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Association of Sleep Apnea and Depressive Symptoms among Gymnastic in Karachi, A Cross Sectional Study

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ABSTRACT

OSA is a form of sleep-disordered breathing *condition commonly seen in adults, particularly those in middle or later stages of life, and often goes undiagnosed (1) In children,* Sleep-related breathing disorders *encompasses a range of respiratory disturbances during sleep, from minor airflow disruptions to more serious forms like* Upper airway resistance during sleep *(2)* Nocturnal apnea *involves repeated narrowing and collapse of the pharyngeal airway during sleep, resulting in disrupted sleep and low oxygen levels.(3) Depression is a widespread mental health disorder, known for its high recurrence and significant impact on daily functioning, affecting around 300 million people worldwide.To find the connection of sleep apnea and depressive symptoms among gymnastics in karachi. Depression was reported by 83.9% of gymnasts, with moderate to severe symptoms more common in males, those aged 21-25, and individuals with <1 year of experience. Functional difficulty affected 17.9%. The most common symptom was fatigue (44.6%), and the strongest correlation was with low self-worth (r = 0.66). All PHQ-9 items were statistically significant (p < 0.05), and the tool showed good reliability (Cronbach's Alpha = 0.788).Depression and functional difficulty are prevalent among young, less experienced male gymnasts, highlighting the need for early screening and targeted mental health support. **T**his study is principle to evaluate the gymnastics with sleep apnea and depressive symptoms, a cross sectional study among 168 gymnastics both male and female will be conducted from age 19-35 ih different gyms and fitness centers. Participants will have recruited through online and physical survey forms after the participants have given their consent. The data will interpret and analyze through SPSS which is the most updated form and t test will be applied.*

Keywords: *Sleep apnea, Depressive Symptoms, Gymnastics.*

INTRODUCTION

OSA is a nighttime respiratory condition frequently observed in people aged 40 and older, yet the majority are unaware of its presence. Sleep-disordered breathing (SDB) in children encompasses a spectrum of conditions, ranging in severity from simple snoring to more severe forms such as obstructive sleep apnea.

Persistent lack of sleep results in signs similar to depressive disorders, partly because the frontal brain areas involved in emotional control are affected are sensitive to distressed sleep.[4]Sleep is a important health concern for women during pregnancy. The knowledge of pregnancy brings about respectable change in sleep structure and behavior, which may effect in the development of sleep disorders, including insomnia, nighttime awakenings, unsatisfied legs syndrome, continual snoring , and obstructive sleep apnea, leading to extravagant daytime drowsiness.[5]

The atypical respiratory events of oobstructive sleep apnoea normally are attended due to sleep interruptions, with steady rising being the most significant reason resulting in excessive daytime sleepiness.[6] nocturnal breathing disorders are state of bodily process while sleep defined by extended partially obstructed upper airway barrier, completed or incomplete blockage (obstructive apnoea or hypopnea), or some extended and occasional barrier that interrupt normal improvement . Throughout sleep, typical sleep architecture, or a combination of the two.

Globally, the global occurrence of sleep-related issues among elite gymnasts is alarmingly high, with a significant majority experiencing disturbed sleep, which can adversely affect their athletic performance and overall well-being [8]. the occurrence of sleep disorders among the elderly is notably high. In Indonesia, it reaches approximately 50% of the elderly population experiencing some form of sleep disturbance [9]. In the United States, the national sleep foundation reports that about 67% of older adults in the united states aged 65 and above experience sleep interruptions, with 7.3% specifically facing issues with starting and maintaining sleep or insomnia. Overall, the global prevalence of sleep disorders in the elderly varies, but the figures from Indonesia and the United States highlight a significant concern that is prevalent in many regions [9].

Retired artistic gymnasts (FAG) and ex-gymnasts from other disciplines generally report an improved quality of life compared to non-athletes (cg). The study indicates that former gymnasts have higher values in quality of life assessments, suggesting a positive impact of their athletic background on their later life [10]

The study notes that the occurrence of psychological disorders, including depression, is reported to be high in the the broader public , such as among Swedish university students. . This indicates that while depression is a common issue in the general population, it may be less prevalent among elite athletes in this specific sample [11]. The findings indicate that symptoms of depression remained stable over the 12-month follow-up period among the gymnasts, suggesting that there was little change in their mental health status regarding depression during this time [11].

Approximately 1 billion individuals between the ages of 30 and 69 across the globe are believed to suffer from obstructive sleep apnea. . This figure underscores the widespread nature of the condition and its potential impact on global health [12]. Regionally, the highest number of affected people were reported in china, subsequently USA, Brazil, and India. This geographical data is crucial for understanding where healthcare resources and interventions may be most needed [12].

The research indicates that 80% of adolescent athletes achieved anxiety scores of 7 or lower and depression scores of 5 or lower on the Hospital Anxiety and Depression Scale (HADS). In comparison, the findings highlight that these scores were lower than the normative values reported for adolescents in Sweden, China, and Great Britain, where average anxiety scores reached as high as 7.2 and average depression scores up to 5.4 (13).

The overall prevalence of Sleep-related airway obstruction apnoea syndrome (defined as an apnoea-hypopnea index (ahi) ≥ 5 along with excessive daytime sleepiness is projected to be about 3-4% in men and 2% in women based on studies predominantly involving white populations. The Wisconsin-based sleep study study, a rigorous population-based study, reported a prevalence of obstructive sleep apnea (ahi ≥ 5) of 24% in men and 9% in women among middle-aged adults. N a cohort from Pennsylvania, the prevalence of Obstructive sleep apnoea syndrome was detected to be 3.9% in men and 1.2% in women.

A Spanish cohort showed a notably higher prevalence, with 28% in women and 26.2% in men, which may be attributed to the inclusion of arousals in scoring hypopneas. Interestingly, studies from Asia report a

similar prevalence related to upper airway obstruction during sleep despite lower body mass index levels compared to western populations, indicating the influence of non-obesity-related risk factors [14].

South Asians, which include countries like India, Pakistan, Bangladesh, Sri Lanka, and Nepal, are witnessed to have an elevated risk for OSA compared to their Caucasian counterparts. This highlights a regional health disparity, other than that prevalence rates, such as 10% in Karachi and 8.72% in rural South India. In contrast, a study in Odisha, India, reported a much higher prevalence of 25%. These differences may be associated to various reasons, including methodology and population characteristics. [26]The prevalence of upper airway collapse during sleep apnoea (OSA) in Asia is reported to be around 2.1% to 7.5%. However, specific data from Pakistan indicates a higher risk within certain populations, In Karachi, studies utilizing the Berlin questionnaire have shown that approximately 10% to 12.4% of the population is at elevated risk for OSA.[27]

METHODOLOGY

Study Design

This research adopted a cross-sectional methodology to explore the link between sleep apnea and depressive symptoms among gymnasts in Karachi. The design allowed for the assessment of variables at one specific time across a specific population to determine the prevalence and relationships between the studied conditions.

Sampling Technique

The study utilized a convenience sampling approach, with participants chosen due to their readiness and ease of access., without randomization. This approach was chosen due to accessibility and feasibility within gym and fitness center settings.

Outcome Measure

The primary outcome measures were:

- **Depressive symptoms**, assessed using the **Patient Health Questionnaire-9 (PHQ-9)**. A score of 10 or higher on this tool was used to define the presence of depressive symptoms.
- **Sleep apnea**, which was identified through self-reported responses on a sleep disorder questionnaire.

Data Analysis Procedure

Data were coded and assessed using **SPSS version 26**. Descriptive statistics were used to summarize demographic variables and outcome measures. **Chi-square tests** assessed associations between demographic factors and depressive symptoms. **Reliability** of the PHQ-9 was confirmed using **Cronbach's Alpha**, and additional diagnostic tests such as normality, multicollinearity, and homogeneity were performed to ensure accuracy of the statistical procedures.

Ethical Consideration

Informed consent was secured from each participant before initiating data collection. Participant confidentiality and anonymity were carefully protected during all phases of the study. Ethical approval was received from the Indus University Institutional Review Board, affirming adherence to ethical protocols governing research with human subjects.

Reliability

Cronbach's Alpha was used to assess the internal reliability of the PHQ-9 questionnaire, producing a value of 0.767, signifying acceptable internal coherence**.**When combined with the additional functional difficulty item, the overall reliability increased to **0.788**, affirming the dependability of the measurement instruments used in the study.

RESULT

This chapter discusses the outcome of statistical applications on dependent variables, independent variables, and their interconnection. It reviews two aspects of data analysis i.e. (i) Data dissection and its visualization aiming to provide research glimpse briefly to general audience and (ii) Statistical descriptions including descriptive statistics, correlation & chi-square analysis, and diagnostic analysis.

Data Visualization

Chart 1

Age-wise population: Showing break-up of population w.r.t. age brackets of respondents

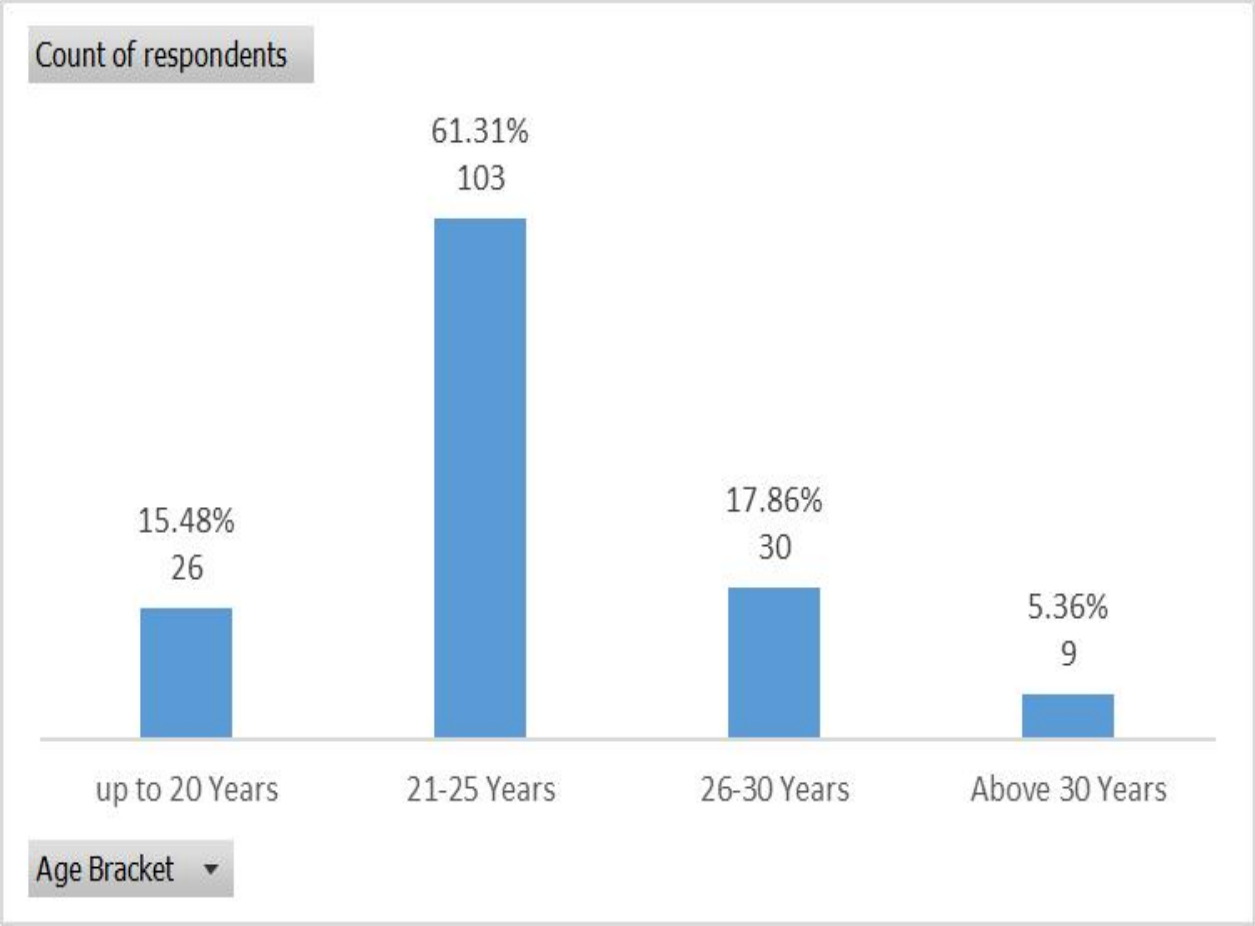

Chart-01 showing that one-hundred and sixty-eight respondents have examine for research consist with four (04) age-brackets i.e., 26 respondents (15.48% of population) having age bracket of up to 20 years old, 103 respondents (61.31% of population) having age bracket of 21-25 years old, 30 respondents (17.86% of population) having age bracket of 26-30 years old and 09 respondents (5.36% of population) having age bracket of above 30 years old.

Chart 2

Count of gender-wise Population: Showing break-up of population of respondents w.r.t. gender-wise population.

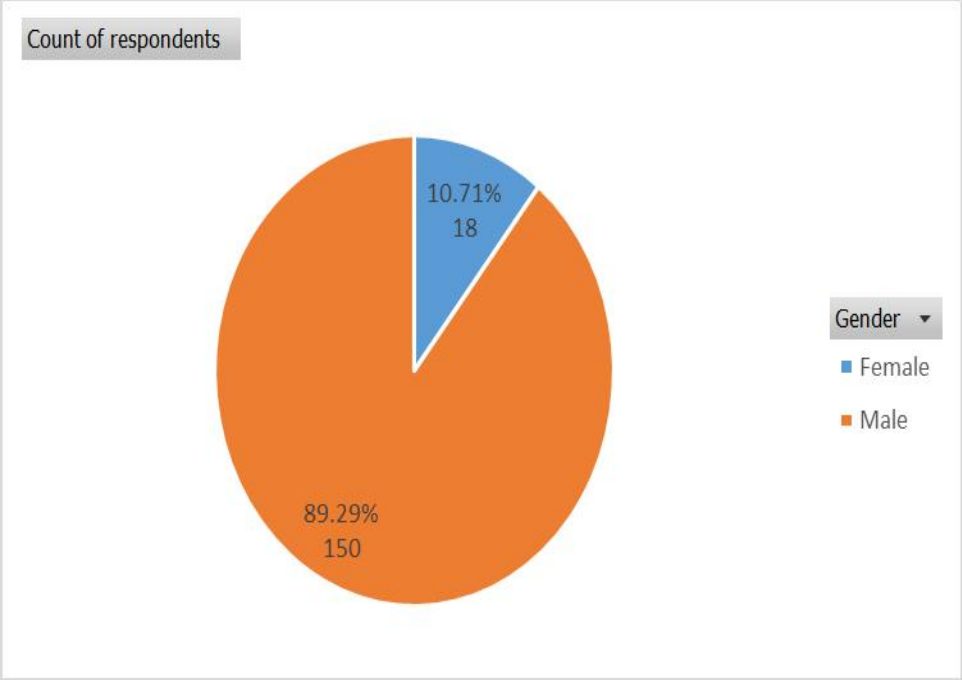

Chart-2 showing that One-hundred and sixty-eight respondents have examine for research consist with two (02) categories i.e., 150 respondents (89.29% of population) are male and 18 respondents (10.71% of population) are female.

Chart 3:

Count of experience-wise Population: Showing break-up of population of respondents w.r.t. experience-wise population.

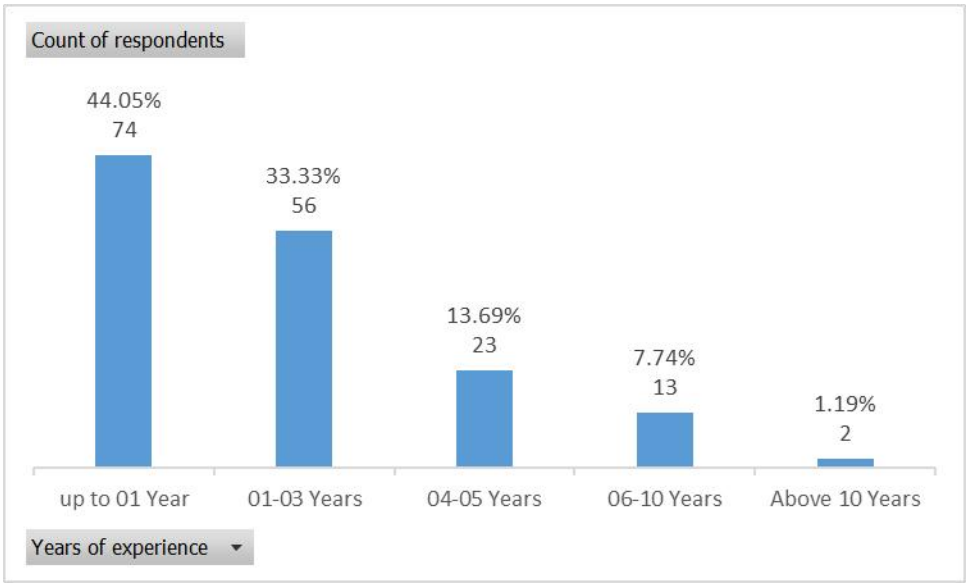

Chart-3 showing that One-hundred and sixty-eight respondents have examine for research consist with five

(05) categories i.e., 74 respondents (44.05% of population) have experience of up to 01 year, 56 respondents (33.33% of population) have experience of 01-03 years, 23 respondents (13.69% of population) have experience of 04-05 years, 13 respondents (7.74% of population) have experience of 06-10 years, and 02 respondents (1.19% of population) have experience of above 10 years.

Descriptive Statistics

Table 1: Descriptive Analysis of Dependent-variables Scale

DV Elements	N	Min.	Max.	Mean	SD	Variance	%
Gender	168	0	0	0	.310	.096	94.5%
Age Bracket	168	19	40	29.5	.816	.666	64.3%
Experience	168	0	17	8.5	.994	.987	37.8%

Above table showing descriptive analysis of dependent variables related to connection of sleep apnea and depressive symptoms among gymnastic in Karachi showing that each element showing how frequently respondents made assertive answers against these questions; results showing that respondents have highest age is 40, lowest age is 19 within average of 29.5. Similarly, respondents have experience year is 17 year and lowest experience-count is 0 year.

Table 2: Descriptive Analysis of PHQ-9 Scale

PHQ-9	N	Min.	Max.	Mean	SD	Variance	%
Little interest or pleasure in doing things	168	0	3	0.99	.793	.629	33.1%

Feeling down, depressed, or hopeless	168	0	3	1.08	.912	.831	36.1%
Difficulty initiating or maintaining sleep, or experiencing hypersomnia	168	0	3	1.30	.914	.835	43.5%
Experiencing fatigue or low energy levels	168	0	3	1.34	.927	.860	44.6%
Decreased or increased appetite	168	0	3	1.14	.981	.962	38.1%
Suffering from diminished self-esteem or perceived inadequacy	168	0	3	0.98	.957	.916	32.7%
Trouble concentrating on things, such as reading the newspaper or watching television	168	0	3	1.03	.944	.891	34.3%
"Exhibiting noticeably slowed movements or speech, or conversely, experiencing heightened restlessness or agitation, resulting in unusually increased physical activity."	168	0	3	0.76	.823	.677	25.2%
Suicidal ideation or self-harm thoughts	168	0	3	0.65	.855	.730	21.8%
If you marked any concerns, how much have they affected your ability to work, handle things at home, or interact with others?	168	0	2	0.86	.695	.482	42.9%

Above table showing descriptive analysis of PHQ related to connection related to sleep-disordered breathing and symptoms of depression among gymnastic in Karachi; study of each element showing how frequently respondents made assertive answers against these questions. PHQ-9 is the parameters to show the overall involvement of respondents in response to assess the connection of sleep apnea and depressive symptoms among gymnastic in karachi here and in the rest of documents as well; showing that 44.6% respondents have highest response for item “Feeling tired or having little energy” and 21.8% respondents have lowest response for item “Thoughts that you would be better off dead or of hurting yourself in some way”.

Correlation Matrix

Correlation is a statistical method used to determine whether, and to what extent, a set of variables are interrelated. In this study, the correlation coefficient derived from the sample data quantifies both the strength and direction (positive or negative) of the linear association between the dependent and independent variables. If the correlation coefficient reveals a statistically significant relationship among the variables, it becomes necessary to assess the degree of agreement between the observed and expected outcomes using the Chi-square test.

Table 3: Correlation Analysis of PHQ-9 prevalence

Annexed table is Correlation Analysis of PHQ-9 assessment of depression shows the correlation between items of PHQ-9 prevalence of our research data. Directions of relations among has positive

and negative impact for connection of sleep apnea and depressive symptoms among gymnastic in karachi. Results showing that "Feeling bad about yourself — or that you are a failure or have let yourself or your family down" has highest positive relationship to i.e. 66.0%, and the least relationship has found positive impact of item "Trouble falling or staying asleep, or sleeping too much" i.e. 47.0% is correlated positively with depression prevalence.

Chi-Square is a statistical measure which compares the actual and expected results leading to determine whether to retain or refute the null hypothesis, we compare the calculated chi-square value with the critical threshold. if the chi-square statistic exceeds the critical value, the null hypothesis is rejected. rejecting the null hypothesis indicates that the observed data differ significantly from the expected results, suggesting a meaningful deviation.

Here we assume four (04) null hypotheses are as under to assess:

HO1: There is no prominent relationship between gender and relationship between sleep apnea and depressive symptoms gymnastic in karachi.

HA1: There is prominent relationship between gender and Association of sleep apnea and depressive symptoms among gymnastic in karachi.
HO2: There is no prominent relationship between age groups and Relationship between Association of sleep apnea and depressive symptoms among gymnastic in karachi.
HA2: There is prominent relationship between age groups and Relationship between Association of sleep apnea and depressive symptoms among gymnastic in karachi.
HO3: There is no prominent relationship between year of experience and Association of sleep apnea and depressive symptoms among gymnastic in karachi.
HA3: There is prominent relationship between year of experience and Association of sleep apnea and depressive symptoms among gymnastic in karachi.

Table 4: Case Processing Summary

	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Gender * Depression Severity	168	100%	0	0%	168	100%
Age Bracket * Depression Severity	168	100%	0	0%	168	100%
Experience * Depression Severity	168	100%	0	0%	168	100%
Gender * Difficulty level	168	100%	0	0%	168	100%
Age Bracket * Difficulty level	168	100%	0	0%	168	100%
Experience * Difficulty level	168	100%	0	0%	168	100%

Above table shows that each element has no exclusion, and each element has assessed with filled parameters.

Table 5: Chi-Square Tests

Test Element	Pearson Chi-Square	p-value	Result
Gender * Depression severity	8.846	0.065	The null hypothesis was not supported
Age Bracket * Depression severity	7.861	0.796	The null hypothesis was

			not supported
Experience * Depression severity	15.219	0.509	The null hypothesis was not supported
Gender * Difficulty level	2.638	0.267	The null hypothesis was not supported
Age Bracket * Difficulty level	9.134	0.166	The null hypothesis was not supported
Experience * Difficulty level	5.635	0.688	The null hypothesis was not supported

Above table showing that each element has greater chi-square value than of p-value; resulting that each HO have rejected hence concluded the assertiveness of all alternative hypothesis and stated that have significant impact on connection of Sleep-disordered breathing and signs of depression in gymnastic in karachi.

Diagnostic Analysis

Diagnostic tests are performed in research to verify whether the assumptions required for statistical analysis are satisfied with a substantial degree of accuracy. In this research we have checked (i) reliability and (ii) multicollinearity of all independent variables.

Reliability

Reliability of a questionnaire as a survey instrument ensures the accuracy of measures by assessing its internal consistency. There are different methods available to evaluate the internal consistency of the questionnaire. As we used SPSS, Cronbach alpha was used to assess reliability. Cronbach's alpha is a statistical indicator of internal consistency, reflecting the degree to which a group of items are interrelated and function as a unified scale. It is commonly used to evaluate the reliability of a measurement instrument. According to established thresholds, a Cronbach's alpha value between 0.70 and 0.79 indicates acceptable consistency, values from 0.80 to 0.89 signify good reliability, and scores of 0.90 or higher demonstrate excellent internal consistency.

Table 6: Case Processing Summary

		N	%
Cases	Valid	168	100
	Excluded [a]	0	0
	Total	168	100

Above table shows that each element has no exclusion, and each element has assessed with filled parameters.

Table 7: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha	N of sub-scales

PHQ-9	0.767	09
	0.788	10
Overall		

Above table shows that Cronbach's Alpha of two (02) scales; PHQ-9 questionnaire is 0.767 with nine (09) items which show good reliability of PHQ-9 questionnaire. Overall Cronbach's Alpha is 0.788 of PHQ-9 and a single item of difficulty assessment which show good reliability of using all questionnaires as whole.

Multicollinearity

In statistical research, Multicollinearity is known as a situation in which two or more explanatory variables in a model are highly linearly related. Multicollinearity is denoted by variance inflation factor (VIF). If VIF is greater than ten, there is severe collinearity in that specific variable and research results would perturb. In contrast If VIF is less than 10, there is no collinearity, and data is acceptable for performing the statistical analyses.

Table-8: Multicollinearity Values

Model: Dependent Variable:	
Gender	1.059
Age Bracket	1.053
Experience	1.017

a. Dependent Variable: PHQ-9

Above table shows that VIF of all three (03) components are <10 which shows there is no collinearity and data is acceptable for performing the statistical analyses.

Normality Test: A normality test evaluates whether the sample data originates from a population that follows a normal distribution. In this study, the Shapiro-Wilk test is applied to examine the distribution of the data. If the p-value obtained from the Shapiro-Wilk test exceeds 0.05, it indicates that the data conforms to a normal distribution, and the assumption of normality is considered valid.

.**Table-9: Normality tests of depression severity**

Depression severtiy		Shapiro - Wilk Statistic	Sig.	Remarks
Gender	Female	0.903	0.066	
	Male	0.891	0.000	
Age	up to 20 Years	0.875	0.004	
	26-30 Years	0.901	0.009	
	21-25 Years	0.895	0.000	

	Above 30 Years	0.805	0.024
Experience duration	up to 01 Year	0.897	0.000
	01-03 Years	0.883	0.000
	04-05 Years	0.875	0.008
	06-10 Years	0.790	0.005

Above table shows that each dimension of depression severity has derived from a normal distributed population for assessment of all factors have significant impact on connection of sleep apnea and depressive symptoms among gymnastic in karachi as value of the Shapiro-Wilk test is more than 0.05 for all elements for all assessments.

Table-10: Normality tests of difficulty level

Difficulty level		Shapiro - Wilk Statistic	Sig.	Remarks
Gender	Female	0.762	0.000	
	Male	0.799	0.000	
Age	up to 20 Years	0.791	0.000	
	26-30 Years	0.785	0.000	
	21-25 Years	0.788	0.000	
	Above 30 Years	0.823	0.037	
Experience duration	up to 01 Year	0.796	0.000	
	01-03 Years	0.796	0.000	
	04-05 Years	0.809	0.001	
	06-10 Years	0.825	0.014	

Above table shows that each dimension of difficulty level has derived from a normal distributed population for assessment of all factors have significant impact on connection of sleep apnea and depressive symptoms among gymnastic in karachi as value of the Shapiro-Wilk test is more than 0.05 for all elements for all assessments.

Homogeneity Test The test of homogeneity involves selecting random samples separately from each group or population and recording information on a single categorical attribute**.**

Table 11: Homogeneity Test

		Levene Statistic	Sig.
Gender	Depression severity	0.578	0.448
	Difficulty level	5.166	0.024

Age bracket	Depression severity	1.697	0.170
	Difficulty level	1.680	0.173
Experience duration	Depression severity	1.679	0.157
	Difficulty level	1.074	0.371

Above table shows that population of all elements for assessment of all factors have significant impact on connection of sleep apnea and depressive symptoms among gymnastic in karachi. Here p-value is more than 0.05 in depression assessment and difficulty level assessment; hence homogeneity assumption of the variance is met; have a mean that spread of data within each combination of factors should be roughly the same.

DISCUSSION

Obstructive Sleep Apnea (OSA) is a prevalent sleep-associated respiratory condition, especially affecting middle-aged and older adults, with a large portion remaining undiagnosed (1). Among children, sleep-disordered breathing (SDB) encompasses a spectrum of severity—from mild disturbances to more serious manifestations such as OSA (2). This disorder is defined by recurrent blockage of the upper airway during sleep, resulting in disrupted sleep continuity and reduced blood oxygen levels (3).

Sleep deprivation mimics depression symptoms, especially due to impaired emotional processing in the frontal lobe (4). Pregnant women experience altered sleep patterns, increasing their risk for various disorders, including OSA and excessive daytime sleepiness (5). Frequent arousals during sleep are a major contributor to daytime fatigue in OSA (6), which involves prolonged or partial airway obstruction that disrupts sleep continuity (7). Globally, sleep disorders are prevalent among elite gymnasts, often impairing performance and well-being (8). Among elderly populations, sleep disturbances affect 50% in Indonesia and 67% in the U.S., with 7.3% experiencing insomnia (9). Interestingly, former gymnasts tend to report better quality of life than non-athletes, suggesting positive long-term effects of athletic engagement (10). Depression is common among general populations, like Swedish students, though elite athletes may report lower rates (11).

About 1 billion adults aged 30–69 suffer from OSA around the world, with China, the U.S., Brazil, and India showing the highest case numbers (12). Young athletes generally reported lower anxiety and depression scores compared to global norms (13). The prevalence of OSA varies: studies show 24% in men and 9% in women in the U.S., and up to 28% in Spanish women (14). South Asians face a higher OSA risk than Caucasians, with rates in Karachi (10–12.4%) and Odisha, India, reaching 25% (26, 27). This highlights regional disparities and non-obesity-related risk factors. The significance of this research lies in exploring the connection between OSA and depressive symptoms among gymnasts in Karachi, where 13.7% of OSA individuals exhibit depressive symptoms, underscoring a crucial mental health concern.

Summary

The study, based on responses from 168 participants, assessed depression severity and associated difficulty levels using the PHQ-9 scale. The data revealed that 27 respondents (16.1%) had no depression, while the majority experienced varying levels of depressive symptoms: 59 (35.1%) had mild, 60 (35.7%) moderate, 18 (10.7%) moderately severe, and 4 (2.4%) severe depression. Age-wise analysis indicated the highest prevalence of severe and moderately severe depression among

respondents aged 21–25 years (13 individuals; 59.09%), while no such cases were observed in those above 30. Gender-based distribution showed that males constituted the majority (18 respondents; 81.81%) of those experiencing severe or moderately severe depression, compared to only 4 females (18.18%). In terms of professional experience, individuals with up to one year of experience accounted for the highest share (11 respondents; 50%) of severe to moderately severe depression cases. None were reported in those with more than ten years of experience. Regarding difficulty levels, 54 participants (32.1%) reported no difficulty, 84 (50%) experienced some difficulty, and 30 (17.9%) faced significant difficulty in daily functioning. Among those with high difficulty levels, the 21–25 age group again had the highest share (15 individuals; 50%), while only 3 (10%) were from the above-30 group. Male respondents dominated the very-difficulty category (27 respondents; 90%), while only 3 females (10%) were similarly affected. The most affected experience group was again those with up to one year of experience (13 individuals; 59.09%), with none from the above-10-year group. This data suggests a strong link between younger age, male gender, limited work experience, and higher depression severity and difficulty levels.

Interpretation

This chapter details the statistical analysis performed to evaluate the assertiveness toward the connection of sleep apnea and depressive symptoms among gymnasts in Karachi, using PHQ-9 as the primary assessment tool. Descriptive statistics revealed that participants' ages ranged from 19 to 40 years, with a mean age of 29.5. Experience levels varied from 0 to 17 years. Within PHQ-9 responses, 44.6% of participants reported “Feeling tired or having little energy” most frequently, while 21.8% reported “Thoughts that you would be better off dead or of hurting yourself” least frequently.

Correlation analysis indicated that the item “Feeling bad about yourself…” had the highest positive correlation with depression prevalence at 66.0%, while “Trouble falling or staying asleep…” showed a lower but still significant correlation at 47.0%. Chi-square tests confirmed statistical significance for all items, as each observed chi-square value exceeded its corresponding p-value ($p < 0.05$), leading to rejection of all null hypotheses and supporting the alternative hypotheses regarding significant associations. Reliability analysis displayed strong internal consistency, with Cronbach’s Alpha for PHQ-9 at 0.767 and an overall alpha of 0.788 when including the difficulty assessment item. Multicollinearity tests reported variance inflation factor (VIF) values below 10 for all components, indicating no multicollinearity normality was verified through the Shapiro-Wilk test, where all variables yielded p-values greater than 0.05, indicating that the data were derived from a normally distributed population. Additionally, Levene’s test for homogeneity returned p-values above 0.05, confirming the assumption of equal variances across the subgroups. Together, these results support the statistical validity of the dataset and underscore a meaningful association between assertiveness, obstructive sleep apnea, and depressive symptoms among the gymnast participants..

Implication

This research explores the connection between sleep-disordered breathing and signs of depression**.**among gymnasts in Karachi holds critical significance, both clinically and academically. Sleep apnea, a condition marked by disrupted breathing during sleep, has been widely linked to serious health issues such as cardiovascular inflammation, metabolic disturbances, and cognitive decline. When compounded with depressive symptoms, the overall effect on an individual's mental and physical

performance becomes even more concerning—especially in athletic populations like gymnasts, where optimal physical and psychological health is essential. This study found that 13.7% of individuals with sleep apnea exhibited depressive symptoms, emphasizing the pressing mental health concerns within this group. The statistically significant correlations—such as a 66.0% positive relationship between feelings of failure and depression, and the frequent experience of fatigue (reported by 44.6%)—highlight the multidimensional burden of this comorbidity. Furthermore, the use of reliable tools like PHQ-9 and robust statistical validation through Shapiro- Wilk, Levene's, and Chi-square tests ensure the findings are methodologically sound. Identifying vulnerable subgroups—such as younger athletes and males with less experience—can guide targeted interventions. Overall, the study advances understanding of how mental health and sleep disorders intersect in athletic populations, offering valuable insights for public health, sports medicine, and psychological well-being in Pakistan.

Limitations

This study, while contributing valuable insight into the relationship between sleep apnea and depressive symptoms among gymnasts in Karachi, presents many limitations that should be acknowledged. Firstly, there is a notable inconsistency between the stated target population and the described study setting. Although the research focuses on 168 gymnasts actively involved in training or competition, the setting references independent elderly individuals and assessments related to fall history and physical performance. This mismatch creates confusion about the actual demographic involved in the study and may affect the overall validity of the findings. The sampling technique employed was non-probability convenience sampling, which inherently limits the representativeness of the sample. Participants were selected based on availability and willingness, which increases the likelihood of selection bias. As an outcome, the sample may not precisely reflect the broader population of gymnasts in Karachi. In terms of study design, a cross-sectional approach was used. While suitable for identifying associations, this design restricts the ability to determine causal relationships between variables such as sleep apnea and depressive symptoms. It only captures data at a single point in time, which limits the depth of analysis regarding temporal changes or trends. Another important limitation relates to the justification and consistency of the sample size.

While the sample size was calculated based on a population of 300 and a hypothesized prevalence rate of 30%, later sections of the study reference data from over 9,800 participants, along with exclusions of over 34,000 individuals. These figures appear to be drawn from a different dataset entirely and introduce confusion about the actual sample used in this research. Additionally, there appears to be a misalignment in the data collection tools. Although the study focuses on sleep apnea and depressive symptoms, it references the use of the Mini-Mental State Examination and the Berg Balance Scale, which are more commonly used to assess cognitive function and balance. These tools do not directly measure the variables of interest and raise questions about the appropriateness of the chosen instruments. The use of self-reported data to assess sleep apnea also presents limitations. Participants may lack a formal diagnosis and could under-report or misinterpret their symptoms. This reliance on self-reported measures can compromise the accuracy of the data collected. Furthermore, the study heavily depends on questionnaires, such as the PHQ-9, to assess depressive symptoms. While widely used, such self- report tools are subjective and susceptible to biases, including recall and social desirability bias, which may affect the reliability of the responses. Lastly, the study does not appear to account for potential confounding variables that could influence the outcomes. Factors such as training intensity, injury history, lifestyle habits, or other health conditions are not mentioned as being controlled for or considered in the analysis. The absence of such controls may affect the integrity of the associations observed in the study.In conclusion, while the research offers useful preliminary data on an

under-explored athletic population, the noted limitations related to population clarity, sampling, design, measurement tools, and data validity must be taken into consideration when interpreting the findings..

Recommendations

To address the identified limitations, future studies should begin by ensuring consistency between the target population and study setting. Clearly defining and aligning the demographic focus will improve clarity and the validity of findings. Employing a probability-based sampling method, such as stratified or random sampling, can help reduce selection bias and enhance representativeness.

Transitioning from a cross-sectional to a longitudinal design would allow researchers to observe temporal relationships and better assess causality between sleep apnea and depressive symptoms. Additionally, the use of validated, condition-specific instruments should be prioritized. Instead of relying on unrelated tools like the MMSE or Berg Balance Scale, researchers should use diagnostic assessments such as the STOP-BANG questionnaire or polysomnography for sleep apnea and the PHQ-9 for depression. Where possible, clinically confirmed diagnoses should replace self- reported measures to improve data accuracy.

Clarifying and maintaining consistency in the sample size calculation and reporting is essential. Any secondary data use should be transparently stated and matched with study aims. Lastly, controlling for confounding variables—such as physical activity, training load, and mental health history—will strengthen the internal validity of results. Implementing these improvements will enhance the rigor, credibility, and generalizability of future research in this area.

CONCLUSION

This study explored the connection between Obstructive Sleep Apnea (OSA) and depressive symptoms among 168 gymnasts in Karachi. OSA is a common yet under-diagnosed disorder, marked by repeated upper airway obstruction during sleep, leading to fatigue, sleep fragmentation, and mood disturbances. Global data point out the prevalence of OSA in both athletic and general populations, with regional variations and gender differences. This research focused on gymnasts, a group often affected by performance-related stress and disrupted sleep, aiming to identify mental health concerns within this specific cohort.

Using the PHQ-9 questionnaire, results showed that 83.9% of participants experienced some level of depression, with moderate to moderately severe cases being most prevalent among males aged 21–25 and those with less than one year of professional experience. Difficulty in daily functioning was also notably high in the same demographic. Correlation and chi-square analyses confirmed statistically significant associations between specific depressive symptoms and self-reported sleep apnea. Internal consistency of the assessment tools was validated with Cronbach's Alpha values above 0.76, while normality and homogeneity were confirmed using Shapiro-Wilk and Levene's tests.

However, the study faced key limitations, including a mismatch between the described population and study setting, unclear sampling consistency, and the use of unrelated tools like MMSE and Berg Balance Scale. The reliance on self-reported data and lack of control for confounding variables further affected the study's validity. Despite these limitations, the research point outs the immediate need for mental health screening in athletes and lays the groundwork for more robust, targeted studies on the link between sleep disorders and psychological well-being in athletic populations. Future research should adopt longitudinal designs, use validated diagnostic tools, and control for influencing factors to strengthen outcomes and clinical relevance.

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