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Prevalence of posterior ankle impingement syndrome in Egyptian swimmers

Manar Mohamed Selmy
Demonstrator, Department of Basic Science, Faculty of Physical Therapy, Badr University in Cairo, Egypt.

Prof. Dr. Neveen Abd. El Latif Abd. El Raoof
Professor, Department of Basic Science, Faculty of Physical Therapy, Cairo University, Egypt.

Dr. Magda Ramadan Zahran
Lecturer, Department of Basic Science, Faculty of Physical Therapy, Cairo University, Egypt.

***Abstract*---**Background: Posterior ankle impingement syndrome is a common cause of posterior ankle pain that is known to be associated with sports which require the athletes to repetitively plantar flex the ankle such as ballet dancers, gymnasts, football, swimming, cycling. PAIS can limit the athlete's ability to perform at the optimal level. Objective: To determine the prevalence of posterior ankle impingement syndrome in Egyptian swimmers. Subjects & Methods: Three hundred and fifty male and female Athletes; their age ranging from 8 to 18 years old practicing swimming for at least one year. Diagnosis of PAIS was made based on history taking and assessment using hyper plantar flexion ankle special test. Results: The prevalence of PAIS in the selected sample was 24.9% with 95% CI of 20.62- 29.64%. Conclusion: Swimming practice must be with precautions to avoid PAIS injury. Routine extensor tendon stretching before swimming and protective ankle dorsiflexion taping are recommended to prevent posterior ankle impingement syndrome.

***Keywords*---**Pais, Swimming, Egyptians, Prevalence.

Introduction

Posterior ankle impingement syndrome (PAIS) is a spectrum of clinical disorders characterized by posterior ankle pain during plantar flexion or hyper flexion. PAIS may present acutely after a forced plantar flexion injury or chronically due to overuse (Yasui et al., 2016). It is a clinical diagnosis which may complicate an

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acute traumatic hyper-plantar flexion event or may relate to repetitive low-grade trauma associated with hyper-plantar flexion, e.g., in female dancers, downhill running, football players, javelin thrower sand gymnasts. The forceful plantar flexion that occurs during these activities produces compression at the posterior aspect of the ankle joint and can put extreme pressure on the anatomic structures normally present between the calcaneus and the posterior part of the distal tibia. Symptoms of posterior ankle impingement are due to failure to accommodate the reduced interval between the posterosuperior aspect of the talus and tibial plafond during plantarflexion (Hayashi et al., 2015).

Even though it can present acutely, PAIS more commonly presents with chronic pain secondary to repetitive stresses in the posterior ankle with forced plantar-flexion activities. Patients usually report chronic or recurrent posterior ankle pain caused or exacerbated by forced plantar flexion (Martins et al., 2017).

Diagnosis of posterior ankle impingement syndrome is based primarily on clinical history and physical examination (Martins et al., 2017). PAIS is characterized by deep posterior ankle pain caused by plantar flexion of the ankle. Pain is described as consistent, sharp, dull, and radiating; however, it is usually hard for patients to indicate the exact location of the pain in the hindfoot (Yasui et al., 2016).

PAIS manifests as activity-related pain that is localized to the posterior ankle. It can be a debilitating condition that limits the athlete's ability to perform at the optimal level (Heier et al., 2017). The pain is aggravated by activities requiring plantarflexion and is typically relieved by rest (Kushare et al., 2019). Other types of sports related to posterior ankle impingement syndrome include football, swimming, cycling or any other sport in which there is repetitive forced plantar flexion (d'Hooghe, 2017).

Swimming has become one of the most practiced and popular sports worldwide thanks to its peculiarity of being in an aquatic environment and the multitude of health benefits it offers. Likewise, swimming is available to everyone regardless of age and gender because water generates a minimal impact on the bones and joints. Nevertheless, its cyclical nature, combined with large training loads, high technical requirements, and demands on strength to overcome an external load, mainly in the upper limb, might lead to joint and muscular overloads, increasing the risk of injury. Regarding lower extremities, knee and ankle are the regions more affected by the injuries in swimmers. (Trinidad et al., 2021).

Ankle and foot injuries account for 5.7-32.5% of all injuries sustained in competitive swimming. They are believed to be caused by the repetitive kicking motions. The extreme plantarflexion of the ankle during each kick cycle, stretching the tendons and retinaculum beyond their normal limits (Chase et al., 2009).

In a study performed by Chase et al. (2009) 12.9% of all injuries involved the ankle which could be due to the forceful kicking motion during swimming. The second most common anatomical location of injury for female swimmers was the ankle (Chase et al., 2009). The study also identified that overuse ankle injuries were the second most problematic for swimmer (Chase et al., 2009).

Risk factors that may be associated with PAIS including Activity history (Training load, volume, and intensity), Stroke distance and stroke specialty (breast, back, crawl, butterfly) (Martens et al., 2015). Swimming training equipment, Years of swimming experience, Cross training and stretching, Demographics Previous history of pain and injury, Competitive level and Core stability are also risk factors that may be associated with PAIS (Hill et al., 2015).

Material and Methods

Ethical consideration

The ethical committee of Cairo University's Faculty of Physical Therapy has authorized the current research (No: P.T.REC/012/003668). prior to the study, the principal investigator will explain all procedures to the subjects, and all subject's parents signed an informed consent form.

Design

Cross sectional study was taken as a one shot. The expected prevalence of ankle and foot injuries in swimmers is 32%. (Chase et al., 2009). For the expected prevalence 32% and precision 5% with 95% confidence interval the required sample size is 335 according to the formula: $n= Z^2 P(1-P)/ d^2$; where n is the sample size, Z is the statistic corresponding to level of confidence, P is expected prevalence and d is the precision level (Daniel et al., 1999).

Participants

335 Male and female athletes were recruited for the study; their age ranging from 8 to 18 years old Practicing swimming for at least one year. Subject who excluded from the study were those with History of trauma or surgery to the foot or ankle, previous history of cancer, lower-extremity fracture or rheumatoid arthritis, Neurological disorders and any deformity to spine, pelvis, or lower limbs. Diagnosis of PAIS was made based on history taking. Collected data included age, gender, weight, height, previous diagnoses, treatment received and posterior joint line tenderness (Kushare et al., 2019).

Other data including risk factors that may be associated with PAIS must be collected including activity history (Training load, volume, and intensity), Stroke distance and stroke specialty (breast, back, crawl, butterfly) (Martens et al., 2015). Swimming training equipment, Years of swimming experience, Cross training and stretching, Demographics Previous history of pain and injury, Competitive level, and Core stability are also risk factors that may be associated with PAIS (Hill et al., 2015).

The weight and the height of the subjects were measured using a standard scale and a standard height ruler. Then BMI was calculated for each subject. The ankle and foot are inspected for abnormal alignment, joint effusion, or soft tissue edema. The bone and soft tissue structures are systematically palpated to assess for localized tenderness (Lavery et al., 2016). PAIS is clinically diagnosed with tenderness on deep palpation posterolateral to the ankle joint and a positive posterior impingement test (hyper plantarflexion ankle special test) (Lee et al., 2008). To have a positive test the ankle is passively and quickly forced from neutral to hyper plantar flexion position. During this movement the patient encounters suddenly recognizable posteriorly located ankle pain. To increase compression on the posterolateral structures of the ankle, plantar flexion, external rotation, and eversion movements are considered during clinical testing. Inversion and internal rotation movements of the ankle are performed during the clinical setup while performing a posteromedial compression (Heier et al., 2017).

Statistical analysis

Descriptive statistics of mean, standard deviation, frequencies, percentages, and confidence interval (CI) were utilized in presenting the subjects demographic and measured data. Quantitative variables were summarized using mean and standard deviation while categorical variables were summarized using frequencies and percentage. Chi-squared statistics and logistic regression were utilized to examine associations between PAIS and risk factors. The level of significance for all statistical tests was set at $p < 0.05$. All statistical measures were performed through the statistical package for social studies (SPSS) version 25 for windows.

Results
Subjects' characteristics

Three hundred and fifty Egyptian swimmers participated in this study. The mean ± SD age of the study group was 12.15 ± 2.38 years. The mean ± SD BMI of the study group was 20.41 ± 3.42 kg/m^2. The mean ± SD training years of the study group was 1.53 ± 0.46 kg/m^2. Table 1 showed the subject characteristics. All participants of the study group participated in competitions and perform cross training, stretching and core stability 3 session/week. No one of the study group had abnormal alignment, previous injury or treatment. Training variables demonstrated in Table 2.

Prevalence of PAIS among participants
The prevalence of PAIS of the studied sample was 24.9% with 95% CI of 20.62-29.64%.

Association between PAIS and subject characteristics and training variables:
There was a significant increase in the prevalence of PAIS in subjects with subjects with > 12- 17 years compared with subjects with 8-12 years. ($p < 0.001$) and in subjects with < 18.5 kg/m compared with subjects with 18.5–24.9 kg/m^2 and 25.0–29.9 kg/m^2 ($p < 0.001$). There was a significant increase in the prevalence of PAIS in girls compared with that in boys ($p < 0.001$) and a significant increase in subjects with 2 years of training compared with subjects with one and 1.5 years of training ($p < 0.001$). (Table 3).

There was a significant increase in the prevalence of PAIS in subjects with 3 -6 km training loads compared with subjects with 1.8-2 and 2-2.5 km of training loads ($p < 0.001$), a significant increase in subjects with 6 groups training volume compared with subjects with 2 and 3 groups of training volume ($p < 0.001$). There was a significant increase in the prevalence of PAIS in subjects with high training intensity compared with subjects with low and moderate of training intensity ($p < 0.001$), a significant increase in subjects with 100 – 150 cm distance compared with subjects with 70 - 100 cm distance ($p < 0.001$) and a significant increase in the prevalence of PAIS with Dolphin stroke (42%), Butterfly stroke (33.3%) and Breaststroke (24%) compared with other stroke types ($p < 0.001$). There was a significant increase in the prevalence of PAIS in subjects who did not use equipment compared with subjects who use equipment ($p = 0.0001$). (Table 4).

Prediction of PAIS among the participants

A Binary logistic regression was performed to determine the variables that can predict PAIS among the participants. Univariate analysis revealed that age, BMI, sex, years of training, training loads, training volume, training intensity, distance and equipment use had significant association with PAIS. Variables with significant association with PAIS in univariate analysis were entered in multivariate logistic regression to identify the significant predictors for PAIS. Increase BM and female sex were the significant predictors for PAIS ($p < 0.05$). (Table 5).

Table 1
Participants' characteristics

	N	%
Age		
8-12 years	191	54.6%
> 12- 17 years	159	45.4%
BMI		
< 18.5 kg/m²	115	32.9%
18.5–24.9 kg/m²	197	56.3%
25–29.9 kg/m²	38	10.9%
Sex		
Girls	159	45.4%
Boys	191	54.6%
Years of training		
1 year	140	40%
1.5 year	48	13.7%
2 years	162	46.3%

Table 2
Training variables

	N	%
Training load		
1.8 - 2 km	92	26.3%
2 - 2.5 km	48	13.7%
3 -6 km	210	60%
Training volume		
2 groups	48	13.7%
3 groups	50	14.3%
6 groups	252	72%

Training intensity		
Low	98	28%
Moderate	90	25.7%
High	162	46.3%
Distance		
70 - 100 cm	90	25.7%
100 – 150 cm	260	74.3
Stroke type		
Back	19	5.4
Breast	25	7.1
Butterfly	15	4.3
Crawl	104	29.7
Dolphine	162	46.3
Mixed	25	7.1
Equipment use	162	46.3%

Table 3
Association between PAIS and subjects characteristics

	Prevalence of PAIS		x^2 value	p -value
	Yes	No		
Age				
8-12 years	29 (15.2%)	162 (84.8%)	21.06	0.001
> 12- 17 years	58 (36.5%)	101 (63.5%)		
BMI				
< 18.5 kg/m²	2 (1.7%)	113 (98.3%)		
18.5–24.9 kg/m²	64 (32.5%)	133 (67.5%)	57.85	0.001
25.0–29.9 kg/m²	21 (55.3%)	17 (44.7%)		
Sex				
Girls	56 (35.2%)	103 (64.8%)	16.75	0.0001
Boys	31 (16.2%)	160 (83.8%)		
Years of training				
1 year	11 (7.9%)	129 (92.1%)		
1.5 year	8(16.7%)	40 (83.3%)	48.8	0.0001
2 years	68 (42%)	94 (58%)		

x^2, Chi squared value; p value, Probability value

Table 4
Association between PAIS and training variables

	Prevalence of PAIS		x^2 value	p -value
	Yes	No		
Training loads				
1.8 - 2 km	7 (7.6%)	85 (92.4%)		
2 - 2.5 km	4(8.3%)	44 (91.7%)	36.11	0.001
3 -6 km	76 (36.2%)	134 (63.8%)		
Training volume				
2 groups	4 (8.3%)	44 (91.7%)	20.31	0.001

3 groups	4(8%)	46 (92%)		
6 groups	79 (31.3%)	173 (68.7%)		
Training intensity				
Low	12(12.2%)	86 (87.8%)		
Moderate	7 (7.8%)	83 (92.2%)	47.81	0.001
High	68 (42%)	94 (58%)		
Distance				
70 - 100 cm	7(7.8%)	83 (92.2%)	18.92	0.001
100 – 150 cm	80 (30.8%)	180 (69.2%)		
Teaching posture				
Back	0 (0%)	19 (100%)	56.96	0.001
Breast	6 (24%)	19 (76%)		
Butterfly	5 (33.3)	10 (66.7%)		
Crawl	8 (7.7%)	96 (92.3%)		
Dolphine	68 (42%)	94 (58%)		
Mixed	0 (0%)	25 (100%)		
Equipment use				
Equipment use	68 (42%)	94 (58%)	47.31	0.001
No equipment	19 (10.1%)	169 (89.9%)		

x^2, Chi squared value; p value, Probability value

Table 5
Predictors of PAIS among participants

	Univariate analysis				*Multivariate analysis*			
Variables	*Odds ratio*	*95% CI*	*p-value*	*Sig*	*Odds ratio*	*95% CI*	*p-value*	*Sig*
Ag > 12- 17 years	3.21	1.92-5.34	0.001	S				
BMI			0.001	S			0.001	S
18.5–24.9 kg/m²	27.18	6.51-113.56	0.001	S	17.45	4.01-76.03	0.001	S
25.0–29.9 kg/m²	69.79	15-324.71	0.001	S	54.18	10.39-282.37	0.001	S
Sex- males	0.35	0.21-0.59	0.001	S	0.3	0.15-0.57	0.001	S
Years of training			0.001	S				
1.5 year	2.34	0.88-6.23	0.09	NS				
2 years	8.48	4.25-16.91	0.001	S				
Training loads			0.001	S				
2 - 2.5 km	1.1	0.31-3.97	0.88	S				
3 -6 km	6.88	3.03-15.64	0.001	S				
Training volume			0.001	S				
3 groups	0.96	0.22-4.1	0.95	NS				
6 groups	5.02	1.74-14.6	0.003	S				
Training intensity			0.001	S				
Moderate	0.6	0.22-1.61	0.31	NS				
High	5.18	2.62-	0.001	S				

		10.23		
Distance (100 – 150 cm)	5.27	2.33-11.9	0.001	S
Stroke	51.94	0-0	0.99	NS
Equipment use	6.43	3.64-11.35	0.001	S

CI: Confidence interval, S, Significant, NS, Non significant.

Discussion

The major finding of the current study was the high prevalence of PAIS of the studied sample was 24.9% with 95% CI of 20.62- 29.64%. The present study agreed with a previous study which suggested that ankle and foot injuries account for 5.7-32.5% of all injuries sustained in competitive swimming (Chase et al., 2009). Furthermore, Martens et al. (2015) mentioned that there were risk factors that may be associated with PAIS including activity history (Training load, volume, and intensity), stroke distance and stroke specialty (breast, back, crawl, butterfly) which was proved in this study (Martens et al., 2015).

This study disagreed with Trinidad et al. (2021) who stated that the latest epidemiological studies in swimming show a high prevalence of short-term muscle/tendon injuries to the shoulder, knee, and lower back in adult swimmers (Trinidad et al., 2021). Also, the current study is disagreed with Richardson et al. (1999) who stated that swimming is a low injury prevalence sport (Richardson., et al 1999).

Conclusion

From the findings of the current study, we can conclude that swimming practice must be with precautions to avoid PAIS injury. Routine extensor tendon stretching before swimming and protective ankle dorsiflexion taping are recommended to prevent posterior ankle impingement syndrome. Periodical assessment for athletes to prevent injury progression because of high rates of failure of conservative management and the surgery is the first-line treatment option.

Conflict of interest

The authors state no conflict of interest to highlight.

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