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Journal of Anthropology of Sport and Physical Education

ORIGINAL SCIENTIFIC PAPER

Access to test selection in children's athletics – Prediction of reaching maximum speed level and result in sprint based on dynamic-kinematic parameters, speed-strength abilities and morphological characteristics

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Abstract

Running speed in the form of sprinting is one of the most important abilities that can significantly define performance success in many sports. From the perspective of genetically inherited motor functions, running speed can be classified as a primary phylogenetic human movement, manifested in the form of a "three-segment model" consisting of speed, power, and coordination. By comprehensively analyzing the general and partial predictive contributions of dynamic-kinematic parameters of running, speed-power abilities, and morphological characteristics, on a sample of 80 boys aged 10-12 years, it can be concluded that regardless of the choice of criteria, achieved maximal speeds (KVMAX) or results in children's athletic sprint over 50 meters (KT50m), the same or related predictor variables contributed to the explanation. The variable running time for 20m from a flying start (KTLS20m) has the greatest predictive contribution (β=0.83, $p<0.001$) to explaining both criteria, which may indicate the importance of conducting this test in the identification and selection for athletic sprint. Additionally, the selection of tests to assess speed-power abilities is extremely important for the identification and selection for athletic sprint. It can be concluded that tests of horizontal and vertical jumps are significant for identification, as well as tests for assessing neuro-muscular excitation. Tests for assessing continuous horizontal jump are also important, although there is an impression that, in boys aged 10-12 years, coordinatively simpler tests should be used. In the analysis of morphological characteristics, variables that significantly contributed to the explanation of criteria at a partial level were body height, back skinfold, and ankle diameter, indicating that in the identification of talented individuals, it should be considered that elite sprinters are characterized by light bones, optimal muscle mass, and low levels of subcutaneous fat tissue.

Keywords: *athletics, talent ID, speed, power, maximal velocity*

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Introduction

Athletics is a complex multidisciplinary sport. The foundation of athletics, as well as various athletic disciplines, consists of fundamental locomotor movements, namely walking, running, jumping, and throwing. Besides walking, running represents the most natural form of human locomotion. Despite the simplicity of the elementary form of running, the technical structure of athletic sprinting is extremely complex. The investigation of running speed and its impact on athletic performance represents a multifaceted and dynamic research area. Scholars have explored various dimensions of running speed, encompassing its biomechanical underpinnings, physiological determinants, and training methodologies. From a biomechanical standpoint, running speed is influenced by factors such as stride length, stride frequency, ground contact time, and flight time (Weyand et al., 2000). Athletes often aim to optimize these biomechanical variables to achieve maximal speed while minimizing energy expenditure and the risk of injury. Physiologically, running speed is intricately linked to the cardiovascular and musculoskeletal systems' ability to deliver oxygen and nutrients to working muscles and remove metabolic byproducts (Joyner & Coyle, 2008). Interventions targeting these physiological systems can result in enhancements in running speed and endurance. Regarding training practices, athletes employ a variety of techniques to improve their running speed, including sprint-specific drills, resistance training, plyometrics, and interval training (McMahon & Wenger, 1998). These training modalities are designed to enhance muscle strength, power, coordination, and neuromuscular efficiency, all of which are critical for sprint performance. Furthermore, the study of running speed transcends individual performance to encompass external factors such as environmental conditions, footwear selection, and track surfaces, all of which can influence an athlete's speed (Hausswirth et al., 2014). Researchers are actively exploring novel training methodologies and technological advancements, such as wearable sensors and biomechanical modelling, to deepen our comprehension of running speed and enhance athletic performance.

Additionally, maximal running speed can depend on various factors related to morphological and physiological characteristics, energy mechanisms, age, genetic inheritance, motor abilities, intermuscular and intramuscular coordination, as well as optimal biomechanical movement technique. Running speed is one of the motor abilities that is very difficult to develop. Furthermore, locomotor speed in the form of sprinting is one of the most important abilities that can significantly define performance success in many other sports. From the perspective of genetically inherited motor functions, running speed can be classified as a primary phylogenetic human movement and is manifested in a "three-segment model," consisting of speed, power, and coordination (Babić, V., & Dizdar, D., 2010; Čoh, Bračić, & Smajlović, 2009; Kampmiller, T., M. Vanderka, P. Šelinger, M. Šelingerová, D. Čierna, 2011). One study (Čović et al., 2015) explained the running structure in boys similar age explaining the similarity in race phases between boys and elite sprinters. Since the purpose of this scientific study is to select tests that are accessible for talent identification in children's athletics, it is necessary to consider the structure of dynamic-kinematic parameters of running in lower school age, speed-power abilities in terms of natural forms of horizontal and vertical jumps, as well as the speed of neuro-muscular excitation, and morphological characteristics of children in this age group.

The aim of the study is to select accessible tests for talent identification in children's athletics by examining the dynamic-kinematic parameters of running, speed-power abilities through natural forms of horizontal and vertical jumps, the speed of neuro-muscular excitation, and morphological characteristics in lower school-aged children.

Methods

Participants

The research was conducted on a sample of 80 respondents, boys aged 10-12, who were selected from the population of pupils of the fourth grade of elementary school (Sarajevo, Bosnia and Herzegovina). Subjects were advised to wear sport equipment and non-slippery shoes suitable for sports activities. Legal guardians were asked to sign a written contest declaring allowance to participate in research and confirming absence of injuries and medical condition that may compromise health. Participants were allowed to forfeit at any time during the testing procedure. All procedures were conducted according to Helsinki declaration with permission of local Ethical Committee.

Procedures

Testing was performed in the morning hours indoors on artificial surface suitable for athletic competitions. Overall, 12 experienced sport scientists were included in the testing procedure. Body mass and stature were measured using a scale with a stadiometer (Seca, Hamburg, Germany) to the nearest 0.1 kg and 0.1 cm, respectively. Body mass index was calculated as body mass (kg)/squared stature (m2). Body measures were measured by a level 3 anthropometrist following the procedures established by the ISAK featuring variables: longitudinal dimensionality of the skeleton – Body height (ALVT), Leg length (ALDN), Foot length (ALDST); transversal dimensionality of the skeleton – Width of the pelvis (ATŠZ), Diameter of the ankle (ATDSZ), Diameter of the knee (ATDKZ); volume and mass of the body – Scope of the upper leg (AVONAT), Scope of the lower leg (AVOPOT), body mass (AVMT).

Running dynamic and kinematic parameters were estimated using 50 meters running test. Running area from 20 to 40 meters was merged with Microgate (Bolzano, Italy) surface sensors while photocells were placed after each 5 meters from start to finish. Subjects were running from standing start 3 m from starting line (flaying start) to avoid any possible mistakes. Subjects started running on their own signal. Sample of variables for estimating running dynamic and kinematic parameters included a set of seven variables: maximum running speed (KVMAX (m/s)), 50m running time (KT50m (s)), 20m running time from flying start (KTLS20m (s)), stride frequency (KFK (Hz)), stride length (KDK (cm)), duration of contact (KTK (ms)) and duration of the flight (KTL (ms)). By selecting one of the two criteria variables (KVMAX or KT50m), the unselected variable was automatically placed in the role of predictor.

Kinematic parameters were registered on tensiometric carpet (Ergo Tester Bosco), while sample of variables estimating speed-strength motor abilities included a set of 12 variables: Standing long jump (MSDM (cm)), Vertical jump – Abalak test (MABL (cm)), Counter movement jump (MCMJ (cm)), Counter movement jump with free hands (MCMJH (cm)), Repetitive jumps over the right foot on the 20m - stride number (MSD20B), Repetitive jumps over the left foot on the 20m - stride number (MSL20B), Repetitive jumps over the right foot on the 20m – time (MSL20V), Repetitive jumps over the left foot on the 20m – time (MSL20B), Hand tapping on 15 seconds (MTAPR), Leg tapping on 15 seconds (MTAPN), Medicine-ball throw backwards (weight 1 kg) from standing

position over head (MSMEDS), Medicine-ball throw forward (weight 1kg) from lying on back over head (MSMEDL).

Statistical analysis

For all the data, measures of central tendency and dispersion (mean ± SD) were calculated, and the normality of distribution was checked using the Kolmogorov-Smirnov test. The predictive general and partial contributions of variables from different anthropological areas to the achieved maximum running speed in boys aged 10-12 years were estimated using multiple regression analysis - Stepwise method, which is based on a successive procedure of variable introduction into the discriminant equation according to the criterion $F \leq 1.00$. This procedure introduces or discards a variable from the discriminant function if another variable more satisfactorily meets the entry criterion. The analysis was conducted using the SPSS software package (v 21.0) (IBM, Chicago), with statistical significance set at the conventional 95% level ($p > 0.05$).

Results

The predictive values of general and partial contributions of treated sets of variables of dynamic and kinematic running parameters, speed-strength abilities, and morphological characteristics (table 1) in explaining the criteria of achieving maximum running speed (KVMAX) and results in children's athletic sprinting over 50 meters (KT50m) were determined. Based on the obtained coefficients of determination (R^2), which reflected the general predictive contribution of three predictor sets of variables in relation to the criterion variables KVMAX and KT50m, the research results indicated the following: the complete set of predictor variables of kinematic running parameters explained 91% of the shared variance of the criterion of achieved maximum running speed - KVMAX (Table 2), and 96% of the shared variance of the criterion variable of 50m sprint running results - KT50m (Table 3); the complete set of predictor variables of speed-strength abilities explained 68% of the shared variance of the criterion variable KVMAX (Table 4), and 69% of the shared variance of the criterion variable KT50m (Table 5); also, based on the obtained results, it was determined that the complete set of morphological characteristics variables explained 21% of the shared variance of the criterion variable KVMAX (Table 6), and 27% of

Tabel 1. Morphology, running dynamic and kinematic and speed-strength features in young school age (n=80) male participants.

Morphology (n=80)	Mean±SD
Body height (ALVT) (cm)	145.3±6.6
Body mass (AVMT) (kg)	39.73±8.88
Leg length (ALDN) (cm)	83.04±5.02
Foot length (ALDST) (cm)	22.89±1.32
Width of the pelvis (ATŠZ) (cm)	20.8±2.68
Diameter of the ankle (ATDSZ) (cm)	6.54±0.435
Diameter of the knee (ATDKZ) (cm)	9.04±0.846
Scope of the upper leg (AVONAT) (cm)	45.22±6.18
Scope of the lower leg (AVOPOT) (cm)	30.79±3.34
Running dynamic and kinematic parameters (n=80)	
50m running time (KT50m) (s)	9.91±0.67
Maximum running speed (KVMAX) (m/s)	6.02±0.433
20m running time from flying start (KTLS20m) (s)	3.48±0.261
Stride frequency (KFK) (Hz)	3.96±0.255
Stride length (KDK) (cm)	145.51±10.72
Duration of contact (KTK) (ms)	0.15±0.015
Duration of the flight (KTL) (ms)	0.1±0.012
Dynamic parameters of speed-strength motor abilities (n=80)	
Standing long jump (MSDM) (cm)	145.54±19.09
Vertical jump – Abalak test (MABL) (cm)	27.13±5.01
Counter movement jump (MCMJ) (cm)	19.87±4.28
Counter movement free arms (MCMJH) (cm)	23.72±4.62
Repetitive jumps over the right foot on the 20m (MSD20V) (s)	12.24±3.12
Repetitive jumps over the right foot on the 20m (MSD20B) (n)	28.52±6.72
Repetitive jumps over the left foot on the 20m (MSL20V) (s)	12.37±2.83
Repetitive jumps over the left foot on the 20m (MSL20B) (n)	28.58±6.42
Leg tapping on 15" (MTAPN) (n)	18.54±1.91
Hand tapping on 15" (MTAPR) (n)	25.77±2.74
Backwards overhead medicine-ball throw (1 kg) from standing position (MSMEDS) (m)	4.95±0.965
Forward overhead medicine-ball throw (1kg) from lying on back (MSMEDL) (m)	6.95±1.34

Table 2. Predictive contribution of dynamic-kinematic parameters to maximum running speed (KVMAX)

Model summary for criterion variable KVMAX					
R= 0.954, R^2= 0.91, SE= 0.131, $F_{(2,78)}$ = 397.78, P<0.001					
Variables in the Equation					
Variable	B	SE of B	Beta	T	P
KTLS20m	-1.010	.269	-.610	-3.746	<.001
KT50m	-.226	.105	-.348	-2.139	.035
Variables not in the Equation					
Variable	Beta In	Partial	Min.	T	P
KFK	.023	.071	.042	.631	.529
KDK	4.515	.001	.042	.011	.991
KTK	-.003	-.011	.042	-.103	.918
KTL	-.030	-.097	.042	-.863	.391

SE – Standard Error; P statistical significance; DF – degrees of freedom; SS – sum of squares; MS – Mean square

Table 3. Predictive contribution of dynamic-kinematic parameters to 50 meters time (KT50)

Model summary for criterion variable KT50					
R= 0.979, R^2= 0.96, SE= 0.136, $F_{(2,78)}$ = 918.93, P<0.001					
Variables in the Equation					
Variable	B	SE of B	Beta	T	P
KTLS20m	2.105	.189	.826	11.129	<.001
KT50m	-.244	.114	-.158	-2.139	.035
Variables not in the Equation					
Variable	Beta In	Partial	Min.	T	P
KFK	.005	.022	.094	.199	.842
KDK	-.009	-.038	.090	-.338	.736
KTK	-.015	-.075	.094	-.662	.509
KTL	-.0172	-.082	.092	-.722	.472

SE – Standard Error; P statistical significance; DF – degrees of freedom; SS – sum of squares; MS – Mean square

Table 4. Predictive contribution of power-speed parameters to maximum running speed (KVMAX)

Model summary for criterion variable KVMAX					
R= 0.824, R^2= 0.68, SE= 0.251, $F_{(4,76)}$ = 40.361, P<0.001					
Variables in the Equation					
Variable	B	SE of B	Beta	T	P
MSD20B	-.025	.005	-.394	-4.506	<.001
MABL	.023	.007	.270	3.116	.002
MTAPR	.034	.010	.215	3.209	.002
MSDM	.004	.001	.207	2.375	.020
Variables not in the Equation					
Variable	Beta In	Partial	Min.	T	P
MCMJ	.086	.108	.441	.945	.347
MCMJH	-.004	-.005	.430	-.048	.962
MSD20V	-.142	-.141	.248	-1.241	.218
MSL20V	-.142	-.168	.428	-1.482	.142
MSL20B	-.069	-.074	.363	-.643	.522
MTAPN	.035	.046	.505	.402	.688
MSMEDL	.103	.166	.543	1.466	.146
MSMEDS	.092	.145	.536	1.270	.208

SE – Standard Error; P statistical significance; DF – degrees of freedom; SS – sum of squares; MS – Mean square

Table 5. Predictive contribution of power-speed parameters to 50 meters time (KT50)

Model summary for criterion variable KT50					
R= 0.832, R^2= 0.69, SE= 0.378, $F_{(4,76)}$ = 42.853, P<0.001					
Variables in the Equation					
Variable	B	SE of B	Beta	T	P
MSD20B	.034	.009	.344	3.597	<.001
MABL	-.040	.010	-.308	-3.795	<.001
MSL20V	.060	.021	.255	2.826	.006
MTAPR	-.040	.015	-.165	-2.526	.013
Variables not in the Equation					
Variable	Beta In	Partial	Min.	T	P
MSDM	-.137	-.175	.428	-1.544	.126
MCMJ	-.168	-.214	.436	-1.902	.061
MCMJH	-.149	-.180	.422	-1.587	.116
MSD20V	.116	.118	.225	1.032	.305
MSL20B	.071	.059	.210	.515	.608
MTAPN	-.101	-.143	.408	-1.255	.213
MSMEDL	-.092	-.149	.424	-1.308	.195
MSMEDS	.092	.145	.536	1.270	.208

SE – Standard Error; P statistical significance; DF – degrees of freedom; SS – sum of squares; MS – Mean square

Table 6. Predictive contribution of morphological characteristics to maximum running speed (KVMAX)

Model summary for criterion variable KVMAX					
R= 0.459, R2= 0.21, SE= 0.389, F(2,78) = 10.417, P<0.001					
Variables in the Equation					
Variable	B	SE of B	Beta	T	P
ANL	-.002	6.022	-.422	-4.07	<.001
ALVT	.020	.006	.311	3.005	.003
Variables not in the Equation					
Variable	Beta In	Partial	Min.	T	P
ALDN	.029	.018	.308	.161	.872
ALDST	-.054	-.034	.313	-.299	.765
ATŠZ	.066	.060	.647	.532	.596
ATDSZ	.181	.144	.498	1.282	.203
ATDKZ	-.088	-.071	.518	-.631	.529
AVONAT	.262	.170	.334	1.522	.132
AVOPOT	.171	.105	.298	.933	.353
AVMT	.172	.073	.143	.647	.519
ANS	.338	.130	.117	1.159	.250
ANPOT	-.101	-.072	.399	-.638	.525

SE – Standard Error; P statistical significance; DF – degrees of freedom; SS – sum of squares; MS – Mean square

Table 7. Predictive contribution of morphological characteristics to 50 meters time (KT50)

Model summary for criterion variable KT50					
R= 0.525, R^2= 0.28, SE= 0.573, $F_{(2,78)}$ = 14.897, P<0.001					
Variables in the Equation					
Variable	B	SE of B	Beta	T	P
ANL	.004	9.002	.518	5.143	<.001
ATDSZ	-.505	.154	-.330	-3.275	.001

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Table 7. Predictive contribution of morphological characteristics to 50 meters time (KT50)

Variables not in the Equation					
Variable	Beta In	Partial	Min.	T	P
ALVT	-.088	-.074	.498	-.656	.514
ALDN	-.079	-.081	.748	-.714	.477
ALDST	-.036	-.029	.483	-.263	.793
ATŠZ	-.134	-.142	.814	-1.262	.210
ATDKZ	.153	.124	.475	1.098	.275
AVONAT	-.261	-.179	.343	-1.604	.112
AVOPOT	-.189	-.121	.297	-1.075	.285
AVMT	-.223	-.116	.197	-1.031	.305
ANS	-.279	-.113	.119	-1.004	.318
ANPOT	.097	.073	.409	.646	.520

SE – Standard Error; P statistical significance; DF – degrees of freedom; SS – sum of squares; MS – Mean square

the shared variance of the criterion variable KT50m (Table 7). These research results may indicate that there is an extremely high general predictive contribution of kinematic running parameters, a high contribution of speed-strength abilities, as well as a negligible contribution of morphological characteristics in relation to both set criteria KVMAX and KT50m, in the case of boys aged 10-12 years.

Discussion

Within the research results, the partial contribution of predictor variables of dynamic-kinematic running parameters was examined in relation to the set criterion variables (Table 1 and 2). It is important to highlight that in the space of dynamic-kinematic running parameters, by choosing one of the two criterion variables (KVMAX or KT50m), the unselected variable automatically assumed the role of predictor. Regardless of the chosen criterion variable, in both cases, the predictor variable - Time to run 20m from a flying start (KTLS20m) emerged as the top contributor to partial predictive contribution with a level of statistical significance (T≤0.01). The variables KMAX or KT50m were then identified as the second contributors to partial predictive contribution when they were set as predictors (P≤0.05), confirming their inverse proportionality and strong interdependence. Since the instrument used to measure the time to run 20m from a flying start (KTLS20m) was set between the 20th and 40th meters of the track, it means it addressed the phase of running over a distance - the time in which the achieved level of maximum running speed is sought to be maintained at an optimal level. Consequently, it is logical that participants reached and maintained their maximum running speed during this period, which can explain the highest partial predictive contribution of the variable KTLS20m, regardless of the chosen criterion. Therefore, a higher achieved and maintained level of maximum running speed over a distance result in a better performance in athletic sprinting. These results confirm findings from earlier studies reporting the significance of 20m flying start running tests and determining the level of maximum running speed as crucial for assessing performance in athletic sprinting (Kampmiller et al., 2011; Ae, Ito, & Suzuki, 1992; Chapman & Caldwell, 1983). However, regardless of the choice of criterion variable (KVMAX or KT50m), all other kinematic variables related to step length (KDK), step frequency (KFK), contact time (KTK), and flight time (KTL) did not meet the inclusion criteria in the discriminant equation (F≤1.00). Identifying factors influencing the development of maximum running speed and differences in dynamic-kinematic running parameters in relation to age in adolescents, it was concluded that an increase in maximum running speed is a result of increasing step length and decreasing contact phase duration (Bračić, Tomažin, & Čoh, 2009). Also, in the case of younger age groups, they concluded that step frequency is less important for the development of maximum running speed.

Based on the results obtained in our study, it is important to note that the analyzed sample of boys aged 10-12 years represented a random sample of participants, consisting of students who had not undergone basic running technique training. Therefore, the occurrence of typical technical errors in running, such as running over the full foot or incomplete leg extension during push-off, was very possible. Consequently, these typical errors in executing the running stride result in a longer contact time (KTK), which automatically negatively affects step length (KDK) and flight time (KTL), which may also be the reason for the partial non-selection of these kinematic variables in explaining the criteria KVMAX and KT50m. Even though these kinematic parameters, which are significant for the result in athletic sprinting, were not singled out by the study results, it is important to consider the fact confirmed by relevant studies that maximum running speed is achieved primarily when step length and frequency are in an optimal ratio (Belotti et al., 1991; Donati, 1995; Čoh et al., 1997, 2001). Studies also indicate that step frequency and ground contact time parameters are significant for assessing running speed and are good indicators of the sprint potential of young runners, being significant for talent identification processes (Kampmiller et al., 2011; Čoh et al., 1994).

Within the research results, the individual contribution of predictor variables from the speed-strength abilities domain in relation to the set criterion variables was examined (Table 3 and 4). The variable that achieved the greatest predictive contribution to the criterion KVMAX was the number of jumps on the right leg (MSD20B). However, it is interesting to note that the variable for the number of jumps on the left leg (MSL20B) did not meet the entry criteria for the discriminant equation, especially considering the general assumption of the left leg being more dominant in jumping. In contrast to the KVMAX criterion, when choosing the criterion KT50m, in addition to the greatest predictive contribution of the variable number of jumps on the right leg (MSD20B), a predictive contribution of the variable jumps on the left leg for 20m time (MSL20V) was observed. Also, a high predictive contribution, regardless

of the criterion choice (KVMAX or KT50m), was achieved by the variable Abalakov jump reach (MABL), which was not the case with the other two variables measuring vertical jump - static jump with preparation (MCMJ) and static jump with free arm swing (MCMJH). By reviewing the research results, specifically the variables that did not meet the inclusion criteria in the discriminant equation (F≤1.00), it can be noted that the variable static jump with preparation (MCMJ) was very close to the statistical significance threshold in the case of the criterion KT50m. The variable standing long jump (MSDM) made a slightly lower contribution compared to the others that met the entry criteria, indicating the extremely high importance of horizontal jumping ability in assessing the criterion of maximum running speed (KVMAX). The variable hand tapping (MTAPR) made a high predictive contribution, indicating an exceptionally high contribution of the neuro-muscular excitation mechanism in achieving maximum speed and results in athletic sprinting. This also confirms the contribution of speed-strength abilities such as vertical and horizontal jumping, as well as the neuro-muscular excitation ability, to the potential maximum speed and results in athletic sprinting, as confirmed by many previous studies (Zatsiorsky & Primakov, 1969; Belotti, 1991).

Within the research results, the individual contribution of predictor variables from the morphological characteristics domain in relation to the set criterion variables was examined (Table 5 and 6). For the criterion KVMAX, two variables - back skinfold thickness (ANL) and body height (ALVT) - achieved a significant predictive contribution (T≤0.01), while for the criterion KT50m, the variables back skinfold thickness (ANL) and ankle joint diameter (ATDSZ) contributed predictively. Other variables from the morphological characteristics domain did not meet the inclusion criteria in the discriminant equation (F≤1.00). The partial contribution of one variable for assessing adiposity to both criteria, as well as the partial contribution of one variable for assessing longitudinal dimensionality and one variable for assessing transversal dimensionality to one of the criteria, may indicate the significance of certain morphological characteristics. However, since the general contribution to explaining the criteria was very low, the conclusion leans more towards the results of some previous studies suggesting that morphological characteristics may not have a decisive impact on achieving maximum speed or results in athletic sprinting. Čoh, Mihajlovič, and Praportnik (2001) state that morphological characteristics are not a significant generator of differences in competitive results. The authors conclude that elite athletic sprinters are characterized by light bones and an optimal amount of muscle mass, emphasizing that this is not the sole relevant factor in speed development, but also highlighting the importance of biochemical energy processes and intermuscular coordination of agonists and antagonists.

Conclusion

Comprehensively analyzing the general and partial predictive contributions of dynamic-kinematic running parameters, speed-strength abilities, and morphological characteristics, it can be concluded that regardless of the criterion chosen, the achieved maximum speeds (KVMAX) or results in children's 50-meter athletic sprint (KT50m) were explained by the same or related predictor variables. In relation to both criteria, the general contribution of the complete set of dynamic-kinematic running parameters was extremely high. The variable Time to run 20m from a flying start (KTLS20m) made the highest predictive contribution to explaining both set criteria, indicating the importance of conducting this test in identifying and selecting for athletic sprinting. Additionally, the variables achieved maximum running speed (KVMAX) and result in the 50m sprint (KT50m) confirmed their inseparable interdependence, suggesting that in identifying talent for athletic sprinting, tests that can accurately assess their speed potential or level of maximum running speed should be considered. It would be beneficial for speed potential in sprinting to be assessed in practice using the 20m flying start running time test, as it contains both the level of achieved maximum running speed and the ability to maintain the achieved speed level when running over a distance. Variables from the domain of speed-strength abilities made significant general predictive contributions to explaining both set criteria. It can be concluded that variables assessing vertical and horizontal jumping ability, as well as the speed of neuro-muscular excitation, made significant individual contributions to explaining both set criteria, confirming the importance of these qualities for speed and performance potential in athletic sprinting. Considering that speed is conditioned by processes of intermuscular coordination of agonists and antagonists, the choice of tests to assess speed-strength abilities is extremely important for identifying and selecting for athletic sprinting. It can be concluded that tests of horizontal and vertical jumping ability, as well as tests assessing neuro-muscular excitation, are significant for identification. Additionally, tests assessing continuous horizontal jumping are important, although it is advisable to use coordinationally simpler tests in the age group of boys aged 10-12 years. The morphological characteristics domain did not show a significant general predictive contribution to explaining the criteria of maximum speed and results in children's athletic sprinting. Variables that made a significant predictive contribution at the partial level in explaining the criteria were body height, back skinfold thickness, and ankle joint diameter, suggesting that in identifying talents for athletic sprinting, it should be taken into account that elite sprinters are characterized by light bones, optimal muscle mass, and a low level of subcutaneous fat tissue.

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Journal of Anthropology of Sport and Physical Education

ORIGINAL SCIENTIFIC PAPER

Growing up healthy: Body mass index patterns among primary school girls

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Abstract

This research addresses the Body Mass Index (BMI) patterns among primary school girls in the Jashore district of Bangladesh, considering the escalating concerns regarding childhood obesity globally. The present study aimed to investigate the Body Mass Index (BMI) patterns among primary school girls in the Jashore district of Bangladesh. A sample of 300 girls (age ranged from 6 to 12 years) from classes one to five were chosen randomly in the study. Height and weight measurements were taken, and BMI was calculated according to WHO guidelines. Statistical analysis, including tests of normality and post hoc tests, was conducted using SPSS. The findings reveal a progressive increase in BMI with advancing academic classes. Significant differences in BMI were observed among Class 2 & Class 3 ($p = 0.002$); Class 2 & Class 4 ($p < 0.0001$); Class 2 & Class 5 ($p < 0.0001$); Class 1 & Class 4 ($p = 0.027$); Class 1 & Class 5 ($p < 0.0001$); Class 3 & Class 5 ($p = 0.002$) and also between Class 4 & Class 5 ($p = 0.012$). But there was no significant difference among Class 2 & Class 1 ($p = 0.109$); Class 1 & Class 3 ($p = 0.117$) and Class 3 & 4 ($p = 0.523$). The significance level was $\alpha \leq 0.05$. The study provides valuable insights for public health interventions aimed at promoting healthy weight management among primary school girls in the region.

Keywords: *Body Mass Index (BMI), primary school girls, obesity, overweight, health*

Introduction

A person's body mass index (BMI) is calculated as their weight (in kg) devided by their height squared (in m). It is the most widely used sensitive, specific, and accurate screening technique to find people who may be at risk for health issues related to their body mass. It can only be used to evaluate obesity, it cannot be used to diagnose obesity (Mahalakshmi & Abirami, 2019).

The body mass index (BMI) pattern in school children can vary depending on a variety of factors such as age, sex, ethnicity, and lifestyle. Generally speaking, BMI is a measure of body fat based on an individual's height and weight, and it is often used as an indicator of overall health status (Nihiser et al., 2009). According to the World Health Organization (WHO), BMI values for children and adolescents are expressed in relation to age and sex, and are classified based on percentiles. A BMI between the 5th and 85th percentile is considered normal, while a BMI between the 85th and 95th percentile is classified as overweight, and a BMI above the 95th percentile is considered obese (Mei et al., 2002). In some countries, there has been a trend towards increasing rates of overweight and obesity among school-aged children. This trend has been associated with factors such as increased availability of high-calorie foods and decreased levels of physical activity (Berg et al., 2003). In school-aged children, the pattern of BMI can vary depending on a variety of factors such as age, sex, ethnicity, genetics, lifestyle, and environmental factors' (Brener et al., 2007).

However, studies have shown that there has been a general increase in the prevalence of overweight and obesity among school-aged children over the past few decades, both in developed and developing countries (Dietz & Bellizzi, 1999). In the United States, for example, according to the Centers for Disease Control and Prevention (CDC), the prevalence of obesity among children and adolescents aged 2-19 years increased from 10.7% in 1999-2000 to 19.3% in 2017-2018.

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In other countries, similar patterns have been observed. For instance, in India, a study conducted in 2017 found that the prevalence of overweight and obesity among school children was 19.1% and 5.9%, respectively (Freedman et al., 2013). These trends are concerning because overweight and obesity can lead to a range of health problems such as type 2 diabetes, heart disease, and certain types of cancer.

Schools help to promote a healthy country by facilitating early diagnosis, screening, and prevention. Earlier investigations in this sector have clearly identified two significant tendencies of concern. According to cohort research conducted in Louisiana on 2610 children aged 2 to 37 between 1973 and 1996, childhood BMI levels are related to adult BMI levels (Freedman et al., 2005). A cross-cultural research conducted in 25 communities that included 182 preschool children revealed similar findings i.e., 59.8% of the children were underweight. A research conducted in South Africa found similar results, revealing that 66-70% of children aged 10 to 12 were underweight and 5% were overweight, highlighting the need to improve school-children's nutritional habits (Dolla et al., 2005).

However, it is important to note that BMI is not a perfect measure of health and does not take into account factors such as muscle mass, bone density, and overall body composition. Therefore, it is important to consider other indicators of health as well, such as blood pressure, cholesterol levels, and overall physical fitness (Jolliffe & Janssen, 2006). Additionally, it is important to approach discussions of BMI and weight with sensitivity and without stigmatization.

Considering previous findings, the present study was realized in primary schools in Jashore among 300 children of classes one to five. The objective was to investigate the BMI pattern of primary school girls in the Jashore district of Bangladesh. The Jashore district is located in the southwestern part of the country and is home to a diverse population of over 1.5 million people. The study will focus on primary school girls, as they represent a critical age group that is at risk of developing overweight and obesity. The study will use a cross-sectional design, and data will be collected through a survey of primary school girls in the Jashore district. We hypothesized that BMI pattern of Primary school Girls of Jashore District would be progressive.

Methodology

The subjects

A total of 300 primary school girls (Class 1 to Class 5) from four primary schools (1. Sultanpur Begum Shamsun Nahar Govt. Primary School, Sadar, Jashore; 2. Hamidpur Govt Primary School, Sadar, Jashore; 3. Churamankati Govt. Primary School, Sadar, Jashore; 4. Gopalpur Government Primary School, Sadar, Jashore) of Jashore District were selected as subjects for the present study. The primary schools were located on Urban, Sub urban and rural areas. Participants age ranged from 6 to 12 years.

Procedure for collecting data

Data has been collected through a survey that includes measurements of height and weight. Trained data collectors who visited the selected schools to measure the height and weight of the primary school girls have administered the survey. A random sampling technique has been used to select primary schools in the Jashore district. Parents, guardians and teachers of the selected primary school have been informed about the purpose and nature of the study. Children's parents/legal guardians gave their consent for participation. The height and weight of the primary school girls were measured using standard procedures. The height was measured using a stadiometer, and weight was measured using a calibrated digital scale. Ethical considerations have been taken into account during the data collection process, and the privacy and confidentiality of the participants have been ensured.

Procedure for analysis of data

Height and weight were taken to compute the BMI and graded as per WHO guidelines: 1) Underweight: <18.50; 2) Normal range: 18.50-24.99; 3) Overweight: >25.00; 4) Obese >30.00 (WHO, 2004). The BMI data were summarized using descriptive statistics, mean and standard deviation. We used the Kolmogorov-Smirnov and Shapiro-Wilk test to test the normality of the distribution. According to observed values for both Kolmogorv-Smirnov and Shapiro-Wilk, data do not follow the Gaussian distribution. Data failed the homogeneity criterion as well, thus, researchers opted for non-parametric statistical tool to draw inherence on the collected data. More precisely, the differences between different classes were examined using the Mann-Whitney U test and the Kruskal-Wallis test. Statistical significance was set at 0.05 and differences were considered significant if $p \leq 0.05$. The software used to compute the statistical data was SPSS package.

Here, table-1 shows the mean values and standard deviation of class one to five: class 1 values is 15.86 ± 1.48, class 2 value is 15.36± 2.30, class 3 value is 16.76± 2.51, class 4 value is 17.21± 3.00 and class 5 value is 18.88± 4.01.

Table 1. Descriptive Statistics of BMI from class 1 to 5

Class	Mean	SD
Class-I	15.86	1.48
Class-II	15.36	2.30
Class-III	16.76	2.51
Class-IV	17.21	3.00
Class-V	18.88	4.01

Table 3 shows that there were significant differences between class 2 and class 3, class 2 and class 4, class 2 and class 5, class 1 and class 4, class 1 and class 5, class 3 and class 5 as well as class 4 and class 5. No significant differences were observed between Class 2 and class 1, class 1 and class 3, and class 3 and class 4

Table 2. Hypothesis test summary

Null Hypothesis	Test	Sig.	Decision
The distribution of BMI is the same across categories of class	Independent sample Kruskal-Wallis Test	<0.0001	Reject the null hypothesis

The significance level is $\alpha \leq 0.05$

Table 3. Post Hoc Test (Mann Whitney U Test) of pair wise comparison of Class.

	Sig.
Class 2- Class 1	0.109
Class 2- Class 3	0.002
Class 2- Class 4	<0.0001
Class 2-Class 5	<0.0001
Class 1-Class 3	0.117
Class 1-Class 4	0.027
Class 1-Class 5	<0.0001
Class 3-Class 4	0.523
Class 3-Class 5	0.002
Class 4-Class 5	0.012

*The mean difference is significance at the .05 level.

Discusion

The research aimed to identify the average BMI score of primary school girls in the district, analyze their BMI distribution, and test if there are any difference in BMI scores between different classes. The findings of the study showed that the BMI was progressive in nature, increasing with the increase of the academic classes. One study that looked at the BMI pattern of primary school girls in Australia (Lazarus et al., 2000) also found similar results. The study included 1421 children aged 7-12 years and found that the prevalence of overweight and obesity was 9.6% and 6.3%, respectively. The study found that the prevalence of overweight and obesity increased with age, with the highest prevalence observed among girls aged 10-12 years. A study conducted in Saudi by (Kordy & Elgamal, 1995) found that the prevalence of overweight and obesity was higher in boys than girls, and the prevalence also increased with age. The study found that girls who were overweight or obese were more likely to have a family history of obesity and to engage in sedentary activities such as watching television. Another study that looked at the BMI pattern of primary school girls in Spain (Moreno et al., 2000) included 90,997 children aged 7-12 years. Between 1985 and 1995, the population under investigation had significant changes in BMI, although these changes varied according to sex and age. In addition to the paediatric population having higher body mass, the rising skewness of BMI in the highest percentiles of the population, particularly in girls, shows that the obese individuals of the population are becoming even more obese. Another study in China (Zhou et al., 2006), found that the prevalence of overweight and obesity was higher in urban areas than in rural areas. The study also found that the prevalence of overweight and obesity was higher in boys than girls in both urban and rural areas. The findings of this study extend upon existing research regarding BMI growth patterns across different socio-demographic groups. Consistent with previous studies (Hankey & Miyazaki, 2019; He & Karlberg, 2001; Lu et al., 2019; Salmela et al., 2020; Wronka, 2010), our results highlight significant differences in BMI trajectories between various classes.

Our observation of significant disparities in BMI progress between specific class combinations aligns with the findings of Wronka, (2010), who reported similar trends in a longitudinal analysis of BMI among adolescents from diverse socio-economic backgrounds. Finally, the findings of the present study provide novel insights into the specific class combinations associated with divergent BMI trajectories. By identifying these differences, our findings may contribute to the refinement of targeted interventions aimed at addressing obesity and promoting healthy weight management behaviors among schoolchildren. Further studies may be conducted with larger sample size collecting data from the whole country.

Conclusion

All primary school girls are close to normal body mass index and BMI progress aligns with the increase of the academic classes. However, authors recommend nutritional adherence and more physical activity with the aim to improve health. Parents and primary school teachers should pay special attention on the children's physical development as well. Findings of this study provide valuable insights into the BMI pattern of primary school girls in the Jashore district and will help to identify any trends or patterns that may be contributing to the increasing prevalence of overweight and obesity among children in the region. This information can be used to inform public health policies and programs aimed at preventing and managing overweight and obesity in children and adolescents. Ultimately, this study can also contribute to the development of evidence-based interventions that will promote healthy weight management among children and adolescents in the Jashore district and beyond.

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ORIGINAL SCIENTIFIC PAPER

Effective Teaching Methods in Physical Education Classes: A pilot study implementing a new survey for teachers

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Abstract

Physical education (PE) classes for children play a crucial role in promoting physical activity and healthy lifestyle. The PE in the Kosovo primary schools, together with its teaching and organizational issues have long been a key topic of political, sport and scientific debate. However, the various actions carried out so far have not been enough to recognize contents and methods of PE correctly oriented in an educational way. The aim of the study is to highlight the latest method and strategies of the teachers, and the new curriculum used in the field of PE for better learning and developing health among children through physical activity. The research involved (n = 100) PE teachers from Kosovo public schools. All teachers are from Kosovo primary schools, classes VI-IX, with an average of 16 years of work experience. Data was collected using questionnaire by an online survey. The learning methods mostly applied are: practical learning method (96%), teaching through lectures (79%), interactive method (72%), effective teaching method (66%), learning through certain goals (47%). The factors that influence the effective use of teaching strategies are: infrastructure and equipment (94%), teacher skills (89%), competitive activities among children (57%), and children's desire for physical and sports activities (46%). The factors that can influence the increase in the effectiveness of teaching strategies are: the addition of teaching hours (92%) teacher trainings (84%) and curricular improvements (78%). Teaching methods help teachers to have an effective communication with students, clear instructions, demonstrations, and techniques being taught.

Keywords: *physical education (PE), teaching method, strategy*

Introduction

Education plays an important role in a society and national development (Poonsri, 2008). Education is the process of knowledge acquisition, skills, and habits of a group of people that are transferred from one generation to the next through teaching, training, or research (Arifin, 2017). The Education sector continues to remain one of the most criticized and sensitive sphere in Kosovo. This sector is characterized by continuous efforts to reform in all sub-sectors, which address the main challenges of increasing quality in education. During the last decade, numerous legal and by-law acts have been approved, schools have been built and new educational institutions have been established, but it has also started to be invested in sports infrastructure through schools. This means linking the education system with current educational goals. The school is one of the most important educational institutions that achieves integrated growth to the individuals from all physical, psychological, mental, social and health aspects. Mainly because of the different and various cognitive and skillful programs provided by the school, so that the individual will be able to adapt to his surrounding environment to achieve the objectives of the family and the community (Oudat, 2016).

Physical education (PE) is part of the overall education system, which includes aspects of developing physical fitness, movement skills, critical thinking skills, emotional stability, social skills, reasoning, and moral action through physical activity. PE is one of the important aspects of the educational and teaching processes, espe-

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cially in the current era, in which high values are placed on physical activity, as it has many positive effects on the individuals. The PE curriculum offers the teacher a structured and balanced program of work. PE programs prepare children's and adolescents for lifelong active lifestyles and the good physical healthcare endorsed in public schools (Sallis, McKenzie, Beets, Beighle, Erwin, & Lee, 2012; Lohaphaiboonkun, 2011). This is because the implementation of PE prioritizes physical activities, especially sports and healthy living habits (Lengkana & Sofa, 2017). The study of teaching models used for PE has been the object of analysis over the last few years (Ferraz et al., 2023). Teaching models are characterized as long term development plans for teaching that convey a central idea and that must follow a unified theoretical structure (Casey & MacPhail, 2018). The PE teacher is the first one to be concerned about an effective PE program (Aboshkair, 2014). Good qualified teachers provide excellent leadership which can overcome lack of the equipment's and facilities in the schools. Teachers should establish clear rules and expectations for behavior during PE class, ensure that equipment and facilities are safe and well-maintained, and monitor students closely to prevent injuries. Moreover, promoting a positive attitude towards teaching PE is indispensable. Teachers should feel confident and competent in their ability to teach PE.

Teachers should have a high quality level of teaching skills that can be described as "the positive combination of the individual's knowledge, ability and willingness to deal effectively and responsibly with changing situations" (Weinert, 2015). By implementing these strategies and addressing the barriers, educators can effectively teach PE and promote healthy, active lifestyles among students. Over the last five years, the professional training of PE teachers has undergone changes (Ferry & Romar, 2020). The examination of teaching effectiveness, within educational domains such as sport pedagogy, remains an important focus (Aktop & Karahan, 2012). Examination of teachers regarding effective pedagogy and teaching models is necessary, considering that the global physical activity levels and participation in sport are decreasing amongst young people and needs to be reversed (Guthold et al., 2020; Vukelja et al., 2022). Classroom management is the most important for implementing appropriate methods of teaching. It is also a skill that all effective teachers must master, because without the skill to manage a classroom, even well planned methods can fail. However, it seems that PE teachers have a central role realizing curricular goals, transforming sports science and pedagogical knowledge into practice, taking into account the developments of the sport movement and negotiating with local agents such as parents (Kougioumtzis, 2006; Kougioumtzis & Patriksson, 2009). During the recent years in Kosovo, few research has been done regarding the PE teacher skills, teaching methodology, strategies, sports infrastructure, sports equipment, curriculum, as well as the positive and negative factors affecting the methods of teaching in PE. Therefore, the aim of the study is to investigate the latest methods and strategies used by the teachers, and curriculum frames used in the field of PE program for better learning and healthy life among children through physical activity. The results of this research will provide important information on teaching methods in PE, and the guidelines for innovative teaching process can be suggested.

Materials and Methods

Participants

This research involved (n = 100) PE teachers from public schools of different municipalities from all over Kosovo. All teachers are from the primary schools, with an average from 16 years of work experience. This research is the survey research type. The instrument applied is a recently developed questionnaire on the opinions of PE teachers. Moreover, it has been implemented for the first time at the present study. The questionnaire contained options to be selected, but also written opinions were required.

Data Collection and Analysis

Data was collected using questionnaire by an online survey, which was sent to the PE teachers, with answers to be circled and also providing their opinions. Collected data were analyzed with Microsoft Excel and percentages have been calculated.

Results

The research results and the opinions of PE Teachers for Effective Teaching Methods are as presented in Figure 1.

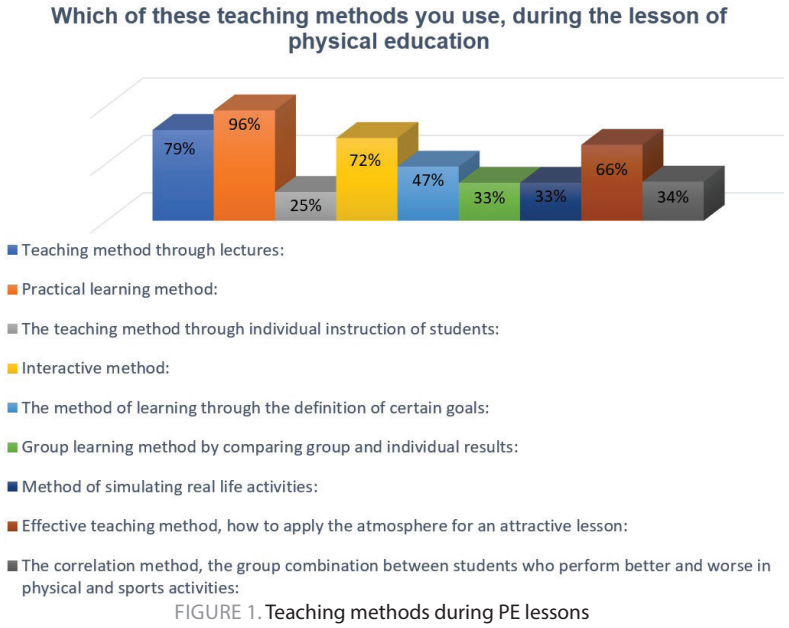

FIGURE 1. Teaching methods during PE lessons

Answers of the PE teachers for the question "Which of the teaching methods you use during the learning of the subject" are shown in Figure 1. Results revealed that the practical learning method is the most applicable, stated by 96% of respondents; teaching method through lectures is stated by 79% of responders; interactive method is stated by 72% of responders; effective teaching method by applying the atmosphere for an attractive lesson is stated by 66% of respondents; the method of learning through

the definition of certain goals is stated by 47% of responders; the method group learning by comparing group and individual results is stated 33% of respondents; method of simulating real life activities is stated by 33% of respondents; the correlation method - the group combination between students who perform better and worse in physical and sports activities is stated by 34% of respondents; and the teaching method through individual instruction of students is stated by 25% of respondents.

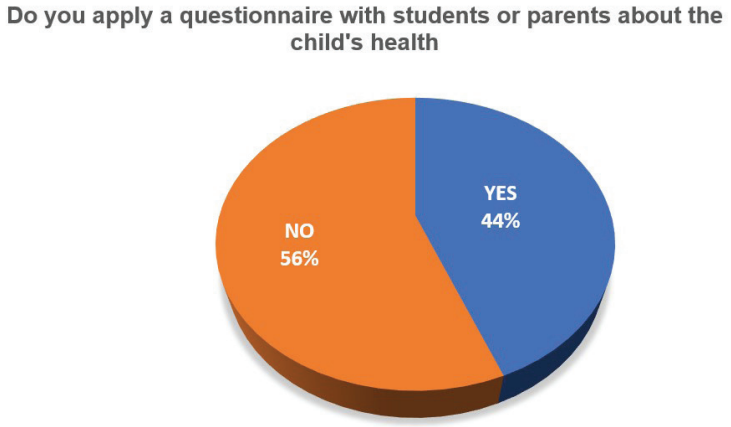

FIGURE 2. Application of the questionnaire for children's health by teachers

Answers of the PE teachers for the question "Do you apply a questionnaire with students or parents about the child's health", are shown in Figure 2. Results revealed that 56% of the teachers does not apply respective questionnaire, and 44% of the teachers apply a questionnaire for the children's health.

Answers of the PE teachers for the question "What are the factors that influence the effective use of teaching strategies" are shown in Figure 3. Responders could select multiple answers. Ninety four % of the respondents stated that infrastructure and equipment is the factor with highest influence to the effective use of teaching strategies; while 89% of respondents stated that teacher skills is the second factor to the effective use of teaching strategies; competitive activities among children with 57%; and the children's desire for physical and sports activities with 46%.

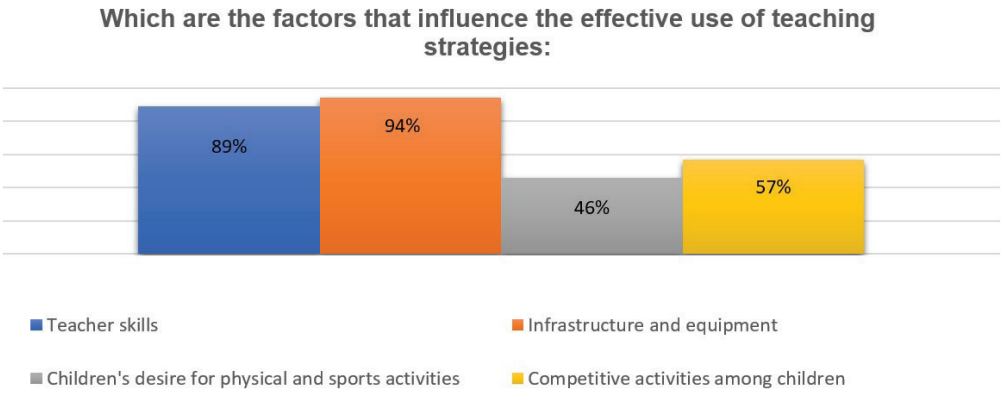

FIGURE 3. Factors that influence the effective use of teaching strategies

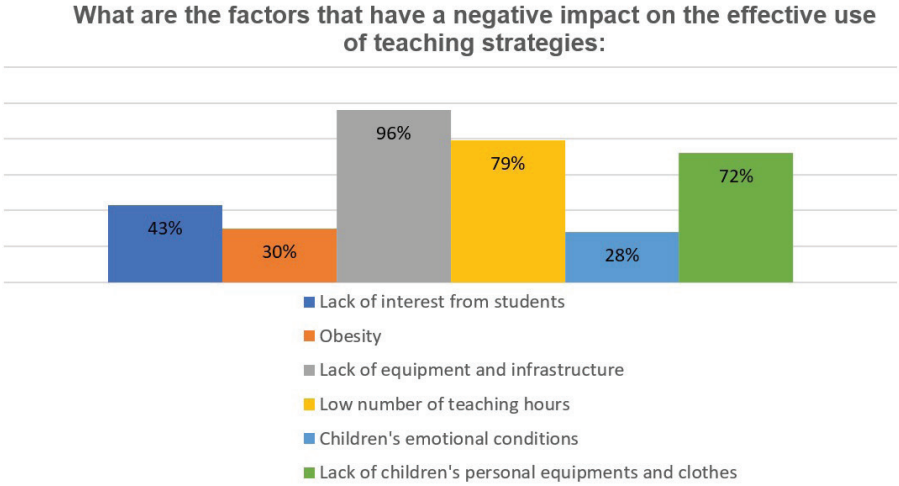

FIGURE 4. Factors that have a negative impact on the effective use of teaching strategies

Answers of the PE teachers for the question "What are the factors that have a negative impact on the effective use of teaching strategies" are shown in Figure 4. Responders could select multiple answers. Results revealed that: lack of equipment and infrastructure is the most stated factor from 96% of the respondents; low number of teaching hours is stated by 79% of the responders; lack of children's personal equipment's and clothes is stated by 72% of the responders; lack of interest from students is stated by 43% of the responders; obesity factor is stated by 30% of the respondents; children's emotional condition is stated by 28% of responders.

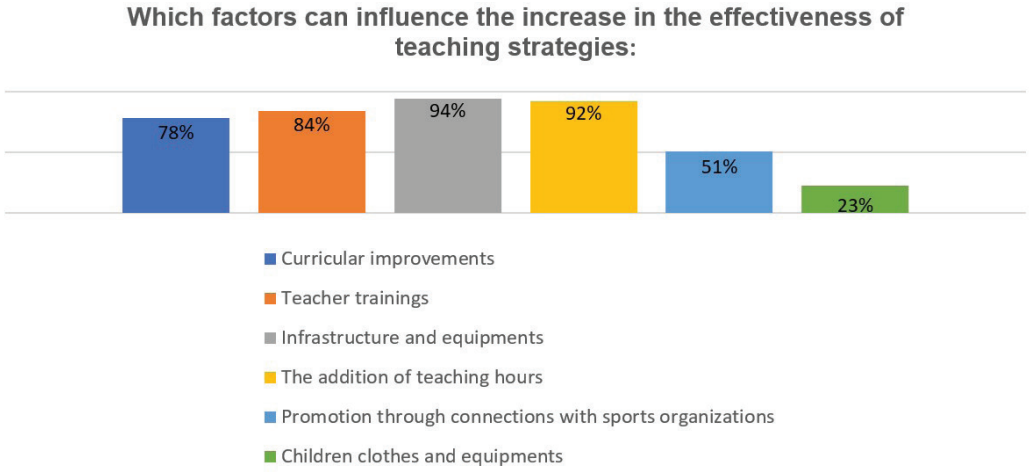

FIGURE 5. Factors with influence in the increase in the effectiveness of teaching strategies

Answers of the PE teachers for the question "What factors can influence the increase in the effectiveness of teaching strategies" are shown in Figure 5. Responders could select multiple answers. Results revealed that infrastructure and equipment's is the main factor stated by 94% of the responders; the addition of teaching hours is the second factor as stated by 92% of the responders; curricular improvements is stated by 78% of the responders; teachers trainings is stated by 84% of the responders; promotion through connections with sports organizations is stated by 51% of the responders; children clothes and equipment is last factor stated by 23% of the respondents.

Discussion

Teaching methods are essential in the PE class as they facilitate learning, skills development, physical fitness, inclusivity and character building. By using a variety of effective methods, teachers can create a positive learning environment that promotes a culture for lifelong participation in physical activity and healthy living. The purpose of this study was to analyze which teaching methods are most applicable in the PE classroom, the positive and negative factors that influence the development of effective strategies for a better teaching in the subject of PE. The main findings of this study revealed that the teaching methods that are mostly applied by PE tachers during the lesson are: 1. Practical learning method is the most applicable one, followed by 2. Teaching method through lectures, 3. Interactive method, 4. Effective teaching method, by applying the atmosphere for an attractive lesson.

Practical learning method is the application of the practical exercise during the learning process in PE and aims to enable the student to independently use these activities in practical life. By applying them professionally and working independently, individually or in groups, it is possible to form, acquire and stabilize the knowledge and motor skills. In order for children to learn a certain exercise, it is not enough to just give a description of it and ask the children to do it, but it is also necessary to show or demonstrate it (Aksović et al., 2021). Our results showed that the most used teaching method is the practical learning method, which coresponds whith authors (Constantinides, Montalvo & Silverman, 2013). The traditional method focuses on lecture-based teaching as the center of instruction, emphasizing delivery of program and concept (Johnson, 2010; Ilkiw et al., 2017; Dickinson et al., 2018).

Teaching method through the lectures pays attention to the essential value in PE classes (Goodyear & Dudley, 2015). Teachers use teaching aids to enhance classroom instruction, extract learners' attention and create a motivation to learn (Bel-Ann Ordu, 2021). Therefore, PE teachers must have a good knowledge of these theoretical contents, which is one of the prerequisites for being competent, effective and confident in their intervention (Herold & Waring, 2017). The teaching model chosen by each teacher needs to be based on the specific characteristics, stage of development and needs of individuals, as this is most likely to increase learning and achievement of PE curriculum outcomes (Ferraz et al., 2023).

Teacher-children interactions help teachers to understand student's details closely and design measures for supporting the learners (Siayi, Pangani, Mabagala, 2023). Furthermore, Hofman et al. (2014) affirmed that interactive engagement and teaching revealed significant results and effects on student's academic achievement. For the teaching method to be effective, teaching should consist of an ongoing process of making desirable changes among learners using appropriate methods (Ayeni, 2011). Effective teaching method, how to apply the atmosphere for an attractive lesson, is the method applied by our PE teachers during the teaching of PE. This method means application of the different games that motivate children and at the same time effectively apply the lessons. Students take part in full or modified games applying all acquired knowledge and skills (Ningthoujam et al., 2017). According to previous evidence (Hidayat et al., 2023; Bellaera et al., 2021), the motivation for active learning; use of dialogue-based exercises; interaction between students and teachers, positively influenced the development of students critical thinking skills in the PE field.

The application of the questionaire from the PE teachers with childrens and parents for the childrens health is very important to be carried out every year. In this research, the largest number of PE teachers responded that they did not apply the questionnaire on the children's health conditions. Various authors have described that: Questioning strategy is one of the most important dimensions of teaching and learning processes (Astrid etal., 2019). Guest (1985) argues that questioning strategy is one of the most important tools to extend students learning which can help teachers to develop their own strategies to enhance students work

and thinking. According to the study of Wells (2001) questioning is a core function of both learning and teaching. Questionnaire is very useful for teaching and learning processes. It is a designer of curricular and instructional activities that facilitate interactions (Gumbo etal., 2019). Also, teaching strategies are significant in supplementing the needs of a variety of learners in carrying out PE classes (Sangco, 2017). Teaching strategy is a generalized plan for a lesson which includes structure, instructional objectives and an outline of planned tactics, necessary to implement the strategies (Issac, 2010). Lumanog (2016) stated that the teaching strategy of a teacher should match the students learning style and needs. A teaching strategy is therefore an educational technique, method or plan of classroom actions or interactions intended to accomplish specific teaching and learning goals (Ada, 2006).

Our responders have stated that the most important factors that influence the effective use of teaching strategies in PE are: Infrastructure and equipment's and teacher skills, followed by competitive activities among children and children's desire for physical and sports activities. Infrastructure and equipment's are necessary to realize the curriculum of PE subject. In PE learning, infrastructure is defined as something that facilitates or speeds up the process. The scope of PE subjects includes aspects of sports games, development activities, gymnastics activities, rhythmic activities, and health (Almusawi et al., 2021; Phelps et al., 2021). Education facilities and infrastructure are very beneficial for teachers and students so that learning can run smoothly and learning objectives can be adequately achieved (Beusker et al., 2012; Lau et al., 2021). The equipment is one of the backbones of PE classes. In PE classes, equipments should be age-appropriate and safe to use for the children (Bevans et al., 2010). PE teachers must manage students, equipment's, environment, and time for efficient learning, because children and adolescents spend almost half of their day at school, and PE is a subject where knowledge and physical activity are important (Sluijs, et al, 2021). Thereby, teachers should equip themselves with knowledge and specific skills to accomplish their job and responsibility in the classroom (Husain et al., 2015).

The teacher's ability to bring subject matters to the students in an imaginative way can also affect the success of the students in PE. Students' success can be credited to the teacher's application of different PE teaching techniques. Taking this into account, it may be assumed that the PE teachers need to be prepared more carefully through effective professional preparation programs. It could be assumed that good professional preparation would create good teachers, and competent teachers could provide more advanced PE programs (Aboshkair, 2014). Children motivation level and the usage of appropriate learning strategies in proper situation plays a key role in succeeding throughout their academic lives (Garcia & Pintrich, 1996). According to the study of Rink & Hall (2018), PE classes are best delivered in ways that are within the competency level of the learners. While regarding the "factors which can influence the increase in the effectiveness of teaching strategies", the infrastructure and equipment's also results to be the main factor, followed by "the addition of teaching hours" and "teacher trainings", while low number of responses is provided for factors such as "promotion through connections with sports organizations" and "children clothes and equipment".

Okebukola (2010) suggests that the activity and method of teaching and learning includes input factors – teachers, facilities, instructional materials, students, and curriculum. In the Republic of Kosovo, the PE class continues to be applied only two times a week, 45 minutes each time. We must point out that in other countries the PE lesson is held three times a week, and additionally including the swimming lesson and the Olympic Education lessons. Therefore, here we have to make a change in order to increase the number of teaching hours for the subject of PE. The effectiveness of teaching and the achievement of the objectives of the subject of PE is closely related to the number of teaching hours. Our findings also correspond with the findings of authors such as (COLEF Council, 2018; Heras et al., 2017; Pérez-Pueyo et al., 2021).

The training of PE teachers is necessary for the development of the teaching according to the newest and most innovative methods. In-service training is a professional and personal educational activity for teachers to improve their efficiency, ability, knowledge and motivation in their professional work (Che Mohd, 2014). This may lead us to consider that teachers with more trainings consolidate their learning better and are more able to identify the desired knowledge (Santiago & Morales, 2012; Kern, Bellar, & Clemons, 2021). Teachers also should possess and master the skills to convey the subject content with the aim to ensure the teaching process can be conducted in harmony and effective way (Husain et al, 2015). With experience, teachers know the content in more detail, can better link content to broader objectives, and can better sequence content across units (Pissanos & Allison, 1996; Rovegno, 1992, 1993, 1998; Sebran, 1995). The findings from this study are aligned with those of other studies PE (Morgan & Bourke, 2005; Xiang, Lowly & McBride, 2002). The continuous development and improvement of the teaching methods, enrich the content of the PE class, is essential to realize the goals of PE, and complete the task of teaching PE. By employing a variety of engaging and effective methods, teachers can create a positive and enriching learning environment that promotes lifelong participation in physical activity and healthy living.

Finally, the findings of the present study must be considered in light of its limitations. The major limitation of the present study is the use of a non-validated and non-standardized questionnaire. However, we believe that the present findings should encourage it's validation and standardization in the future.

Conclusions

With the aim to achieve the education to be in coordination with scientific, technological, sports and social developments, it must be continuously updated with new methods that affect teaching and learning as effectively as possible. Each country should build different policies that must be adapted to their own conditions and circumstances. According to the findings of the present study, we can conclude that the achievement of the goals of the PE subject is linked with the combination of the teaching methods, teacher's professional ability and knowledge, infrastructure, equipment, and number of the PE classes per week. PE teachers are required to choose the right method to create an effective learning process. The scientific contribution and obtained results from this study is suggested to be used in practice, for potential improvements and enrichment of the effective teaching methods in PE classes. Based on the results of this study, a new opportunity is opened for other studies of this nature, with the aim of enriching the scientific knowledge of the treated topics.

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Journal of Anthropology of Sport and Physical Education

ORIGINAL SCIENTIFIC PAPER

Biomechanics of the Spine: A case study on the fourth and fifth lumbar vertebrae

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Abstract

The spine's lumbar and sacral regions are critical in load-bearing activities typical in daily life and sports, such as lifting and carrying heavy objects. These activities subject the spine to complex biomechanical forces—namely compression, tension, and shear—particularly impacting the lumbar vertebrae. Understanding these forces is crucial for developing preventive strategies against injuries and enhancing physical performance. This case study aims to elucidate the biomechanical dynamics at play in the lumbar and sacral vertebrae under various loading conditions to identify the causes of injuries and devise methods to minimize their occurrence through improved lifting techniques. The research employed advanced biomechanical analysis, including the use of the DWATBAK computer model, to measure spinal forces during physical activities. This case study focused on the impact of shear forces and the resultant stresses during weightlifting, integrating anthropometric measurements to determine safe and effective lifting postures Present findings highlight the necessity of maintaining the natural curvature of the lumbar spine to decrease injury risk. Carrying loads close to the body's center was shown to significantly reduce spinal stress, particularly in the lower lumbar region. The case study delineated how specific postures could alleviate the risk of shearing forces that primarily affect the fourth and fifth lumbar vertebrae. Adopting correct lifting postures is imperative to prevent spinal injuries in the lumbar and sacral areas. The study emphasizes incorporating biomechanical insights into training regimes to improve safety and efficacy in activities involving heavy lifting.

Keywords: *biomechanics, lumbar vertebrae, spine*

Introduction

In our current era, where daily loads on individuals are increasing, the spine emerges as a crucial element requiring a precise understanding of its mechanisms and the forces affecting it to avoid potential injuries and to improve physical performance. The spine serves as a center for load bearing in the human body, consisting of vertebrae arranged in a way that allows for significant flexibility and support (Hanan Murad Marzouk & Hoda Badawi Shabib, 2023). The main forces impacting the spine discussed in this study include compression, tension, and shear. Continuous exposure to these forces without proper biomechanical planning can lead to complex injuries, particularly between the fourth and fifth lumbar vertebrae, necessitating in-depth research to understand these mechanisms and develop strategies for injury prevention. This case study aims to explore the biomechanical mechanisms of the spine, especially in the lumbar and sacral regions, which endure significant stress during activities such as lifting and carrying. More precisely, we aimed to investigate how the lumbar and sacral vertebrae are affected by different forces during daily activities, especially during weightlifting, and to identify the factors leading to injuries and how to minimize their occurrence through proper techniques and appropriate lifting postures. Additional goal was to understand how external loads affect the lumbar joint and the extent to which weight and the upper body's center impact the stability and safety of the spine.

By understanding the dynamics affecting the spine, effective strategies can be developed to reduce the risk of injuries

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and enhance individuals' physical performance (Davis, 2020). This research not only highlights the necessary precautions for lifters but also provides doctors and therapists with valuable information about the biomechanical adaptations required for spinal patient.

Based on these goals and methodology, the present case study strives to make significant contributions to the field of occupational health and safety and improve training and sports performance standards, reflecting the importance of biomechanical studies in maintaining the musculoskeletal system's health.

Methodology

Accurate biomechanical analyses were used to measure the forces affecting the spine during various activities, focusing on shear forces and the stresses resulting from lifting and carrying. The study relies on detailed biomechanical analysis that includes the use of computer models (such as DWATBAK) to analyze loads and evaluate performance, and measuring the forces impacting the spine during various activities. Additionally, the study employs anthropometric measurements to determine the safest and most effective postures during lifting.

This methodology allows for a comprehensive examination of how different forces impact the spine under simulated conditions, providing insights into optimal lifting techniques that can reduce the risk of injury. By using computer models, researchers can simulate a wide range of activities and scenarios, which helps in understanding the biomechanical stresses that occur on the spine and thus informing better practices and preventive measures. The incorporation of anthropometric data ensures that the findings are applicable to different body sizes and shapes, enhancing the practical application of the research outcomes in real-world settings.

Analysis

The three directions that force is applied to human tissue are compression, tension, and cutting (as shown in Figure 1). The curvature that exists in the spine, the nature of its S-shaped formation, and the various pressures to which it is exposed are one aspect of the variables to which it is exposed. The spine in vertebral compression and shear force, and torsion is a type of cut. This discussion is about the mechanics of the lumbar vertebrae. Shear force is defined as the force that acts in a direction parallel to the surface of the spine, as slippage can occur. Between the fourth point and the other are the fifth lumbar vertebrae, due to their vulgar formation and the force and shape that are affected by this area.

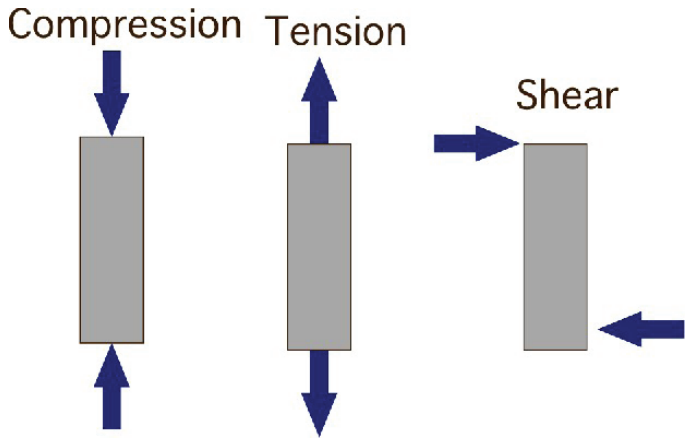

FIGURE 1. Terms used for strength trends

Mechanical Impacts:

1. Weightlifting and Its Effect: Lifting a weight centered on the upper part of the body and arms creates significant pressure on the lumbar vertebrae. This pressure generates a large torque around these vertebrae, necessitating considerable force to maintain balance and support. (Jones & Raasch, 2011)

2. Rotation Around the Cartilage: The cartilage located between the fourth and fifth lumbar vertebrae acts as the rotation center for this force, The muscular line of the spinal pelvic region is very close to the joint's rotation center, approximately 6-7 cm away, thus these muscles must exert a collective force to lift the spine. (Bauer & Paulus, 2020)

3. Muscular and Ligament Stress: The illustration also shows how the muscle line pulls the lumbar vertebrae together, creating pressure between them. This concept might be hard to visualize, but when the body's base is actually grounded the lower lumbar vertebrae are "pushed up" from below and pulled downwards by the muscles, generating significant compression forces again for lifting heavy weights. (Toyooka et al., 2019)

Additionally, there is a torque wanting to rotate the lifted weight towards the front side (clockwise direction in the illustration), along with the weight and load of the upper body during the descent of the weight (gravity pull). A component of this force involves cutting through the fourth and fifth lumbar cartilages. This force could pose a threat to slippage or particularly more severe injuries (Nachemson et al., 1986).

Anatomy of the Vertebrae and Causes of Injury
Understanding the Spinal Structure

- Complexity of Spinal Anatomy: The spinal column is highly complex and understanding it is not straightforward (Susan Hill & Translated by Hassan Hadi Al-Ziyadi and others, 2014) . Maintaining the natural curvature of the lumbar vertebrae (bending) is essential for spinal health.
- Mechanism of Injuries: Discussing the mechanics behind these injuries is crucial. The affected area typically involves the muscle line and various ligaments that connect the vertebrae to each other (from one segment to another) as illustrated in Figure 2. The muscle action line should be visible, and these components work to counteract the narrative force, which means the vertebrae are subjected to two forces acting in opposite directions, thereby attempting to create a balance between the force exerted and the impact on spinal operations.
- Types of Forces: Scientists and experts identify two main types of forces affecting the spine: shearing, which occurs when carrying heavy weights. The closer the upper body moves horizontally with the effect of the moving weight, the more significant is the actual impact on the joint between the fourth and fifth lumbar vertebrae and the strength of the muscle ligament (John McLester & Peter St. Pierre, 2008). This influencing force includes the effects of muscles and the ligament strength which causes the actual "infection" or damage to the fourth and fifth lumbar vertebrae (Panjabi & White, 1980).

Ligament Strength Visibility

- Visibility of Ligament Strength: The strength of the ligaments does not show clearly if you maintain the natural curvature of your lumbar spine. The spinal muscles create an opposing torque to extend your trunk, an element of this significant muscular force causes neutralization or reduction of the shearing force resulting from carrying a weight and the body mass.
- Muscle Forces: The muscular force is mostly parallel to the spine but also acts to pull back to resist forward movement. Many trainers believe that shearing force on the back does not occur unless the force impacting it is substantial. Although this may not be particularly intuitive, it is accurate that muscular forces compensate for the weight's impact (force) of the load and the upper body mechanically. Furthermore, these bends in the spine help absorb shocks without further injury when straight to respond to the forces impacting them in the same way (Tsuchida et al., 2022).

Common Injuries During High-Energy Activities

- Soft Tissue and Ligament Injuries: Injuries to soft tissues and ligaments are among the most common during activities requiring high friction and energy, such as collisions in basketball. Excessive tension or stress in the tissues or longitudinal ligaments can lead to tears or bone failures, as occurs when a ligament pulls a piece of the bone away from its attachment site (Susan J. Hall, 2007) (Predel et al., 2017) .

What happens when you bend backward? Understanding the spinal flexion and its effects.

1. Backward Bending (Extension):
   - Studies incorporating the analysis of electrical activity in the spine show that when the lumbar region is fully flexed forward (rounded forward), the contribution of the muscles to the required torque is significantly reduced, with the supportive force primarily generated by the ligaments. This state allows you to "turn off" your muscles, letting the ligaments bear the weight, which is not ideal.
2. Implications of Full Lumbar Flexion:
   - A well-trained athlete, though strong and adaptable, does not have sufficient ligament strength to counteract the shearing forces alone—the overlapping ligaments imply that they contribute significantly to the shearing component. During lumbar flexion, the angle at which these ligaments are pulled. Carrying a weight with full spinal bending leads to a phenomenon known as myoelectric silence (reduced muscle tension due to the relaxation and flexion relaxation phenomena), with all joints remaining static (O'Neill et al., 2022).
3. Muscle Inactivity and Ligament Recruitment:
   - It is observed that the definition in the lower back remains unchanged; then, the ligaments are recruited to contribute to the anterior shearing force which sometimes exceeds (1000 N) (Kamegaya, 2016) .

Common Misconceptions in Weightlifting:

1. Postural Misconceptions:
   - Most novice weightlifters (and even the more experienced ones) believe that their shoulders should be behind the bar, and their posture should be as straight as possible (McGill & Norman, 1987). This natural inclination aims to reduce the shearing force affecting the back, but this mechanical posture is incorrect.

Proper Training Focus:

Training should always focus on reassuring young athletes that having a flat back is not the same as having a straight back. A natural curve in the back, the state of the natural spine, should be maintained. Thus, the weight should be kept as close to the vertical axis as possible.

Biomechanical Analysis of Lifting and Its Impact on the Quadriceps and Spine

Part One: Range of Motion

- First Phase: This encompasses the first 60 degrees of motion, focusing primarily on the anterior bending of the leg.
- Second Phase: This includes an additional 25 degrees of bending, intensifying the movement's complexity and the precision needed to perform it safely.

Part Two: Biomechanical Analysis

- Detailed Analysis: The biomechanical analysis of lifts that pose risks to the quadriceps offers a detailed view. The ability to study the forces impacting the spine is invaluable for understanding the real risk of spinal injuries. This analysis is based on a program and numbers that simulate the condition of this crucial and fundamental part of human movement and the specific risks some lifts pose to the cervical vertebrae.
- Use of DWATBAK Program: The commercial computer model known as DWATBAK (Richardson, 2002) is utilized in the field of biomechanics. It mainly focuses on the spine, the central pillar in all lifting and carrying tasks, helping many researchers, doctors, and health and safety officials to minimize the occurrence of back injuries.

Program Specifications:

- Model Functionality: The program is designed for ease of use with a static model, meaning it calculates the torque due to loads and weights around the body's joints without motion. Because it computes non-dynamic forces in static (stationary) situations, the muscle torque must be exactly equal in strength but opposite in direction to maintain the correct posture since no injury occurs (Nachemson et al., 1986).
- Model Limitations: Such models cannot be used if the loads are unstable or mobile. Given that the process of lifting high weights is inherently risky and perilous at the outset, the program features relatively slow lifting, and the values it producer (Norman et al., 1998) are close to the actual forces affecting the spine. The model must also assume average measurements.

Implications for Training and Safety:

- Risk Assessment: By simulating real-life conditions and measuring forces accurately, the program helps in preparing individuals for safe lifting techniques that prevent undue stress on the spine, particularly protecting the cervical vertebrae.
- Safety Protocols: The static nature of the model ensures that trainers and health professionals can develop lifting strategies that avoid dynamic or unexpected loads, which are more likely to cause injuries.

Assumptions and Limitations:

- Assumption of Average Measurements: The model assumes average measurements for body parts, crucial for assessing the deep anatomy of the spine and ligaments based on MRI studies. A test conducted on a six-foot man (198 cm) weighing 200 pounds (90 kg) showed that although the pressure and loading values for a lighter individual are not significantly less, the weight of the load, not the body weight, is the dominant factor in calculations.
- Introduction of a 300-pound Load: A load of 300 pounds (136 kg) was introduced, and using this heavy-weight lifting model provides accurate values for the force impacting the spine. Despite some limitations, the model offers useful data for weightlifting when utilized correctly.

Computational Benefits:

- Spinal Posture and Force Calculation: The computer program is advantageous as it allows you to set loads either in a position of normal spine or fully flexible spine. The program then calculates the forces based on whether the muscles or ligaments bear this weight (load). The arm's torque (distance from a turning point) of muscles and ligaments is essentially the same in both cases, significantly influencing the shearing force.
- Figures and Graphical Representation: Figure (2) below show the lifting posture for weight (alignment of the normal spine and complete curvature) and the computer model measurements of the same postures, with "force arrows" representing the weight of the load. Acceptable values also appear on the tape graph. As shown above, these include (3433 N) pressure (also the upper limit of strength 6376 N as maximum allowed) and (500 N) for shearing (also with a maximum of (1000 N).

The Minor Difference Between the Two States in Lifting

The slight difference between the two scenarios is that adopting the correct mechanical posture for your back during snatch lifting, with less than maximum effort, involves moving your trunk slightly more horizontally and lowering your shoulders. This action increases torque, requiring the balance of the correct mechanical position. The significant difference between these two forces is that they impact the cervical spine area due to the collective shearing force. In the correct form of snatch, the proper biomechanical performance would only involve a shearing force of (699 N), which is below the maximum. However, the shearing force affecting the flexible back is (3799 N), equivalent to (775 pounds). Given that the computer program is designed for correct usage, the narrative force value for this lift is literally "below the level." A (600 pounds) load was entered into the program. The correct lifting values were pressure (17000 N), equivalent to (3500 pounds), and shearing (1200 N), equivalent to (240 pounds). Therefore, when lifting a quad weight of (600 pounds) properly as a narrative force, it is only 20% above what sports medicine scientists indicate as the maximum. With the incorrect spine posture, however, the pressure is 18300 N and the shearing force large (6700 N). This condition poses a risk to the spin (Kattoju et al., 2023, Hambali et al., 2019).

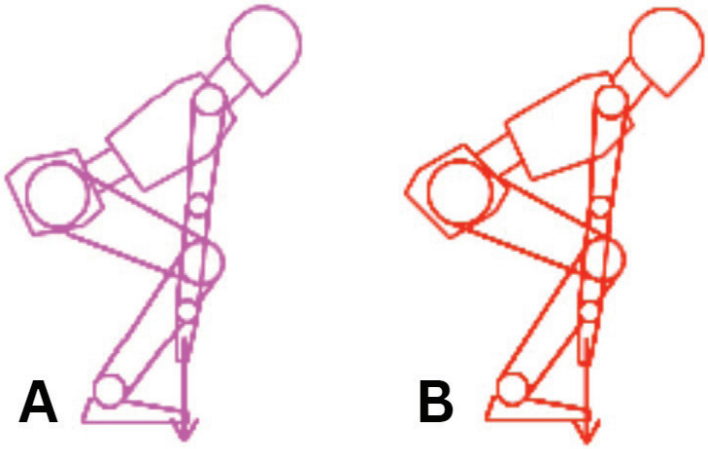

FIGURE 2. The model A represents inappropriate position and the B model represents the correct shape with the elasticity of the spine in the cotton area.

Importance of Proper Lifting Techniques

The illustration above shows the positioning of the spine at the back with the stretching force approximately 6 cm (Moramarco et al., 2010) away, which necessitates resisting the torque generated by the body's weights in addition to any external load. This explains why it is advisable to lift and carry heavy objects close to the trunk, emphasizing the importance of proper lifting techniques to minimize the risk of back injuries. Proper posture, especially keeping heavy loads close to the body's center, significantly reduces the stress on the spine, particularly in activities requiring heavy lifting (Labaj, 2014).

Causes and Treatment of Individual Lumbar Vertebrae Pain
Causes of Lumbar Vertebrae Pain

Lumbar vertebrae pain is one of the most severe and challenging types of pain for humans, with numerous underlying causes. Here are some of the main reasons for individual cases of lumbar vertebrae pain:

1. Severe Psychological Stress: One of the primary causes of lumbar vertebrae pain is severe psychological stress, which can lead to back muscle strain, spasms, and lower back cramps. These pains often do not respond to conventional treatment.
2. Inflammation and Infections: Back inflammation, bone abscesses, or meningitis can also cause lumbar pain.
3. Mechanical Usage of the Back: The way the back is used in daily activities can affect the lumbar area, leading to issues like disc slippage. This can be treated conservatively with rest and physical therapy sessions if mild, or may require surgical intervention if severe and significantly painful.
4. Gastrointestinal Diseases: Diseases such as gallbladder issues, pancreatitis, neuromas, and duodenal ulcers can also lead to lumbar pain.
5. Osteoporosis: Osteoporosis is a critical cause of structural damage to the lumbar vertebrae and severe pain.
6. Degenerative Disc Disease: The most significant cause of spinal damage and lumbar disc herniation is spinal stenosis, which results in intense pain in the lumbar vertebrae. This can be compounded by conditions like rheumatism or psoriatic arthritis, and fibromuscular inflammation associated with insufficient sleep or inadequate rest and intestinal arthritis (Saraswati et al., 2022).

Treatment for Lumbar Vertebrae Pain

The treatment for lumbar vertebrae pain involves several approaches depending on the severity and the underlying cause:

1. Complete Rest: Doctors often prescribe complete bed rest for a period of one to two weeks in a fully relaxed posture, using warm compresses, gentle massage, and avoiding carrying any weight exceeding 40-50 Newtons.
2. Medication: Pain relievers and anti-inflammatory drugs are

commonly used, and sometimes sedatives are prescribed.
3. Physical Therapy: This may include specific exercises, thermal or electrical therapy, and hydrotherapy to help relieve pain and restore function.
4. Surgical Intervention: In severe cases affecting mobility and causing intense pain, surgical intervention may be necessary to treat the disc slippage.
5. Lifestyle Adjustments: Modifications in daily activities to reduce the mechanical use of the back can prevent the aggravation of lumbar area issues.

Conclusion

The loads experienced by an individual on the spine are crucially linked, with the impact of the load and weights focused on the fourth and fifth lumbar vertebrae. Anatomical knowledge of the movement of the spine plays a significant role in preventing injuries. Adopting the correct mechanical posture when carrying a specific weight clearly influences injury prevention. Increasing the effectiveness of muscles and ligaments significantly contributes to avoiding injuries or complications. Weights should be carried close to the body to reduce additional loads, pinpoint the lumbar sacral area, and prevent injuries. Learning the causes of injuries, avoiding them, and their rehabilitation are essential.

Understanding the mechanical and metaphysical aspects of the athlete and the coach contributes to creating a positive environment in reducing injury occurrences. There is a need to focus on knowledge in mechanical, anatomical, and physical aspects to define loads. Training for athletes engaged in weightlifting and other sports influences the risk of injuries. Conducting clinical examinations and understanding the anatomical aspects of the spine thereby knowing the extent to which strength training can be endured when carrying weights, whether dynamic or static.

There is a need for rehabilitation exercises to consider the possibility of developing balanced muscle work for all muscles surrounding the operations, stabilizing, counteracting to assist, and assisting. There is a need to study and rehabilitate sports injuries according to the correct mechanical performance for each sport. Each sport has a different muscular structure from one to another and plays a significant role in adopting a model for muscular and kinetic performance. Knowing the weak and anatomical aspects of muscles, ligaments, and bones has a positive effect in reducing the occurrence of injuries when progressing in training loads.

These conclusions and recommendations emphasize the importance of proper technique, anatomical understanding, and preventive strategies to enhance safety and effectiveness in lifting practices, thereby reducing the risk of spine-related injuries. It is crucial to integrate these insights into training regimes and rehabilitation programs to ensure athletes can perform safely and effectively.

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Journal of Anthropology of Sport and Physical Education

ORIGINAL SCIENTIFIC PAPER

The challenges of selected provincial coaches in implementing circuit training: basis for program development. A pilot study

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Abstract

This research comprehensively explored the challenges of provincial coaches in implementing circuit training. Utilizing a qualitative research design, the study included nine provincial coaches in the Philippines contributing as the main source of data. Using an open-ended guiding questionnaire verified by experts in the field, the research subjects actively participated in focus groups and in-depth interviews. The study revealed five essential themes capturing the significant challenges of provincial coaches in implementing circuit training: Participation in Training, Knowledge about Circuit Training, lack of Equipment and Facilities, Coaches' Expertise in Circuit Training, and Character of Athletes. As this research contributes critical insights into the different challenges associated with the implementation of circuit training, it provides different strategic programs and practices for development and enhancement of the inclusion of circuit training program in provincial areas.

Keywords: *Challenges of Provincial Coaches, Implementation, Expertise, Character, Participation, Qualitative Research*

Introduction

Various training approaches are available in the field of fitness and exercise to improve strength, endurance, and total physical fitness. Circuit training is a notable methodology that has gained a significant status among fitness enthusiasts, athletes, and professionals due to its versatility and high effectiveness. Circuit training is widely recognized for its worth and capacity to accommodate a wide range of fitness purposes. This form of exercise provides a dynamic and organized workout routine that effectively engages different muscle groups, hence optimizing calorie expenditure and cardiovascular advantages.

Circuit training is a dynamic fitness strategy in which series of exercises are performed consecutively, frequently at different stations, with brief rest intervals in between (Shekhawat & Chauhan, 2020). It is particularly developed to improve agility, strength, velocity, and power, resulting in increased physical fitness and endurance. This routine combines cardiovascular training and strength building into a single workout session by working multiple muscle groups and combining a variety of exercises. The ultimate result is a general improvement in physical fitness characteristics such as power, endurance, strength, velocity, and agility.

According to Halil (2009) and Edwarsyah & Hardiansyah (2020), circuit training is an adaptable exercise regimen that integrates a variety of training strategies with brief periods of leisure. It consists of numerous variations of training that are station-organized in an effort to maximize efficiency and effectiveness. This methodology amalgamates diverse exercises characterized by varying degrees of physical intensity, with the objective of augmenting qualities such as velocity, strength, explosive capability, and stamina. The exercise regimen at each station is customized to accommodate specific athletic demands and prerequisites. Empirical evidence indicates that the integration of weightlifting into circuit training can yield substantial enhancements in strength, muscular endurance, stamina, and cardiovascular capacity. The approach is modern

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in nature and frequently incorporates band resistance training, weightlifting, and bodyweight exercises (e.g., push-ups, squats). Individuals who are in search of sports-specific capabilities and general functional fitness can derive advantages from circuit training, specifically in relation to tasks that require lifting, pressing, or carrying. It facilitates the development of muscular strength and explosive power, which are critical during the anatomical adaptation stage of training. This stage emphasizes conditioning, fundamental strength, and overall preparedness for more challenging exercises (Edwarsyah & Hardiansyah, 2020)

A variety of physiological capabilities—muscular endurance, strength, aerobic capacity, and power—can be enhanced by means of the comprehensive approach provided by this training regimen. Circuit training provides a multifaceted framework encompassing three discrete modalities. According to the research conducted by Mchenry and Nitka (2022), these modalities consist of bodyweight training, which does not require any apparatus and is portable, allowing for workouts to be conducted virtually anywhere. When selecting the circuit type, location and apparatus accessibility should be considered.

Circuit training has surfaced as a potentially effective strategy for encouraging physical well-being and fitness across all age groups and levels of fitness. Provincial instructors are of paramount importance in the Philippines, where sports development initiatives are critical for promoting physical fitness and overall health. They are entrusted with the implementation of exercise programs at the community level. Nevertheless, the incorporation of circuit training into coaching methodologies encounters a multitude of obstacles that are shaped by socio-economic, cultural, and logistical considerations. In the Philippines, several fitness and sports coaches use this circuit training method to strengthen their athletes, specifically in urban areas such as the National Capital Region but limited in provinces. Recognizing this gap, the main objective of this study is to identify the challenges that provincial coaches in the Philippines face when implementing circuit training programs. It also seeks to offer program development for effectively overcoming these obstacles. Additionally, it aims to supply the gap in the literature by delivering significant insights concerning the challenges of provincial coaches in implementing a circuit training program.

Methodology

Research Design and Procedures

This study used social cognitive theory by Albert Bandura (1960). According to Schunk (2012), social cognitive theory emphasizes the connection between the person and the environment as a determining factor of behavior. The theory provides a guide to understanding how a person learns from observing others, how they regulate their behaviors, and how their values, beliefs, and views influence their action. Thus, a descriptive qualitative research design was utilized to identify the challenges of provincial coaches in implementing the circuit training. According to Regonel (2023), a study method called descriptive qualitative research aims to comprehend phenomena by analyzing their features and attributes. Before the online interview, the coaches who participated in the study signed a consent form to be familiar with the aim of the study. After securing the consent form from the participants, the researcher utilized informal, open-ended, and in-depth online interviews to make the participants feel comfortable so they could precisely discuss what they were thinking. While doing the interviews, the researcher invested in taking down notes and documenting the experienced barriers of provincial coaches in implementing circuit training supported in gathering essential data.

Ethical Consideration

In conducting the study, compliance with ethical standards was observed. The researcher confirmed that all necessary procedures were taken to guarantee conformity with ethical standards. Tagare and Villaluz (2021) mentioned Bryce's (2001), principles for research in real-world experiences include (1) looking for the truth; (2) people's perspective of life was derived from their own experiences; and (3) leading to new approaches to thinking about philosophy, methods, and philosophy.

Coaches who participated in this study were treated with utmost respect and informed of their rights. Privacy and anonymity were guaranteed, therefore, participants' responses were kept confidential. The researcher provided informed consent to the participants, signifying their independent decision to be part of the study. Before data collection, an orientation session was conducted to clarify the study's objectives and tasks, ensuring fairness and transparency throughout the research process.

Research Participants and Materials

Nine provincial coaches (4 female and 5 male) from different provinces participated in this pilot study. More precisely, 55.56% are from Luzon, 33.33% are from Visayas, and 11.11% are from Mindanao. The researcher utilized non-probability sampling, specifically the purposeful sampling technique. According to Palinkas et al. (2015), in qualitative research, purposeful sampling is frequently employed to find and choose cases that are rich in information on the topic of interest. The participants were selected to provide their challenges in implementing circuit training.

Open-ended questions were utilized by the researcher so that the participants could precisely discuss their challenges in implementing circuit training. The questions are reviewed and validated by five sports coaches in Metro Manila who mastered the implementation of circuit training followed by the analysis of collected data. The researcher also navigates the use of voice recorders, cameras, and memo pads.

Data Analysis and Interpretation

The data of this study were analyzed and interpreted using thematic analysis. Usually, it is used for a collection of texts, such as transcripts or interviews. To find recurring themes—topics, concepts, and patterns of meaning—the researcher scrutinizes the data (Caulfield, 2023). The researcher followed the six steps of Braun and Clarke. In the study of Maguire and Delahunt (2017), they mentioned the six steps of Braun and Clarke which are: Become familiar with the data, Generate initial codes, Search for themes, Review themes, Define themes, and Write-up. With the method mentioned, the researcher set the day of the online interview. The collection of data was written on a memo pad while the interview was being recorded. After the interview, the researcher plays the recording multiple times to identify the respondents' exact words. After that, the statements of participants were categorized by coding and themes. The findings were reviewed for an in-depth characterization of a phenomenon, and then the researcher formulated the phenomenon's basic framework. After the phenomenon's basic framework was formulated, the researcher asked the participants to authenticate the result on the lived challenges of provincial coaches in implementing circuit training. Verification in thematic analysis reinforces the key findings by reviewing the data as often required until the appropriate confirmation level was reached.

Results

Table 1. Essential themes, Category, and Core Ideas on the Challenges of Selected Provincial Coaches in Implementing Circuit Training

Essential Themes	Category	Core Ideas
Participation in training	Participants discuss that athletes' participation is one of the problems in the implementation of circuit training.	Overload circuit training can cause players to quickly fatigue. Too much focus on circuit training can cause compromising. You have to evaluate them individually by doing movement analysis. When the clients are too many in a session, as a coach I would not be able to monitor all of them at the same time. Some of the players are not physically fit, because of a lack experience and because some of them are new for the training drills. Hard to provide circuit training during training because of the athlete's ability to participate in the training.
Knowledge about circuit training	Participants expressed that knowledge of athletes hinders the implementation of circuit training.	Not all kids are familiar in different kind of skills that they encounter in practice. In our provinces, they are not familiar with the concept of circuit training, thus they don't show interest. Lack of awareness and its importance in bringing out proper training for players.
Lack of Equipment and Facilities	Participants discussed that lack of equipment and facilities is one of the contributing factors in the implementation of circuit training.	Unavailability of equipment and limited or tiny space. There are moments inside the gym when some clients want to use the same equipment at the same time. Having no equipment can block the implementation of the circuit training.
Coaches Expertise in circuit training	Participants expressed that their expertise in implementing circuit training is one of the problems.	Teaching circuit training is not feasible without support from other coaches For me as a coach, there might be fewer opportunities for us to attend workshops or training, specifically focusing on circuit training.
Character of Athletes	Participants exposed that the character of the athletes hinders the implementation of circuit training.	Lack of motivation of athletes Lack of discipline of athletes Trainee should be able to construct managing his time to ensure the completeness of the training session. Players are inactive in training because of the intense training.

Discussion

Theme 1: Participation in training

This theme delves into the challenges of provincial coaches in implementing circuit training. According to the participants, the mainly challenges when it comes to participation in circuit training are: fatigability induced by circuit training, individual differences, and too many participants. Coaches in the provinces typically practice their respective sports without proper conditioning through circuit training. These challenges represent a significant issue that impacts the implementation of the circuit training by the provincial coaches. According to the participants:

"Overload circuit training can cause players to quickly fatigue, and they are very exhausted even if their practice game is not yet started. Compromising their strategy and the technique in the game/play. Too much focus on circuit training can cause compromising and they did not implement their plan and strategies in the game." – Coach Three

When it comes to circuit training, we have what we called individual approach and team or group approach. Individually, people have different maturity, we have those beginner types, we have those average that can adapt and adjust already, and those that are advanced usually do high intensity workouts. You have to evaluate them individually by doing movement analysis. This will ensure if the exercises that you're giving to each of your clients are appropriate in a circuit training set-up"– Coach Seven

When the clients are too many in a session, as a coach I would not be able to monitor each of them at the same time. I will be having a hard time to correct their forms if ever see them."- Coach Nine

"Some of the players are not physically fit, they have lack of experience and they need to train well."- Coach Four

"It is challenging to implement circuit training during our sessions because athletes need to conserve their energy for sports practice."- Coach Five

These challenges regarding participation in training hamper the provincial coaches from implementing circuit training, thus should be addressed. To do so, coaches should identify the capabilities of their athletes. Also, coaches should be responsible for designing long and short training programs for the athletes, including the conditioning program through circuit training. On the other hand, designing a program should consider the number of participants.

Overload circuit training can lead to fatigue if not balanced with adequate recovery, potentially resulting in nonfunctional overreaching or overtraining syndrome, which impacts performance and well-being(Meeusen et al., 2013). According to Mola & Bayisa (2020), not all players are supposed to be in their best performance form all the time, especially when they are new to the given sport or have few experience in this type of training.

Theme 2: Knowledge about circuit training

The second theme that delves into the challenges of provincial coaches in implementing circuit training is the knowledge about circuit training. According to the participants, they are being challenged because not all athletes are familiar with the concept of circuit training. With these challenges, coaches are having a hard time introducing circuit training into their programs. This can be a significant issue that impacts the implementation of the circuit training by the provincial coaches According to the participants:

"Not all kids are familiar in different kind of skills that they encounter in practices. Kids are not familiar with the circuit train-

ing provided to them. Not all players have interest in doing circuit training. In our province, they are not familiar with this concept, thus they don't have interest in circuit training."- Coach Six

"Lack of awareness and its importance in bringing out proper training for players. Because lack of awareness can hinder progress, it is essential to remove such a habit in one's system. Circuit training is a highly effective way to improve overall fitness. If players are not in their complete level of awareness, they cannot perform optimally both in training and competition."- Coach Eight

This theme exposed that familiarity and awareness can easily address the challenges related to knowledge in circuit training. Coaches should not only involve their athletes in physical activity but also help them improve mentally. Experiencing circuit training at the beginner level will help the athletes gain experience and knowledge.

According to Velasco and Jordà (2020), one reason why athletes experience lack of knowledge in terms of training can be the feeling of boredom. This feeling stems primarily from repetitive actions performed during training. These scenarios occur when an athlete has reached a stage when improvement is not occurring as a result of achieving a specific objective and requires additional effort to develop. On the other hand, Brittain-Catlin (2004) emphasized that in training, achieving satisfactory quality requires both feedback and recognition. He pointed out that consistent, constructive feedback helps individuals understand their progress and areas needing improvement, while recognition serves to motivate and validate their efforts. These elements are crucial for fostering a positive and effective training environment, ensuring that participants remain engaged and committed to their development. Without feedback and recognition, trainees may struggle to gauge their performance and feel undervalued, ultimately hindering their growth and satisfaction. Furthermore, offering support during the early post-training stages is crucial for continuous development.

Theme 3: Lack of Equipment and Facilities

The third theme that delves into the challenges of provincial coaches in implementing circuit training is the lack of equipment and facilities. According to the participants, implementing circuit training needs a required number of equipment and facilities to cater the needs of the athletes. These challenges that deal with the lack of equipment and facilities are significant issues that influence the implementation of circuit training in the province. According to the participants:

"Unavailability of equipment and limited or tiny space. Upon our training it requires a variety of equipment to attain specific objectives and goals that must be executed or reached, and tiny or no space will affect the comprehensive training sessions required."- Coach Two

"Although we have enough equipment like for example, dumbbells, plates, barbells, and other essential equipment, there are moments inside the gym that some clients want to use the same equipment at the same time, thus this is one of the challenges. Coach Seven

"…having no equipment blocks the implementation of the circuit training"- Coach Nine

A prevalent issue in circuit training is the lack of space and equipment. Having appropriate equipment and plenty of space is essential for athletes to feel comfortable while training and to complete their exercises more efficiently. Sports equipment plays a key role in the way people perceive sports. It is important to invest in proper facilities and equipment since they help the athletes in their sporting journey.

Athletes face challenges due to limited training space and equipment, hindering their progress and performance skills. As a result, one of the biggest obstacles for athletes is how to perform well in competitions (Dehghansai et al., 2021) However, it is important to keep in mind that while planning training, there will be limited space and equipment available (Wahl-Alexander et al., 2021). In the study of Li et al. (2022), it has been emphasized the importance of strict and intelligent management of sports equipment primarily in school-settings because it has been revealed that it may affect children's attitude towards sports participation. This approach of managing equipment in sports could also be applied in gym-settings or training locations. It can basically make the essential sports and gym equipment always readily available for clients and athletes. As described in the article of Li (2015), sports equipment is a requisite in any sports activities. It is a necessary material that somehow keeps most sporting events moving. If there is a lack of equipment, especially in the gym, the training program could be negatively affected, and those set goals may not be reached. According to Lim et al. (2022), in many cases, there are insufficient resources to provide adequate exercise stations and ample space for individuals to work out comfortably and safely. As a result, overcrowding, extended wait times, and logistical difficulties in regulating the circuit's movement may arise, especially when the client-to-coach ratio is high. The lack of resources can also lead to a sub-optimal workout experience, which can have a negative impact on the participants' motivation to exercise regularly.

Theme 4: Coaches expertise in circuit training

The fourth theme that exposed the challenges of provincial coaches in implementing circuit training is the coaches' expertise in circuit training. According to the research participants, although they are familiar with circuit training, it is still important for them to have a deep understanding of circuit training. This will allow them to help the athletes understand the benefits of engaging in this type of training. According to them:

"… there are a lot of stations to provide different exercises and need coaches for checking the health of the players during training while doing the program to avoid injuries"- Coach Five

"For me as a coach there might be fewer opportunities for us to attend workshops or training, specifically focus on circuit training. This lack of access to resources can make it difficult for us to stay updated with the trends and practices in circuit training."- Coach Eight

This issue is relevant since coaches should have a solid foundation of knowledge before they introduce this type of training. Coaches should also instill in themselves the idea of life-long learning. Seeking for training workshops is one great way to accomplish this. Coaches must understand there are still things in the world, particularly in the sports world.

According to MacDonald et al. (2010), formally trained coaches can produce athletes with "higher personal and social skills" compared to untrained coaches. This suggests that receiving any form of training for coaches is more than enough in terms of helping athletes develop. In addition, those skills are significant not just in sports but in life in general. According to the study by Anyadike-Danes et al (2023), it is found that there are plenty of coaches who still don't apply essential periodization concepts. This is concerning because, as someone who is supposed to be good already in sports training, there are still coaches who probably and unknowingly do such things. This is why the lack of workshops for coaches must be a continuous duty.

Theme 5: Character of athletes

The last theme that delves into the challenges of provincial athletes in the implementation of circuit training is the character of athletes. According to the research participants, some athletes

do not have enough motivation to do circuit training, do not have time management, and are inactive athletes. This observation of coaches affects their implementation of circuit training. Thus, coaches need to create a space wherein athletes will understand the benefits of circuit training. According to them:

"Lack of motivation of athletes, there are a few athletes who doesn't really like to do the circuit training; and Lack of Discipline of Athletes, there are students who doesn't go through the process of training and hard work, they choose to show off immediately rather than go through the process of training."- Coach One

It is important that the trainee should be able to construct managing his time to ensure the completeness of the training session. Circuit training is not just a one-time training it has to be planned and well-arranged."- Coach Two

"Athletes are inactive in training because of the intense training, it affects their mental issues for being absent-minded and also some of the players don't understand the rules of the program."- Coach Four

These challenges should be addressed as soon as possible because everyone in the field has equal sentiments that character should go first before the skills of the athletes since if an athlete lacks discipline and immediately wants to show off – disregarding his/her training, there will be a lot of problems in the future. It will really be a difficult time for the coach to instill knowledge and a better "game plan" for players who do not trust in the process. Also, coaches and staff should provide clear instructions and perform well, especially those players who are not familiar with and lack understanding of the skills and training program given. Lastly, athletes should also know how to balance their schedules to have a successful training plan.

Motivation encompasses both internal and external factors that drive a person toward a specific course of action. It involves being spurred into action by impulses or desires and experiencing satisfaction and fulfillment upon achieving a goal. In sports, motivation is recognized as crucial for athletes, serving as a fundamental component in their pursuit of success (Kucukibis and Gul, 2019.) Athletes who regularly show up for training understand that it's not just about reaching their goals but also about recognizing the importance of dedication and effort in achieving success in every aspect of life. This mindset, characterized by an internal sense of control, empowers athletes to feel more self-driven and in control of their own paths to success. (Mallett & Hanrahan, 2004). On the other hand, to effectively manage the demands of academic endeavors and sports training, elite athletes need to manage their time well. (Quimbo, 2023). Gontijo et al. (2023) state that an athlete's mind has a major influence on both their performance and overall success. Constructive mental codes, such as believing in oneself after failure, have been shown to be significant in athletes' perseverance, motivation, and performance improvement through a systematic review study. In addition, it has been shown that a positive mindset improves an athlete's performance, indicating that practicing cognitive skills might improve competitive performance.

Conclusion

In conclusion, this study has explored the challenges of provincial coaches in implementing circuit training. Main findings indicate on five main challenges for coaches in implementing circuit training such as participation in training, knowledge about circuit training, lack of equipment and facilities, coaches' expertise in circuit training, and character of athletes. Participation in training reveals that athlete fatigue, individual differences in fitness level, and large participants are the challenges faced by coaches since they have a hard time designing their conditioning problem. Knowledge about circuit training reveals that familiarity, skills, and awareness are the contributing factors. On the other hand, the lack of equipment and facilities seems to be a significant factor as well. It shows that lacking space and inadequate access to important equipment hinder the ability to conduct effective training sessions. Coaches' expertise, such as limited access to seminars and training related to circuit training, is contributing to the challenges faced by the provincial athletes. Lastly, the character of an athlete, such as motivation, poor time management,and inactive, affects the implementation efforts.

Recommendations

Coaches should develop an individualized circuit training program that aligns with athletes' capabilities. They should organize a small group session to monitor its effectiveness and provide quality feedback. Additionally, they should implement a periodization to gradually increase the intensity of the training while ensuring an adequate recovery to avoid overtraining. Coaches should provide comprehensive educational training on benefits and techniques in circuit training, starting from beginner's level sessions to build familiarity. Additionally, coaches should enhance mental engagement through collaborative discussions and demonstrations to foster a deeper understanding of circuit training.

It is essential to invest in and upgrade sports facilities and equipment in provincial areas. During special events such as "palarong pamabansa" or division meets, coaches can ask the local government unit for sponsorship. Implementing a well-planned schedule can help accommodate a large number of participants. Coaches' regular maintenance and intelligent management of equipment can also ensure its longevity. Coaches should establish partnerships with sports organizations to access updated resources and training opportunities. Coaches should actively seek out and participate in training workshops and professional development programs focused on circuit training. Coaches should also seek a mentorship program with other coaches to further develop coaching expertise. Coaches should implement motivational strategies such as attainable goals and recognize athletes' progress. Establishing well-planned training programs with clear expectations can improve athletes' time management skills. Include visualization techniques for athletes to stay focused on the training. Additionally, coaches should create an environment that highlights the benefits of circuit training with an emphasis on discipline and commitment.

Practical applications

The study is beneficial to the provincial coaches for program development and optimizing resource allocation. By understanding the challenges encountered the design of the circuit training can be practical, relevant, and responsive to the capabilities of the athletes and the environment. Furthermore, this research can help athletes gain quality training programs- athletes can improve their physical fitness, skill development, and general performance by getting better training programs. It also helps the athlete to prevent injury- by finding the things that make circuit training less effective, coaches can better incorporate injury-prevention strategies into their athletes' workout plans, which will lower the chance of injuries related to sports. And enhance performance- through the utilization of the study's findings to optimize circuit training programs, athletes can attain elevated levels of performance, stamina, and resilience throughout training sessions and competitions.

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Number (Arabic numerals) the pages consecutively (centering at the bottom of each page), beginning with the title page as page 1 and ending with the Figure legend page.

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- A structured abstract of less than 250 words;
- Maximum number of references is 15.

Invited papers and award papers include invited papers from authors with outstanding scientific credentials. Nomination of invited authors is at the discretion of the JASPE editorial board. JASPE also publishes award papers selected by the scientific committee of the publisher's conferences.

☐Open Submissions ☑Indexed ☐Peer Reviewed

Invited papers and award papers should be:
- Up to 3000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 30;
- Maximum combined total of 6 Tables/Figures.

1.3. Submission

JASPE only accepts electronic submission to the e-mail of the Journal Office: **office.jaspe.mne@gmail.com; vasileva.jaspe@gmail.com**.

Submitted material includes:

- A manuscript prepared according to the Guidelines for the Authors;
- A signed form that states the study was not previously published, nor has been submitted simultaneously for consideration of publication elsewhere, that states that all of the authors are in agreement with submission of the manuscript to JASPE, and that, for studies that use animal or human individuals, authors must include information regarding their institution's ethics committee, and which identifies the official approval number;
- A signed form that there is no conflict of interest.

Name the files according to the family name of the first author. Authors submitting revised versions of the manuscript can use the identification number of their manuscript as provided by the Journal Office. *See* example:

- ✓ FAMILY NAME-manuscript.doc – (main manuscript file)
- ✓ FAMILY NAME-statement.PDF – (authorship statement)
- ✓ FAMILY NAME-declaration.PDF – (declaration of potential conflict of interest)
- ✓ FAMILY NAME-fig1.tiff – (Figure 1)

1.4. Peer Review Process

A manuscript submitted for publication will be submitted to the review process as long as it fits the following criteria:

- The study was not previously published, nor has been submitted simultaneously for consideration of publication elsewhere;
- All persons listed as authors approved its submission to JASPE;
- Any person cited as a source of personal communication has approved the quote;
- The opinions expressed by the authors are their exclusive responsibility;
- The author signs a formal statement that the submitted manuscript complies with the directions and guidelines of JASPE.

The editors-in-chief and associate editors will make a preliminary analysis regarding the appropriateness, quality, originality and written style/grammar of the submitted manuscript. The editors reserve the right to request additional information, corrections, and guideline compliance before they submit the manuscript to the ad-hoc review process.

JASPE uses ad-hoc reviewers, who volunteer to analyze the merit of the study. Typically, one or two expert reviewers are consulted in a double-blind process. Authors are notified by e-mail when their submission has been accepted (or rejected). Minor changes in the text may be made at the discretion of the editors-in-chief and/or associate editors. Changes can include spelling and grammar in the chosen language, written style, journal citations, and reference guidelines. The author is notified of changes via email. The final version is available to the author for his or her approval before it is published.

1.5. Open Access License and Publisher Copyright Policies

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The editors of JASPE consider plagiarism to be a serious breach of academic ethics. Any author who practices plagiarism (in part or totality) will be suspended for six years from submitting new submissions to JASPE. If such a manuscript is approved and published, public exposure of the article with a printed mark ("plagiarized" or "retracted") on each page of the published file, as well as suspension for future publication for at least six years, or a period determined by the editorial board. Third party plagiarized authors or institutions will be notified, informing them about the faulty authors. Plagiarism will result in immediate rejection of the manuscript.

JASPE only publishes studies that have been approved by an institutional ethics committee (when a study involves humans or animals). Fail to provide such information prevent its publication. To ensure these requirements, it is essential that submission documentation is complete. If you have not completed this step yet, go to JASPE website and fill out the two required documents: Declaration of Potential Conflict of Interest and Authorship Statement. Whether or not your study uses humans or animals, these documents must be completed and signed by all authors and attached as supplementary files in the originally submitted manuscript.

1.6. After Acceptance

After the manuscript has been accepted, authors will receive a PDF version of the manuscripts for authorization, as it should look in printed version of JASPE. Authors should carefully check for omissions. Reporting errors after this point will not be possible and the Editorial Board will not be eligible for them.

Should there be any errors, authors should report them to the Office e-mail address **jaspe@ucg.ac.me.** If there are not any errors authors should also write a short e-mail stating that they agree with the received version.

1.7. Code of Conduct Ethics Committee of Publications

JASPE is hosting the Code of Conduct Ethics Committee of Publications of the **COPE** (the Committee on Publication Ethics), which provides a forum for publishers and Editors of scientific journals to discuss issues relating to the integrity of the work submitted to or published in their journals.

2. MANUSCRIPT STRUCTURE

2.1. Title Page

The first page of the manuscripts should be the title page, containing: title, type of publication, running head, authors, affiliations, corresponding author, and manuscript information. *See* example:

Analysis of Dietary Intake and Body Composition of Female Athletes over a Competitive Season

Original Scientific Paper

Diet and Body Composition of Female Athletes

Svetlana Nepocatych[1], Gytis Balilionis[1], Eric K. O'Neal[2]

[1]Elon University, Department of Exercise Science1, Elon, NC 27215
[2]University of North Alabama, Department of Health, Physical Education and Recreation, Florence, AL 35632

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100 Campus Dr.

2525 CB

Elon, NC 27244

United States

E-mail: snepocatych@elon.edu

Word count: 2,946

Word count: 4259

Abstract word count: 211

Number of Tables: 3

2.1.1. Title

Title should be short and informative and the recommended length is no more than 20 words. The title should be in Title Case, written in uppercase and lowercase letters (initial uppercase for all words except articles, conjunctions, short prepositions no longer than four letters etc.) so that first letters of the words in the title are capitalized. Exceptions are words like: "and", "or", "between" etc. The word following a colon (:) or a hyphen (-) in the title is always capitalized.

2.1.2. Type of publication

Authors should suggest the type of their submission.

2.1.3. Running head

Short running title should not exceed 50 characters including spaces.

2.1.4. Authors

The form of an author's name is first name, middle initial(s), and last name. In one line list all authors with full names separated by a comma (and space). Avoid any abbreviations of academic or professional titles. If authors belong to different institutions, following a family name of the author there should be a number in superscript designating affiliation.

2.1.5. Affiliations

Affiliation consists of the name of an institution, department, city, country/territory (in this order) to which the author(s) belong and to which the presented / submitted work should be attributed. List all affiliations (each in a separate line) in the order corresponding to the list of authors. Affiliations must be written in English, so carefully check the official English translation of the names of institutions and departments.

Only if there is more than one affiliation, should a number be given to each affiliation in order of appearance. This number should be written in superscript at the beginning of the line, separated from corresponding affiliation with a space. This number should also be put after corresponding name of the author, in superscript with no space in between.

If an author belongs to more than one institution, all corresponding superscript digits, separated with a comma with no space in between, should be present behind the family name of this author.

In case all authors belong to the same institution affiliation numbering is not needed.

Whenever possible expand your authors' affiliations with departments, or some other, specific and lower levels of organization.

2.1.6. Corresponding author

Corresponding author's name with full postal address in English and e-mail address should appear, after the affiliations. It is preferred that submitted address is institutional and not private. Corresponding author's name should include only initials of the first and middle names separated by a full stop (and a space) and the last name. Postal address should be written in the following line in sentence case. Parts of the address should be separated by a comma instead of a line break. E-mail (if possible) should be placed in the line following the postal address. Author should clearly state whether or not the e-mail should be published.

2.1.7. Manuscript information

All authors are required to provide word count (excluding title page, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References), the Abstract word count, the number of Tables, and the number of Figures.

2.2. Abstract

The second page of the manuscripts should be the abstract and key words. It should be placed on second page of the manuscripts after the standard title written in upper and lower case letters, bold.

Since abstract is independent part of your paper, all abbreviations used in the abstract should also be explained in it. If an abbreviation is used, the term should always be first written in full with the abbreviation in parentheses immediately after it. Abstract should not have any special headings (e.g., Aim, Results…).

Authors should provide up to six key words that capture the main topics of the article. Terms from the Medical Subject Headings (MeSH) list of Index Medicus are recommended to be used.

Key words should be placed on the second page of the manuscript right below the abstract, written in italic. Separate each key word by a comma (and a space). Do not put a full stop after the last key word. *See* example:

Abstract

Results of the analysis of

Key words: *spatial memory, blind, transfer of learning, feedback*

2.3. Main Chapters

Starting from the third page of the manuscripts, it should be the main chapters. Depending on the type of publication main manuscript chapters may vary. The general outline is: Introduction, Methods, Results, Discussion, Acknowledgements (optional), Conflict of Interest (optional), and Title, Author's Affiliations, Abstract and Key words must be in English (for both each chosen language of full paper). However, this scheme may not be suitable for reviews or publications from some areas and authors should then adjust their chapters accordingly but use the general outline as much as possible.

2.3.1. Headings

Main chapter headings: written in bold and in Title Case. *See* example:

- ✓ **Methods**

Sub-headings: written in italic and in normal sentence case. Do not put a full stop or any other sign at the end of the title. Do not create more than one level of sub-heading. *See* example:

- ✓ *Table position of the research football team*

2.3.2 Ethics

When reporting experiments on human subjects, there must be a declaration of Ethics compliance. Inclusion of a statement such as follow in Methods section will be understood by the Editor as authors' affirmation of compliance: "This study was approved in advance by [name of committee and/or its institutional sponsor]. Each participant voluntarily provided written informed consent before participating." Authors that fail to submit an Ethics statement will be asked to resubmit the manuscripts, which may delay publication.

2.3.3 Statistics reporting

JASPE encourages authors to report precise p-values. When possible, quantify findings and present them with appropriate indicators of measurement error or uncertainty (such as confidence intervals). Use normal text (i.e., non-capitalized, non-italic) for statistical term "p".

2.3.4. 'Acknowledgements' and 'Conflict of Interest' (optional)

All contributors who do not meet the criteria for authorship should be listed in the 'Acknowledgements' section. If applicable, in 'Conflict of Interest' section, authors must clearly disclose any grants, financial or material supports, or any sort of technical assistances from an institution, organization, group or an individual that might be perceived as leading to a conflict of interest.

2.4. References

References should be placed on a new page after the standard title written in upper and lower case letters, bold.

All information needed for each type of must be present as specified in guidelines. Authors are solely responsible for accuracy of each reference. Use authoritative source for information such as Web of Science, Medline, or PubMed to check the validity of citations.

2.4.1. References style

JASPE adheres to the American Psychological Association 6th Edition reference style. Check "American Psychological Association. (2009). Concise rules of APA style. American Psychological Association." to ensure the manuscripts conform to this reference style. Authors using EndNote® to organize the references must convert the citations and bibliography to plain text before submission.

2.4.2. Examples for Reference citations

One work by one author
- ✓ In one study (Reilly, 1997), soccer players
- ✓ In the study by Reilly (1997), soccer players
- ✓ In 1997, Reilly's study of soccer players

Works by two authors
- ✓ Duffield and Marino (2007) studied
- ✓ In one study (Duffield & Marino, 2007), soccer players
- ✓ In 2007, Duffield and Marino's study of soccer players

Works by three to five authors: cite all the author names the first time the reference occurs and then subsequently include only the first author followed by et al.
- ✓ First citation: Bangsbo, Iaia, and Krustrup (2008) stated that
- ✓ Subséquent citation: Bangsbo et al. (2008) stated that

Works by six or more authors: cite only the name of the first author followed by et al. and the year
- ✓ Krustrup et al. (2003) studied
- ✓ In one study (Krustrup et al., 2003), soccer players

Two or more works in the same parenthetical citation: Citation of two or more works in the same parentheses should be listed in the order they appear in the reference list (i.e., alphabetically, then chronologically)
- ✓ Several studies (Bangsbo et al., 2008; Duffield & Marino, 2007; Reilly, 1997) suggest that

2.4.3. Examples for Reference list

Journal article (print):

Nepocatych, S., Balilionis, G., & O'Neal, E. K. (2017). Analysis of dietary intake and body composition of female athletes over a competitive season. *Montenegrin Journal of Sports Science and Medicine, 6*(2), 57-65. doi: 10.26773/mjssm.2017.09.008

Duffield, R., & Marino, F. E. (2007). Effects of pre-cooling procedures on intermittent-sprint exercise performance in warm conditions. *European Journal of Applied Physiology, 100*(6), 727-735. doi: 10.1007/s00421-007-0468-x

Krustrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., Bangsbo, J. (2003). The yo-yo intermittent recovery test: physiological response, reliability, and validity. *Medicine and Science in Sports and Exercise, 35*(4), 697-705. doi: 10.1249/01.MSS.0000058441.94520.32

Journal article (online; electronic version of print source):

Williams, R. (2016). Krishna's Neglected Responsibilities: Religious devotion and social critique in eighteenth-century North India [Electronic version]. *Modern Asian Studies, 50*(5), 1403-1440. doi:10.1017/S0026749X14000444

Journal article (online; electronic only):

Chantavanich, S. (2003, October). Recent research on human trafficking. *Kyoto Review of Southeast Asia, 4*. Retrieved November 15, 2005, from http://kyotoreview.cseas.kyoto-u.ac.jp/issue/issue3/index.html

Conference paper:

Pasadilla, G. O., & Milo, M. (2005, June 27). *Effect of liberalization on banking competition*. Paper presented at the conference on Policies to Strengthen Productivity in the Philippines, Manila, Philippines. Retrieved August 23, 2006, from http://siteresources.worldbank.org/INTPHILIPPINES/Resources/Pasadilla.pdf

Encyclopedia entry (print, with author):

Pittau, J. (1983). Meiji constitution. In *Kodansha encyclopedia of Japan* (Vol. 2, pp. 1-3). Tokyo: Kodansha.

Encyclopedia entry (online, no author):

Ethnology. (2005, July). In *The Columbia encyclopedia* (6th ed.). New York: Columbia University Press. Retrieved November 21, 2005, from http://www.bartleby.com/65/et/ethnolog.html

Thesis and dissertation:

Pyun, D. Y. (2006). *The proposed model of attitude toward advertising through sport.* Unpublished Doctoral Dissertation. Tallahassee, FL: The Florida State University.

Book:
Borg, G. (1998). *Borg's perceived exertion and pain scales*: Human kinetics.

Chapter of a book:
Kellmann, M. (2012). Chapter 31-Overtraining and recovery: Chapter taken from Routledge Handbook of Applied Sport Psychology ISBN: 978-0-203-85104-3 *Routledge Online Studies on the Olympic and Paralympic Games* (Vol. 1, pp. 292-302).

Reference to an internet source:
Agency. (2007). Water for Health: Hydration Best Practice Toolkit for Hospitals and Healthcare. Retrieved 10/29, 2013, from www.rcn.org.uk/newsevents/hydration

2.5. Tables

All tables should be included in the main manuscript file, each on a separate page right after the Reference section.

Tables should be presented as standard MS Word tables.

Number (Arabic) tables consecutively in the order of their first citation in the text.

Tables and table headings should be completely intelligible without reference to the text. Give each column a short or abbreviated heading. Authors should place explanatory matter in footnotes, not in the heading. All abbreviations appearing in a table and not considered standard must be explained in a footnote of that table. Avoid any shading or coloring in your tables and be sure that each table is cited in the text.

If you use data from another published or unpublished source, it is the authors' responsibility to obtain permission and acknowledge them fully.

2.5.1. Table heading

Table heading should be written above the table, in Title Case, and without a full stop at the end of the heading. Do not use suffix letters (e.g., Table 1a, 1b, 1c); instead, combine the related tables. *See* example:

- ✓ **Table 1.** Repeated Sprint Time Following Ingestion of Carbohydrate-Electrolyte Beverage

2.5.2. Table sub-heading

All text appearing in tables should be written beginning only with first letter of the first word in all capitals, i.e., all words for variable names, column headings etc. in tables should start with the first letter in all capitals. Avoid any formatting (e.g., bold, italic, underline) in tables.

2.5.3. Table footnotes

Table footnotes should be written below the table.

General notes explain, qualify or provide information about the table as a whole. Put explanations of abbreviations, symbols, etc. here. General notes are designated by the word *Note* (italicized) followed by a period.

- ✓ *Note.* CI: confidence interval; Con: control group; CE: carbohydrate-electrolyte group.

Specific notes explain, qualify or provide information about a particular column, row, or individual entry. To indicate specific notes, use superscript lowercase letters (e.g. $^{a, b, c}$), and order the superscripts from left to right, top to bottom. Each table's first footnote must be the superscript ^{a}.

- ✓ ^{a}One participant was diagnosed with heat illness and n = 19.^{b}n =20.

Probability notes provide the reader with the results of the texts for statistical significance. Probability notes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || etc.

- ✓ *P<0.05,†p<0.01.

2.5.4. Table citation

In the text, tables should be cited as full words. *See* example:

- ✓ Table 1 (first letter in all capitals and no full stop)
- ✓ ...as shown in Tables 1 and 3. (citing more tables at once)
- ✓ ...result has shown (Tables 1-3) that... (citing more tables at once)
- ✓ ....in our results (Tables 1, 2 and 5)... (citing more tables at once)

2.6. Figures

On the last separate page of the main manuscript file, authors should place the legends of all the figures submitted separately.

All graphic materials should be of sufficient quality for print with a minimum resolution of 600 dpi. JASPE prefers TIFF, EPS and PNG formats.

If a figure has been published previously, acknowledge the original source and submit a written permission from the copyright holder to reproduce the material. Permission is required irrespective of authorship or publisher except for documents in the public domain. If photographs of people are used, either the subjects must not be identifiable or their pictures must be accompanied by written permission to use the photograph whenever possible permission for publication should be obtained.

Figures and figure legends should be completely intelligible without reference to the text.

The price of printing in color is 50 EUR per page as printed in an issue of JASPE.

2.6.1. Figure legends

Figures should not contain footnotes. All information, including explanations of abbreviations must be present in figure legends. Figure legends should be written bellow the figure, in sentence case. *See* example:

- ✓ **Figure 1.** Changes in accuracy of instep football kick measured before and after fatigued. SR – resting state, SF – state of fatigue, *p>0.01, †p>0.05.

2.6.2. Figure citation

All graphic materials should be referred to as Figures in the text. Figures are cited in the text as full words. *See* example:

- ✓ Figure 1
  - × figure 1
  - × Figure 1.
  - ✓ ….exhibit greater variance than the year before (Figure 2). Therefore…
  - ✓ ….as shown in Figures 1 and 3. (citing more figures at once)
  - ✓ ….result has shown (Figures 1-3) that... (citing more figures at once)
  - ✓ ….in our results (Figures 1, 2 and 5)... (citing more figures at once)

2.6.3. Sub-figures

If there is a figure divided in several sub-figures, each sub-figure should be marked with a small letter, starting with a, b, c etc. The letter should be marked for each subfigure in a logical and consistent way. *See* example:

- ✓ Figure 1a
- ✓ …in Figures 1a and b we can…
- ✓ …data represent (Figures 1a-d)…

2.7. Scientific Terminology

All units of measures should conform to the International System of Units (SI).

Measurements of length, height, weight, and volume should be reported in metric units (meter, kilogram, or liter) or their decimal multiples.

Decimal places in English language are separated with a full stop and not with a comma. Thousands are separated with a comma.

Percentage	Degrees	All other units of measure	Ratios	Decimal numbers
✓ 10%	✓ 10º	✓ 10 kg	✓ 12:2	✓ 0.056
× 10 %	× 10 º	× 10kg	× 12 : 2	× .056

Signs should be placed immediately preceding the relevant number.		
✓ 45±3.4	✓ p<0.01	✓ males >30 years of age
× 45 ± 3.4	× p < 0.01	× males > 30 years of age

2.8. Latin Names

Latin names of species, families etc. should be written in italics (even in titles). If you mention Latin names in your abstract they should be written in non-italic since the rest of the text in abstract is in italic. The first time the name of a species appears in the text both genus and species must be present; later on in the text it is possible to use genus abbreviations. *See* example:

- ✓ First time appearing: *musculus biceps brachii*

Abbreviated: *m. biceps brachii*

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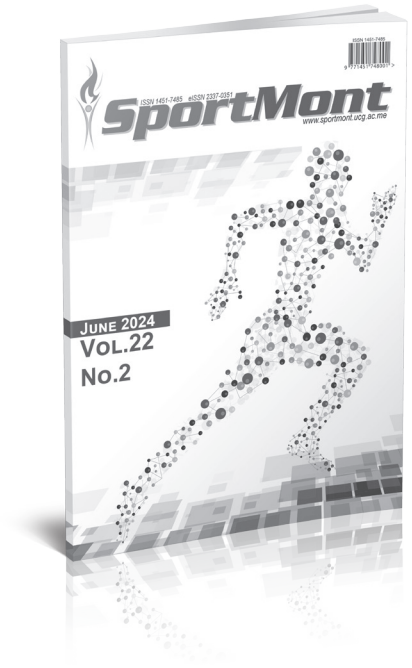

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- Post-publication tools to indicate quality and impact;
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SMJ is published three times a year, in February, June and October of each year. SMJ publishes original scientific papers, review papers, editorials, short reports, peer review - fair review, as well as invited papers and award papers in the fields of Sports Science and Medicine, as well as it can function as an open discussion forum on significant issues of current interest.

SMJ covers all aspects of sports science and medicine; all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side.

Prospective authors should submit manuscripts for consideration in Microsoft Word-compatible format. For more complete descriptions and submission instructions, please access the Guidelines for Authors pages at the SMJ website: http://www.sportmont.ucg.ac.me/?sekcija=page&p=51. Contributors are urged to read SMJ's guidelines for the authors carefully before submitting manuscripts. Manuscripts submissions should be sent in electronic format to sportmont@ucg.ac.me or contact following Editors:

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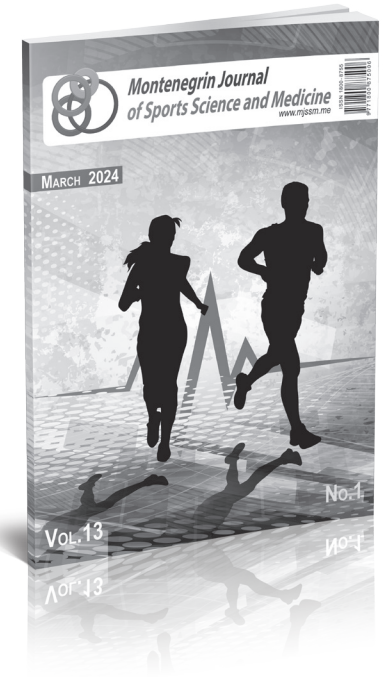
Summer issue – June 2025

Montenegrin Journal of Sports Science and Medicine

MONTENEGRIN **J**OURNAL
OF **S**PORTS **S**CIENCE
AND **M**EDICINE



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CALL FOR CONTRIBUTIONS

Montenegrin Journal of Sports Science and Medicine (MJSSM) is a print (ISSN 1800-8755) and electronic scientific journal (eISSN 1800-8763) aims to present easy access to the scientific knowledge for sport-conscious individuals using contemporary methods. The purpose is to minimize the problems like the delays in publishing process of the articles or to acquire previous issues by drawing advantage from electronic medium. Hence, it provides:

- Open-access and freely accessible online;
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- Peer review by expert, practicing researchers;
- Post-publication tools to indicate quality and impact;
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MJSSM is published biannually, in September and March of each year. MJSSM publishes original scientific papers, review papers, editorials, short reports, peer review - fair review, as well as invited papers and award papers in the fields of Sports Science and Medicine, as well as it can function as an open discussion forum on significant issues of current interest.

MJSSM covers all aspects of sports science and medicine; all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side.

Prospective authors should submit manuscripts for consideration in Microsoft Word-compatible format. For more complete descriptions and submission instructions, please access the Guidelines for Authors pages at the MJSSM website: http://www.mjssm.me/?sekcija=page&p=51. Contributors are urged to read MJSSM's guidelines for the authors carefully before submitting manuscripts. Manuscripts submissions should be sent in electronic format to office@mjssm.me or contact following Editors:

Dusko BJELICA, Editor-in Chief – sportmont@t-com.me
Damir SEKULIC, Editor-in Chief – damirsekulic.mjssm@gmail.com

Publication date: Autumn issue – September 2024
Spring issue – March 2025

MONTENEGRIN SPORTS ACADEMY

Founded in 2003 in Podgorica (Montenegro), the Montenegrin Sports Academy (MSA) is a sports scientific society dedicated to the collection, generation and dissemination of scientific knowledge at the Montenegrin level and beyond.

The Montenegrin Sports Academy (MSA) is the leading association of sports scientists at the Montenegrin level, which maintains extensive co-operation with the corresponding associations from abroad. The purpose of the MSA is the promotion of science and research, with special attention to sports science across Montenegro and beyond. Its topics include motivation, attitudes, values and responses, adaptation, performance and health aspects of people engaged in physical activity and the relation of physical activity and lifestyle to health, prevention and aging. These topics are investigated on an interdisciplinary basis and they bring together scientists from all areas of sports science, such as adapted physical activity, biochemistry, biomechanics, chronic disease and exercise, coaching and performance, doping, education, engineering and technology, environmental physiology, ethics, exercise and health, exercise, lifestyle and fitness, gender in sports, growth and development, human performance and aging, management and sports law, molecular biology and genetics, motor control and learning, muscle mechanics and neuromuscular control, muscle metabolism and hemodynamics, nutrition and exercise, overtraining, physiology, physiotherapy, rehabilitation, sports history, sports medicine, sports pedagogy, sports philosophy, sports psychology, sports sociology, training and testing.

The MSA is a non-profit organization. It supports Montenegrin institutions, such as the Ministry of Education and Sports, the Ministry of Science and the Montenegrin Olympic Committee, by offering scientific advice and assistance for carrying out coordinated national and European research projects defined by these bodies. In addition, the MSA serves as the most important Montenegrin and regional network of sports scientists from all relevant subdisciplines.

The main scientific event organized by the Montenegrin Sports Academy (MSA) is the annual conference held in the first week of April.

Annual conferences have been organized since the inauguration of the MSA in 2003. Today the MSA conference ranks among the leading sports scientific congresses in the Western Balkans. The conference comprises a range of invited lecturers, oral and poster presentations from multi- and mono-disciplinary areas, as well as various types of workshops. The MSA conference is attended by national, regional and international sports scientists with academic careers. The MSA conference now welcomes up to 200 participants from all over the world.

It is our great pleasure to announce the upcoming 21th Annual Scientific Conference of Montenegrin Sports Academy “Sport, Physical Activity and Health: Contemporary Perspectives” to be held in Dubrovnik, Croatia, from 18 to 21 April, 2024. It is planned to be once again organized by the Montenegrin Sports Academy, in cooperation with the Faculty of Sport and Physical Education, University of Montenegro and other international partner institutions (specified in the partner section).

The conference is focused on very current topics from all areas of sports science and sports medicine including physiology and sports medicine, social sciences and humanities, biomechanics and neuromuscular (see Abstract Submission page for more information).

We do believe that the topics offered to our conference participants will serve as a useful forum for the presentation of the latest research, as well as both for the theoretical and applied insight into the field of sports science and sports medicine disciplines.

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Sports Science and Medicine Journals

from Montenegrin Sports Academy

We have expanded the quality of our journals considerably over the past years and can now claim to be the market leader in terms of breadth of coverage.

As we continue to increase the quality of our publications across the field, we hope that you will continue to regard MSA journals as authoritative and stimulating sources for your research. We would be delighted to receive your comments and suggestions, mostly due to the reason your proposals are always welcome.

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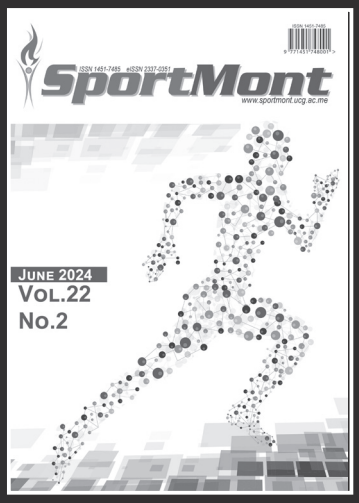

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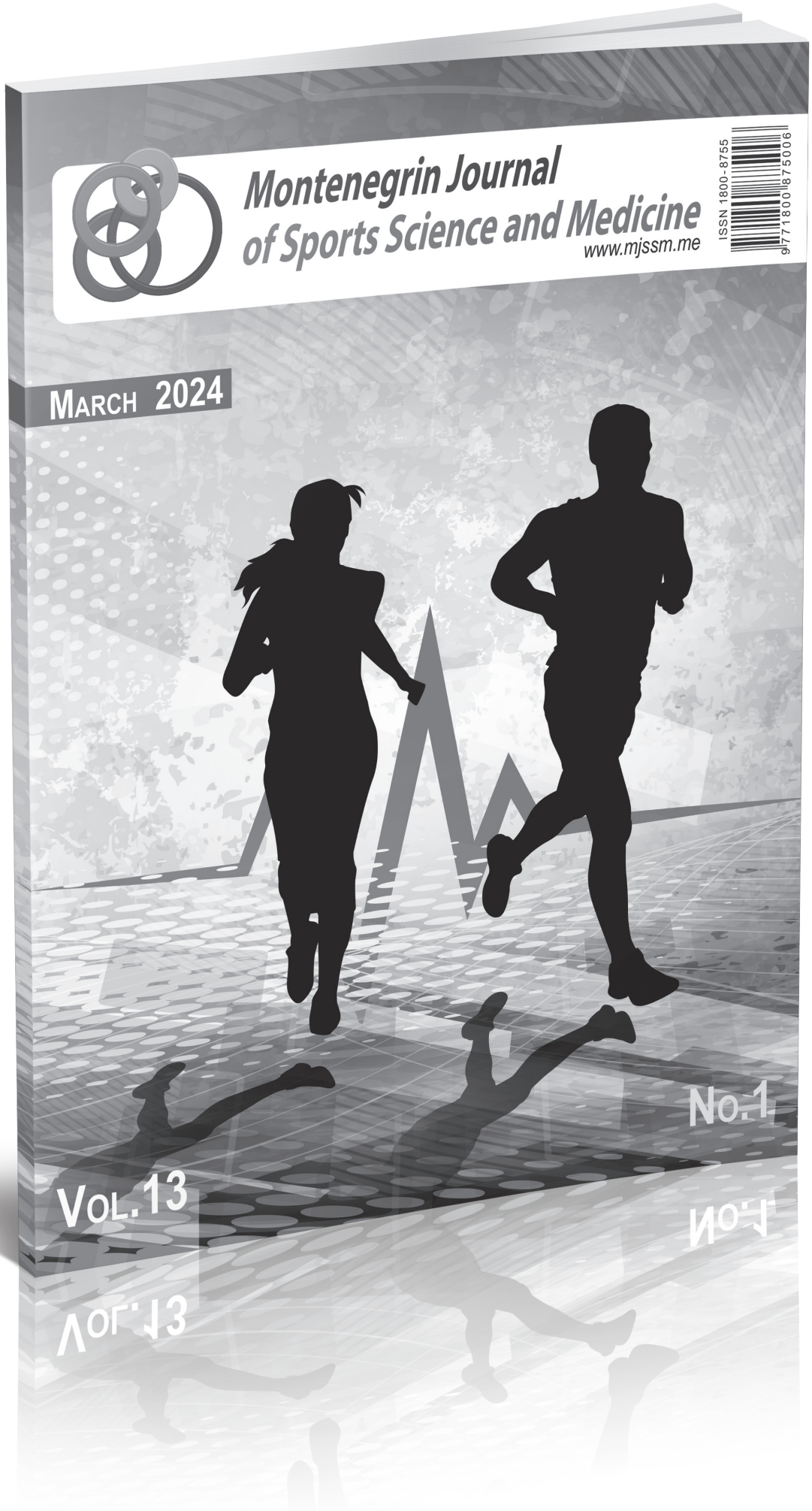
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