significant differences were observed in peak power output among playing positions ($p=0.003$, $\eta^2=0.226$), with forwards superior over midfielders ($p=0.011$). However, no meaningful disparities were found in vertical jump characteristics. Variations in center of body pressure sway speed medial-lateral direction were identified for nondominant and dominant leg ($p=0.025$, $\eta^2=0.211$; $p=0.033$, $\eta^2=0.198$), with the lower sway speed in goalkeepers ($p=0.022$) in comparison with forwards ($p=0.040$). However, the study found no significant differences in the other characteristics of static balance performance, nor in the dynamic balance. In conclusion, the study emphasizes significant variations in peak power output across player positions but not for lower limb explosive strength and balance performance among groups.

Keywords: peak power, vertical jump, static and dynamic balance, football.

Introduction

Strength, power, and endurance play a significant role in performing sprinting, passing, shooting, jumping, and changing direction throughout a football game (Helgerud et al., 2011; Malina et al., 2024; Martinho et al., 2024). Power and strength development are important for improving the physical performance of young footballers (Barbalho et al., 2018; França et al., 2024). Moreover, enhancing youth football players' physical and physiological performance is emphasized according to their playing position (Joo & Seo, 2016; Toselli et al., 2022).

The evaluation of anaerobic performance has been extensively used to assess short-term power action (Cossio-Bolaños et al., 2021; Gross & Lüthy, 2020; Haugen et al., 2013; Ostojić et al., 2010). It contributed to repeated sprinting, jumping, shooting, and dueling against the opponent, known as short-burst activity. Development of power for a short period of time is a fundamental aspect of the young's physical capacity that increases during growth and maturation (Baker & Davies, 2002). The vertical jump is a test frequently employed for estimating the strength and power of the inferior limb (Rodríguez-Rosell et al., 2017; Chamari et al., 2004) and impulsive ability. It has also been used to evaluate physical performance in young football players (Petridis et al., 2019; Rodríguez-Rosell et al., 2017). The cycling ergometer test evaluated peak power output by the six-second peak power test (Herbert et al., 2015; Wehbe et al., 2015), and the Wingate test investigated the short-term strength endurance of young players' leg muscles (Nikolaidis & Knechtle, 2021; Nikolaidis et al., 2016).

Balance performance is the capacity to maintain a support base with restricted movement while doing tasks in a steady postural stance (Bressel et al., 2007). In football, balance plays a crucial role in enhancing the technical skills of players (Evangelos et al., 2012; Teixeira et al., 2011) and injury prevention, particularly in adolescent football players (Bressel et al., 2007; Malliou et al., 2004; Teixeira et al., 2011). Paillard et al. (2019), Pau and Attene (2014) confirmed that football players' balance ability is strongly linked to maturation and the level of playing experience.

A great number of research articles on football players' playing positions (AlTaweel et al., 2022a; Bortnik et al., 2024; Harry et al., 2018; Jadczak et al., 2019; Mahmoudi et al., 2023) have been examined to analyze physiological performance and motor skills in football players. However, peak power production, lower body explosive strength, and static and dynamic balance performance characteristics have not been investigated on a wide scale in adolescent unmatured footballers playing in different positions. Therefore, the objective of this study was to examine the differences in anaerobic power production, explosive strength of the lower body, and static and dynamic balance based on player position. We hypothesized that young players would have smaller peak power production, explosive strength, and balance variations based on their playing position than adult footballers.

Methods and Materials

Subjects

Forty-three young male football players (age = 15.81±1.33 years) from various football clubs, who attended regular training sessions and competitions at the weekends, were selected for this study. The players had less than eight years of experience in football training. The maturation of the adolescent players was estimated using the Tanner method (Beunen et al., 1992) by the physician, only participants classified as Tanner stage 3 – 4 were included in the investigation. The players were classified into four groups according to playing positions: Goalkeepers (GK) (N=5, body height 185.42±2.20, body mass=76.20±9.85), Defenders (D) (N=12, body height 182.48±2.20, body mass=73.70±4.73), Midfielders (MD) (N=20, body height 174.89±5.03, body mass=63.77±6.92), Forwards (F)

(N=6, body height 184.00±3.69, body mass=75.28±12.25). None of the participants has experienced injury in the previous six months. Parents and participants were briefed on the study's protocols, risks, and advantages. The parents submitted the informed consent form to allow their sons to participate in the study. The research that pertains to human use has followed all pertinent national regulations and institutional policies, adhered to the principles of the Declaration of Helsinki, and was approved by the Ethics Committee of the Latvian Academy of Sport Education (Meeting Protocol No. 6, decision No. 1/51813 of February 24, 2023).

Data Collection

Before the tests, the participants engaged in warm-up sets for approximately 30 minutes, involving jogging and dynamic stretching. Anthropometric assessments of young football players wearing briefs were performed using SECA 220 for height measurement with an accuracy of up to 1 mm and SECA 874 for weight measurement with an accuracy of up to 0.05 kg (SECA, Hamburg, Germany). Body mass index (BMI) was calculated as weight in kilograms (kg) divided by the square of height in meters (m^2).

All devices and platforms used in this research have demonstrated validity and reliability in measuring peak power output on bicycle ergometer (Herbert et al., 2015; Wehbe et al., 2015), short-term strength endurance on bicycle ergometer (Nikolaidis & Knechtle, 2021; Nikolaidis et al., 2016), vertical jump for muscle strength and power investigation (Bellicha et al., 2022; Attia et al., 2017) and static and dynamic balance (Srishti et al., 2023). With a flying start, the six-second peak power test was performed using a cycling ergometer (Wattbike Pro, Nottingham, UK). The Wattbike was 'zeroed' before the testing to ensure reliability by the manufacturer's recommendations. Initially, the players selected saddle height and handlebar position based on their preferences. The Wattbike test guide recommended body mass-based resistance levels. The WattBike Pro cycle ergometer's performance computer calculated power via a load cell located next to the chain. As force is exerted through the cranks, the load cell calculates power by the sum of all forces applied during one complete pedal revolution. After completing the test, the power output in Watts (W) shown on the WattBike monitor is calculated using the following equation: $P(W)=(F[N]*1[m])/T[s]$, where F -the forces applied in N multiplied by the distance covered in meters (m) and divided by the time T in seconds (s). Peak power (W), mean power (W), relative peak power (W/kg), and distance completed (m) throughout the six-second WattBike test were recorded. Before starting the test, the participants could pedal for 20 to 30 seconds without any load. Subsequently, an investigator raised the resistance to the chosen level, then the subjects pedaled as strong as possible during six-seconds. The participants were encouraged verbally to exert maximal effort. Throughout testing, the investigator stabilized the Wattbike to prevent ergometer shifting (Herbert et al., 2015; Hopker et al., 2010).

The vertical jump was widely used in health care and athletes to measure lower limb muscle strength and power (Vanegas et al., 2021). The subjects' arms were allowed to move freely during the vertical jump assessment (Petrigna et al., 2019). The players start a countermovement and jump maximally in one motion after a verbal command. The best jump test result (the highest jump) was used for analysis after three jump trials, one minute of passive recovery was given between each trial of jumps. An **Optojump (Microgate, Srl., Bolzano, Italy)** measured jump height and time flight, and a force plate **BTSP-6000 (BTS Bioengineering, Garbagnate Milanese, Italy)** measured the peak force.

The subjects stood on the balance platform **ProKin 252 stabilometry platform (TecnoBody, Dalmine, Italy),** accurately measuring pressure sway in all directions. The participants were instructed to keep balance in a one-leg stance, concentrate on a screen for thirty seconds, set hands on their hips and the opposite leg at a 45-degree knee flexion. A smaller perimeter length of the center of pressure movements' area indicated better static balance (Donath et al., 2012). The body center of pressure which sways an ellipse area (mm^2) is a well-defined elliptical form encompassing at least 90% or 95% of the chaotic sway lines. Smaller ellipse areas indicated better balance (Asseman et al., 2004). The ProKin 252 stabilometric platform also assessed the dynamic balance ability as a total stability index and the trunk deviation angle in degrees**.** The total stability index was categorized as normative for trained subjects with a value of 0 – 0.83, normal for nonathletes between 0.84 and 2.32, and poor postural control if it exceeded 2.33. A greater score of the total stability index and the trunk deviation angle meant a worse sense of trunk position (Toprak Celenay et al., 2019).

Statistical Analysis

The statistical analyses were performed using SPSS version 26.0 for Windows, developed by SPSS Inc. in Chicago, IL, USA. Shapiro-Wilk's and Levene's test of equality of error variances ($p > 0.05$) verified that the data was normal and homogent. The variable did not follow a normal distribution; the Kruskal-Wallis H test was performed to compare peak power output, explosive strength of the lower limb, and balance characteristics based on the subjects' playing position. Multiple comparisons used Post hoc Dunn's tests when groups were significantly different. Eta-squared (η^2) was used to calculate the effect sizes: 0.01 small, 0.06 medium, and 0.14 large (Richardson, 2011).

Results

Table 1 shows that the goalkeepers were the tallest among all outfield positions compared to the other groups (185.42 ± 2.20 cm, p=0.00). Furthermore, the forwards demonstrated greater body mass (76.20 ± 9.85 kg) compared to the defenders (63.77 ± 6.92 kg), the midfielders (63.77 ± 6.92 kg), and the strikers (75.28 ± 12.25 kg), p = 0.000. Nevertheless, there were no disparities in BMI and age among all outfield positions, as indicated by p-values of 0.263 and 0.203, respectively.

Table 1
Anthropometric characteristics of the football players based on their playing positions

Parameters	Players	Mean	Std. Deviation	95% confidence interval for mean		p-value	eta-square (η^2)
				Lower Bound	Upper Bound		
Height (cm)	GK	185.42	2.20	182.69	188.15	0.000*	0.523
	D	182.48	4.12	179.86	185.09		
	MD	174.89	5.03	172.53	177.24		
	F	184.00	3.69	180.13	187.87		
Weight (kg)	GK	76.20	9.85	63.97	88.43	0.000*	0.373
	D	73.70	4.73	70.70	76.70		
	MD	63.77	6.92	60.54	67.01		
	F	75.28	12.25	63.43	89.14		
BMI (kg/m²)	GK	22.17	2.89	18.59	25.75	0.263	0.096
	D	22.14	1.19	21.39	22.89		
	MD	20.85	2.15	19.85	21.86		
	F	22.54	3.64	18.72	26.35		
Age (years)	GK	16.40	1.14	14.98	17.82	0.203	0.110
	D	16.33	1.61	15.31	17.36		
	MD	15.45	1.19	14.89	16.01		
	F	15.50	1.05	14.40	16.60		

Abbreviation: BMI = Body Mass Index, GK (Goal Keeper), D (Defender), MD (Midfielder), F (Forward).
Notes: * Significant difference among the players' positions (p= < 0.05)

Table 2 exhibits a significant comparison of anaerobic peak power production based on the subjects' playing positions ($p=0.018$, $\eta^2=0.226$). However, cadence peak and time to peak did not differ significantly among the groups. The post hoc Dunn test demonstrated considerable disparities in peak power characteristics between the forwards and the midfielders (p=0.011). However, no distinctions were observed among the other groups regarding peak power output. Moreover, Table 2 indicates no statistically significant differences in jump height, flight time, and peak force in vertical jump performance among the players in different positions.

Table 2

The six-second peak power output and explosive strength of lower limbs determined by a counter-movement jump in young football players

6s cycling sprint	**Position**	**Mean**	**Std. Deviation**	**95% confidence interval for mean**		**p- value**	**Eta- square (η²)**
				Lower Bound	Upper Bound		
PPO (W)	GK	855	46.24	797.57	912.42	0.003*	0.226
	D	816.75	109.65	747.08	886.41		
	MD	690.54	198.97	597.42	783.66		
	F	885.83	77.18	804.82	966.83		
CP(Rpm)	GK	151.6	14.94	133.04	170.15	0.904	0.009
	D	150.91	10.16	144.45	157.37		
	MD	152.55	14.54	145.74	159.35		
	F	154.83	14.51	139.6	170.06		
TP(s)	GK	1.59	0.99	0.35	2.83	0.782	0.053
	D	1.34	0.65	0.93	1.76		
	MD	1.33	0.6	1.05	1.61		
	F	1.78	1	0.72	2.84		
Vertical jump	Position	Mean	Std. Deviation	95% confidence interval for mean		P value	Eta- square(η²)
				Lower Bound	Upper Bound		
JH (cm)	GK	42.84	2.56	39.66	46.02	0.316	0.055
	D	40.27	5.19	36.97	43.56		
	MD	39.37	5.98	36.57	42.17		
	F	38.63	2.81	35.68	41.58		
TF (s)	GK	0.59	0.02	0.57	0.61	0.272	0.070
	D	0.57	0.04	0.55	0.6		
	MD	0.57	0.04	0.55	0.59		
	F	0.56	0.02	0.53	0.58		
PF (N)	GK	1850.14	222.01	1574.48	2125.8	0.111	0.175
	D	1824.36	270.82	1652.29	1996.43		
	MD	1571.48	270.38	1444.93	1698.02		
	F	1819.3	439.45	1358.12	2280.48		

Abbreviation: PPO (Peak power output), CP (cadence peak), TP (Time to peak), W (watt), Rpm (Revolution per minutes, JH (Jump height), TF (Time flight), PF (Peak force), cm (centimeters), s (Seconds), N (Newton). Notes: * Significant difference among the players' positions ($p= < 0.05$)

Table 3 shows that a minor difference was observed in the average medial-lateral speed parameter (AMLS) between the nondominant leg ($p=0.025$, $\eta^2=0.211$) and the dominant leg ($p=0.033$, $\eta^2=0.198$) based on the players' positions. In addition, Dunn's posthoc test identified disparities between the goalkeepers and the forwards in their non-dominant leg ($p=0.022$) and dominant average medial-lateral speed ($p=0.040$). However, characteristics of static balance: a center of body pressure deviations ellipse area (EA), perimeter (P), and average Anterior – Posterior speed (AAPS) exhibited no significant differences among the players across playing positions. No statistical significance was identified in assessing the dynamic balance of the young football players in unipedal stances based on their positions.

Table 3
Static and dynamic balance characteristics in unipedal stance among the groups of football players

Static Balance	Position	Mean	Std. Deviation	95% confidence interval for mean		P value	Eta-square (η^2)
				Lower Bound	Upper Bound		
EA (mm^2) ND	GK	860.4	214.96	593.49	1127.3	0.324	0.109
	D	743.22	320.5	539.58	946.85		
	MD	847.02	401.06	659.32	1034.72		
	F	1172.82	593.81	549.65	1795.99		
EA (mm^2) D	GK	985.62	331.99	573.4	1397.84	0.456	0.042
	D	823.11	221.02	682.68	963.53		
	MD	896.3	432.26	694	1098.6		
	F	1034.64	254.33	767.73	1301.54		
P (mm) ND	GK	1215.62	190.36	979.26	1451.99	0.171	0.171
	D	1476.71	369.31	1242.06	1711.35		
	MD	1596.23	520.65	1352.56	1839.91		
	F	2036.29	793.06	1204.02	2868.56		
P (mm) D	GK	1369.26	235.62	1076.7	1661.82	0.423	0.089
	D	1639.68	509.22	1316.14	1963.22		
	MD	1584.23	454.16	1371.68	1796.78		
	F	1923.35	666.94	1223.44	2623.26		
AAPS (mm/s) ND	GK	24.18	3.24	20.16	28.2	0.406	0.09
	D	29.33	8.06	24.21	34.45		
	MD	31.89	11.9	26.33	37.46		
	F	36.87	17.25	18.76	54.98		
AAPS (mm/s) D	GK	26.24	5.34	19.61	32.87	0.307	0.102
	D	32.34	9.25	26.46	38.22		
	MD	29.46	9.46	25.03	33.88		
	F	37.32	13.7	22.94	51.69		

Table 3

Static and dynamic balance characteristics (*cont.*)

Static Balance	**Position**	**Mean**	**Std. Deviation**	**95% confidence interval for mean**		**P value**	**Eta-square (η^2)**
				Lower Bound	Upper Bound		
AMLS (mm/s) ND	GK	27.29	5.34	20.66	33.92	0.025*	0.211
	D	32.94	9.05	27.19	38.69		
	MD	35.43	10.65	30.44	40.41		
	F	47.21	17.02	29.34	65.08		
AMLS (mm/s) D	GK	31.37	5.94	23.99	38.75	0.033*	0.198
	D	36.77	13.11	28.44	45.1		
	MD	36.77	9.97	32.11	41.44		
	F	52.29	20.5	30.78	73.81		
Dynamic Balance	Position	Mean	Std. Deviation	95% confidence interval for mean		p value	Eta-square (η^2)
				Lower Bound	Upper Bound		
TSI (^{0}) ND	GK	2.57	0.87	1.5	3.65	0.571	0.047
	D	2.18	0.73	1.72	2.64		
	MD	2.33	0.83	1.94	2.72		
	F	2.67	0.66	1.98	3.36		
TSI (^{0}) D	GK	2.7	1.25	1.14	4.25	0.619	0.027
	D	2.37	1.01	1.73	3.01		
	MD	2.23	0.91	1.81	2.66		
	F	2.4	0.43	1.95	2.85		
TTD (^{0}) ND	GK	2.01	0.8	1.02	3.01	0.168	0.12
	D	3.43	2.61	1.77	5.09		
	MD	2.31	1.35	1.68	2.94		
	F	3.86	2.47	1.27	6.45		
TTD(^{0}) D	GK	3.29	2.53	0.15	6.43	0.483	0.06
	D	3.03	2.43	1.49	4.57		
	MD	2.28	1.85	1.41	3.14		
	F	3.62	2.04	1.48	5.76		

Abbreviation: EA (Ellipse area), P (Perimeter), AAPS (Average Anterior – Posterior speed), AMLS (Average Medial – Lateral speed), TSI (Total Stability Index), TTD (Trunk Total Deviation), (0) (Degree). ND (Nondominant leg), D (Dominant leg)

Notes: *. Significant difference among the players' positions ($p = < 0.05$)

Discussion

The study purposed to compare peak power output, explosive strength of the lower limb, and balance performance across football player positions. Prior research has emphasized variations in anthropometric characteristics among football players depending on their specific positions (Slimani & Nikolaidis, 2019; Towlson et al., 2017). Our data research indicated that the goalkeepers had the highest average height and body mass in comparison to other groups' positions (AlTaweel et al., 2022; Bujnovsky et al., 2019; Leão et al., 2019). Nevertheless, the adolescent football players presented significant differences in body composition and physique compared to adult players. Effect size revealed that age and body mass index had a small effect on alactic anaerobic profile for all groups, confirming no significant differences among football players in all positions (Nikolaidis et al., 2014; Nikolaidis et al., 2021).

The peak power output was based on the maximum force value and its rate of production, which were influenced by the growth and maturation of adolescent athletes (Armstrong et al., 2001; Bar-Or & Rowland, 2004; Nobari et al., 2023). Our findings revealed that the forwards exhibited the highest, but the midfielders had the lowest peak power production (AlTaweel et al., 2022). The forwards and the midfielders demonstrated a difference in large effect size. Former studies have argued about the highest peak power between defenders and goalkeepers (AlTaweel et al., 2022; Joo & Seo, 2016; Nikolaïdis, 2014), but the midfielders had the lowest peak power output.

Vertical jump tests were commonly used to assess athletes' lower body explosive strength by measuring jump height and mechanical power (Hübner et al., 2013). The study reported no statistically significant differences in jump height, flight time, or peak force among different players' positions. These results consistently agreed with previous studies on elite Slovak football players (Pivovarnicek et al., 2015), national collegiate athletic association (NCAA) (Harry et al., 2018), and young football players in five groups (Silva et al., 2022). Our findings indicated a trend in which jump height is a result of force production during vertical jump. In line with this, Miller et al. (2022) found that peak reaction force development is a significant predictor of vertical jump height.

The medial-lateral sway speeds of the nondominant and dominant legs are significantly different across the playing positions, but there was no difference for another variable of static balance. This finding is consistent with earlier research that reported the assessment of static balance based on the body center of pressure (COP) displacement (Teixeira et al., 2013), 95% COP elliptical area, standard deviation (King & Wang, 2017), total path length area, and deviation speed in anterior-posterior/mediolateral directions (Huurnink et al., 2014). Regarding dynamic balance, no significant differences were identified among the players' positions in TSI and TTD parameters. Previous studies have also found no differences in dynamic balance performance with different platforms of balance tests and sports disciplines (Sinulingga et al., 2024; Ateş, 2019; Cuğ et al., 2016). Balance performance is influenced by environmental and experimental conditions, as well as intrinsic factors. Additionally, balance is organized by individual factors like body somatotype, muscle strength, awareness of body position, and brain hemisphere dominance (Paillard & Noé, 2020).

The study's limitations should be acknowledged. The participation number was limited and the distribution of players across different playing positions was unequal. Full defenders (right and left) and wide midfielders (right and left) should be included to provide a more comprehensive analysis. Nevertheless, the data collected from the individuals provided a valuable insight into the future endeavors of young footballers.

The hypothesis that young players' peak power production, explosive strength of the lower limbs, and balance variations according to their playing position would be smaller in comparison with adult footballers is confirmed. This is possible to explain by a large amount of conditioning exercises in young athletes training sessions which are the same for players of different positions, and with smaller training experience in particular positions.

Conclusion

The study manifested significantly higher peak power output of the six-second peak power test on bicycle ergometer in the forwards than in the midfielders. Static and dynamic balance characteristics did not exhibit differences (with one exception: average medial-lateral speed was significantly lower in the goalkeepers in comparison with the forwards), as well as a countermovement vertical jump based on the group's playing position.

Directions for future research

Considering the age groups, puberty's effects are critical factors characterized by substantial physical and physiological changes, growth spurts, and hormonal fluctuations, needing investigation in future studies. The findings could be useful for coaches and trainers in identifying adolescent football players' strengths and weaknesses, enabling the development of specific training programs for individuals and groups.

Acknowledgments

We express our gratitude to all players and their coaches who took part in our research.

STATEMENT OF ETHICS

The research that pertains to human use has followed all pertinent national regulations and institutional policies, adhered to the principles of the Declaration of Helsinki, and has been approved by the Ethics Committee of the Latvian Academy of Sport Education (Meeting Protocol No. 6, Decision No. 1/51813 of February 24, 2023).

DECLARATION OF CONFLICTING INTERESTS

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