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Prevalence of piriformis syndrome and its associated risk factors among university students in Pakistan: a cross-sectional study

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ABSTRACT

Objective To determine the prevalence of piriformis syndrome (PS) among undergraduate university health sciences students aged 18 to 25 and assess the significant predictors of PS regardless of its type and severe PS in particular.

Design A cross-sectional study.

Setting The study was conducted at a tertiary care hospital of a public university in Pakistan from December 2023 to May 2024.

Participants A total of 190 subjects enrolled in the study who met the eligibility criteria, which included being an undergraduate health sciences student (medical and allied health specialities), aged 18 up to 25 years, and willing to participate in the study. Participants were selected using multistage random sampling.

Primary and secondary outcome measures The prevalence of PS in addition to associated risk factors as a primary outcome measures. Secondary outcome measures included the severity of PS.

Results Of the total, 119 (62.6%) were female, 114 (60.0%) were between 22 and 25 years old, and 125 (65.8%) had standard body mass index. The prevalence of PS was (61.1%), whereas half suffered from severe PS, and the remaining half had mild and moderate PS. We found that factors such as casual sitting positions, sitting duration and International Physical Activity Questionnaire (IPAQ) score (physical activity) were associated with odds of PS in the crude and adjusted regression analyses. When stratified by severity of PS, factors such as writing positions, casual sitting positions, sitting duration and IPAQ score (physical activity) were associated with odds of severe PS in the crude and adjusted regression analyses.

Conclusions Students have a high prevalence of PS, with an increased likelihood of buttock pain associated with prolonged sitting, poor posture and physical inactivity. Future research that includes several factors related to students' social and psychological backgrounds is required.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Sample selection passes through rigorous stages to mitigate the selection bias.
⇒ Physical activity is assessed through valid and reliable tool.
⇒ Clinical assessment of participants of both sexes by physiotherapists of both sexes induces unintentional bias and leads to varied outcomes.
⇒ The generalisability of the study findings is limited to the sampled population only.

INTRODUCTION

A neuromuscular illness that is becoming more widely known is called piriformis syndrome (PS). Because of its complexity and frequently elusive diagnosis, PS poses a particular challenge to the medical profession. Recent studies have revealed an increase in the prevalence of this illness, characterised by localised gluteal pain and radiating low back pain.[1] A study analysed data on the age of individuals presenting with PS over two consecutive years and found a reduced mean age in the second year. This raises serious concerns, suggesting a change in the demographics of PS.[2] PS is still difficult to precisely identify because of its vague symptoms and tendency towards underdiagnosis, even with increased awareness and documented instances.[3 4] The interplay between the spasmodic piriformis muscle and the sciatic nerve, which passes behind it, results in PS. The sciatic nerve may be compressed, irritated and stretched due to the piriformis muscle, a deep gluteal region muscle that becomes tight and contractile. The person's mobility and quality of life may be severely compromised by this compression, resulting in symptoms such as tingling, numbness and radiating pain that may go down the leg.[5] Comprehending the physiological and anatomical factors underlying PS is essential to create efficient diagnostic and treatment plans.

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Younger populations are seeing an alarmingly high frequency of PS, prompting an inquiry into the contributing variables impacting this generation. The sedentary lifestyle that is common in settings is a significant factor. For most of their academic careers, students at schools, colleges, academies and universities sit while doing tasks like reading, writing, listening and using computers. These activities require a variety of postures, including extended sitting sessions, which can cause muscle tension and sciatic nerve compression.[6]

Developing preventive and therapeutic measures for PS requires understanding its etiological aspects. Numerous theories have been put out; however, the precise causes remain unclear. Consistent microtrauma and strain on the piriformis muscle, frequently brought on by extended sitting or lousy posture, can cause inflammation, muscle hypertrophy and, ultimately, compression of the sciatic nerve. Furthermore, individuals may be predisposed to PS by structural changes such as a split sciatic nerve or an aberrant nerve route.[7] Finding these indicators is essential to focusing on interventions that can lessen PS severity and risk.

PS affects productivity and quality of life,[8] potentially compromising work performance as well.[9] As a result, it has important implications for public health. PS-related chronic pain and discomfort can cause a decline in function, a reduction in physical activity and a reduction in involvement in everyday activities. This emphasises the importance of proper diagnosis and care to control symptoms effectively. Early interventions such as physical therapy, stretching exercises and ergonomic changes can reduce symptoms and limit the disease progression. In addition, prevention necessitates teaching people, particularly those in academic settings, about the value of keeping good posture and getting regular exercise.[5]

The social and economic costs associated with PS further highlight the need for efficient management techniques. PS and other chronic pain disorders can result in substantial medical expenses for prescription drugs, physical therapy sessions and maybe even surgery. Furthermore, missing workdays and poor performance on productivity may have wider economic ramifications. The psychological components of PS are gaining more attention than their clinical and public health implications. Significant emotional and psychological suffering, such as anxiety, sadness and a decline in quality of life, can result from chronic pain disorders. Addressing these problems through efficient management and preventative measures can lessen the overall impact of PS on people and society.

While available data on the prevalence of PS between adolescents and teenagers in Pakistan is limited, recent studies showed that PS is becoming a public health concern among Pakistani people.[10–12] For example, undergraduate students in Pakistan who often study for long durations in inappropriate sitting postures and do not engage in regular exercise or physical activity are at risk of developing PS.[11] This sedentary lifestyle and lack of physical activity contribute to the increasing prevalence of back pain among students worldwide.[13] It is worth noting that there are currently no specific guidelines to teach ergonomics and promote an active lifestyle to health sciences students in Pakistani universities during their early years of education. This gap in health education and awareness about proper posture and regular physical activity may contribute to developing PS and related tangible back pain. Therefore, this study aimed to determine the prevalence of PS among undergraduate health sciences students and assess the associated predictors related to PS and the severe form of PS in particular.

METHODS

Design

An analytical cross-sectional study design was conducted from December 2023 to May 2024 using a self-administered questionnaire to collect data on demographics and task-related posture, an assessment test and the International Physical Activity Questionnaire (IPAQ). This study complies with Strengthening the Reporting of Observational Studies in Epidemiology.

Setting

The study was conducted at the tertiary care hospital of the Public University in Rawalpindi, Pakistan. Rawalpindi is a city located in the southeast of Pakistan, with a total population of 2 430 388 inhabitants.[14] The university is a federal university located in Rawalpindi. It is backed up by an extensive network of 45 hospitals, nine medical colleges, four dental colleges, six nursing colleges, ten single specialty institutes and three allied health sciences institutes, making it the country's largest healthcare provider regarding trajectory and patient volume.

Participants and public involvement

Students in the Public University attended non-compulsory workshops and lectures about the study's purposes. Therefore, participants were considered patients eligible for healthcare provided at the tertiary care hospital. Consequently, they were motivated and answered the first and second sections of the questionnaires. However, they were not involved in developing the research question, commenting on the questionnaire, study design, outcome measures, conducting the study or contributing to the writing or editing this study.

Sampling and data collection

The sample size was estimated using the Raosoft webpage, which is a platform that allows the calculation of samples for cross-sectional studies.[15] Thus, the sample size was calculated using a total population of 1500 students, a 95% confidence level and a 5% margin of error, with a prevalence of 17% estimated through a previous study.[11] As a result, 190 subjects were required to conduct the study. The sampling technique employed to recruit participants from different universities is multistage random

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sampling. First, to narrow down the sampling process, 35 eligible public universities in Rawalpindi and Islamabad were divided into clusters, and each university was treated as an independent cluster. These universities have the same structure in terms of students' demographics since they are following the same legislative body. Additionally, a lottery method was used for the random selection from the clusters using a random number generator from SPSS software, and one public university was selected. Due to the variety of health specialities, the departments at this university served as a stratification factor. Subsequently, the sampling frame consisted of the students' roll or registration numbers from the stratified departments. Participants were then selected starting from the fourth subject in the list through systematic random sampling, followed by a selection of every ninth individual to ensure that the selection process remained random and unbiased. Even though selection from the departments was disproportional, this multistage approach allowed for a representative sample of the university student population. Finally, only those students who met the eligibility criteria for the study were included in the final sample. Online supplemental figure S1 elucidates sampling method. Eligibility criteria included being an undergraduate health sciences student (from medical and allied health specialities) aged 18 to 25 years and willing to participate by providing informed written consent. At the same time, people with a history of accidents/injuries, pregnant women, hip region surgery, disabled, lumbar disc pathology, hip arthritis, opioid analgesia and corticosteroid interventions were excluded from the study, along with those who did not complete the questionnaire. Participants were informed about the study's purpose and their rights, such as data confidentiality and withdrawal at any study stage.

The official format consisted of four sections. The first section is a self-administered questionnaire filled out by participants regarding their general demographic data, such as age, sex, weight, height and body mass index (BMI). In the second section, we showed the participants three pictures by Candotti *et al* to help them identify their usual positioning while performing three activities.[16] Such activities included writing, casual sitting and the use of electronic devices, and the participants were asked to identify the body positions they mainly adopted during these activities. The third section of the data collection tool was about PS data filled out by skilled male and female physiotherapists after screening male and female participants, respectively. This assessment was done with a modified seated Flexion, Adduction and Internal Rotation (FAIR) test of two types: FAIR test 1 and FAIR test 2.[17,18] A FAIR test is primarily used to assess hip joint impingement. The assessments were performed by skilled physiotherapists who requested all participants to do FAIR test 1 first, followed by FAIR test 2. In the FAIR test 1, participants actively moved their lower extremities in four positions (90-degree flexion, adduction, internal rotation) while applying upward pressure to the knee. During this test, if a participant complained of mild gluteal muscle tightness, the test result was positive; otherwise, it was negative. For FAIR test 2, participants actively moved their lower extremities into a figure of four positions (90-degree flexion, adduction, internal rotation) while applying downward pressure to the knee to internally rotate and adduct the hip. During this test, if a participant complained of moderate gluteal muscle pain, then the test result was positive; otherwise, it was negative. The fourth and last section of the data collection tools was the IPAQ.[19] IPAQ is a standardised and widely utilised instrument for assessing diverse populations' physical activity levels. The used short-form IPAQ included questions about vigorous and moderate physical activity, walking and sitting time, typically over the past 7 days, which is administered in Urdu to enhance comprehension among participants. More importantly, a previous study demonstrated its reliability and validity among the Pakistani population,[20] which underscores its appropriateness for assessing physical activity levels in our cohort of health sciences students. Respondents reported their frequency of physical activities as days per week and the duration as minutes per day.

METHODS OF MEASUREMENT

We collected the most relevant variables related to participants, such as sex, age, body weight and body height. The age category was divided into two categories: the first group was from 18 to 21 years, which was categorised as the most recognised adult age in several countries in the world while the second group was the remaining age from 22 to 25 years of participants. The investigators calculated the BMI variables. Then, they categorised them into four groups: underweight (<18.5 kg/m^2), standard (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), obese grade 1 (30.0–34.9 kg/m^2), obese grade 2 (35.0–39.9 kg/m^2) and obese grade 3 (≥40.0 kg/m^2). Such classification was obtained from the WHO.[21] Depending on the Metabolic Equivalent Task (MET), which is gathered from the IPAQ score in a unit of minutes per week, we classified the levels of physical activities according to the following: <600 MET-minutes/week as low, 600–3000 MET-minutes/week as moderate and >3000 MET-minutes/week as a high level of physical activity. Such classifications were mandatory to simplify the quantitative analysis. The severity of PS was classified according to the FAIR tests 1 and 2: healthy in case of negative results in tests 1 and 2, mild in case of only test 1 is positive, moderate in case of only test 2 is positive, severe in case of both 1 and 2 tests are positive. In addition, we also classify the severity of PS from the perspective of symptomatic and asymptomatic status. Although mild and moderate PS are similar to healthy participants in that they do not develop pain after both FAIR tests, they are considered asymptomatic. In contrast, participants with severe PS are classified as symptomatic because they would have pain as the response to both FAIR tests 1 and 2.

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Statistical analysis

We computed by rows adding up to 100% the differences in numbers and percentages of subgroups of variables related to participants' characteristics such as sex, age categories, BMI categories and IPAQ score between healthy participants and three different ordinal forms of PS: mild, moderate, and severe. Similarly, we calculated the difference in numbers and percentages of subgroups related to different patterns of postures during various activities. Sitting duration and IPAQ score were calculated column-wise, adding up to 100% concerning different categories of five participants' characteristics variables: sex, age category, BMI category, PS status and severe PS status. Furthermore, we tested the difference using Pearson's χ^2 or Fisher's exact tests where appropriate.[22]

Participants' PS outcomes were treated as binary variables (healthy participants as the reference). Unadjusted ORs and adjusted ORs with a 95% CI were computed. After univariate, or unadjusted, logistic regression, all participants' characteristics were added to the model to assess the adjusted association between participants' characteristics and developing PS. Additionally, we conducted crude and adjusted binary logistic regression to assess the association between variables and the odds of severe PS (healthy, mild and moderate PS were computed together and considered the reference).

RESULTS

Table 1 shows that the total number of eligible participants was 190. The males were 37.4 %, the age category of 22 to 25 years, 60.0%, BMI of the standard category, 65.8% and IPAQ score of moderate activity, 59.5%. In addition, sex, age category and IPAQ score were all significantly associated with the healthy participants and PS regardless of severity. Males and those aged 22 to 25 years showed a higher proportion of severe PS. The prevalence of PS is 61.1%, and the remaining participants were healthy (38.9%).

Table 2 shows the number and percentage of tests performed and the severity levels of PS participants compared with the healthy group. We found that the writing positions, casual sitting positions and sitting duration were significantly associated with sex at ($p<0.05$). Age categories were significantly associated with using electronic devices sitting position and the sitting duration at a $p<0.05$. Participants' BMI was significantly associated with IPAQ score at a $p<0.05$. A significant difference was detected in writing position and severe/non-severe PS. In contrast, no significant value was detected when PS severity was stratified.

Table 3 shows the findings of the crude and adjusted logistic regression models. In the crude model, the casual sitting position, use of the electronic devices (positioning), sitting duration and IPAQ score were found to be associated with odds of PS of all three types. When the model was adjusted, the casual sitting position, sitting duration and IPAQ score were found to be associated with the odds of PS of all three types.

Table 4 shows the findings of the crude and adjusted logistic regression models. In the crude model, sex, age category, writing position, casual sitting, use of electronic

Table 1 Characteristic feature of participants (n=190) according to their finding of piriformis syndrome (PS) severity

		PS health status				PS health status	
		Mild	Moderate	Severe	Healthy	Severe	Non-severe
Characteristics	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Sex							
Male	71 (37.4)	5 (7.0)	12 (16.9)	32 (45.1)	22 (31.0)	32 (45.1)	39 (54.9)
Female	119 (62.6)	17 (14.3)	21 (17.6)	29 (24.4)	52 (43.7)	29 (24.4)	90 (75.6)
P value		0.020*				0.003*	
Age category							
18–21	76 (40.4)	11 (14.5)	16 (21.1)	15 (19.7)	34 (44.7)	15 (19.7)	61 (80.3)
22–25	114 (60.0)	11 (9.6)	17 (14.9)	46 (40.4)	40 (35.1)	46 (40.4)	68 (59.6)
P value		0.029*				0.003*	
BMI category							
Underweight	39 (20.5)	8 (20.5)	7 (17.9)	14 (35.9)	10 (25.6)	14 (35.9)	25 (64.1)
Normal	125 (65.8)	12 (9.6)	26 (20.8)	35 (28.0)	52 (41.6)	35 (28.0)	90 (72.0)
Overweight	20 (10.5)	2 (10.0)	0 (0.0)	10 (50.0)	8 (40.0)	10 (50.0)	10 (50.0)
Obese grade 1	6 (3.2)	0 (0.0)	0 (0.0)	2 (33.3)	4 (66.6)	2 (33.3)	4 (66.6)
P value		0.067†				0.244†	

*χ^2 test.
†Fisher's exact test.
BMI, body mass index.

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Table 2 Number and percentage of test performed and severity of piriformis syndrome (PS) to 190 participants according to their sex, age category and body mass index (BMI)

	Sex		Age		BMI category				PS health status				PS health status	
	Male	Female	18–21	22–25	Underweight	Normal	Overweight	Obese grade 1	Mild	Moderate	Severe	Healthy	Severe	Non-severe
Test performed	n=71	n=119	n=76	n=114	n=39	n=125	n=20	n=6	n=22	n=33	n=61	n=74	n=61	n=129
Writing positions														
Bad posture bending (neck)	8 (11.3)	32 (26.9)	22 (28.9)	18 (15.8)	9 (23.1)	25 (20.0)	6 (30.0)	0 (0.0)	6 (27.3)	6 (18.2)	15 (24.6)	13 (17.6)	15 (24.6)	25 (19.4)
Good sitting position	35 (49.3)	44 (37.0)	27 (35.5)	52 (45.6)	17 (43.6)	50 (40.0)	7 (35.0)	5 (83.3)	7 (31.8)	11 (33.3)	31 (50.8)	30 (40.5)	31 (50.8)	48 (37.2)
Bad posture (leaning)	28 (39.4)	43 (36.1)	27 (35.5)	44 (38.6)	13 (33.3)	50 (40.0)	7 (35.0)	1 (17.7)	9 (40.9)	16 (48.5)	15 (24.6)	31 (41.9)	15 (24.6)	56 (43.4)
P value	0.032*		0.083*		0.520†				0.247*				0.043*	
Casual sitting positions														
Bad posture bending (neck)	8 (11.3)	37 (31.1)	24 (31.6)	21 (18.4)	9 (23.1)	31 (24.8)	5 (25.0)	0 (0.0)	7 (31.8)	10 (30.3)	11 (18.0)	17 (23.0)	11 (18.0)	34 (26.4)
Good sitting position	22 (31.0)	37 (31.1)	25 (32.9)	34 (29.8)	9 (23.1)	41 (32.8)	6 (30.0)	3 (50.0)	6 (27.3)	10 (30.3)	11 (18.0)	32 (43.2)	11 (18.0)	48 (37.2)
Bad posture (leaning)	41 (57.7)	45 (37.8)	27 (35.5)	59 (51.8)	21 (53.8)	53 (42.4)	9 (45.0)	3 (50.0)	9 (40.9)	13 (39.4)	39 (63.9)	25 (33.8)	39 (63.9)	47 (36.4)
P value	0.040*		0.047*		0.711†				0.013*				0.001*	
Use of electronic devices														
Bad posture bending (neck)	22 (31.0)	38 (31.9)	31 (40.8)	29 (25.4)	8 (20.5)	43 (34.4)	6 (30.0)	3 (50.0)	7 (31.8)	12 (36.4)	10 (16.4)	31 (41.9)	10 (16.4)	50 (38.8)
Good sitting position	17 (23.9)	32 (26.9)	23 (30.3)	26 (22.8)	15 (38.5)	29 (23.2)	5 (25.0)	0 (0.0)	8 (36.4)	12 (36.4)	13 (21.3)	16 (21.6)	13 (21.3)	36 (27.9)
Bad posture (leaning)	32 (45.1)	49 (41.2)	22 (28.9)	59 (51.8)	16 (41.0)	53 (42.4)	9 (45.0)	3 (50.0)	7 (31.8)	9 (27.3)	38 (62.3)	27 (36.5)	38 (62.3)	43 (33.3)
P value	0.852*		0.007*		0.337†				0.004*				<0.001*	
Sitting duration														
0–2 hours per day	7 (9.9)	16 (13.4)	10 (13.2)	13 (11.4)	2 (5.1)	16 (12.8)	5 (25.0)	0 (0.0)	1 (4.5)	0 (0.0)	6 (9.8)	16 (21.6)	6 (9.8)	17 (13.2)
3–4 hours per day	16 (22.5)	45 (37.8)	37 (48.7)	24 (21.1)	12 (30.8)	39 (31.2)	8 (40.0)	2 (33.3)	9 (40.9)	15 (45.5)	6 (9.8)	31 (41.9)	6 (9.8)	55 (42.6)
5–6 hours per day	20 (28.2)	38 (31.9)	18 (23.7)	40 (35.1)	18 (46.2)	36 (28.8)	3 (15.0)	1 (16.7)	8 (36.4)	8 (24.2)	24 39.3)	18 (24.3)	24 39.3)	34 (26.4)
> 7 hours per day	28 (39.4)	20 (16.8)	11 (14.5)	37 (32.5)	7 (17.9)	34 (27.2)	4 (20.0)	3 (50.0)	4 (18.2)	10 (30.3)	25 (41.0)	9 (12.2)	25 (41.0)	23 (17.8)
P value	0.005*		<0.001*		0.163†				<0.001*				<0.001*	
IPAQ score														
Low	33 (46.5)	41 (4.5)	23 (30.3)	51 (44.7)	15 (38.5)	48 (38.4)	11 (55.0)	0 (0.0)	12 (54.5)	12 (36.4)	49 (80.3)	1 (1.4)	49 (80.3)	25 (19.4)
Moderate	36 (50.7)	77 (64.7)	52 (68.4)	61 (53.5)	24 (61.5)	76 (60.8)	8 (40.0)	5 (83.3)	10 (45.5)	21 (36.6)	11 (18.0)	71 (95.9)	11 (18.0)	102 (79.1)
High	2 (2.8)	1 (0.8)	1 (1.3)	2 (1.8)	0 (0.0)	1 (0.8)	1 (5.0)	1 (16.7)	0 (0.0)	0 (0.0)	1 (1.6)	2 (2.7)	1 (1.6)	2 (1.6)
P value	0.115†		0.103†		0.026†				<0.001†				<0.001†	

*χ^2 test.
†Fisher exact test.
IPAQ, International Physical Activity Questionnaire.

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Table 3 Predictors of piriformis syndrome

Predictive variable	Crude results				Adjusted results			
	Beta	SE	OR (95% CI)	*P* value	Beta	SE	OR (95% CI)	*P* value
Sex								
Female	Reference				Reference			
Male	0.547	0.32	1.729 (0.930 to 3.213)	0.084	0.061	0.545	1.063 (0.365 to 3.093)	0.91
Age category								
22–25	Reference				Reference			
18–21	0.404	0.3	0.668 (0.369 to 1.209)	0.182	0.074	0.509	0.929 (0.342 to 2.520)	0.885
BMI								
Normal	Reference				Reference			
Underweight	0.725	0.41	2.066 (0.926 to 4.606)	0.076	0.707	0.562	2.029 (0.674 to 6.103)	0.208
Overweight	0.066	0.49	1.068 (0.408 to 2.798)	0.893	0.544	1.004	0.580 (0.081 to 4.154)	0.588
Obese grade 1	1.032	0.89	0.356 (0.063 to 2.018)	0.243	0.63	1.122	0.533 (0.059 to 4.808)	0.575
Writing positions								
Good sitting position	Reference				Reference			
Bad posture bending (neck)	0.24	0.41	1.272 (0.570 to 2.837)	0.557	1.245	0.874	3.472 (0.626 to 19.266)	0.154
Bad posture (leaning)	0.236	0.33	0.790 (0.411 to 1.518)	0.479	0.628	0.733	0.534 (0.127 to 2.244)	0.392
Casual sitting positions								
Good sitting position	Reference				Reference			
Bad posture bending (neck)	0.669	0.4	1.952 (0.885 to 4.305)	0.097	0.022	0.754	1.023 (0.233 to 4.480)	0.976
Bad posture (leaning)	1.062	0.35	2.892 (1.447 to 5.777)	0.003	1.652	0.765	5.219 (1.166 to 23.363)	0.031
Use of electronic device								
Good sitting position	Reference				Reference			
Bad posture bending (neck)	0.791	0.4	0.454 (0.207 to 0.992)	0.048	0.812	0.59	0.444 (0.140 to 1.411)	0.169
Bad posture (leaning)	0.031	0.39	0.970 (0.456 to 2.063)	0.936	1.055	0.652	0.348 (0.097 to 1.249)	0.105
Sitting duration								
3–4 hours per day	Reference				Reference			
0–2 hours per day	0.794	0.52	0.452 (0.163 to 1.254)	0.127	2.667	1.206	0.069 (0.007 to 0.738)	0.027
5–6 hours per day	0.831	0.38	2.296 (1.085 to 4.858)	0.03	0.007	0.571	1.007 (0.329 to 3.087)	0.99
>7 hours per day	1.499	0.45	4.478 (1.854 to 10.813)	0.001	1.492	0.721	4.447 (1.082 to 18.274)	0.038
IPAQ score								
Moderate	Reference				Reference			
Low	4.815	1.03	123.405 (16.537 to 920.906)	<0.001	5.493	1.262	242.909 (20.480 to 2881.099)	<0.001
High	0.168	1.24	0.845 (0.074 to 9.607)	0.892	0.741	1.507	0.477 (0.025 to 9.144)	0.623

BMI, body mass index; IPAQ, International Physical Activity Questionnaire; SE, Standard error.

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Table 4 Predictors of severe piriformis syndrome

Predictive variable	Crude results				Adjusted results			
	Beta	SE	OR (95% CI)	*P* value	Beta	SE	OR (95% CI)	*P* value
Sex								
Female	Reference				Reference			
Male	0.935	0.32	2.546 (1.360 to 4.769)	0.004	0.84	0.548	2.317 (0.791 to 6.787)	0.125
Age category								
22–25	Reference				Reference			
18–21	−1.012	0.346	0.364 (0.185 to 0.716)	0.003	−0.122	0.556	0.885 (0.297 to 2.632)	0.826
BMI								
Normal	Reference				Reference			
Underweight	0.365	0.389	1.440 (0.672 to 3.085)	0.348	−0.181	0.67	0.834 (0.224 to 3.103)	0.787
Overweight	0.944	0.49	2.571 (0.985 to 6.713)	0.054	1.319	0.919	3.741 (0.618 to 22.656)	0.151
Obese grade 1	0.251	0.889	1.286 (0.225 to 7.338)	0.777	0.449	1.437	1.567 (0.094 to 26.168)	0.755
Writing positions								
Good sitting position	Reference				Reference			
Bad posture bending (neck)	−0.074	0.4	0.929 (0.424 to 2.034)	0.854	0.734	0.853	2.084 (0.391 to 11.092)	0.389
Bad posture (leaning)	−0.88	0.371	0.415 (0.200 to 0.858)	0.018	−3.275	0.947	0.038 (0.006 to 0.242)	0.001
Casual sitting positions								
Good sitting position	Reference				Reference			
Bad posture bending (neck)	0.345	0.482	1.412 (0.549 to 3.629)	0.474	0.268	0.889	1.308 (0.229 to 7.472)	0.763
Bad posture (leaning)	1.287	0.398	3.621 (1.659 to 7.904)	0.001	2.586	0.963	13.276 (2.013 to 87.574)	0.007
Use of electronic device								
Good sitting position	Reference				Reference			
Bad posture bending (neck)	−0.591	0.474	0.554 (0.219 to 1.402)	0.213	−1.306	0.864	0.271 (0.050 to 1.473)	0.131
Bad posture (leaning)	0.895	0.393	2.447 (1.133 to 5.285)	0.023	0.756	0.766	2.131 (0.475 to 9.560)	0.323
Sitting duration								
3–4 hours per day	Reference				Reference			
0–2 hours per day	1.174	0.641	3.235 (0.922 to 11.355)	0.067	1.831	0.916	6.243 (1.037 to 37.601)	0.046
5–6 hours per day	1.867	0.506	6.471 (2.401 to 17.441)	<0.001	2.139	0.815	8.487 (1.719 to 41.901)	0.009
>7 hours per day	2.299	0.518	9.964 (3.610 to 27.501)	<0.001	2.73	0.831	15.333 (3.006 to 78.221)	0.001
IPAQ score								
Moderate	Reference				Reference			
Low	2.9	0.401	18.175 (8.275 to 39.915)	<0.001	2.882	0.545	17.859 (6.132 to 52.015)	<0.001
High	1.534	1.265	4.636 (0.388 to 55.349)	0.225	0.442	1.528	1.556 (0.078 to 31.076)	0.772

BMI, body mass index; IPAQ, International Physical Activity Questionnaire .

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devices positioning, sitting duration, and IPAQ score were associated with the odds of developing severe PS. When the model was adjusted, the following predictors: writing positions, casual sitting positions, sitting duration and IPAQ score remained associated with the odds of developing severe PS.

DISCUSSION

The present study aimed to determine the prevalence of PS among medical and health-allied students in a single public university in Pakistan and assess the associated factors with PS. Our study showed that the prevalence rate of PS and severe PS among health specialty students was more than 60.0% and 31.0%, respectively. Our finding is less than that of a previous Pakistani study, which found that the prevalence of PS among health-allied students was 41.7%.[23] This difference can be explained by the nonprobability convenient sampling technique used in that study, whereas our study passed through multiple-stage selection to reduce bias. To the best of our knowledge, this is the first study that investigated those categories of students who study at the colleges of medicine and allied health aged 18 to 25 years of both sexes in Pakistan using crude and adjusted binary logistic regression. Most medical and other health-allied students require further time in continuous learning during the weekly days and in their homes compared with other students studying another discipline. As a result, prolonged sitting postures and low physical exercise due to time constraints become the predominant lifestyle. Several studies showed women had suffered PS more than males, with Kean *et al* reporting a ratio of 3:2, whereas Jankovic *et al* compared it to 6 to 1.[3 24] In females, the pelvis is wider than in males due to the different anatomical angles of pelvic muscles. Female hormonal changes due to pregnancy can also cause trauma to the piriformis muscle itself.[1] In our study, sex was not significantly associated with PS or severe PS, which aligns with Muhammed *et al*.[23] A possible explanation is that most female participants in our study were younger, 18–25 years, than those women who were found to be predominant. In our study, participants' students were between 18 and 25. Based on the χ^2 test (table 1), there was an association between age category and PS. Nevertheless, the crude and adjusted model in tables 3 and 4 showed that the senior students between the ages of 22 and 25 had the odds of developing PS and severe PS compared with junior students between 18 and 21 years old, at p value >0.05. Muhammed *et al* found that age increases were associated with PS.[23] Interestingly, our finding related to the BMI category was not significant to PS, which is inconsistent with Park *et al*, who found that as BMI increases, the distance between the subcutaneous tissue and piriformis muscle also increases, thus triggering the PS.[25] Our finding can be explained by the fact that more than half of this study's participants had standard BMI, followed by underweight (20.5%), overweight (10.5%) and obese of grade 1 (3.2%). The prevalence of overweight and obesity between school-aged children and adolescents in Pakistan was 5.8% and 5.4%, respectively.[26] Future research on the relationship between obesity and PS is warranted and in line with Siahaan *et al*, who concluded that the relationship between PS and BMI requires further studies.[1]

Long duration of sitting while maintaining a static poor posture weakens the piriformis muscle, causing PS (p<0.001). Young adults' internet addiction is associated with adopting poor static postures for long durations, encouraging sedentary lifestyles. The piriformis muscle is primarily a postural muscle. It tends to be short, hypertonic, hyperactive and weak. During prolonged sitting in poor posture, the piriformis muscle works hyperactively to maintain the tone of the muscle.[27] Gluteus muscles work synergistically with the piriformis muscle to compensate for the primary muscle. Prolonged sitting and poor sitting postures weaken the gluteus muscles, and as compensation, the piriformis muscle becomes weak, causing muscular damage.[1] Our study results corroborate this fact. In our study, bad posture (leaning) during casual sitting positions was associated with odds of PS and severe PS in crude and adjusted models. Our study showed that increased sitting duration was associated with the odds of PS and severe PS. Interestingly, we found that using a computer or laptop was not associated with the odds of PS and severe PS.

Physical activity has a protective effect and an inverse association with musculoskeletal pain. Our study found that low physical activity was associated with increased odds of developing PS and severe PS in the crude and adjusted model. People with low physical activity and lack physical fitness are more comfortable in their sedentary lifestyles and more prone to developing PS.[11] This association was statistically significant in this study, with (p=0.000) for the duration of vigorous activities and (p=0.019) for moderate activities.

Physical activity, sitting posture and prolonged sitting duration are all modifiable risk factors for PS. Students should regularly pause their sitting activities to perform stretching exercises.[1] Institutes should employ ergonomic furniture to improve students' sitting posture and encourage them to be more physically active. However, future studies are still warranted to assess the effectiveness of these suggestions in similar study settings.

Health sciences students are known to spend a longer time in the sitting-down positions to do all tasks and homework required by their tutors. Our study found that longer sitting durations were significantly associated with both PS and severe PS. However, several studies have explored the effectiveness of reminder applications in reducing such sedentary behaviour, which can help prevent conditions like piriformis syndrome. These studies highlighted using mobile apps and wearable technology to prompt users to take breaks and move, thereby reducing long sitting durations.[28–30]

Strengths and limitations

This study had several limitations. While offering valuable insights into PS among undergraduate students, it

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acknowledges several limitations that warrant deeper consideration for future research endeavours. The first limitation can be attributed to the study's recruitment strategy, which might have inadvertently introduced selection bias. Students already experiencing pain or suspected PS might have been more likely to volunteer for the study, potentially inflating the prevalence estimates. Future studies should employ more robust recruitment strategies. Using random sampling techniques or collaborating with university departments to reach a broader student population could help ensure a more representative sample and reduce potential bias. The second limitation can be attributed to self-reported data, for example, the self-reported data for pain intensity and FAIR test results. This approach may introduce inherent biases that affect the study's accuracy. Participants might underreport or overreport pain based on their individual pain perception, expectations and pain tolerance.

Similarly, self-administered FAIR tests might not be as precise as those conducted by trained healthcare professionals. Factors like participant understanding of test instructions, limitations in self-assessment techniques and the potential for misinterpreting sensations could contribute to inaccuracies. Therefore, future studies incorporating standardised pain assessment tools alongside self-reported measures may mitigate these limitations. For example, using tools like visual analogue scales would provide a more objective measure of pain intensity. Another limitation might be related to generalisability. The study was conducted at a single university, which could limit the generalisability of our findings to the broader undergraduate population in another field of study. Pakistani universities can vary significantly in terms of academic schedules, campus layout, access to ergonomic furniture and even the culture surrounding physical activity. Students at different institutions might experience varying levels of physical activity demands, posture requirements during class time or study sessions and access to resources that could influence the prevalence of PS. Therefore, future studies should involve multiple universities with diverse student populations. This could include collaborating with researchers from other institutions to conduct a multi-centre study.

Additionally, gathering data on factors like university size, location and academic programmes offered could allow for further analysis of how these variables might interact with risk factors and PS prevalence. The final limitation was related to other important psychological factors that have yet to be included with our study's independent variables. While the study acknowledges the potential influence of stress and academic demands, a deeper exploration of psychological factors is warranted. Future studies could incorporate standardised psychological questionnaires to assess stress, anxiety and depression levels in participants. Analysing these factors alongside PS prevalence and risk factors could shed light on potential psychological contributions to PS development or pain perception in this population.

CONCLUSIONS

This study showed that the prevalence of PS among health-allied and medical students was higher than among the healthier ones. PS was higher for males, senior students, obese participants and participants with lower activities. Longer sitting duration and lower exercise were the most associated factors in predicting PS development. Future research that includes several factors related to students' social and psychological backgrounds is required, in addition to research that assesses the effectiveness of treatment interventions for PS. Qualitative research focused on deep causes that discourage students from practising physical exercise is also required. Policymakers may find this study valuable in proposing future preventive measures that curb the factors that might trigger PS.

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Contributors All authors conceived the study, conceptualised the ideas and supervised the study design and definition of essential terms and study measures. NB, NA, HNM, AH, NI, HM, WAS, ASM, ABM, JMM and MA performed the data cleaning, management and analysis. NB was the formal analysis and NA provided statistical advice on study design and analysis. NB, NA and HNM had full access to all of the data in the study. NB takes responsibility for the integrity of the data and the accuracy of data analysis. NB, NA, HNM, AH, AA, MA, HM and JMM interpreted the data. NB and NA were the project administrators. NB was the primary supervisor. NB drafted the manuscript, and all authors contributed substantially to its revision. NB takes responsibility for the paper as a whole. NB is the guarantor.

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