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Athletic profiling of young swimmers: Physical tests and training practices

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Abstract

Background: Assessing athletic qualities, coach training, and sports infrastructure can influence athletic performance. This study examines the link between the swimmer's athletic profile test and the role of athletic quality assessment in optimizing performance.
Aims: To study the role of athletic quality assessment among Moroccan coaches and technical directors in the physical preparation of their swimmers, in relation to sports infrastructure.
Method: twenty elite swimmers of both sexes, aged 14 to 16, and 33 coaches and technical directors participated in this study. An athletic profile assessment test was conducted, and a survey was conducted on the role of athletic quality assessment across various aspects, including training, athletic quality assessment, and constraints related to sports infrastructure. Chi-square and independence correlation tests were used to analyze the significance and correlation between variables.
Results: The swimmers' athletic profile tests were exploratory. No significant difference was found between participants' training and their physical preparation practices for training ($p = 0.085 > 0.05$). No significant difference was found between participants' status and the location of their physical preparation ($p = 0.939$). No significant correlation was found between the importance of the assessment and participants' gender in the Mann-Whitney test (46 with exact; p = 0.540 > 0,05).
Conclusion: Our results suggest that implementing athletic profile testing for swimmers can be useful for selecting and customizing training programs and improving performance in specific disciplines. Our findings indicate that the importance of physical preparation is not linked to coach training or to constraints on sports infrastructure.

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INTRODUCTION

Many factors influencing athletic performance, such as mental preparation, sleep, and nutrition, offer promising avenues for optimizing athlete preparation thanks to recent advances in sports science. These opportunities provide leverage for coaches and other sports support professionals (Haff & Triplett, 2015). Their main challenge is to harmoniously integrate these performance-optimizing means into specific training (Barbosa et al., 2023). Among these factors, physical preparation plays a crucial role, as it is commonly integrated into specific training due to its effects on preserving athletes' physical integrity and performance (Weldon et al., 2022)The assessment and monitoring of the abilities targeted by training protocols make it possible to

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overcome certain limitations discussed above to optimize the effects of these protocols, in particular through the individualization and regulation of training content (Helms et al., 2020).

Insofar as it aims above all to optimize performance (Crowley et al., 2018). This approach aims to reduce the risk of injury, develop the swimmer's specific physical qualities, and improve the technical efficiency of the movement. This can lead to injuries characteristic of the activity (Barry et al., 2022). Knowledge of body composition (BC) also improves performance, particularly given the specific morphological characteristics of each sport (Slater et al., 2017). It is important for assessing performance and physical condition before, during, and after sports competitions, as well as during training sessions (Trexler et al., 2017). It influences the athlete's strength, speed, agility, endurance, flexibility, and athletic performance (Silva, 2019). Assessing body composition and muscle characteristics in adolescent athletes can provide information about their susceptibility to injury as well as their optimal level of performance (Al Azim, 2025). According to coaches and physical trainers, integrating physical training into swimming aligns with the general definition of this concept, insofar as it primarily aims to optimize performance (Crowley et al., 2018). This approach aims to reduce the risk of injury, develop the swimmer's specific physical qualities, and improve the technical efficiency of their movements. This can lead to injuries characteristic of the activity (Barry et al., 2022). In swimming, this physical preparation is carried out outside the water by the vast majority of swimmers, and even more so by elite swimmers.

Nevertheless, the specific and complex constraints of the aquatic environment make it difficult for coaches and physical trainers to organize dry-land training. In addition, the scientific literature still lacks practical recommendations for planning dry-land training and for transferring skills to swimming in real conditions (Fone & van den Tillaar, 2022; Wirth et al., 2022). Similarly, this practice imposes specific physiological and biomechanical constraints due to the variety of distances and strokes used in competition (Nugent et al., 2017). An imbalance in the strength-speed relationship could impair sprint performance (Junge et al., 2023; Samozino et al., 2022).In fact, the force-velocity profile can be modified after a resistance-sprint training program based on speed zones (Lahti et al., 2020; Samozino et al., 2022). Determining an athlete's physical profile through a series of tests is essential for tailoring training programs and reducing certain training loads (Didier & Pascal, 2013; Reiss et al., 2017).

To optimise the transfer of dry-land physical training to swimming, one approach is to ensure that the movements practised on dry land are as close as possible to swimming movements (Sadowski et al., 2020). Athletic training methods for swimmers have shown positive results, particularly ballistic, plyometric, and maximum strength training, with a view to improving turn performance (Hermosilla et al., 2021). In addition, dry-land or swimming training sessions may impair the following session (Arsoniadis et al., 2022). This negative effect seemed to be even more pronounced when dry resistance training included sets of repetitions with heavy loads (> 80%), sets of strength endurance training (> 15 repetitions), or when water training included high-intensity swimming phases (Arsoniadis et al., 2022; Arsoniadis et al., 2020; Arsoniadis et al., 2024). However, this negative impact appears to be limited by scheduling a passive recovery period of at least 20 minutes between workouts (Arsoniadis et al., 2022). Some authors have also shown that dry strength and power training had a positive impact on swimming strength measured using a tethered swimming protocol, without necessarily observing direct positive effects on performance (Norberto et al., 2023), which could suggest that the conditions for an attached swimming assessment are not suitable for actual swimming activity.

The objective of this study is to make a scientific and practical contribution to the optimization of training programs, both on land and in the water. This approach is based on field tests that characterize swimmers' athletic profiles and personalize physical preparation programs. The measurement protocol is based on field tests that assess swimmers' athletic qualities. One of the scientific contributions of this study is to establish a link between the exploratory results of various tests assessing swimmers' athletic qualities and training conditions.

In this context, the idea of conducting our study entitled “Athletic profiling of young swimmers: physical tests and training practices” is considered exploratory research combining both an athletic profile assessment test using test batteries for a group of elite Moroccan swimmers belonging to a swimming club whose physical training conditions are inadequate (1 to 2 times per week). A survey of Moroccan swimming coaches and technical directors to explore the context in which they conduct physical training for their swimmers and its influence on athletic preparation. The central research question is as follows: to what extent can the athletic profile of young swimmers be influenced by regular physical training under suitable conditions, and what are the drivers and barriers to its widespread adoption in a performance-oriented approach? We hypothesized that swimming coaches receive specialized training in swimming while neglecting swimmers' physical preparation, and that most clubs, due to a lack of sports infrastructure, do the same. Finally, we examined whether the frequency of physical training sessions for swimmers is significantly influenced by whether their coach has undergone swimming training.

METHOD

Test to assess the athletic abilities of male and female swimmers.

Research design

The exploratory assessment of the swimmers' athletic profiles was conducted in a well-equipped fitness room that meets safety and hygiene standards. Data collection and analysis for this study were carried out between June and October 2025. The participants' training, nutritional, and psychological monitoring were closely supervised. The swimmers' athletic abilities were assessed at the end of the test. After a 30-minute warm-up, we measured the following physical qualities: Scapular flexibility, Static postural balance, Core strength, Muscular endurance, Lower-limb power, and Start speed (10-meter timed run).

Participants

Our study comprises two complementary parts. The first involves exploratory tests of the athletic profiles of 20 swimmers (10 boys and 10 girls) who train for physical fitness once or twice a week, to characterize their profiles and account for both pool and outdoor training. The second part is based on a survey of coaches and technical directors, aimed at analyzing the importance placed on assessing athletic qualities, the use of physical tests, and the sports facilities available for swimmers' physical preparation. The link between these two parts highlights how suitable facilities shape the creation of a structured, personalized athletic profile.

Procedures

The stages of participant recruitment. The target population of this study consisted of licensed swimmers aged 14 to 16 years who belonged to the same swimming club. This population was selected to ensure relative homogeneity across age range, training environment, and competitive background. In the first stage, eligibility criteria were applied to determine participants' suitability for inclusion in the study. To be eligible, swimmers had to be between 14 and 16 years of age, hold a currently valid federal swimming license, and participate regularly in training sessions at least 4 times per week. In addition, participants were required to be free from any injury that could limit sports practice at the time of assessment. Ethical participation was also ensured through the provision of informed consent signed by the legal representative, along with the swimmer's own agreement to participate. *In the second stage*, an initial selection was conducted, resulting in a sample of 30 swimmers. This group comprised 15 male and 15 female swimmers, reflecting a balanced sex distribution at the outset of the study. *In the third stage*, participant withdrawals and attrition were recorded, resulting in the exclusion of 10 swimmers from the initial sample. The reasons for attrition included repeated absences from training sessions, voluntary withdrawal by either the participant or the legal guardian, and injuries during the study period. This stage was necessary to ensure that only participants who consistently met the study requirements remained in the final sample. *In the fourth and final stage*, 20 participants were retained and assessed. The final sample consisted of 10 male swimmers and 10 female swimmers. Therefore, the study sample was established through a stepwise selection process, beginning with the target population, followed by eligibility screening, initial recruitment, and final inclusion after accounting for withdrawal and attrition.

Instruments

The battery of physical tests applied is based on the model developed. These tests were used during a training camp for the French national team in preparation for the 2012 international competitions. For the lower-limb power test (Sargeant), the participant performed 3 trials, and the best performance was recorded (Selmi et al., 2016). This procedure helps reduce the impact of technical or coordination errors; however, the other tests were performed as a single trial, for reasons related to the fatigue it may cause, and especially for tests of leg muscular endurance and core strength, which require significant time and resistance

Description of the tests

Tables 1 to 6 present the description of the tests for the different athletic qualities: Scapular flexibility (shoulder mobility test), Static postural balance, Lumbar back strength, Lower limb muscle endurance (squats), Lower limb power (vertical jump), and Starting speed (10-meter timed run).

Table 1. Scapular Flexibility (Shoulder Mobility Test)

Protocol:	The swimmer slides one hand behind their head onto the opposite shoulder blade and tries to grasp the other hand.
Skill:	Shoulder mobility
Indication:	- The swimmer stands with their pelvis in anteversion, their back straight, and their head up. - Warming up the tendons and muscles after exercise naturally increases flexibility. Therefore, always perform this test under the same conditions.
Scoring Scale	
5	Fingers grip
4	Fingers touch
3	Fingers brush against each other
2	No contact between hands
1	No contact with the shoulder

Table 2. Static Postural Balance

Protocol:	Standing barefoot, bend one leg against the other and place your hands on your waist. Close your eyes and try to maintain this balance for as long as possible (ask someone to time you).	
Skill:	Measurement of lower and upper limb balance.	
Indication:	The evaluator starts timing as soon as the subject is in the correct position. They stop the timer as soon as the subject loses their balance (e.g., when they start to move or when their foot is no longer in contact with their knee). The result is recorded in seconds.	
Scoring Scale	**Male**	**Female**
5	> 80 (second)	> 60 (second)
4	60 à 79	45 à 59
3	40 à 59	30 à 44
2	20 à 39	15 à 29
1	< 20	< 15

Table 3. Lumbar Back Strength

Protocol:	The swimmer holds a prone position for as long as possible.	
Skill:	Strength endurance of the lumbar back muscles	
Indication:	- Arms outstretched, biceps against the ears. - Head aligned with the spine. - Back of the hands in contact with those of the tester. - The tester stops the stopwatch when the swimmer is no longer able to hold this position and the backs of their hands are no longer in contact with the tester's hands.	
Scoring Scale	**Male**	**Female**
5	> 100(second)	> 60(second)
4	76 à 100	46 à 60
3	56 à 75	36 à 45
2	30 à 55	20 à 35
1	< 30	< 20

Table 4. Lower Limb Muscle Endurance (Squats)

Protocol:	The swimmer performs knee bends every 2 seconds until exhaustion.	
Skill:	Muscular endurance of the thighs (quadriceps and glutes)	
Indication:	- Hands on hips - Thighs parallel to the ground in the lower position (touch the bench with your buttocks) - Legs straight in the upper position	
Scoring Scale	**Male**	**Female**
5	> 100(repetition)	> 70(repetition)
4	80 à 99	50 à 69
3	50 à 79	30 à 49
2	30 à 49	20 à 29
1	< 30	< 20

Table 5. Lower Limb Power (Vertical Jump)

Protocol:	Place the swimmer against the wall, feet flat. The arm on the wall side is raised to maximum shoulder extension. Then the swimmer stands with feet slightly apart, 3/4 facing the wall, about 30 cm away from it. Without moving their feet (no preliminary bounce), they prepare to jump by lowering their arms and bending their torso and limbs to 90°. They jump with one arm extended. The difference between the two marks gives the result.	
Skill:	Explosive thigh strength and quality of start	
Indication:	- No cushioning phase before the jump. - Perform the test 3 times and record the best result.	
Scoring Scale	**Male**	**Female**
5	> 60(cm)	> 50(cm)
4	55 à 59	45 à 49
3	50 à 54	40 à 44
2	46 à 49	35 à 39
1	< 45	< 35

Table 6. Starting Speed (10-meter Timed Run)

Protocol:	- Standing with 4 points of contact on the ground, hands aligned and feet staggered (same position as on the block). - The swimmer must cover 10 meters as quickly as possible.	
Skill:	Starting speed, movement speed, and explosiveness	
Indication:	- The tester starts the stopwatch as soon as the swimmer starts moving. - The time is taken when the shoulders cross the 10-meter mark. The intermediate time is taken at 5 meters.	
Scoring Scale	**Male**	**Female**
5	< 2’00(min)	< 2’20(min)
4	2’10 et 2’00	2’50 et 2’20
3	2’25 et 2’11	2’75 et 2’51
2	2’35 et 2’26	35 à 39
1	> 2’35	> 2’90

Analysis plan

Descriptive statistics were calculated for each athletic quality score (scale of 1 to 5) according to gender. Differences between female and male swimmers were examined using comparisons of means for each group of both genders. Absolute differences were calculated to identify gender-related performance trends. Given the scale's ordinal nature, the analyses were primarily exploratory and descriptive.

The formula used to calculate the mean: $\grave{X} = \frac{\sum_{i=1}^{n} X_i}{n}$

X̀*:** the group score; ***Xi: *the individual score of participant i based on the evaluation criteria,* **n:** the total number of participants included in the test

The methodology used is a relevant approach for an exploratory study aimed at describing and comparing a standardized athletic profile. However, the results were interpreted with caution due to limitations related to sample size, the nature of the assessment scale, and the essentially descriptive nature of the analyses.

Survey addressed to coaches and technical directors of Moroccan swimming clubs.
Research design

The data recorded in this survey were obtained from 33 coaches and technical directors at Moroccan swimming clubs. The participants were divided as follows: a group of coaches (n=15); a group of technical directors (n=18); a total of 33 participants, including 4 females and 29 Males. Participants agreed to answer our questionnaire voluntarily and without conditions.

Participants

We pretested the questionnaire on a small sample of 5 people to correct specific errors, rephrase unclear questions, convert open-ended questions into closed-ended ones for greater clarity, and refine the question sequence. Of the 82 coaches and technical directors surveyed, 33 agreed to take part. Regarding the inclusion and exclusion criteria, we included all adult Moroccan coaches and technical directors who were active, could read and understand French, and were willing to answer our questionnaire. Exclusion criteria: coaches and technical directors who are not active with their sports clubs and/or who are unable to respond to our questionnaire.

Instruments

We used an online questionnaire via Google Forms as our research tool. This allowed us to collect information from a large number of coaches and technical directors and to evaluate the progress of our survey in real time (by analyzing the characteristics of the respondents and the relevance of their responses). Our questionnaire consisted mainly of closed-ended multiple-choice questions, with some single-choice options. Our data collection lasted approximately one month.

Analysis plan

SPSS software (IBM Corp., version 26.0 for Windows, 2017) was used to perform all statistical analyses for this study. Differences in nominal variables (gender, level of education, training completed, position held) and ordinal variables (years of management experience, weekly frequency of physical training, the place of physical training practice, importance of athletic assessment) were analyzed using Pearson's chi-square test, Fisher's test, and Mann-Whitney test, respectively. The association between coaches' training in physical preparation for swimming and its implementation during training sessions was assessed using Fisher's exact test, as the chi-square test assumptions were not met (sample size < 5). A Mann–Whitney U test was used to examine the association between gender and participants' opinions on the location for assessing swimmers' athletic qualities in annual planning. The minimum threshold for statistical significance was set at $p < 0.05$. Pearson's chi-square test was used to examine the association between the location of physical preparation and the position held.

Ethical considerations

Informed consent was obtained from each participant via the online questionnaire in Google Forms and during the test assessing the swimmers' athletic abilities. This study was conducted in accordance with ethical principles. Given the participants' ages (14 to 16 years), written informed consent was obtained from the swimmers' parents, along with the swimmers' informed assent. Strict protective measures were implemented, including anonymizing personal data, maintaining confidentiality, mitigating risks, implementing appropriate procedures in the event of injury, and ensuring the secure handling and protection of personal data.

RESULTS AND DISCUSSIONS

Results:

Results of the athletic profile assessment test for young swimmers

The results obtained in Figures 1 and 2 were obtained through athletic profile exploration tests conducted with young swimmers. The athletic performance of the 20 swimmers aged 14 to 16 reveals an exploratory athletic profile in swimmers for both sexes (Figures 1 and 2).

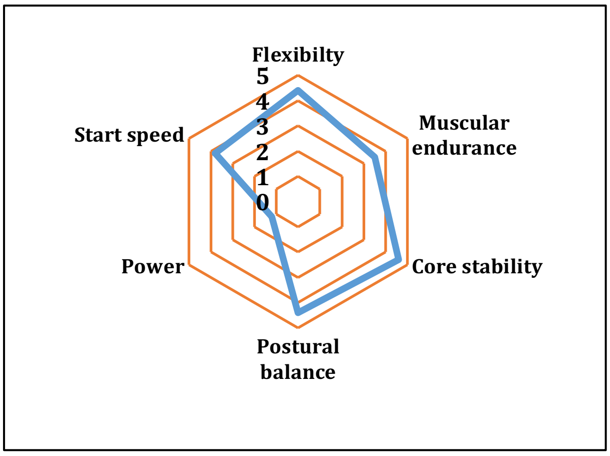

Figure 1. Athletic Profile of Female Swimmers

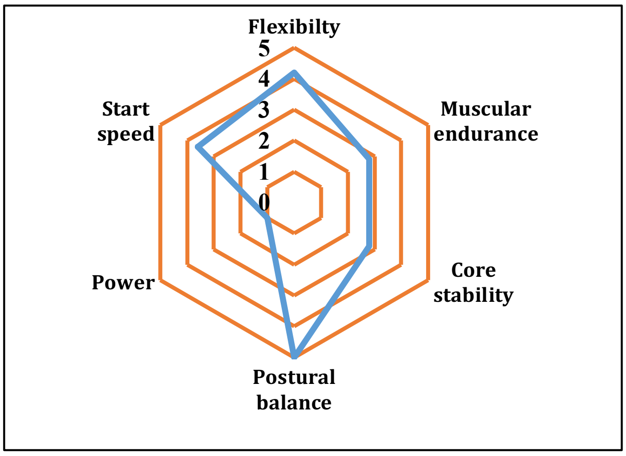

Figure 2. Athletic Profile of Male Swimmers

The results of the different tests assessing the swimmers' athletic abilities, as shown in Table 7, reveal that: Flexibility: The majority of participants have good shoulder mobility, with scores of 4.4 for girls and 4.2 for boys (on a scale of 1 to 5). A swimmer performs approximately 10,000 movements per week with each shoulder (Richardson et al., 1980). Postural balance and core strength: Scores ranged from 4.4 for boys to 5 for girls for postural balance and from 2.8 for boys to 4.6 for girls for core strength (scale of 1 to 5). These two components generally showed satisfactory performance, although some lateral imbalances were identified in some swimmers. Postural control is multifactorial and influenced by neuromuscular coordination and proprioceptive integration (Shumway-Cook & Woollacott, 2007).

Muscular endurance of the upper limbs: Scores ranged from 3.5 for girls to 2.8 for boys (scale of 1 to 5). These results vary significantly, suggesting differences in previous exertion or in the intensity of the loads applied during training. Females may demonstrate greater resistance to fatigue during submaximal efforts, possibly due to differences in muscle fiber composition and metabolic efficiency (Hunter, 2014). Lower limb power: The results show a significant deficit in muscle tone among boys, with a score of 1.2 on a scale of 1 to 5, and a score of 1 among girls, with heights below the expected standards for their age and gender. Explosive strength is a critical determinant of performance in many sports and is strongly associated with neuromuscular recruitment efficiency (McGuigan, 2017).

Start speed: The recorded times are average, but a lack of initial explosiveness is evident in several swimmers. The values ranged from 3.8 for girls to 3.6 for boys (on a scale of 1 to 5). Short-distance acceleration performance depends on the coordination of force and neuromuscular control (Young, 2006).

Table 7. The Results of the Various Tests of the Swimmers' Athletic Qualities

Physical qualities	Test Scores (1 to 5)	
	Female	Male
Scapular flexibility (shoulder mobility test)	4,4	4,2
Muscular endurance	3,5	2,8
Core strength	4,6	2,8
Static postural balance	4,4	5
Lower limb power (vertical jump)	1,2	1
Start speed (10-meter timed run)	3,8	3,6

Questionnaire Survey Results

The descriptive characteristics of our survey participants are summarized in *Table 8.* Our survey included 33 participants, including 29 males and 4 Females who are active in their clubs. This is due to the specific nature of the swimming coach profession. Training sessions are generally scheduled in the evening, which is difficult for women. Regarding the age of our sample, we observed a significant representation of the 51+ age group. This suggests the strategy adopted by certain Moroccan clubs in terms of recruiting coaches for long-term contracts, particularly those with financial stability. Coaches with a university degree are the most represented (97%). The remaining participants (3%) have a high school education.

Table 8. Descriptive Characteristics of Survey Participants

Parameters	Categories	Frequency	Percentage (%)	Mean	Standard deviation
Sex	Male	29	87,9	1,12	0,331
	Female	4	12,1		
Age	Under 30	6	18,2	3,39	1,638
	Between 30 and 36	1	3,0		
	Between 36 and 40	6	18,2		
	Between 41 and 45	4	12,1		
	Between 46 and 50	4	12,1		
	51 and above	12	36,4		
Education Level	University Level	32	97,0	1,03	0,174
	Secondary Level	1	3,0		
Profession	Technical Director	15	45,5	1,55	0,506
	Coach	18	54,5		

The results are presented as percentages, averages, and standard deviations (SD) and calculated using SPSS software.

The parameters of the Link between Participants' Training in Swimming, Physical Preparation, and Its Practice in Swimmers' Training Sessions

Table 9 presents the results of chi-square tests examining the association between two categorical variables, based on 33 valid observations. The analysis of the association between two variables revealed a significant relationship. Pearson's chi-square test (χ^2 = 4,897; df = 1; p = 0.027) and the likelihood ratio test (χ^2 = 5,082; df = 1; p = 0.024) both led to rejecting the hypothesis of independence. However, the conditions for applying the chi-square test were not met: 50% of the cells had expected frequencies less than 5, with a minimum of 0.61, which violates the chi-square test's assumptions. Consequently, the results of Fisher's exact test (p = 0.085) confirm the absence of a statistically significant association between the variables. Since dry-land training adds stresses not found in the water (Wirth et al., 2022), one challenge in overall swimming training is transferring the qualities acquired in dry land to swimming.

Table 9. Results (chi-square test) of the Link between Participants' Training in Physical Preparation for Swimming and its Practice in Swimmers' Training Sessions

	Value	df	Asymptotic Significance (2-sided)	Exact Significance (2-sided)	Exact Significance (1-sided)
Pearson Chi-Square	4,897[a]	1	0,027	0,085	
Continuity Correction[b]	2,014	1	0,156		
Likelihood Ratio	5,082	1	0,024	0,085	0,085
Fisher's Exact Test				0,085	0,085
N of Valid Cases	33				

[a] **2** cells (50.0%) have an expected count less than 5. The minimum expected count is .61.
[b] Computed only for a 2x2 table.

The Parameters of the Link between the Place Where Physical Training Is Carried out and the Position Held

Analysis of the link between participants' roles (technical director or coach) and where they do their physical training showed no significant difference ($\chi^2 = 0.125$; df = 2; p = 0.939). These results suggest that the choice of location for physical training is not determined by the position held, but probably by the availability of facilities. Analysis of the results suggests that the use of training facilities can be interpreted as reflecting a shared sporting ecosystem rather than a difference linked to the role occupied. The environment, particularly sports infrastructure, influences coaches' professional behaviour and methodological choices (Henriksen et al., 2010).

Table 10. Results (chi-square test) of the Link between the Location of Physical Training and the Position Held

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	0,125[a]	2	0,939
Likelihood Ratio	0,126	2	0,939
Linear-by-Linear Association	0,004	1	0,950
Valid N (listwise)	32		
[a]**. 3** cells (50,0%) have an expected count less than 5. The minimum expected count is 2,81**.**			

The Parameters of the Link between Gender and the Opinion of Participants on the Site Regarding the Assessment of Swimmers' Athletic Qualities in Annual Planning

The results show no significant difference, as determined by the Mann-Whitney test. The statistic was U = 46,00 with a standardized value of Z = -0,759. The two-tailed asymptotic significance was p = 0.448, well above the 5% threshold, and the exact two-tailed significance was also non-significant (p = 0.540). The gender of coaches and technical directors can influence how they perceive and evaluate swimmers' athletic qualities. Research in sport science suggests that these gender differences often lead to variations in perceptions, priorities, and coaching styles, even when performance objectives remain the same. For example, Fletcher & Scott (2010) show that psychological stress and perceptions of training priorities vary by gender, thereby affecting the relative importance assigned to developing different athletic qualities.

Table 11. Results of the Mann-Whitney Test between Gender and Participants' Opinions on the Assessment of Swimmers' Athletic Qualities in Annual Planning

Mann-Whitney Test					
Test Statistics					
Participants' opinion on the role of evaluating swimmers' athletic qualities in annual planning		**Ranks**			
Mann-Whitney U	46,000	**Sex**	**N**	**Mean Rank**	**Sum of Ranks**
Wilcoxon W	56,000	1	29	17,41	505,00
Z	-0,759	2	4	14,00	56,00
Asymp. Sig. (2-tailed)	0,448	**Total**	**33**		
Exact Sig. [2*(1-tailed Sig.)]	0,540[b]				
a. Grouping Variable: sex**; b.** Not corrected for ties.					

The Parameters of the Link between Swimming Physical Preparation Training and the Weekly Frequency of Physical Preparation

The analysis of the link between physical preparation training and the weekly frequency of physical preparation did not reveal a significant relationship (p = 0.540). According to Bishop (2008) emphasizes that adaptation responses to training vary with factors such as age, fitness level, and recovery capacity, which can influence the frequency of training sessions for some individuals.

Table 12. Results of the chi-square test between physical training for swimming and the weekly frequency of physical training

	Valeur	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1,700[a]	2	0,427
Likelihood Ratio	1,829	2	0,401
Linear-by-Linear Association	0,667	1	0,414
Valid N (listwise)	32		
[a]. 3 cells (50,0%) have an expected count less than 5. The minimum expected count is 2,25.			

The Parameters between Participants' Years of Experience and the Importance They Place on Evaluating Their Swimmers' Athletic Abilities in Their Annual Planning

The majority of respondents consider this assessment important or very important, while a small number consider it moderately important. Annual planning based on a rigorous assessment of athletic abilities allows for structuring training cycles and recovery periods, which are essential for optimizing performance and reducing the risk of overtraining (Mujika et al., 2018).

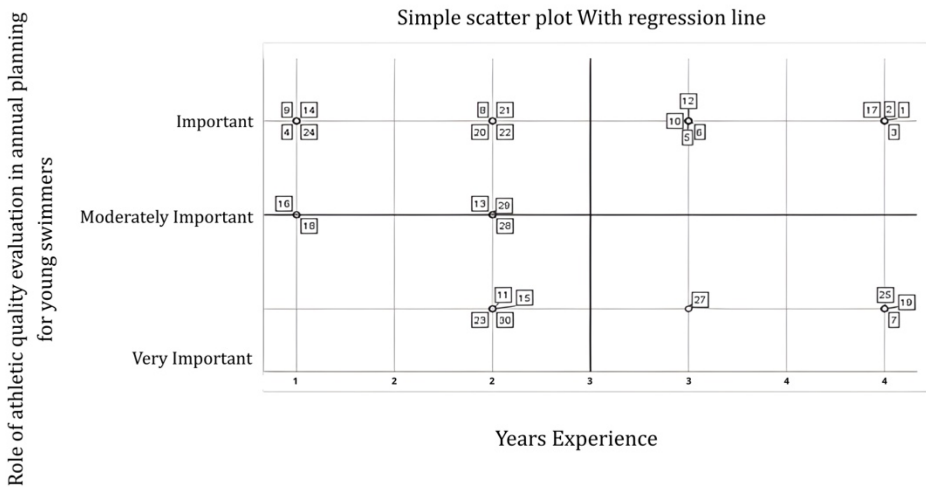

Figure 3. Distribution of Participants According to Their Years of Experience and the Importance They Place on Assessing the Athletic Qualities of Their Swimmers in Their Annual Planning

The Parameters between the Role of Evaluating a Swimmer's Athletic Qualities and Physical Preparation Training

The graph (Figure 5) shows that participants who have undergone physical training place greater importance on assessing athletic abilities than those who have not. The lower dispersion in the "trained" group reflects a consistent, coherent perception of the assessment's role in annual planning, whereas the "untrained" group has more varied opinions. Integrating assessment into annual planning improves the personalization of training programs, reduces the risk of overtraining, and optimizes physiological adaptations (Mujika et al., 2018).

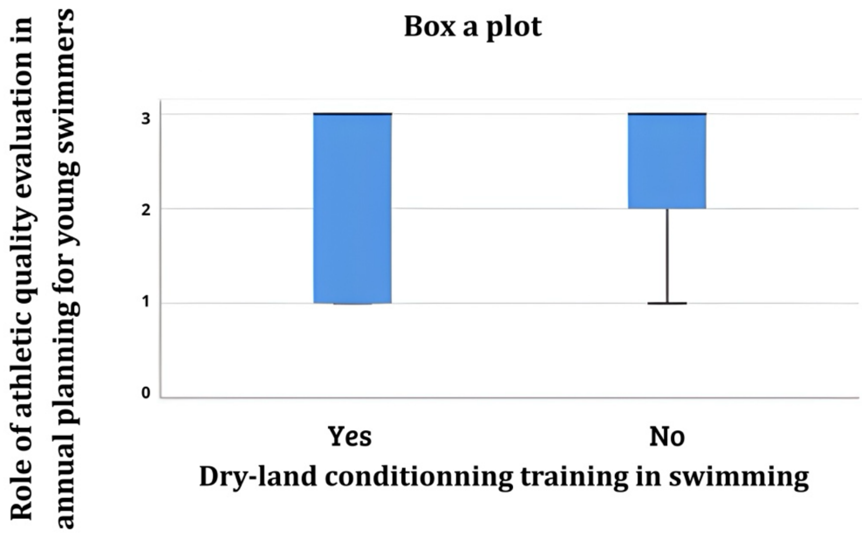

Figure 4. Link between the Importance of Assessing Swimmers' Athletic Abilities and Physical Training

Discussion

Our study explored the athletic profile of a group of 20 swimmers through a series of tests and a survey of coaches and technical directors, including analyses of coach training, the implementation of physical training for swimmers, and the training conditions for swimmers. The assessment of the swimmers' athletic profile revealed some heterogeneity in certain physical qualities, notably lower-limb strength, which was relatively low for both sexes. In contrast, other qualities, such as flexibility and postural balance, were comparatively higher. The heterogeneity of the results suggests individualized monitoring and training content tailored to the development of maximum strength in a structured setting. Studies have explored related topics, questioning the parameters of maximum dry strength and maximum dry speed, which significantly affect swimming performance (Chalkiadakis et al., 2023; Miras-Moreno et al., 2024; Ruiz-Navarro et al., 2023). The relative contribution of these phases to the total race time varies with distance: the non-swimming phases (start, glide, and turns) account for an increasing proportion as distance decreases (Lyttle & Benjanuvatra, 2005).

Monitoring is a fundamental principle of training because of differences in ability to adapt to training, particularly those related to heredity and genetics (Wilmore et al., 2017). The results can serve as a basis for more precise, targeted management of the training process. The morphological parameters of the athlete's body and partial scores of the somatotype index can serve as useful indicators of the suitability of the chosen training techniques (Mimouni et al., 2021). The results indicate no significant association between the training of physical preparation coaches and their implementation in swimmers' training sessions ($p > 0.05$). These results suggest that coaches and technical directors recognize that improving athletic performance requires conducting a series of tests after each training cycle (over 2 to 3 months), particularly during the swimmer's general physical preparation phase, when competition dates are far apart, to avoid fatigue. These results also show that training plays a key role in adopting structured practices and that continuing education is a major determinant of the quality of athlete monitoring (Zainuddin et al., 2024).

The status of participants (technical director or coach) and the location of physical training did not differ significantly ($p > 0.05$). These results suggest that the choice of physical training location is not determined by the position held, but probably by the unavailability of facilities within clubs. Previous studies have shown that although dry physical training can have an almost immediate positive impact on spatiotemporal swimming parameters, the beneficial effects on overall swimming performance often take time to manifest (Morais et al., 2018). Similarly, the training received by coaches and the weekly frequency of physical training were not significantly related ($p > 0.05$). Trained coaches reported 2 to 3 more weekly sessions than untrained coaches. These results show that the frequency of physical training sessions is not solely determined by the coach's training. According to Trudel & Gilbert (2006), Training and experience are the two main ways to learn to coach.

The results of this study can help coaches, physical trainers, and technical directors customize their training programs and monitor swimmers' progress using test batteries. The measured athletic qualities can also help coaches identify their swimmers' specialities (sprinting, endurance, etc.). Develop, on an exploratory basis, an athletic profiling model for young swimmers, in the form of a test grid and a practical guide. The latter should be tailored to the coaches' level and the swimmers' performance and could serve as a basis for standardized protocols in future studies.

Research Contribution

Study the feasibility of agreements between sports associations and private-sector actors, such as fitness centre owners, to improve physical training conditions. The development of public projects, such as swimming pools with additional sports facilities, could also be considered. Develop, on an exploratory basis, an athletic profiling model for young swimmers, in the form of a test grid and a practical guide. The latter should be tailored to the coaches' level and the swimmers' performance and could serve as a basis for standardized protocols in future studies.

Limitations

This study has several methodological limitations that must be considered when interpreting the results. The use of non-random sampling and a small sample (4 females, 29 males) limits external validity and generalizability. Some χ^2 analyses included low expected frequencies, which may compromise the reliability of the statistical conclusions. Additionally, the lack of direct performance indicators (e.g., swimming times, running metrics, or competitive measures) restricts the ability to infer implications for athletic performance. These limitations highlight the need for future research that uses larger, more representative samples, validated instruments, and objective performance measures to enhance the robustness and applicability of the findings.

Suggestions

Although our study provides preliminary, exploratory results on the characterization of the athletic profiles of young swimmers and their physical training practices, these results are specific to Moroccan swimmers and coaches. They may not be generalizable to different age groups, competition levels, or sports disciplines. Future studies should use a larger and more diverse sample to improve the generalizability of the results. In addition, integrating nutritional assessments with evaluations of athletic qualities could provide a more in-depth understanding of swimmers' athletic profiles for future research. Researchers should also examine the impact of these determinants on athletic performance.

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CONCLUSION

The assessment of athletic qualities is a determining factor in optimizing swimmers' performance. Our results highlight the need for personalized, periodic monitoring using standardized tests. The profiles observed indicate a lack of individualized physical training, often due to the unavailability of suitable sports facilities. The results showed no significant relationship between physical training and its practical application, highlighting the crucial role of training in the professionalization and monitoring of swimmers. The frequency and quality of training sessions remain insufficient, underscoring the need for dedicated facilities to ensure regular monitoring and continuous assessment of young swimmers. Coaches and technical directors unfamiliar with the test batteries used should become familiar with them to develop personalized programs that promote the harmonious development of all athletic qualities in swimmers. Finally, future research could combine this protocol for exploring athletic profiles with the survey's assessment of nutritional factors.

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AUTHOR CONTRIBUTION STATEMENT

In our manuscript, HM, EK, SS, BM, AO, and LA contributed as follows: HM conceptualized the study, designed the methodology, analyzed the results, and coordinated data collection. EK, SS, and AO contributed to the study design.BM and SS participated in the development of the methodology and data collection. BM and LA performed the data analysis, interpreted the results, and wrote the manuscript.

AI DISCLOSURE STATEMENT

The author used ChatGPT and Grammarly during the preparation of this work to improve the structure and technical aspects of the academic writing. After using the tool/service, the authors thoroughly reviewed and proofread the study's content and accuracy.

CONFLICTS OF INTERES

The authors of this article declare that there are no conflicts of interest related to this publication. No financial relationships or personal affiliations influenced the results.

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