BAQAI JOURNAL OF HEALTH SCIENCES

Baqai Journal of Health Sciences (BJHS)

(Formerly, The Journal of Baqai Medical University)

Biannual
ISSN (Print): 2312-4423
ISSN (Online): 2312-6884

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LETTER TO EDITOR

TRANSFORMING MEDICINE: HOW ROBOTICS, AI, AND IMMERSIVE TECHNOLOGIES ARE REVOLUTIONIZING HEALTHCARE

Alishba Eman*[1]

Robots have evolved from autonomous mechanisms in the 1960s to sophisticated systems supporting patients, nurses, and surgeons in controlled environments. Pakistani research has shown the growing importance of artificial intelligence and machine learning in healthcare delivery through neural network algorithms and cognitive simulation capabilities. Healthcare robotics integration follows a systematic three-phase approach: assessment and planning, implementation and training, and evaluation and optimization.

AI-powered diagnostic tools have shown success in early detection of conditions like cancer, cardiovascular diseases, and neurological disorders, while robotic surgical systems have enhanced precision and reduced recovery times for patients undergoing complex procedures. Pakistan's healthcare landscape presents unique opportunities and challenges for implementing robotic technologies and telemedicine solutions. Case studies from the Civil Hospital in Karachi and the Sindh Institute of Urology and Transplantation demonstrate successful implementation of robotic surgery programs, with the Sindh government funding 150 robotic cases annually. Telemedicine initiatives in Pakistan have shown promising results in addressing healthcare access challenges in remote areas [1,2].

AI-driven algorithms enable large-scale dataset analysis, enabling more precise diagnosis and individualized treatment plans. Remote patient monitoring reduces readmission rates and enhances long-term treatment standards. Robotic-assisted operations improve surgical precision, expedite recuperation, and reduce complications. AI-powered virtual assistants and chatbots simplify administrative tasks [2]. Over the past ten years, robotic laparoscopy has advanced significantly in the clinical, commercial, and academic domains. Intuitive Surgical's da Vinci robot enables semi-automated arm and patient cart placement, enhanced instrument coupling, and the capacity to mount endoscopic and laparoscopic instruments on any arm. 2019 saw the completion of almost 1.2 million surgeries, with improvements in single-port laparoscopic robots resulting in more precise and effective surgical operations. Prototypes of detached surgical robots that remove the trocar-pivot limitation have also been investigated. With over 5 million patients treated, the most advanced medical robots are those that facilitate laparoscopic surgery, indicating strong momentum into the next ten years. Endoluminal and natural orifice interventions, as well as robots for microsurgery, are examples of non-laparoscopic procedure-specific robots. Assistive wearable robotics focuses on the design and control of wearable robotic devices intended to improve the mobility or functionality of individuals with musculoskeletal or neuromuscular impairment. Rehabilitation robots are designed to deliver repetitive movement therapy to the limbs following neurological injuries. More seriously disabled people can now benefit from robotic therapy because to advancements in control

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techniques for rehabilitation robots that have made it easier for the patient and robot to cooperate, encouraging neuroplasticity [3].

In catastrophe situations and outside of populated regions, tele-operated robots provide remote medical care, including tele-surgery. Operation Lindbergh, the first successful tele-surgery, was performed in 2000 with the Zeus surgery robot and France Telecom's multiservice transmission network. Immersion interfaces are used in telepresence, a branch of tele-robotics, to shorten emergency response times and hospital stays. Autonomous robots in healthcare are being made possible by the fascinating field of tele-robotics [4]. Personalized treatments, unstructured settings, and the integration of cutting-edge technology like artificial intelligence (AI), robotics, quantum computing, the Internet of Things (IoT), and multi-robot systems are all made possible by the growing usage of robotic systems in healthcare. While sophisticated surgical robotic systems like VisAR use VR and AR for simulated reality, the meta verse, which combines these technologies, has the potential to revolutionize services [5].

Healthcare robotics represents a transformative force in modern medicine, bridging geographical barriers and democratizing access to advanced care. From Pakistan's pioneering telemedicine initiatives to da Vinci surgical systems worldwide, these technologies offer genuine hope for reducing health disparities. Success stories from Karachi's Civil Hospital demonstrate how thoughtful implementation can benefit underserved populations. As we embrace this digital revolution, ensuring equitable access and affordability remains paramount for creating a healthier, more connected global community where quality healthcare transcends borders.

Author's Contribution:

AE: Concept & design, writing, final approval of manuscript and responsible for accuracy and integrity of research

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ORIGINAL ARTICLE

ORAL HEALTH-RELATED QUALITY OF LIFE (OHRQoL) AMONG UNIVERSITY STUDENTS OF KARACHI

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ABSTRACT

Background: In the field of health services research, the concept of Oral Health-Related Quality of Life (OHRQoL) plays a crucial role in examining oral health trends and assessing the needs of the population. It helps gauge the impact of oral diseases on people's daily lives. This study aimed to assess OHRQoL among university students in Karachi.

Methods: A cross-sectional, questionnaire-based study was done among 300 individuals belonging to a university in Karachi. The age of the participants ranged from 20 to 24 years, and most of them were females (79.7%). Data collection was carried out using a self-administered short-form of oral health impact profile (OHIP-14) questionnaire, comprising 14 questions organized into 7 subscales. Data quality was analyzed descriptively, and the reliability of the data was evaluated using Cronbach's alpha coefficient.

Results: The study found that 25.9% of the participants reported an impact on their OHRQoL. The mean OHIP-14 score was 12.26 ± 10.9. Notably, the subscales of psychological discomfort and physical pain had the highest impact, affecting 43.9% and 34.2% of participants, respectively. In contrast, the social handicap subscale had the least impact, affecting only 13.2% of participants.

Conclusion: The mean OHIP-14 score indicates that oral health had limited overall impact on students' OHRQoL, although psychological discomfort and physical pain were the most affected domains. The OHIP-14 showed acceptable reliability, supporting its usefulness as an assessment tool in this population. Strengthening school-based oral health education, implementing routine dental screening, and improving access to preventive dental services are recommended to reduce discomfort and enhance students' oral health–related quality of life.

Keywords: Oral health; quality of life; students.

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INTRODUCTION
According to the World Health Organization (WHO), health is not simply the absence of disease and ailment but rather a state of complete physical, mental, and social well-being]. Oral health serves as a vital indicator of individuals' overall health and is closely intertwined with their general health and health-related quality of life (HRQoL)]. HRQoL offers a suitable metric for evaluating people's overall well-being and the impact of health conditions on their quality of life.

Oral health-related quality of life (OHRQoL) encompasses various dimensions, including physical, social, and psychological aspects]. Research on OHRQoL involves assessing different facets of individuals' self-reported oral health, which aids in enhancing dental care delivery and can also be used to determine factors affecting oral health and evaluate the effectiveness of dental treatments. Poor oral hygiene leads to periodontal diseases, periodontitis is independently associated with Alzheimer's diseases, cardiovascular diseases, diabetes, chronic obstructive pulmonary disease, obstructive sleep apnea and COVID-19 complications [4-6].

It's essential to stop compartmentalizing oral health from the rest of the body because poor oral health can significantly impact overall health, causing pain, suffering, altering eating habits, and affecting one's quality of life and well-being. Poor oral hygiene has multiple adverse consequences and places an increased burden on the healthcare system. Several tools are available for measuring OHRQoL, with the Oral Impact on Daily Performance (OIDP) being one such example. Unlike clinical examination tools that primarily assess the presence and severity of diseases, OIDP evaluates how oral health conditions impact a person's quality of life (QoL).

OHRQoL is evaluated using questionnaires that generate data on oral health and its effects on an individual's QoL. The most commonly used questionnaire for this purpose is the oral health impact profile (OHIP-14), which assesses various aspects of oral health, including functional

limitations, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and social handicap [7,8]. Understanding university students' self-perceptions of oral health, including OHRQoL, has significant value in adapting effective teaching methods. This perspective can also contribute to enhancing curricula and refining health education policies for students. The primary aim of this study was to assess OHRQoL among students at Medical Universities in Karachi.

METHODSOLOGY
Sample population and response:
This cross-sectional study was conducted among the university students of Karachi with (n = 320) sample size between July to September, 2023. Out of 320 students, fifteen refused to participate and five students (1.6 %) were excluded due to incomplete questionnaires, so the final sample encompassed 300 students (98.4 % response rate). The sample size (n = 320) was calculated using the WHO sample size formula for a single proportion, assuming a 50% expected prevalence, 95% confidence interval, and 5% margin of error.

Inclusion and exclusion criteria:
Participants of both genders who were generally healthy, without any oral diseases or lesions were included in the study. Those undergoing orthodontic treatment or who had any major oral surgical procedures were excluded from the study. The participants were explained the objectives of the study and everyone was asked to complete the questionnaire after taking their verbal consent, anonymity and confidentiality was maintained. The study was approved by the Ethical Review Board of Baqai Medical University (Reference number BDC/ERB/2023/035).

Assessment of Oral Health-Related Quality of Life:
The researchers in this study utilized the shorter version of the Oral Health Impact Profile (OHIP-14) to evaluate OHRQoL]. The reference period for this assessment was the preceding 24 months, and the students independently completed the questionnaire. The OHIP-14 is a widely employed

generic OHRQoL measure with a history of proven reliability and validity in numerous prior studies]. Due to its robust conceptual and empirical foundation, the OHIP-14 is frequently used in the field of dentistry. To calculate the OHIP-14 score, the responses to all 14 items are summed, resulting in a total score that ranges from 0 to 56. A higher score indicates a poorer OHRQoL].

Statistical Analysis:

The research data collected was processed using the SPSS software version 21. Data quality was assessed through descriptive analysis, which included calculating the mean value, standard deviation, minimum, and maximum values. Additionally, the internal consistency reliability of the data was evaluated using Cronbach's alpha coefficient. In the analysis, the variable OHRQoL was categorized into two groups: "absence of impact" (comprising responses of "never" and "hardly ever") and "presence of impact" (encompassing responses of "occasionally," "fairly often," and "very often"). To determine the prevalence of impact on OHRQoL, the study calculated the percentage of respondents indicating the presence of impact concerning the total number of participants, both for the overall OHIP-14 scale and for its individual questions. The OHIP-14 questionnaire uses a five-point Likert scale (never, hardly ever, occasionally, fairly often, very often). For analytical clarity and to estimate the prevalence of oral health impacts on quality of life, the responses were dichotomized into two categories: "absence of impact" (never, hardly ever) and "presence of impact" (occasionally, fairly often, very often). This dichotomization method has been widely applied in OHRQoL research to facilitate categorical analysis and allow calculation of impact prevalence [13].

The prevalence of impact was determined by dividing the number of participants reporting a "presence of impact" by the total number of respondents, expressed as a percentage for both the overall OHIP-14 scale and individual items.

RESULTS

Mean age of the participants was 22.1 ± 1.8 years (79.7 % were females). The prevalence of impact on OHRQoL was 25.9 % and the mean OHIP-14 score was 12.26 ± 10.9 (range: 0 to 52) (Figure 1). The mean scores for the subscales ranged from 0.53 (SD = 0.9) for social handicap to 1.47 (SD = 1.4) for psychological discomfort, indicating that psychological discomfort was the most frequently reported impact on oral health-related quality of life (OHRQoL). In contrast, social handicap had the lowest reported impact. The prevalence of impacts i.e. psychological discomfort (43.9%) and physical pain (34.2%) were the most commonly affected domains. Other subscales such as psychological disability (25.8%), physical disability (24.5%), and functional limitation (21.5%) showed moderate levels of impact, whereas social disability (16.3%) and social handicap (13.2%) were less frequently reported. The total OHIP-14 score had a mean of 12.26 (SD = 10.9), with a range from 0 to 52. Overall, 25.9% of students experienced an impact on OHRQoL, while 74.1% reported no significant impact (Table 1). These findings suggest that while the majority of students reported minimal or no effect of oral health on their daily lives, a considerable proportion still experienced negative impacts, particularly in the domains of psychological discomfort and physical pain.

Figure 1: Histogram of the OHIP-14 score in the overall study sample.
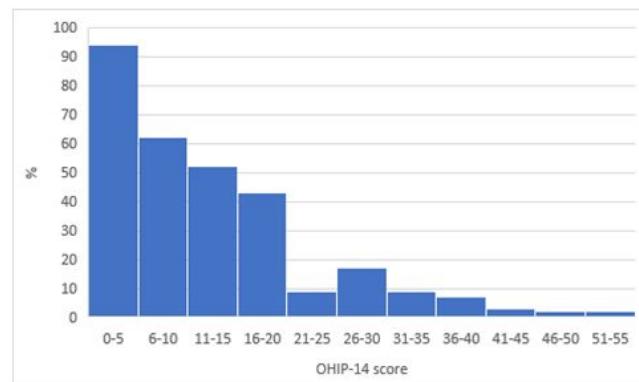
OHIP-14: Oral Health Impact Profile

Table 1: Descriptive statistics of OHIP-14 subscale scores and total score among the students.

OHIP-14 Subscales	Score			Impact on OHRQoL	
	Mean (SD)	Minimum	Maximum	No Impact (%)	Impact (%)
Functional limitation	0.73 (1.1)	0	8	78.5	21.5
Physical pain	1.11 (1.2)	0	8	65.8	34.2
Psychological discomfort	1.47 (1.4)	0	8	56.1	43.9
Physical disability	0.79 (1.1)	0	8	75.5	24.5
Psychological disability	0.89 (1.2)	0	8	74.2	25.8
Social disability	0.6 (0.9)	0	8	83.7	16.3
Social handicap	0.53 (0.9)	0	8	86.8	13.2
OHIP-14 Total	12.26 (10.9)	0	52	74.1	25.9

OHIP-14: Oral Health Impact Profile; SD: standard deviation; OHRQoL: oral health-related quality of life; *statistically significant correlation on $p < 0.05$.

Table 2 indicates that the majority of students reported no impact ("never") for most OHIP-14 items. For functional limitation, 65% had no difficulty pronouncing words and 56.7% reported no change in sense of taste. Physical pain was more noticeable, with 40% reporting no mouth pain, while 22.3% experienced occasional pain. Similarly, 40.7% had no eating discomfort, whereas 21.3% experienced it occasionally. Psychological discomfort showed higher impact: only 32.7% were never self-conscious, while 16–20% reported feeling self-conscious or embarrassed fairly often or very often. For tension, 43.4% reported no impact, but around 19% experienced it occasionally. Physical and social disabilities were generally low, with 54–55% reporting no meal interruption or dietary dissatisfaction, and 61.7% reporting no irritability with others. Social handicap had the lowest impact overall, with 72.7% never feeling unable to function due to oral health problems. Overall, occasional discomfort particularly psychological and physical was present, but frequent or severe impact remained low across all OHIP-14 domains.

Table 2: Frequency of impact of each item of the OHIP-14 on OHRQoL among university students of Karachi.

List of Questions on OHIP -14 Questioner	Responses				
	0-Never	1-Hardly ever	2-Occasionally	3-Fairly often	4-Very often
	n (%)	n (%)	n (%)	n (%)	n (%)
Functional limitation					
"Have you had trouble pronouncing any words because of problems with your teeth, mouth or dentures?"	195 (65)	50 (16.7)	35 (11.6)	13 (4.3)	7 (2.4)
"Have you felt that your sense of taste has worsened because of problems with your teeth, mouth or dentures?"	170 (56.7)	59 (19.6)	47 (15.9)	13 (4.3)	11 (3.5)
Physical pain					
"Have you had painful aching in your mouth?"	120 (40)	77 (25.7)	67 (22.3)	18 (6)	18 (6)
"Have you found it uncomfortable to eat any foods because of problems with your teeth, mouth or dentures?"	122 (40.7)	80 (26.7)	64 (21.3)	18 (6)	16 (5.3)
Psychological discomfort					
"Have you been self -conscious because of your teeth, mouth or dentures?"	98 (32.7)	45 (15)	60 (20)	49 (16.3)	48 (16)
"Have you felt tense because of problems with your teeth, mouth or dentures?"	130 (43.4)	62 (20.7)	52 (17.3)	27 (9)	29 (9.6)
Physical disability					
"Has been your diet been unsatisfactory because of problems with your teeth, mouth or dentures?"	167 (55.7)	61 (20.3)	51 (17)	13 (4.3)	8 (2.7)
"Have you had to interrupt meals because of problems with your teeth or mouth?"	162 (54)	60 (20)	51 (17)	19 (6.3)	8 (2.7)
Psychological disability					
"Have you found it difficult to relax because of problems with your teeth or mouth?"	159 (53)	61 (20.3)	42 (14.1)	29 (9.6)	9 (3)
"Have you been a bit embarrassed because of problems with your teeth or mouth?"	165 (55)	62 (20.7)	39 (13)	19 (6.3)	15 (5)
Social disability					
"Have you been a bit irritable with other people because of problems with your teeth or mouth?"	185 (61.7)	61 (20.3)	36 (12)	7 (2.3)	11 (3.7)
"Have you had difficulty doing your usual jobs because of problems with your teeth or mouth?"	203 (67.7)	55 (18.3)	31 (10.3)	5 (1.7)	6 (2)
Social handicap					
"Have you felt that life in general was less satisfying because of problems with your teeth or mouth?"	183 (61)	71 (23.7)	30 (10)	4 (1.3)	12 (4)
"Have you been totally unable to function because of problems with your teeth or mouth?"	218 (72.7)	47 (15.6)	19 (6.3)	8 (2.7)	8 (2.7)

OHIP-14: Oral Health Impact Profile; OHRQoL: oral health-related quality of life; n: number of participants.

DISCUSSION

This study presented the OHRQOL status of professional students at universities in Karachi. The primary objective of this research was to raise awareness about the significance of oral health in positively impacting overall health, well-being, and the quality of life. It underscores the importance of evaluating OHRQOL in young adults for preventive measures aimed at enhancing their general health, as they represent the future of a nation.

44 % of Pakistani population is aged between 15 to 29 years of age bracket]. Understanding health trends and estimating the burden of disease at the national and subnational levels helps policy makers track progress and identify disparities in overall health performance. Pakistan is a developing country that has insufficient healthcare for its rapidly growing population, and studies like these help to identify the treatment needs of the population and subsequently reducing the burden on the government for providing healthcare].

Oral health is an integral component of overall health and significantly contributes to the quality of life. Quality of life concerns are at the forefront of public health initiatives. Assessing OHRQOL shifts the focus from traditional medical criteria to an approach that considers the social and emotional aspects of a person's well-being, in addition to their physical health. This approach informs the establishment of appropriate goals and the evaluation of outcomes resulting from treatment interventions.

The study found that the mean OHIP-14 score for the students in the research was 12.26 ± 10.9, which was a bit higher than a similar study done among 895 Crotian students in which the mean OHIP-14 score was 11.66 ± 8.72]. Since a mean OHIP-14 score less than 14 suggests no substantial impact on students' oral health, it can be inferred that the effect of oral health on the daily activities of students was relatively low. Similar findings have been observed in prior research]. Factors associated with a lower OHIP-14 score include the uncommonness and mild severity of oral diseases, as well as students' limited

ability to identify such problems. Oral conditions that typically affect OHRQOL in this age group, such as periodontal disease or dental caries, were infrequent and not severe, which could explain the low OHIP-14 scores. Furthermore, oral health care practices among the surveyed students may also contribute to the low frequency and severity of oral problems, considering that the participants are generally well-educated and young.

The study identified that the subscales of psychological discomfort, physical pain, and psychological disability had the highest mean scores and the most significant impact on students' quality of life. Psychological discomfort may be linked to students' concerns about the appearance of their teeth and mouth, as they are encouraged to pay attention to and value their oral health, especially aesthetics through social media rather than a health education curriculum. The subscale of social handicap had the least impact on students' quality of life, followed by the subscales of social disability and functional limitations. The low impact observed for the social handicap subscale suggests that, based on their oral health status, students did not "feel that life in general was less satisfying" and were not "completely unable to function [16,17]."

It's important to note that this study exclusively utilized the OHIP-14 questionnaire and did not include visual or tactile clinical dental examinations. Despite employing a rigorous standard methodology, certain limitations should be acknowledged when interpreting the study's findings. Firstly, this study relies on self-reported questionnaire data, which may introduce recall bias, exaggerated responses, and selection bias. Secondly, selection bias could be implemented as data was collected only from the students from medical universities.

CONCLUSION

The mean OHIP-14 score indicates that oral health had limited overall impact on students' OHRQoL, although psychological discomfort and physical pain were the most affected domains. The OHIP-14 showed acceptable reliability, supporting its

usefulness as an assessment tool in this population. Strengthening school-based oral health education, implementing routine dental screening, and improving access to preventive dental services are recommended to reduce discomfort and enhance students' oral health–related quality of life.

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ORIGINAL ARTICLE

PHYTOCHEMICAL CHARACTERISATION AND IN VITRO ANTIOXIDANT POTENTIAL OF CAROM (*TRACHYSPERMUM AMMI* L.), A TRADITIONAL MEDICINAL PLANT

Fatima Nawaz[1], Sadia Malik[*1], Riffat Tahira[2], Aamara Muzaffar[1], Eiman Fatima[2]

ABSTRACT

Trachyspermum ammi L., commonly known as ajwain or carom, is an important medicinal herb in the Apiaceae family, traditionally employed as a stimulant, carminative, and treatment for ailments ranging from asthma and bronchitis to diarrhea and abdominal pain. This study sought to evaluate the diversity of key health-promoting compounds across seventeen different accessions of this plant, moving beyond agronomic traits to a biochemical focus. After cultivation, methanolic extracts were prepared from the fresh leaves of each accession to analyze their phytochemical profiles. The research specifically quantified the total phenolic and flavonoid content, two major classes of bioactive compounds renowned for their health benefits and evaluated the corresponding in vitro antioxidant potential using a DPPH free radical scavenging assay. The results demonstrated significant variation in the levels of these phytochemicals among the different accessions, with many exhibiting substantial concentrations that correlated strongly with potent, dose-dependent antioxidant activity. These findings are crucial as they provide a scientific basis for the traditional use of ajwain, directly linking its therapeutic effects to its high antioxidant content. The observed biochemical diversity underscores the plant's potential as a rich source of natural antioxidants for nutraceutical or functional food applications. Ultimately, this research highlights the importance of selective cultivation to optimise the medicinal quality of ajwain and deserves further investigation into the specific active constituents responsible for its efficacy.

Keywords *Trachyspermum ammi*, Phenolic Content, Flavonoid Content, Anti-Oxidant Potential

INTRODUCTION

Trachyspermum ammi L., commonly known as ajwain or carom, is an annual aromatic herb indigenous to Egypt and a member of the Apiaceae family. While it is cultivated as a significant spice crop across Iran, Iraq, Afghanistan, Pakistan, and India, its value extends far beyond the culinary realm into the domain of therapeutic and nutraceutical applications. This botanical species, characterised by a somatic chromosomal number of $2n = 18$ and a cross-pollination mechanism facilitated by insects, produces small, Schizocarpic fruits that are among the most potent and fragrant in the spice world, often dominating a dish's flavour profile with their sharp, bitter-herbal notes reminiscent of oregano and anise [1,2].

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The profound health significance of ajwain is fundamentally rooted in its complex and diverse phytochemical constitution. Nutritional analysis reveals a substantial composition of macronutrients, including proteins (17.1%), fats (21.1%), carbohydrates (24.6%), and dietary fibre (11.9%), alongside essential micronutrients such as calcium, phosphorus, iron, cobalt, copper, iodine, manganese, thiamine, riboflavin, and nicotinic acid [3,4]. However, its primary pharmacological activity is attributed to its rich array of secondary metabolites. Phytochemical screening has confirmed the presence of potent bioactive compounds, including tannins, glycosides, saponins, and flavones. The most therapeutically renowned component is the volatile essential oil, often referred to as ajwain oil, which is a complex mixture dominated by the monoterpene phenol thymol, which can constitute up to 50% of the oil's volume. The whole oil itself possesses demonstrated anti-aggregatory, antimicrobial, and fungicidal activities [5].

These properties provide a scientific basis for the plant's extensive history in traditional medicine systems, where it has been employed as a carminative, laxative, stomachic, and anthelmintic agent for treating a wide spectrum of ailments. These include, but are not limited to, abdominal tumours, pains, piles, bronchial problems, cough, pleurisy, atonic dyspepsia, and flatulence.

Thymol is the cornerstone of ajwain's medicinal properties, acting as a powerful germicide, antifungal, and anti-spasmodic agent. This compound is so effective that it is commercially utilised in formulations for toothpaste, mouthwashes, and perfumery due to its antimicrobial and aromatic qualities [6]. This free radical scavenging capacity is further linked to its high phenolic and flavonoid content. The plant's morphology, including the structure of its fruit with a distinct epicarp, mesocarp containing vittae (oil ducts), and endosperm filled with oil globules, is directly correlated to the production and storage of these valuable compounds [7].

Persian practitioners traditionally utilized the hydrosol and oil extracted from ajwain seeds to treat neuropathic pain, chronic fevers, and digestive issues such as gripes. These extracts were also included in medicinal formulations for managing skin conditions like pityriasis and various forms of ecchymosis (bruising). Moreover, ajwain was employed to help ease the symptoms associated with opioid withdrawal. In cosmetics, it has been used for its ability to impart a yellowish tone to the skin. Ajwain seeds possess a range of therapeutic properties, functioning as analgesics, anthelmintics, aphrodisiacs, anti-inflammatories, antioxidants, galactagogues, carminatives, laxatives, and stomachic agents. Additionally, the essential oil derived from these seeds exhibits antimicrobial, anti-aggregatory, and fungicidal effects [8].

Carom, or ajwain, holds a significant place in traditional medical systems across the Indian subcontinent. Its use is documented in classical Ayurvedic texts such as the Sushruta Samhita (where it is named *Bhootika*) and the Charaka Samhita (as *Yavanika*). For centuries, Vaidya gurus and Unani hakims have prepared formulations like *Admoda ArkaÊ*and prescribed the seeds to treat diverse conditions, including digestive issues (acidity, indigestion), headaches, menstrual pain, and the common cold [9-11]. This long-standing ethnomedicinal use underscores the plant's perceived therapeutic value. The medicinal properties and distinct aroma of ajwain are derived from its phytochemical constituents, primarily volatile essential oils. However, the concentration and profile of these bioactive compounds are not static; they are influenced by a multitude of factors, including soil composition, climatic conditions (temperature, humidity), and post-harvest processing techniques such as extraction duration and method. When obtained via steam distillation, the essential oil of *T. ammi* is characterised by a complex mixture of monoterpenes. Detailed analytical studies have revealed that this volatile fraction is composed of nine predominant monoterpenes, comprising seven hydrocarbons and two alcohols, which are largely

responsible for its antioxidant and pharmacological potential [12].

Phytochemical screening of Trachyspermum ammi seeds confirmed the presence of carbohydrates, glycosides, amino acids, saponins, phenolic compounds, and volatile oils, including thymol, terpinene, para-cymene, and á- and ?-pinene. The seeds are also rich in protein, fats, fibre, and minerals such as calcium, chromium, cobalt, copper, iodine, iron, manganese, phosphorus, and zinc. In addition, they provide essential vitamins and bioactive compounds like thiamine, riboflavin, ascorbic acid, nicotinic acid, and carotene [13,14]. Ajwain essential oil exhibited insecticidal effects against Callosobruchus chinensis during the oviposition stage, and also showed inhibitory activity on egg hatching and further development.

Ajwain (*Trachyspermum ammi* L.), a member of the Apiaceae family, is one of the traditional potential herbs used as a spice in daily life and is frequently used for medicinal purposes. Several illnesses that affect both people and animals. Other names for it in literature include Bishop's weed, carom, Ethiopian cumin, ajwān, and ajowan. The tiny fruit that resembles caraway is the most commonly used part of ajwain and is especially well-liked in Indian savoury recipes, savoury pastries, snacks, and as a spice [15]. By significantly reducing the food transit time, Ajowan exerted its digestive-stimulating effects [16]. The broad-spectrum bioactivity ofÊ*Trachyspermum ammi*Êextends to specific pharmacological targets. Notably, its ethanolic extract demonstrates antibacterial efficacy againstÊ*Helicobacter pylori*Ê[17], a key pathogen in the pathogenesis of peptic ulcers and gastric cancer. Beyond antimicrobial effects, the plant's components exhibit significant neuromodulatory properties. For instance, thymol, a major active constituent ofÊ*T. ammi*, has been shown to inhibit key neuronal enzymes, including acetylcholinesterase, lactic dehydrogenase, succinic dehydrogenase, and cytooxidase, in the snailÊ*Lymnaea acuminata*, explaining its observed molluscicidal toxicity [18]. Furthermore, the therapeutic potential of its extracts

is underscored by their action on mammalian systems. Essential oil and various extracts ofÊ*Carum copticum*Ê(a synonym forÊ*T. ammi*) demonstrated potent antihistaminic effects on guinea pig tracheal chains. The rightward shift of the histamine dose-response curve suggests a competitive antagonism at histamine H1-receptors, a mechanism similar to that of the standard drug chlorpheniramine [19].

Therefore, given the established critical link between its biochemical constituents and its wide-ranging health benefits, there exists a compelling rationale for the biochemical characterization of different ajwain accessions. The present study was consequently designed to determine the diversity ofÊ*Trachyspermum ammi*Êacross 17 distinct accessions based on both morphological and biochemical characters. The ultimate objective is to identify and select superior germplasm with enhanced concentrations of these health-promoting phytochemicals, thereby contributing to its optimised application in functional foods, nutraceuticals, and evidence-based phytomedicines.

METHODOLOGY

Seventeen accessions ofÊ*Trachyspermum ammi*ÊL., comprising both local and exotic varieties, were obtained from the Seed Bank of the Plant Genetic Resources Institute (PGRI) at the National Agricultural Research Centre (NARC), Islamabad, Pakistan. The plants were cultivated in the experimental fields of NARC. Seeds were sown on 15 December 2022. Phenological monitoring recorded the onset of initial flowering on 16 February 2023. Agronomic parameters, including plant height and number of branches, were measured from three randomly selected plants per accession at full maturity. The total days to initial flowering and 50% flowering were also recorded for each accession. Fresh leaves were harvested from all 17 accessions at a uniform growth stage. The leaves were rinsed with distilled water to remove surface contaminants and air-dried at room temperature. Briefly, fresh leaves were manually triturated using a pestle and mortar with liquid nitrogen to create a fine powder. A measured quantity of the ground leaf material

from each accession was transferred into individually labelled test tubes. A 70% (v/v) methanol solution was added to each tube in a volume sufficient to fully immerse the plant material (approximately a 1:10 w/v ratio). The tubes were then sealed and placed on an orbital shaker at 120 rpm for 24 hours at room temperature to facilitate exhaustive extraction. Following maceration, the crude extracts were filtered through Whatman No. 1 filter paper. The filtrates were transferred to pre-weighed petri dishes and allowed to dry completely in a fume hood for 48 hours. The resulting dried extracts were carefully scraped from the petri dishes using a sterile steel spatula and stored in labelled 1.5 mL Eppendorf tubes. All prepared extracts were stored at 4°C until further phytochemical and antioxidant analysis.

Determination of Total Polyphenols

The total polyphenolic content (TPC) of the methanolic leaf extracts was determined using the Folin-Ciocalteu (F-C) method with slight modifications. Briefly, 0.05 g of each plant extract was dissolved in 5 mL of methanol. From this solution, a 500 µL aliquot was mixed with 2.5 mL of Folin-Ciocalteu reagent (diluted 1:5 with distilled water) in a test tube. After 5 minutes, 2.5 mL of a sodium bicarbonate (Na_2CO_3) solution was added. The reaction mixture was then vortexed, covered with aluminum foil to protect it from light, and incubated in a water bath at 25°C for 30 minutes. Following incubation, the absorbance of the resulting blue complex was measured at 700 nm using a UV-VIS Spectrophotometer (Lambda 5) against a prepared reagent blank. The total polyphenolic content was quantified by comparison to a gallic acid standard curve and is expressed as milligrams of gallic acid equivalents per 100 grams of dry plant mass (mg GAE/100 g DW) [20].

Determination of Total Flavonoid Content

The total flavonoid content (TFC) was determined using a colorimetric assay based on the aluminum chloride method. All reagents were prepared fresh: a 5% sodium nitrate solution, a 10% aluminum chloride solution, and a 1M sodium hydroxide (NaOH) solution. For the assay, a stock solution was prepared by dissolving 0.001 g of the plant extract in 5 mL of methanol. A 1 mL aliquot of this stock was then transferred to a 10 mL volumetric flask. To this, 4 mL of distilled water was added, followed by 0.3 mL of the 5% sodium nitrate solution. After standing for 5 minutes, 0.3 mL of the 10% aluminium chloride solution was added, and the mixture was allowed to stand for another 5 minutes. Subsequently, 2 mL of the 1M NaOH solution was added, and the total volume was made up to 10 mL with distilled water. The absorbance of the resulting pink solution was measured immediately at 510 nm using a UV-Vis spectrophotometer. The total flavonoid content was calculated from a quercetin standard calibration curve and expressed as milligrams of quercetin equivalents per gram of dry weight (mg QE/g DW) [21].

Determination of Anti-oxidant potential by DPPH Assay

The free radical scavenging activity of the extracts was evaluated using the 2, 2-diphenyl-1-picrylhydrazyl (DPPH) assay. A 0.1 mM DPPH solution was prepared by dissolving 0.012 g of DPPH in ethanol within a volumetric flask, which was then wrapped in aluminum foil to protect it from light and stored at 4°C until use. For the assay, a stock solution of each plant extract was prepared by dissolving 0.01 g of the sample in 25 mL of methanol with stirring until fully dissolved, and the beaker was covered to prevent solvent evaporation. The reaction was initiated by adding 200 µL of the extract stock solution to 3 mL of the freshly prepared DPPH solution in a test tube. The mixture was vortexed and incubated in the dark for 20 minutes at room temperature. After incubation, the absorbance was measured at 517 nm against a methanol blank using a UV-Vis spectrophotometer. The radical scavenging activity, expressed as a percentage of inhibition (I%), was calculated using the formula: I% = [(A blank – A sample) / A blank] × 100, where A blank is the absorbance of the control (DPPH solution without extract) and A sample is the absorbance of the test reaction [22].

RESULTS

The phenology and morphology of the seventeen carom accessions were recorded during the growth cycle. Plants were sown on 15 December 2022, with initial flowering observed in most accessions on 16 February 2023, and 50% flowering reached by 9 March 2023. Significant morphological variation was evident among the accessions (Fig. 1a). Plant height varied considerably, with accession 20613 being the tallest at 43 cm (Fig. 1b). Furthermore, accession 21514 produced the highest number of branches at 13 per plant (Fig. 1c). Raw data for plant height and branch number for all accessions are provided in Table 1. The average values for these morphological traits, along with the average days to initial and 50% flowering, are summarized in Table 2. The descriptive statistical analysis confirmed significant morphological diversity among the seventeen *Trachyspermum ammi* accessions (Table 3). Plant height averaged 22.92 cm with substantial variation, as indicated by a standard deviation of 7.96 cm and a wide range from 11.10 cm to 43.90 cm. Similarly, the number of branches per plant showed considerable variability, with a mean of 12.62, a standard deviation of 6.02, and values spanning from 5 to 27. The distribution of both traits was positively skewed (Skewness: 1.08 for height, 0.85 for branches), indicating a concentration of accessions with lower values and a tail of higher-performing ones. Furthermore, the kurtosis value for height (1.88) suggests a distribution that is more peaked with longer tails than a normal distribution, while the branches (0.40) show a relatively flatter distribution. The high standard deviations and the nature of their distributions underscore the pronounced phenotypic variation present in the germplasm collection, highlighting its potential for selecting superior accessions for breeding programs.

Table 01: Height and Number of Branches of 17 Accessions of Ajwain

Accessions	Height			No of branches			Total days (initial flowering)	Total days (50% flowering)
	P1	P2	P3	P1	P2	P3		
20565	18.5	16.5	21.5	7	6	5	63	83
20579	20.5	24.5	21	21	9	18	63	83
20591	15.4	30	24.5	7	5	4	63	83
20613	13	16.4	14.5	6	11	9	63	83
20698	21.2	12.2	Nil	13	6	Nil	63	83
20717	23	25	14	10	18	7	63	83
20782	25	23.5	20	26	7	19	63	83
20802	11.9	16.2	8.5	7	8	8	63	83
20809	25	16.4	10	23	11	6	63	83
20850	16.5	19	19.5	9	13	10	63	83
20967	17	24	16.5	7	6	11	63	83
21116	18.5	21	24.9	11	9	17	63	83
21189	20	16.5	24	14	7	24	63	83
21227	35	33	23	29	21	9	63	83
21255	29.5	30	36	10	7	11	63	83
21468	18.5	22.4	35	19	17	26	63	83
21514	29	37	29	40	26	15	63	83

Table 02: Average Calculation of Morphological Data

Accession	Height(cm) Average	No of branches Average	Total days of flower initiation	50% flowering (total days)
20565	18.8	6	63	83
20579	22	16	63	83
20591	23.3	5	63	83
20613	43.9	9	63	83
20698	11.1	6	63	83
20717	20.6	12	63	83
20782	22.8	17.3	63	83
20802	12.2	7.6	63	83
20809	17.1	13.3	63	83
20850	18.3	10.6	63	83
20967	19.1	8	63	83
21116	21.4	12.3	63	83
21189	20.1	15	63	83
21227	30.3	19.6	63	83
21255	31.8	9.3	63	83
21468	25.3	20.6	63	83
21514	31.6	27	63	83

Morphological variation
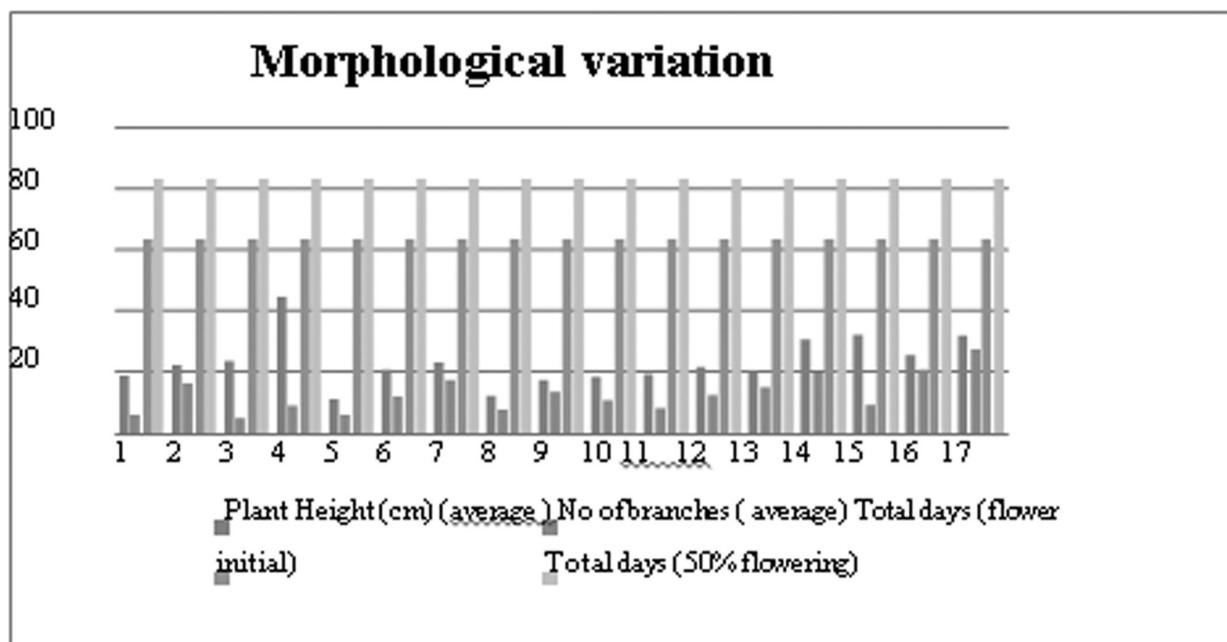
Fig. 1a: Morphological Variation Among 17 Accessions of Carom

Height (cm) (Average)
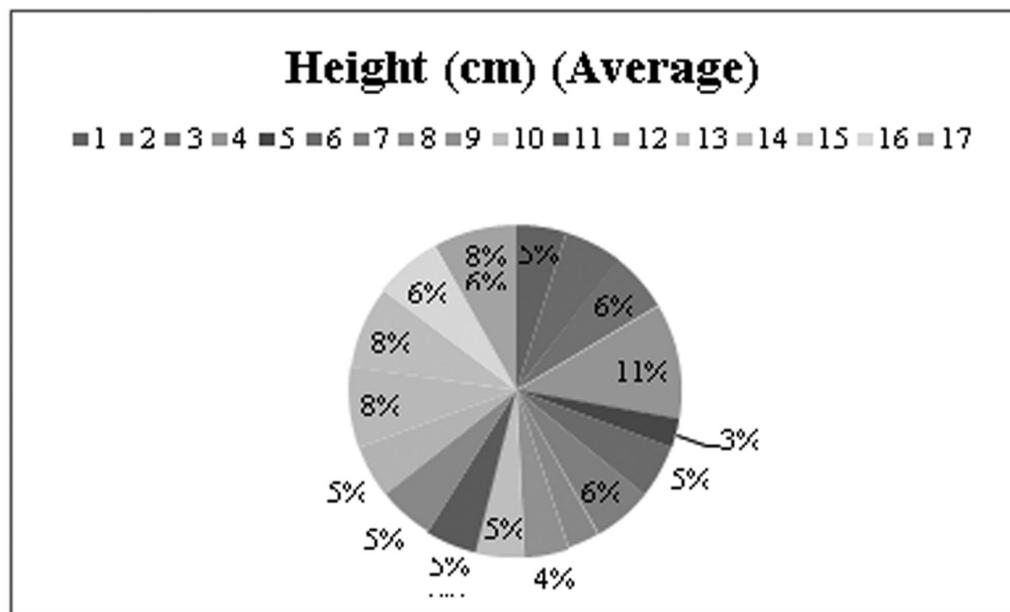
Fig. 1b: Pie Chart Showing Variation in Height Among Carom Accessions
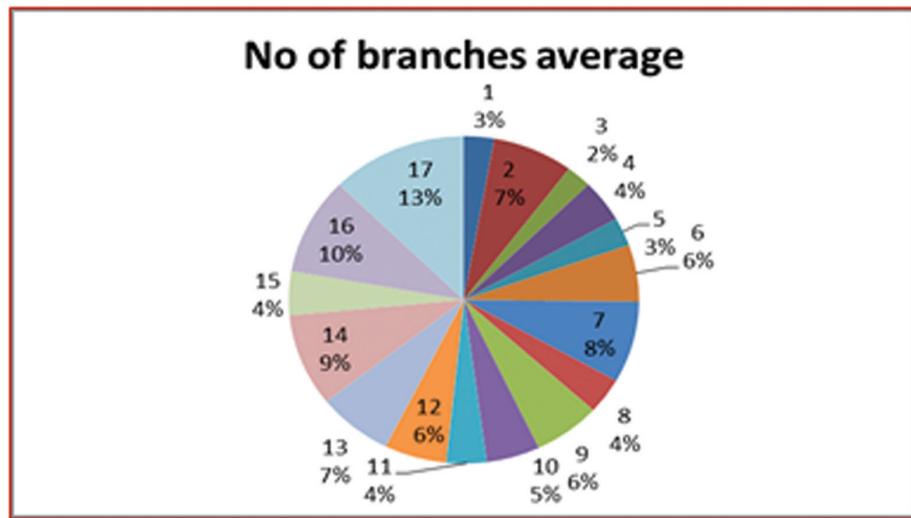
Fig. 1c: Pie Chart Showing Variation in the Average Number of Branches Among Carom Accessions

Table 03: Descriptive Statistics for the Morphological Variation in Seventeen Accessions of *Trachyspermum ammi*.

Statistic	Height (cm)	Number of Branches
Mean	22.92	12.62
Standard Error	1.93	1.46
Median	21.40	12.00
Standard Deviation	7.96	6.02
Sample Variance	63.28	36.22
Range	32.80	22.00
Minimum	11.10	5.00
Maximum	43.90	27.00
Count (n)	17	17
Confidence Level (95.0%)	4.09	3.09

Biochemical Analysis Results
Total Phenolic Content in Different Accessions of Ajwain:

The biochemical analysis revealed the presence of phenolic compounds in all seventeen accessions ofÊ*Trachyspermum ammi*. The total phenolic content (TPC), quantified using the Folin-Ciocalteu method and expressed as gallic acid equivalents per gram of dry weight (mg GAE/g DW), exhibited considerable variation across the accessions. The values ranged from 25.93 to 30.12 mg GAE/g DW. The methanolic extract of accession 20809 contained the highest TPC, while accession 20967 showed the lowest concentration. This variation is presented numerically in Table 4 and is further illustrated graphically in Fig. 2a and Fig. 2b, which clearly corroborate the superior phenolic content in accession 20809.

Table 04: Total Phenolic Contents of Methanolic Extracts of Different Accessions of *Trachyspermum ammi*

Accession No.	Plant part	Solvent	Total phenols (mg of GAE/g of dry weight)
20565	Leaves	Methanol	28.75
20579	Leaves	Methanol	26.60
20591	Leaves	Methanol	26.79
20613	Leaves	Methanol	27.63
20698	Leaves	Methanol	27.07
20717	Leaves	Methanol	27.01
20782	Leaves	Methanol	28.93
20802	Leaves	Methanol	28.98
20809	Leaves	Methanol	30.12
20850	Leaves	Methanol	28.63
20967	Leaves	Methanol	25.93
21116	Leaves	Methanol	28.59
21189	Leaves	Methanol	27.12
21227	Leaves	Methanol	27.56
21255	Leaves	Methanol	28.47
21468	Leaves	Methanol	27.15
21514	Leaves	Methanol	29.55

Fig. 2a: Determination of the Presence and Absence of Phenol Compounds

Total Flavonoid Contents
The total flavonoid content (TFC) across the seventeen ajwain accessions displayed significant variation, with values ranging from 18.45 to 252.45 mg QE/g of dry weight. Accession 21189 was found to contain the highest flavonoid concentration, while the lowest value was recorded in another accession (18.45 mg QE/g). The complete quantitative data are presented in Table 5, and the comparative variation among all accessions is graphically illustrated in Fig. 3a and Fig. 3b, which clearly confirm the superior TFC in accession 21189

Fig.2b: Total Polyphenols in Methanolic Extracts of All 17 Ajwain Accessions

Fig. 3a: Determination of Flavonoid Content in 17 Accessions of Ajwain
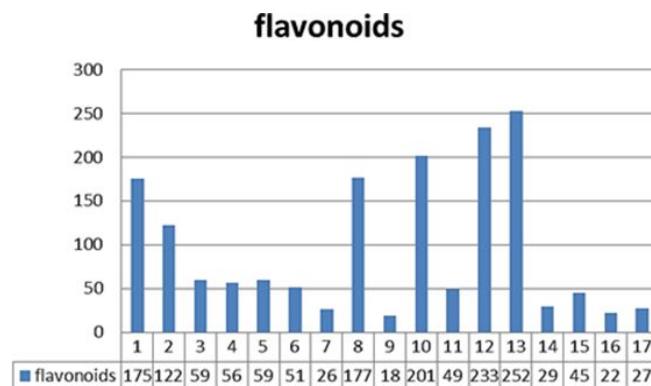
Fig. 3b: Total Flavonoid Content in Methanolic Extracts

Accession no	Plant part	Solvent	Total Flavonoid (CE/g DW)
20565	Leaves	Methanol	175.45
20579	Leaves	Methanol	122.45
20591	Leaves	Methanol	59.45
20613	Leaves	Methanol	56.45
20698	Leaves	Methanol	59.45
20717	Leaves	Methanol	51.45
20782	Leaves	Methanol	25.95
20802	Leaves	Methanol	176.95
20809	Leaves	Methanol	18.45
20850	Leaves	Methanol	201.45
20967	Leaves	Methanol	49.45
21116	Leaves	Methanol	233.45
21189	Leaves	Methanol	252.45
21227	Leaves	Methanol	29.19
21255	Leaves	Methanol	45.37
21468	Leaves	Methanol	21.53
21514	Leaves	Methanol	27.22

Table 05: Total Flavonoid Content

Antioxidant Potential

The DPPH radical scavenging assay confirmed the presence of antioxidant activity in all seventeen ajwain accessions, with considerable variation in potency (Table 6). The methanolic extract of accession 20809 exhibited the highest antioxidant activity at 55% inhibition, which aligns with its previously noted high phenolic content. In contrast, accession 20967 demonstrated the lowest activity at 12% inhibition. The full spectrum of variation in free radical scavenging potential among the accessions is presented graphically in Fig. 4.

Table 06: Total Antioxidant Potential

| Accession no	Plant part	Solvent	Antioxidant potential (%)
20565	Leaves	Methanol	37.38%
20579	Leaves	Methanol	27.33%
20591	Leaves	Methanol	12.36%
20613	Leaves	Methanol	26.83%
20698	Leaves	Methanol	33.46%
20717	Leaves	Methanol	38.89%
20782	Leaves	Methanol	18.59%
20802	Leaves	Methanol	43.31%
20809	Leaves	Methanol	54.87%
20850	Leaves	Methanol	51.15%
20967	Leaves	Methanol	15.0%
21116	Leaves	Methanol	30.95%
21189	Leaves	Methanol	36.38%
21227	Leaves	Methanol	28.64%
21255	Leaves	Methanol	28.34%
21468	Leaves	Methanol	30.55%
21514	Leaves	Methanol	30.45%
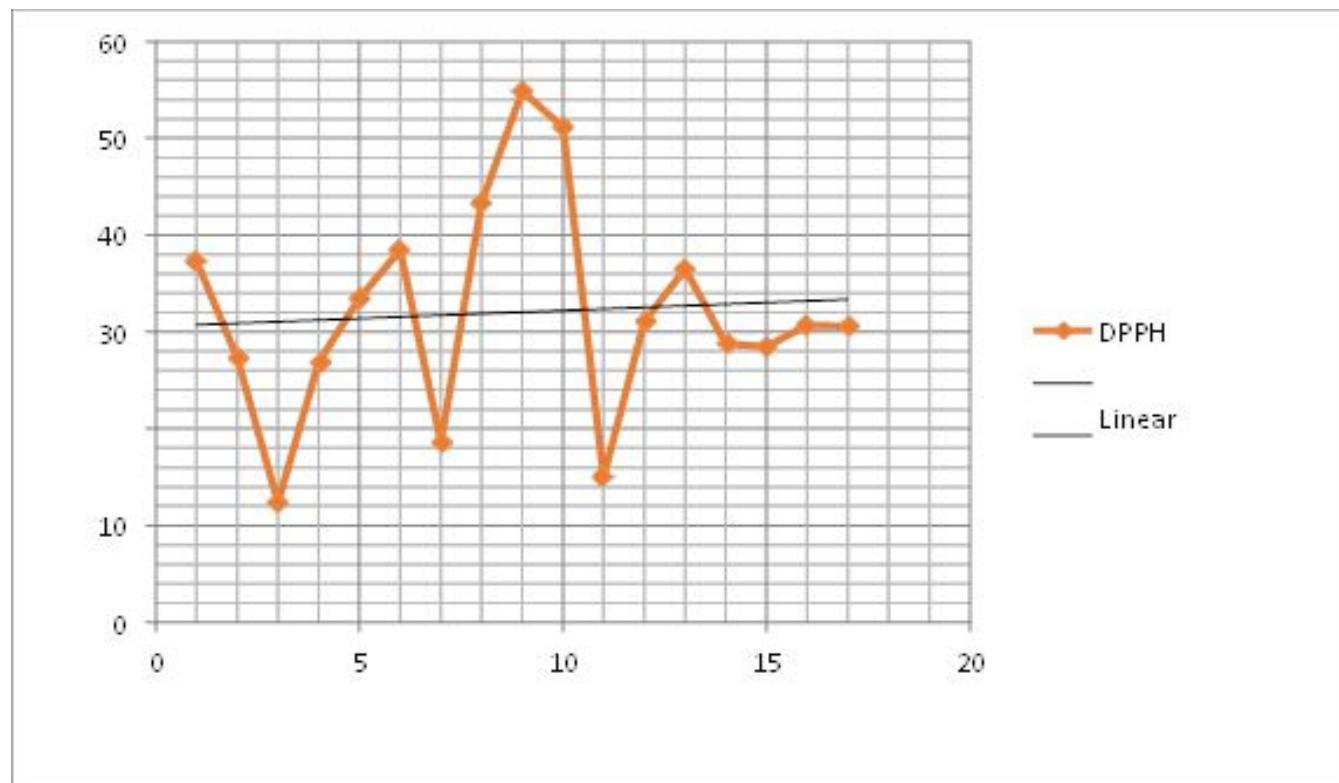
Fig. 4: Total Antioxidant Potential in Methanolic Extracts of All Accessions

A comparative analysis of the biochemical profiles revealed a pronounced relationship between phytochemical composition and antioxidant activity. Accession 20809, which exhibited the highest antioxidant potential (55%), also contained the greatest concentration of total phenolics. Interestingly, its flavonoid content was not the highest among the accessions, suggesting that its potent antioxidant capacity may be primarily driven by its polyphenolic constituents. This could indicate that the specific phenolic compounds present in this accession possess a high degree of bioactivity, or that synergistic effects between different phytochemicals are enhancing the overall antioxidant effect. In contrast, accession 21189 recorded the highest flavonoid content but demonstrated a lower antioxidant activity than accession 20809. Correlation analysis further substantiated a positive relationship between phenolic content, flavonoid content, and antioxidant activity across the germplasm (Table 7 and 8, Fig. 5), underscoring the collective contribution of these metabolites to the plant's radical scavenging potential. Future studies focusing on the isolation and identification of the specific phenolic compounds in accession 20809 are warranted to elucidate the precise mechanisms behind its superior bioactivity.

Table 07: Comparison of Total Polyphenol, Flavonoid and Antioxidant Potential Between Methanolic Extracts of Ajwain

| Accession no	Phenol's	Flavonoid	Antioxidant (DPPH)
20565	28.75	175.45	37.38%
20579	26.60	122.45	27.33%
20591	26.79	59.45	12.36%
20613	27.63	56.45	26.83%
20698	27.07	59.45	33.46%
20717	27.01	51.45	38.89%
20782	28.93	25.95	18.59%
20802	28.98	176.95	43.31%
20809	30.12	18.45	54.87%
20850	28.63	201.45	51.15%
20967	25.93	49.45	15.0%
21116	28.59	233.45	30.95%
21189	27.12	252.45	36.38%
21227	27.56	29.19	28.64%
21255	28.47	45.37	28.34%
21468	27.15	21.53	30.55%
21514	29.55	27.22	30.45%
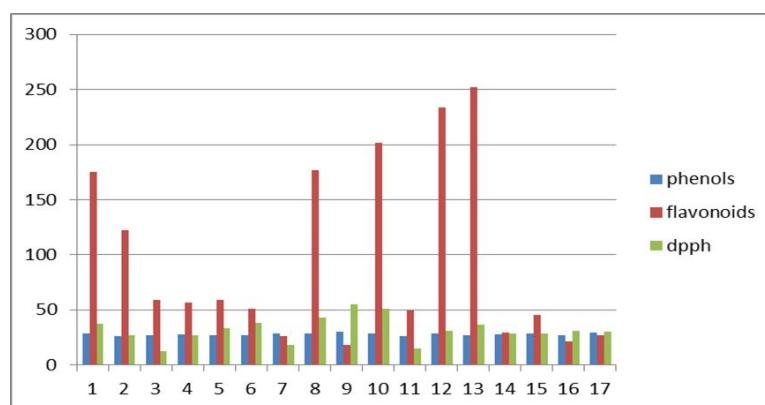
Fig. 5: Comparison of Phenol, Flavonoid and DPPH among Methanolic Extracts of Ajwain

Table 08: Correlation between Morphological and Biochemical Characters

	Phenols	Flavonoid	DPPH	Height	Branches
Phenols	1				
Flavonoid	0.05002	1			
DPPH	0.558255	0.338168	1		
Height	-0.00567	-0.36378	-0.36457	1	
Branches	0.226876	-0.26753	0.008137	0.34057	1

DISCUSSION

Trachyspermum ammi L. (ajwain) is recognized not only as a culinary spice but also as a significant reservoir of bioactive phytochemicals. These compounds, including phenolic acids, flavonoids, and other antioxidants, are increasingly associated with protective effects against a spectrum of chronic diseases, such as inflammation, diabetes, cancer, and cardiovascular disorders [23]. The present study affirms that ajwain, a member of the Apiaceae family a group renowned for its medicinal species [24] contains substantial levels of these health-promoting compounds.

Our investigation of seventeen distinct ajwain accessions revealed considerable morphological and biochemical diversity. This variation, observed in traits such as plant height and branch number, is critical from a germplasm perspective, as it indicates a rich genetic base that can be exploited in targeted breeding programs to develop superior cultivars. The biochemical analysis further demonstrated a wide variation in total phenolic and flavonoid contents among the accessions. A key finding of this study is the strong positive correlation established between the total phenolic content and the antioxidant activity, as measured by the DPPH radical scavenging assay. This relationship is mechanistically plausible, as the redox properties of phenolic compounds allow them to act as hydrogen donors and free radical quenchers [25-27]. The methanolic extract of accession 20809, which exhibited the highest phenolic content, concurrently displayed the most potent antioxidant activity, underscoring the likely contribution of these polyphenols to its radical-scavenging capacity.

In contrast, the relationship between total flavonoid content (TFC) and antioxidant activity was less straightforward. While a positive trend was observed, the correlation was not as strong as that for phenolics. This finding aligns with several previous reports that found a weak or non-significant correlation between TFC and antioxidant power [28]. A plausible explanation is that antioxidant efficacy is not merely a function of the total quantity of flavonoids, but is highly dependent on their specific structural features, such as the pattern of hydroxylation and glycosylation, which influence their redox potential [29,30]. Therefore, the specific profile of flavonoid compounds in an accession, rather than the total concentration alone, may be the determining factor for its bioactivity.

The choice of extraction solvent is another critical factor influencing the yield and composition of bioactive compounds. Our results, showing varying extraction yields for different solvents, corroborate earlier findings [31]. The polarity of the solvent selectively dissolves different classes of compounds; while water yielded the highest extract mass, medium-polarity solvents like ethyl acetate are often more effective for concentrating specific phenolic antioxidants [32-34]. The use of methanol in this study proved effective in extracting a range of antioxidant compounds, as evidenced by the

significant DPPH scavenging activity across accessions.

In conclusion, this study validates the significant phytochemical potential ofÊ*T. ammi*Êand highlights the substantial intrinsic variation present across different accessions. The identification of accessions like 20809, with high phenolic content and potent antioxidant activity, is of particular value. These findings provide a solid foundation for the future conservation and utilisation of ajwain genetic resources. Subsequent research should focus on the detailed characterisation of the specific phenolic compounds in high-performing accessions and furtherÊ*in vivo*Êstudies to fully elucidate their health-promoting mechanisms.

CONCLUSION
This study successfully characterized the morphological and biochemical diversity of seventeenÊ*Trachyspermum ammi*ÊL. accessions from a conserved seed bank. Significant variation was observed in key agronomic traits such as plant height and branching architecture, as well as in critical biochemical markers, specifically total phenolic and flavonoid content and associated antioxidant activity. A strong positive correlation was established between phenolic content and antioxidant potential, identifying accession 20809 as a particularly promising candidate due to its high phenolic levels and potent DPPH radical scavenging activity. The findings confirm that carom is a rich source of natural antioxidants, underscoring its potential for nutraceutical and functional food applications. The documented diversity underscores the value of seed bank resources for selective breeding programs aimed at enhancing the medicinal quality of ajwain. To build upon these findings, future work should employ molecular markers to elucidate the genetic basis of this variation and conduct further phytochemical analysis to identify the specific active compounds responsible for the observed bioactivity. Such advanced research will be crucial for the full exploitation and conservation of this valuable medicinal species.

Ethical Approval & Ethical Consent
This study did not involve human participants or activities posing ecological risk; hence, ethical approval was not required.

Author's Contribution
FN: Conceived and designed the study, performed statistical analysis, and drafted the manuscript also conducted experiments, collected and analyzed data.

SM & RT: Supervised the study, contributed to study design and interpretation of results. Sadia Malik critically revised the manuscript, approved the final version, and is for correspondence throughout the publication process.
AM: Revised the manuscript critically.
EF: Assisted in manuscript revision, and approved the final version.

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ORIGINAL ARTICLE

KNOWLEDGE, ATTITUDES, AND PRACTICES (KAP) OF STAFF NURSES REGARDING PEDIATRIC PAIN ASSESSMENT AND ITS INFLUENCE ON THEIR PERCEIVED SELF-EFFICACY IN PAIN MANAGEMENT

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ABSTRACT

Background:
Effective pediatric pain management is a critical component of nursing care, yet under treatment remains a widespread challenge. Nurses' perceived self-efficacy is a key determinant of their clinical performance, but its relationship with their knowledge, attitudes, and practices (KAP) is not well understood, particularly in the Pakistani context.

Objective: This study aimed to assess the KAP of staff nurses in Karachi regarding pediatric pain assessment and management and to identify the significant predictors of their perceived self-efficacy.

Methods: A cross-sectional study was conducted with 165 nurses from pediatric wards of tertiary care hospitals using a validated, self-administered questionnaire. Data were analyzed using descriptive statistics and multiple linear regressions.

Results: The regression model revealed that both knowledge (â=0.457, p<0.001) and attitudes (â=0.460, p<0.001) were strong, nearly identical predictors of self-efficacy, while self-reported practices were a weaker but still significant predictor (â=0.086, p=0.044).

Conclusion: The findings demonstrate that a nurse's confidence is built on a dual foundation of knowledge and positive attitudes. This underscores the necessity for holistic training interventions that move beyond knowledge dissemination to actively cultivate the professional mindset and self-belief required for nurses to become effective advocates and managers of pediatric pain.

Keywords: Pediatric Pain Management; Nursing Self-Efficacy; Health Knowledge, Attitudes, Practice; Pakistan; Clinical Competence.

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INTRODUCTION

The effective management of pediatric pain remains a significant challenge and a moral imperative within modern healthcare, directly impacting a child's recovery, psychological well-being, and overall hospital experience. Despite its critical importance, undertreatment of pain in children is a persistent global issue, often stemming from complex barriers at the clinical level. Nurses, as the primary caregivers at the bedside, play an indispensable role in the continuous assessment and initiation of pain relief measures, making their competencies the linchpin of effective pediatric pain management [1,2]. Existing research from various contexts reveals concerning gaps; studies among nursing students and emergency department nurses highlight foundational knowledge deficits and negative attitudes that can impede adequate care [3,4]. Furthermore, investigations into specialized units, including intensive care and palliative care settings, consistently identify shortcomings in nurses' practices and significant perceived barriers that hinder optimal pain management for vulnerable populations [5,6].

While these studies effectively map the landscape of knowledge, attitudes, and practices (KAP) in isolation, a critical gap persists in understanding the dynamic interplay between these factors and their collective influence on a nurse's professional confidence. Research from China and Iran suggests a complex relationship where knowledge does not automatically translate into proficient practice, indicating that other psychological factors, such as self-efficacy, may be a crucial mediator [7,8]. This concept of perceived self-efficacy, a nurse's belief in their own capability to successfully assess and manage a child's pain, is a powerful determinant of clinical behavior, yet it remains underexplored in the Pakistani context. The domestic research landscape has primarily focused on knowledge assessments in areas like palliative care and dengue fever, leaving a substantial void regarding the specific competencies required for pediatric pain management [9, 10]. Therefore, merely documenting KAP levels is insufficient; there is a pressing need to investigate how these elements collectively shape the confidence of nurses, which ultimately drives their clinical actions and advocacy for their young patients.

This study is designed to address this gap by moving beyond a descriptive account to an analytical examination of the predictors of nursing confidence. The purpose of this research is to comprehensively assess the knowledge, attitudes, and practices of staff nurses in Karachi regarding pediatric pain assessment and management, and to determine the association of these factors with their perceived self-efficacy [11]. The findings will provide crucial, evidence-based insights for nursing educators and hospital administrators in Pakistan, guiding the development of targeted training interventions that not only disseminate knowledge but also strategically build the attitudes and practical confidence necessary to ensure that no child suffers needless pain.

METHODOLOGY

A cross-sectional study was conducted over a four-month period among staff nurses working in the pediatric wards of three major tertiary care hospitals in Karachi. A minimum sample size of 148 participants was calculated using the RaoSoft online calculator, with a 5% margin of error and a 95% confidence level, based on an estimated population of 500 nurses. The final sample included 165 nurses, recruited via convenience sampling.

Data were collected using a self-administered, structured questionnaire adapted from previously validated instruments used in similar KAP studies on pediatric and pain management [2,5]. The questionnaire was modified for contextual relevance and comprised four sections: demographic details, a 8-item knowledge scale (true/false), a 6-item attitude scale (5-point Likert), a 5-item practice scale (5-point frequency scale), and a 6-item perceived self-efficacy scale (5-point confidence scale). The instrument was piloted with 15 nurses, resulting in a high Cronbach's alpha of 0.92, indicating excellent internal consistency.

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) version

16.0. Descriptive statistics (frequencies and percentages) summarized participant characteristics. A multiple linear regression analysis was employed to identify whether knowledge, attitude, and practice scores were significant predictors of the nurses' perceived self-efficacy. For all statistical tests, a p-value of less than 0.05 was established as the threshold for statistical significance, defining the level for rejecting the null hypothesis.

RESULTS:
The participant profile reveals a predominantly female, early-career nursing workforce, with most possessing either a diploma or bachelor's degree. The sample is characterized by limited pediatric experience, as over 70% reported three years or less, and was nearly evenly split between public and private tertiary care hospitals.

Table 1: Demographic and Professional Profile of Participants

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Male	41	24.8%
	Female	124	75.2%
Age (Years)	21-25	58	35.2%
	26-30	67	40.6%
	31-35	29	17.6%
	>35	11	6.7%
Highest Nursing Qualification	Diploma in General Nursing	89	53.9%
	BSc Nursing	62	37.6%
	Post-RN BSc/MSc Nursing	14	8.5%
Clinical Experience in Pediatrics	< 1 year	47	28.5%
	1 - 3 years	72	43.6%
	4 - 6 years	34	20.6%
	> 6 years	12	7.3%
Current Hospital Type	Public Tertiary Care	78	47.3%
	Private Tertiary Care	87	52.7%

The results demonstrated excellent internal consistency for the research instrument, with a Cronbach's alpha of 0.951. This high reliability coefficient confirms the scales used in the questionnaire were exceptionally consistent and dependable for measuring the intended constructs.

Table 2: Inter-Item Reliability of the questionnaire

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.951	.951	25

The regression analysis reveals a compelling narrative about the drivers of nursing confidence in pediatric pain management. Both knowledge and attitudes emerged as powerfully significant and nearly equal predictors of self-efficacy, with standardized coefficients of 0.457 and 0.460, respectively. This indicates that a nurse's confidence is not solely built on what they know, but is equally fueled by their underlying beliefs and professional mindset. While self-reported practices were also a statistically significant predictor, their substantially lower coefficient suggests that actual clinical behavior, while important, is a less dominant contributor to a nurse's perceived competence compared to their foundational knowledge and attitudes.

Table 3: Predictors of Nurses' Perceived Self-Efficacy in Pediatric Pain Management: Multiple Linear Regression Analysis

Predictor Variable	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	t-value	p-value
(Constant)	0.084	0.138		0.603	0.547
Knowledge Score	0.458	0.051	0.457	9.044	<0.001*
Attitude Score	0.442	0.048	0.460	9.196	<0.001*
Practice Composite	0.078	0.039	0.086	2.031	0.044*

Dependent Variable: Perceived Self-Efficacy in Pediatric Pain Management

*Note: * indicates statistical significance at $p < 0.05$.

DISCUSSION:

The findings of this study confirm the central hypothesis that knowledge, attitudes, and practices collectively predict the perceived self-efficacy of nurses in managing pediatric pain, with the model revealing a more nuanced hierarchy of influence than might be assumed. The powerful, nearly identical predictive strength of both knowledge and attitudes underscores a critical synergy; a nurse's confidence is not built on intellectual understanding alone but is equally dependent on a supportive professional mindset. This aligns with research from Iran which noted a disconnect between knowledge and practice, suggesting that attitudes are a pivotal intermediary variable [9]. However, it contrasts with studies that identified knowledge deficits as the primary barrier, highlighting that in our context, educational and psychological factors are deeply intertwined [2,4].

The most significant new insight from this work is the quantification of this dual foundation of

confidence. While previous studies in Pakistan have focused on isolated knowledge assessments [10,11], this analysis demonstrates that self-efficacy is a composite outcome, heavily reliant on both cognitive and affective domains. The clinical significance is profound; it implies that interventions aimed solely at updating knowledge, such as traditional lectures, will be insufficient. To truly empower nurses, training must be holistic, incorporating components that actively challenge negative beliefs and foster positive attitudes towards their role as pain management advocates. The weaker, though still significant, contribution of self-reported practices suggests that while clinical experience matters, the internal confidence to act may be a prerequisite for consistent practice [12,13].

This study is not without limitations. Its cross-sectional design precludes establishing causality, and the use of self-reported data may be influenced by social desirability bias. Furthermore, the model did not account for potent external barriers like staffing ratios or hierarchical workplace cultures, which could overshadow individual competencies. Future research should therefore employ longitudinal or mixed-methods designs to explore how self-efficacy evolves with experience and to investigate the systemic and institutional obstacles that may constrain a nurse's ability to apply their knowledge and positive attitudes in daily practice, ultimately ensuring that confidence can be fully translated into compassionate and effective clinical care.

CONCLUSION:
This study concludes that a nurse's confidence in managing pediatric pain is not born from knowledge or attitude alone, but from their powerful synergy. Our findings reveal that both a strong understanding of pain principles and a positive, proactive professional mindset are equally vital in building the self-assurance required for effective clinical action. This pivotal insight demands a fundamental shift in how we prepare and support our nursing workforce. To truly safeguard children from needless suffering, training must evolve beyond mere information transfer to become a holistic endeavor

that simultaneously cultivates competence, shapes empowering attitudes, and builds the resilient confidence essential for advocacy at the bedside.

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DUPLICATE PUBLICATION

Most journals do not wish to consider for publication a paper on work that has already been reported in a published paper or is described in a paper submitted or accepted for publication elsewhere. This policy does not usually preclude consideration of a paper that has been rejected by another journal or of a complete report that follows publication of a preliminary report, usually in the form of an abstract. Nor does it prevent consideration of a paper that has been presented at a scientific meeting if not published in full in a proceedings or similar publication. Press reports of the meeting will not usually be considered as breaches of this rule, but such reports should not be amplified by additional data or copies of tables and illustrations. When submitting a paper an author should always make a full statement to the editor about all submissions and previous reports that might be regarded as prior or duplicate publication of the same or very similar work. Copies of such material should be included with the submitted paper to help the editor decide how to deal with the matter

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ORIGINAL ARTICLE

KNOWLEDGE, ATTITUDES, AND PRACTICES (KAP) OF COMMUNITY PHARMACISTS IN KARACHI REGARDING ANTIMICROBIAL STEWARDSHIP (AMS) AND ITS ASSOCIATION WITH THEIR PERCEIVED COMPETENCE IN PATIENT COUNSELING

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ABSTRACT

Background: Antimicrobial resistance poses a severe threat to global public health, with community pharmacists serving as crucial frontline defenders. While their knowledge and practices are often studied, the psychological drivers of their effectiveness, particularly their perceived competence in stewardship counseling, remain poorly understood.

Objective: This study aimed to assess the knowledge, attitudes, and practices (KAP) of community pharmacists in Karachi regarding antimicrobial stewardship (AMS) and to identify the key predictors of their perceived competence in patient counseling.

Methods: A cross-sectional study was conducted with 165 community pharmacists using a validated, self-administered questionnaire. Data were analyzed using descriptive statistics and multiple linear regression to determine the associations between KAP scores and perceived competence.

Results: The analysis revealed that while knowledge and practices showed positive associations, only attitudes emerged as a statistically significant predictor of perceived competence ($\hat{a} = 0.289$, $p = 0.044$). This indicates that a pharmacist's confidence is more strongly influenced by their underlying beliefs and professional mindset than by their knowledge base alone.

Conclusion: The findings suggest that to fully leverage community pharmacists in the fight against antimicrobial resistance, interventions must move beyond traditional education. Training programs should be redesigned to actively cultivate positive attitudes, strong professional identity, and communication resilience, thereby empowering pharmacists with the confidence needed to be effective stewards.

Keywords: Antimicrobial Stewardship, Community Pharmacists, Health Knowledge, Attitudes, Practice, Professional Competence, Pakistan, Drug Resistance, Microbial

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INTRODUCTION

The escalating crisis of antimicrobial resistance (AMR) represents a profound global health threat, driven significantly by the misuse of antibiotics across human and animal health sectors [1]. In response, Antimicrobial Stewardship (AMS) has emerged as a critical framework of coordinated interventions designed to promote appropriate antimicrobial use, improve patient outcomes, and preserve drug efficacy [2]. Within this landscape, community pharmacists occupy a uniquely strategic position as the most accessible healthcare professionals, serving as a crucial bridge between the public and formal health systems and providing a vital opportunity to guide rational antibiotic use and prevent dangerous self-medication practices [1,3].

Globally, research consistently reveals significant gaps in healthcare professionals' understanding and implementation of AMS principles. Studies from the United Arab Emirates and various African nations, including Kenya and Zambia, indicate that even moderate knowledge does not reliably translate into optimal practices, such as refusing non-prescription antibiotic sales [4,5]. This concerning disconnect between awareness and action is further evidenced by research in Sudan, which found undergraduate pharmacy students often lack confidence in their understanding of AMR and stewardship principles, highlighting systemic educational challenges [6]. Investigations across the African continent, particularly in Zambia and South Africa, have documented substantial deficiencies in both knowledge and practical application of AMS among practicing pharmacists [7,8].

The situation in Pakistan demands particular attention, as the country faces a severe AMR crisis exacerbated by unregulated antibiotic access and entrenched self-medication habits [9]. A recent intervention study in Punjab demonstrated that pharmacist-led education could significantly improve healthcare workers' knowledge, attitudes, and practices, proving that targeted interventions can yield positive changes [8]. However, a critical gap remains in understanding the interconnected KAP of community pharmacists in major urban centers like Karachi, particularly regarding how these factors influence their perceived competence in patient counseling. This psychological dimension is crucial, as a pharmacist's self-confidence directly impacts their willingness to engage in challenging conversations about antibiotic misuse [10, 11].

The challenge extends beyond pharmacy practice, with studies in Uganda revealing that community members often possess poor knowledge and practices regarding antibiotics, creating additional pressure on healthcare providers and complicating stewardship efforts [12]. This underscores the need for a multi-pronged approach that addresses both public education and professional development. Research into Pakistan's veterinary sector reveals parallel crises of antimicrobial misuse in livestock, creating reservoirs of resistance that inevitably impact human health [13]. The consistency of these findings across different countries and healthcare levels, from public perceptions in Uganda to hospital pharmacists in South Africa and Nigeria, indicates that combating AMR requires empowering every link in the healthcare chain [5,6].

The purpose of this cross-sectional study is to comprehensively assess the Knowledge, Attitudes, and Practices of community pharmacists in Karachi, Pakistan, regarding Antimicrobial Stewardship, and to determine the association of these factors with their Perceived Competence in patient counseling on antibiotic use. To optimize community pharmacists' role in fighting antimicrobial resistance, training must target their mindset. This study demonstrates that in high-pressure environments like Karachi, a pharmacist's confidence and competence are driven more by their underlying attitudes than by their knowledge, demanding a new approach to professional development. This study aims to assess community pharmacists' knowledge, attitudes, and practices (KAP) regarding antimicrobial stewardship (AMS) in Karachi. It further seeks to determine their perceived competence in patient counseling and to analyze, via linear regression, whether KAP components are significant

predictors of this specific competence.

METHODOLOGY

A six-month, cross-sectional study was conducted among community pharmacists in Karachi. With an estimated population of 1200 registered pharmacies, a minimum sample of 165 was determined using the OpenEpi calculator, applying a 95% confidence level, 5% margin of error, and 50% response distribution. The convenience sampling technique was employed due to practical constraints, including the absence of a comprehensive national pharmacist registry and the need for timely data collection amidst the busy schedules of practicing pharmacists. This method facilitated efficient recruitment across the city's various districts.

Data were gathered using a structured, self-administered questionnaire, developed from an extensive literature review. The instrument contained five sections: 1) demographic and professional details, 2) an 8-item Knowledge scale, 3) a 6-item Attitude scale, 4) a 5-item Practices scale, and 5) a 6-item Perceived Competence scale. Likert scales were used for sections 2-5. A pilot study with 15 pharmacists confirmed the tool's clarity and reliability, demonstrating good internal consistency with a Cronbach's alpha above 0.75 for all scales.

Analyses were performed in SPSS version 16.0. Descriptive statistics summarized participant characteristics. To address the primary objective, a multiple linear regression model was constructed with Perceived Competence as the dependent variable and the Knowledge, Attitudes, and Practices composite scores as predictors. Statistical significance was set at $p < 0.05$.

RESULTS

The participant profile revealed a predominantly male cohort with a mid-career workforce. Most participants held a Pharm-D qualification and possessed moderate professional experience, averaging nearly seven years. The sample represented all major districts of Karachi, ensuring geographic diversity in this cross-sectional study (table 1).

Table: Demographic and Professional Profile of Participants

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Male	121	73.3%
	Female	44	26.7%
Age (Years)	22-30	68	41.2%
	31-40	72	43.6%
	41-50	21	12.7%
	>50	4	2.4%
Highest Qualification	Pharm-D	98	59.4%
	B. Pharmacy	57	34.5%
	M. Pharmacy/Other	10	6.1%
Experience in Community Pharmacy (Years)	< 2 years	32	19.4%
	2 - 5 years	47	28.5%
	6 - 10 years	59	35.8%
	> 10 years	27	16.4%
Location of Pharmacy	Central District	45	27.3%
	East District	38	23.0%
	West District	52	31.5%
	South District	30	18.2%

The results demonstrated excellent internal consistency for the research instruments, with a Cronbach's alpha of 0.951. This high reliability coefficient confirmed the scales used in the questionnaire were exceptionally consistent and dependable for measuring the intended constructs (table 2).

Table : Reliability Statistics – Inter Item Reliability of the Questionnaire

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
0.951	0.951	25

regression analysis revealed that among the three predictors, only Attitude emerged as a statistically significant predictor of pharmacists' perceived competence in AMS counseling (â = 0.289, p = 0.044). This indicates The that for every unit increase in positive attitude scores, perceived competence increased by 0.319 units, holding other factors constant. While Knowledge and Practices showed positive associations with competence, they did not reach statistical significance. This finding implies that interventions aimed at boosting pharmacists' confidence in AMS may be most effective if they focus on shaping positive attitudes and beliefs, rather than solely delivering knowledge or prescribing specific practices (table 3).

Table : Predictors of Pharmacists' Perceived Competence: Multiple Linear Regression Analysis

Predictor Variable	Unstandardized Coefficients (B)	Predictor Variable	Standardized Coefficients (Beta)	t-value	t-value
(Constant)	0.976	0.269		3.625	< 0.001
Knowledge	0.221	0.125	0.200	1.778	0.077
Attitude	0.319	0.157	0.289	2.031	**0.044***
Practice	0.166	0.119	0.156	1.389	0.167

Dependent Variable: Perceived Competence in Antimicrobial Stewardship Counseling
*Note: * indicates statistical significance at p < 0.05.

DISCUSSION

The present findings offer a complex understanding of the factors driving antimicrobial stewardship (AMS) competence among community pharmacists in a high-burden setting. Our central hypothesis, that knowledge, attitudes, and practices collectively predict perceived competence, was partially supported. The identification of attitudes as the sole significant predictor aligns with emerging research [14] highlighting the primacy of psychological factors in professional behavior. For instance, a study in Sudan similarly identified that self-confidence was a critical mediator in pharmacy students' preparedness for AMS roles [10]. Our results extend this concept, suggesting that even among practicing professionals, underlying beliefs and confidence may be a more powerful driver of perceived capability than knowledge alone.

This finding, however, presents a point of divergence from studies that primarily document knowledge deficits as the core barrier. While research from the UAE, Zambia, and Nigeria correctly identifies gaps in understanding and practice [1,2,5], our analysis suggests that filling these knowledge gaps may not automatically translate into a more confident workforce. The non-significance of the practice's variable is particularly insightful. It implies that self-reported engagement in AMS-related activities does not necessarily bolster a pharmacist's own sense of competence, possibly due to external pressures, such as patient demands documented in Ugandan communities [15,16] or the commercial realities of pharmacy practice.

The most important new aspect of this study is its explicit focus on *perceived competence* as a critical outcome variable. Much of the existing literature, including work from South Africa and Egypt, has focused on quantifying knowledge and practice gaps [6,13]. Our study adds a crucial layer by demonstrating that competence is not merely a function of what pharmacists know or do, but fundamentally how they *feel* about their role. This has direct clinical significance; a confident pharmacist is more likely to effectively counsel patients, push back against inappropriate antibiotic demands, and serve as a reliable AMS advocate. Therefore, our conclusions indicate that educational interventions, like the one shown to be successful in Punjab [17], may achieve greater impact by incorporating components specifically designed to build professional identity, resilience, and positive attitudes, moving beyond pure didactic knowledge transfer.

This study is not without limitations. Its cross-sectional design precludes causal inferences, and the use of self-reported data for practices and competence may be subject to social desirability bias [18,19]. Future longitudinal research should observe actual counseling behaviors to validate these self-perceptions. Furthermore, qualitative investigations are needed to explore the specific contextual and systemic barriers that may weaken the link between knowledge, practice, and confidence in Pakistan. Addressing these factors will be essential for designing truly effective, multi-pronged stewardship programs that empower pharmacists as confident guardians of antimicrobial efficacy.

CONCLUSION

This study concludes that the journey to empowering community pharmacists as effective antimicrobial stewardship champions hinges more profoundly on nurturing their professional attitudes and self-belief than on merely expanding their knowledge base. While a strong foundation in AMS principles remains essential, our findings compellingly show that a pharmacist's confidence in providing counseling is most strongly fueled by their positive attitudes and sense of responsibility. This pivotal insight calls for a strategic shift in training programs, moving beyond traditional educational modules to include components that actively build professional identity, communication resilience, and a profound belief in their role as frontline defenders in the global fight against antimicrobial resistance.

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Authors

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ORIGINAL ARTICLE

THE PSYCHOLOGICAL IMPACT OF THE COVID-19 PANDEMIC ON FACULTY AND MEDICAL COLLEGE STUDENTS IN KARACHI, PAKISTAN: A CROSS-SECTIONAL STUDY

Sabeen Hashmat Qazi[1], Humaira Sharif [1*], Javeria Raza[2,3], Durr-e-Sameen[2]

ABSTRACT

Objective: This study aimed to assess the prevalence of stress, anxiety, and depression among medical students and faculty members in Karachi, Pakistan during the COVID-19 pandemic, and to explore how these psychological outcomes were associated with selected demographic factors.

Methods: A cross-sectional study was conducted between July 2021 and April 2022 using a convenient sampling method. Participants from several medical colleges in Karachi were invited to complete an online questionnaire distributed through Google Forms. The survey collected demographic information and incorporated three validated scales: Perceived Stress Scale (PSS-10) for stress, the Generalized Anxiety Disorder Scale (GAD-7) for anxiety, and the Patient Health Questionnaire (PHQ-9) for depression. Data analysis was performed using SPSS version 25.0.

Results: Three hundred complete responses were included. A substantial level of psychological distress was observed, with 78.0% reporting moderate-to-high stress, 58.3% showing moderate-to-severe anxiety, and 49.7% experiencing moderate-to-severe depression. Medical students reported significantly higher anxiety ($p < 0.05$) and depression ($p < 0.05$) compared to faculty members. Multivariable analysis revealed that being female; having student status, experiencing dissatisfaction with academic progress, and losing a close relative or friend to COVID-19 were significantly associated with higher psychological distress levels.

Conclusion: The COVID-19 pandemic contributed to significant emotional and psychological strain within the medical academic community in Karachi, particularly among students. These outcomes likely reflect academic disruption, limited clinical exposure, and pandemic-related grief. There is a clear need for structured mental health support systems, proactive counseling services, and institutional stress-management interventions to protect the well-being of students and faculty.

Keywords: COVID-19, Psychological Impact, Mental Health, Medical Students, Medical Faculty, Stress, Anxiety, Depression, Pakistan.

Cite this article as: Qazi SH, Sharif H, Raza J, Sameen D. The Psychological Impact of the COVID-19 Pandemic on Faculty and Medical College Students in Karachi, Pakistan: A Cross-Sectional Study. Baqai J Health Sci. 2025;26(2): 41 -50

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INTRODUCTION

The global pandemic was triggered by the identification of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) in late 2019, declared by the World Health Organization (WHO) on March 11, 2020 [1]. While the immediate global response was rightly focused on understanding the virology, transmission, and clinical management of the disease to mitigate its physical health consequences, a parallel and equally devastating crisis began to unfold regarding mental health on a global scale. The imposition of lockdowns, social isolation, and a shift to remote learning created an environment of uncertainty and fear, significantly affecting the educational sector [2]. The strategies employed to contain the virus, including nationwide lockdowns, social distancing mandates, and travel restrictions, while necessary, created an environment of profound uncertainty, isolation, and fear, disrupting the very fabric of societal and economic functioning . The educational sector worldwide faced an unprecedented challenge, with institutions shuttered and an abrupt, unplanned transition to remote learning [4].

Within this complex and challenging environment, medical education stands out as a particularly critical and high-pressure system. Medical students and faculty are already recognized as populations vulnerable to psychological morbidity due to the inherently demanding nature of their profession and training, characterized by intense academic pressure, chronic sleep deprivation, and a highly competitive environment . The pandemic acted as a potent multiplier of these pre-existing stressors. For medical students, the closure of universities and teaching hospitals meant not just a shift to online lectures, but a critical deprivation of hands-on clinical experience, practical skill development, and patient interaction, the cornerstones of medical training [7]. This led to significant anxiety about academic progression, competency development, and future career prospects, compounded by the anxieties of contracting the virus themselves or transmitting it to family members [8].

For faculty members, the challenge was twofold.

Firstly, they faced the same personal fears and uncertainties as the general population. Secondly, they were tasked with the monumental duty of rapidly adapting curricula designed for in-person, hands-on learning to a remote format, often without adequate training, technical resources, or institutional support [9]. This transition demanded immense effort, innovation, and resilience, all while managing their own psychological response to the pandemic and, in many cases, juggling increased family responsibilities at home due to lockdowns [10].

A growing body of international literature has documented the severe psychological impact of the pandemic on medical students. Studies from Jordan, Turkey, Japan, and the United States have consistently reported elevated rates of anxiety, depression, and stress within this demographic [11-14]. Similarly, research within Pakistan has begun to illuminate this issue. Studies have reported heightened psychological distress among university students in general [15], and among medical students in specific regions like Punjab [15]. Research focusing on final-year medical students [16] and dental students in Pakistan has further highlighted the acute anxiety related to disrupted academics and future uncertainties.

However, a critical gap in the existing literature remains. While students have been the focus of several studies however, the faculty members who are the pillars of the medical education system have been comparatively overlooked. Furthermore, many studies focus on a single psychological parameter or a specific sub-group (e.g., final-year students). There is a lack of thorough investigation that assesses the trio of stress, anxiety, and depression collectively across the entire medical and academic community encompassing both students across all years and faculty members within a defined metropolitan context.

Karachi, as Pakistan's most populous city and a major epicenter of the COVID-19 pandemic in the country, presents a critical setting for such an investigation. Therefore, this study aims to fill this

knowledge gap by assessing the prevalence and severity of stress, anxiety, and depression among both medical students and faculty members across various medical colleges in Karachi. The outcomes of this research may offer foundational evidence to inform institutional policies, design targeted mental health support programs, and develop effective crisis intervention strategies to safeguard the well-being of those who are entrusted with the nation's future healthcare.

METHODOLOGY:

This study investigation was carried out using a cross-sectional, convenient framework over ten months (July 2021 - April 2022) across multiple medical and dental colleges in Karachi, Pakistan. Sample size was calculated using OpenEpi online calculator which was found to be 319. The target population included both faculty members (teaching MBBS, BDS, Pharm D, or DPT programs) and students enrolled in MBBS/BDS programs. Participants were invited to participate via online platforms (WhatsApp, Facebook) and through paper-based forms distributed in person. A structured questionnaire was administered in English via Google Forms. It comprised four sections: A digital consent form was presented first. Age, gender, and marital status, vaccination status, occupation (student/faculty), academic year, designation, living situation, family dynamics, lifestyle habits (sleep, exercise, internet use, smoking), and personal exposure to COVID-19 (illness or death in family/friends).

A 10-item scale measuring perceived stress over the previous month. Scores range from 0-40, categorized as low (0-13), moderate (14-26), or high (27-40) stress (Reis *et al.*, 2010). Furthermore, a 7-item scale screening for anxiety over the last two weeks. Scores range from 0-21, categorized as minimal (0-4), -- mild (5-9), moderate (10-14), or severe (15-21) anxiety. A 9-item scale assessing depression over the last two weeks. Scores range from 0-27, categorized as minimal (0-4), mild (5-9), moderate

(10-14), moderately severe (15-19), or severe (20-27) depression [17].

Ethical approval was obtained from Jinnah Medical and Dental College. Participation was voluntary, anonymous, and informed consent was obtained from all participants at the beginning of the online survey.

Statistical Package for the Social Sciences (IBM SPSS) Version 25.0 was utilized for all analyses. Continuous variables are expressed as mean ± standard deviation, and categorical variables are described using number (n) and percentage (%). The Chi-square test was used to determine associations between categorical demographic variables and the categorized outcomes of stress, anxiety, and depression. A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1 summarizes the demographic profile of the participants. Marital status differed significantly between faculty and students (p < 0.0001); most faculty members were married (72.5%, n=116), whereas the majority of students were single (97.1%, n=136). COVID-19 vaccination status also showed a significant difference (p = 0.003), with 98.8% (n=158) of faculty vaccinated compared with 91.4% (n=128) of students. Living arrangements varied markedly between the groups (p < 0.0001): 67.5% (n=108) of faculty lived with their spouse, while 90.7% (n=127) of students lived with their parents. Family structure also differed significantly (p = 0.014), with nuclear families reported more frequently among students (75.7%, n=106) than faculty (62.5%, n=100). Additionally, faculty members more commonly belonged to smaller households of fewer than five members (63.7%, n=102) compared with students (47.1%, n=66), a difference that was statistically significant (p = 0.004)

Table-01: Demographic Characteristics of Participants

Demographic Variable		Faculty (N=160)	Students (N=140)	p-value
Marital Status	Single	41 (25.6%)	136 (97.1%)	<0.0001
	Married	116 (72.5%)	4 (2.9%)	
	Divorced	3 (1.9%)	0 (0%)	
Vaccinated against Covid-19	Yes	158 (98.8%)	128 (91.4%)	0.003
	No	2 (1.3%)	12 (8.6%)	
Living Situation	Alone	8 (5.0%)	10 (7.1%)	<0.0001
	With Spouse	108 (67.5%)	3 (2.1%)	
	With Parents	44 (27.5%)	127 (90.7%)	
Family Type	Nuclear	100 (62.5%)	106 (75.7%)	0.014
	Joint	60 (37.5%)	34 (24.3%)	
Number of Family Members	< 5	102 (63.7%)	66 (47.1%)	0.004
	> 5	58 (36.3%)	74 (52.9%)	

The internet browsing habits of faculty and students showed distinct patterns (Figure 1a & 1b). Among faculty members, the most common duration was 5-6 hours per day. In contrast, medical students reported 2-4 hours per day as their most frequent browsing duration. A significant portion of both groups engaged in extended internet use, with a combined 46.4% of faculty and 36.4% of students browsing for 5 hours or more daily.

Internet Browsing Duration Among Faculty Members

Legend:
- < 2 hours
- 2-4 hours
- 5-6 hours
- > 6 hours
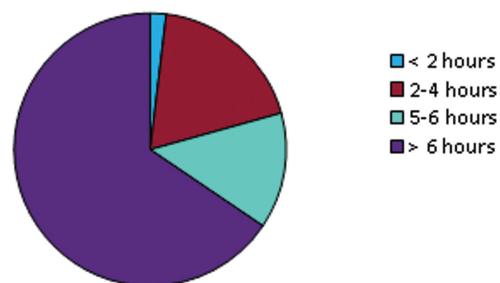
Figure-1(a) Internet Browsing Duration Among Faculty Members

## Internet Browsing Duration Among Medical Students
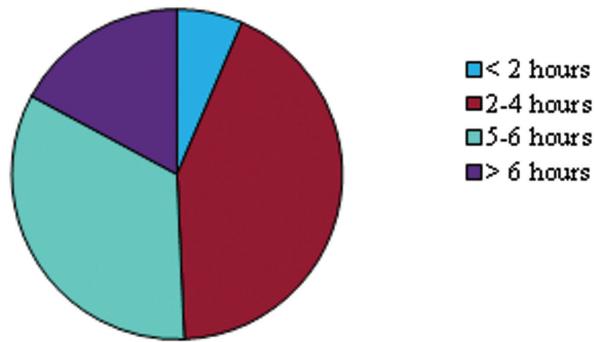
Figure-1(b) Internet Browsing Duration Among Medical Students

Both groups exhibited concerning sleep patterns, but faculty members were significantly more affected (Figure 2). An overwhelming majority of faculty (78%) reported getting less than 7 hours of sleep per night. This was notably higher than the already high percentage of students (65.7%) in the same category. Adequate sleep (7-9 hours) was reported by only 20% of faculty compared to 32.9% of students. Prolonged sleep (>9 hours) was rare in both groups.
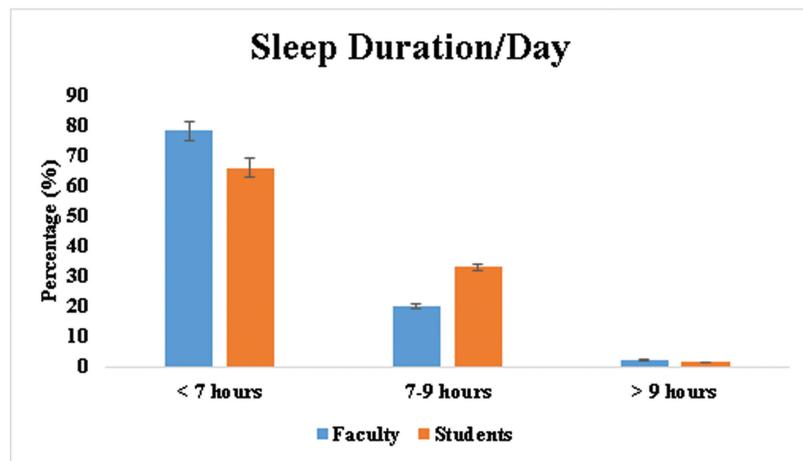
Figure-2: Sleep Duration Among Faculty Members & Medical Students

Table-2 highlighted a significant pandemic impact on health behaviors and mental health risks of academic community. Faculty members reported a higher prevalence of smoking and were more likely to have experienced the loss of a family member or friend to COVID-19 compared to students. Both groups showed high levels of sleep dissatisfaction and COVID-19 exposure in their social circles, though direct bereavement was more common among faculty.

Table-2: Impact of Lifestyle Factors and COVID-19 Exposure Among Faculty and Medical Students

Variable	Category	Faculty (N=160)	Students (N=140)	p-value
Sleep Satisfaction	Yes	50 (31.3%)	56 (40.0%)	0.114
	No	110 (68.8%)	84 (60.0%)	
Smoking Status	Yes	38 (23.8%)	7 (5.0%)	<0.0001
	No	122 (76.3%)	133 (95.0%)	
Relative/Acquaintance had COVID-19	Yes	140 (87.5%)	106 (75.7%)	0.008
	No	20 (12.5%)	34 (24.3%)	
Family Member/Friend Died from COVID-19	Yes	103 (64.4%)	44 (31.4%)	<0.0001
	No	57 (35.6%)	96 (68.6%)	

Stress (PSS-10): 78.0% (n=234) of participants reported moderate to high levels of stress. Anxiety (GAD-7): 58.3% (n=175) of participants reported moderate to severe anxiety. Depression (PHQ-9): 49.7% (n=149) of participants reported moderate to severe depression (table 3).

Table-03: Prevalence of Psychological Morbidity

Condition	Severity	Frequency (n)	Percentage (%)
Stress	Low (0-13)	66	22.0
	Moderate (14-26)	154	51.3
	High (27-40)	80	26.7
Anxiety	Minimal (0-4)	125	41.7
	Mild (5-9)	72	24.0
	Moderate (10-14)	63	21.0
	Severe (15-21)	40	13.3
Depression	Minimal (0-4)	151	50.3
	Mild (5-9)	62	20.7
	Moderate (10-14)	45	15.0
	Moderately Severe (15-19)	30	10.0
	Severe (20-27)	12	4.0

Statistical analysis revealed several significant associations between demographic factors when p<0.05. Medical students reported significantly higher rates of moderate-to-severe anxiety (67.1% vs. 50.6% in faculty, p<0.01) and depression (57.9% vs. 42.5% in faculty, p<0.01). Females reported higher levels of moderate-to-severe stress (82.1% vs. 70.5% in males, p<0.05). Participants who were

dissatisfied with their academic progress showed significantly higher rates of stress, anxiety, and depression (p<0.001 for all). Those who lost a family member or friend to COVID-19 had significantly higher rates of depression (p<0.05).

DISCUSSION:

The present study reveals a profoundly alarming prevalence of psychological distress among the medical academic community in Karachi during the COVID-19 pandemic. Our findings indicate that a staggering 78.0% of participants reported moderate-to-high levels of stress, 58.3% reported moderate-to-severe anxiety, and nearly half (49.7%) reported moderate-to-severe depression. These figures are substantially higher than those reported in pre-pandemic studies of similar populations , unequivocally demonstrating that the pandemic served as a significant catalyst for a severe mental health crisis within this group.

The significantly higher levels of anxiety and depression observed among medical students compared to faculty members are a pivotal finding of this study. This disparity aligns with research conducted in Lahore, which found clinical-year students to be particularly susceptible to these morbidities [18] and with international studies [19,20]. This can be attributed to the distinctive combination of stressors, faced via students. Beyond the generic fears of the virus, their academic and professional futures were thrown into disarray. The loss of clinical rotations, a cornerstone of medical training, led to anxieties about skill degradation and unpreparedness for future responsibilities as doctors, a concern echoed in a UK study [21]. Furthermore, the challenges of remote learning, including technological barriers, diminished peer interaction, and the perceived inadequacy of online instruction for a practice-based field, created a prevailing sense of academic dissatisfaction, which our analysis confirmed as a strong predictor of poor mental health.

Despite demonstrating more favorable mental health outcomes than their student counterparts, faculty members nonetheless reported a clinically significant prevalence of psychological distress. The etiologies of their distress, however, were distinctly occupational. The precipitous transition to remote instruction necessitated a rapid adaptation of pedagogical methods, acquisition of technical proficiencies, and navigation of eroded work-life boundaries as domestic and professional spaces merged [22,23]. This responsibility to maintain educational continuity, frequently while managing personal pandemic-related anxieties and potential bereavement, constituted a substantial cognitive and emotional burden.

The data reveals a severe public health issue, with sleep deprivation alarmingly prevalent among both groups but critically higher in faculty (78% vs. 65.7% of students getting <7 hours), a finding consistent with global reports of eroded work-life boundaries during the pandemic [24]. This deficit is directly linked to the pandemic's disruption, where for faculty, prolonged digital work hours and high cognitive load from the sudden shift to online teaching led to increased stress and screen time, a phenomenon extensively documented as a key driver of sleep disturbances [25]. For students, academic stress and the screen-based nature of remote learning disrupted natural sleep patterns, a correlation strongly supported by studies linking excessive screen time to delayed melatonin production and poor sleep quality [26]. These factors intertwine in a vicious cycle: a high workload demands more time online, which increases stress, leading to poorer sleep quality, which in turn reduces cognitive function and productivity, creating a need to work even longer hours to compensate [26]. This cycle has dire implications, as chronic sleep deprivation is a well-established risk factor for the burnout, anxiety, depression, and stress measured in this study, ultimately impairing the cognitive function and emotional regulation essential for both effective teaching and learning.

The association between female gender and higher stress levels is consistent with the broader global literature on mental health, which consistently shows women reporting higher levels of psychological

distress. This could be influenced by a complex interplay of biological, socio-cultural, and psychosocial factors, including a greater tendency to internalize stress and to report symptoms. Furthermore, the finding that personal bereavement (loss of a family member or friend to COVID-19) was significantly linked to higher rates of depression underscores the direct traumatic impact of the virus. It highlights that beyond the anxieties of the pandemic, the experience of actual loss was a profound driver of psychological morbidity, adding a layer of grief to an already stressful situation [27].

The near-universal vaccination rate (95.3%) among participants is a positive finding, reflecting the high level of health awareness and access within this community. However, it also starkly illustrates that even high levels of biomedical protection could not shield individuals from the pervasive psychological repercussions of the pandemic environment. It is one of the first in Pakistan to simultaneously investigate all three core dimensions of psychological distress i.e., stress, anxiety, and depression in both medical students and faculty using validated, internationally recognized instruments (PSS-10, GAD-7 and PHQ-9). The adequate sample size and high response rate enhance the reliability of the findings.

CONCLUSION:

The COVID-19 pandemic contributed to significant emotional and psychological strain within the medical academic community in Karachi, particularly among students. These outcomes likely reflect academic disruption, limited clinical exposure, and pandemic-related grief. There is a clear need for structured mental health support systems, proactive counseling services, and institutional stress-management interventions to protect the well-being of students and faculty.

Future prospects: Future research should employ longitudinal designs to track the long-term mental health outcomes of this population and to quantitatively assess the effectiveness of the mental health interventions implemented in response to these findings in order to ensure that mental well-being of medical students and faculty is not just an ethical concern, it is fundamental for building a skilled, adaptable, and sustainable healthcare workforce in Pakistan.

Recommendations: Present study recommends that medical colleges:

l   Integrate mandatory mental health screening using validated tools like the PHQ-9 and GAD-7 into student and faculty health services.
l   Establish and promote accessible, confidential, and free counseling services within institutions.
l   Develop and implement wellness programs and workshops focused on building resilience, stress management, and coping strategies.
l   Foster a supportive academic environment that acknowledges these challenges and provides flexibility and support.

Conflict of Interest: There is no conflict of interest.
Acknowledgment: None.
Funding Source: None
Author's Contribution:

SHQ: Concept & design, manuscript writing, responsible for integrity of research.
HS: Editing of manuscript, review and final approval of manuscript
JR: Data collection, manuscript writing and statistical analysis
DS: Data collection and manuscript writing

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CASE REPORT

CARDIAC TAMPONADE: A CASE REPORT

Neelam Javed[1]

ABSTRACT

Abstract: Cardiac Tamponade is a medical or traumatic emergency that occurs when the pericardial sac fills with enough fluid to compress the heart, resulting in shock and reduced cardiac output. It is a rare, but life-threatening condition. During 13 years, 66,812 invasive cardiac procedures were documented, with 118 of those procedures involving CT complications, and the rate of iatrogenic cardiac tamponade was 0.176% of all the procedures. The incidence of pericardial effusions is thought to occur in about two cases out of every 10,000 people. Patients with HIV, end-stage renal illness, occult malignancies, tuberculosis, autoimmune diseases such as lupus, or penetrating traumatic injuries to the chest have higher prevalences. This case was about 59 years old female patient who presented in the Aga Khan University Hospital with the complaint of Iatrogenic LAD perforation after undergoing Percutaneous Coronary Intervention at a tertiary care charitable hospital. The diagnosis in the case scenario is Cardiac Tamponade.

Keywords: Cardiac Tamponade, Iatrogenic LAD perforation, Percutaneous Coronary Intervention

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INTRODUCTION

Cardiac Tamponade (CT) is a medical or traumatic emergency that occurs when the pericardial sac fills with enough fluid to compress the heart, resulting in shock and reduced cardiac output [1]. It is caused by the gradual buildup of pericardial fluid (effusion), blood, pus, or air in the pericardium that compresses the heart chambers and can result in hemodynamic compromise, circulatory shock, cardiac arrest, and death [2]. Cardiac Tamponade is a rare, but life-threatening condition. During 13 years, 66,812 invasive cardiac procedures were documented, with 118 of those procedures involving CT complications and the rate of iatrogenic cardiac tamponade was 0.176% of all the procedures. The incidence of

certain invasive cardiac procedures varied from

0.09% to 1.42%. Most patients (104/118) underwent pericardiocentesis, up to 16 patients underwent pericardiotomy, and four underwent both treatments. 25–45% of patients required inotropes and 45% required blood transfusions [3].

The incidence of pericardial effusions is thought to occur in about two cases out of every 10,000 people. Patients with HIV, end-stage renal illness, occult malignancies, tuberculosis, autoimmune diseases such as lupus, or penetrating traumatic injuries to the chest have higher prevalences. The heart's chambers are compressed when the fluid volume accumulates quickly enough, and tamponade physiology quickly emerges with much smaller volumes. The fluid could be serosanguineous, chylous, or hemorrhagic. The underlying pathophysiology causing cardiac tamponade is reduced diastolic filling, which results in a lower cardiac output. To compensate for the decreased output, tachycardia is one of the earliest

compensatory symptoms. Additionally, the compression restricts systemic venous return, which hinders the filling ability of the right atrium and ventricle [1]. Here, I present a relatively rare case of a female patient diagnosed with cardiac tamponade presented with Iatrogenic LAD perforation after undergoing Percutaneous coronary intervention (PCI) at a tertiary care charitable hospital.

CASE SCENARIO

A 59-year-old female patient came to the Emergency department with a history of angina pectoris and dyspnea for the last twenty days. She had known case of hypertension for the last ten years. However, she had a negative family history of cardiac diseases. The patient had typical central chest pain and SOB on exertion 20 days ago for which she went to the hospital in Quetta where Angiography revealed 2-vessel coronary artery disease [mid-LAD 100% occluded Chronic Total Occlusion (CTO); mid diffuse RCA severe lesion] then she came to Karachi for further management. She went to one of the Cardiac specialized hospitals in Karachi where Coronary Artery Bypass Grafting (CABG) surgery was advised then she went to the tertiary care charitable hospital where she underwent angioplasty resulting in perforation of the left anterior descending (LAD) coronary artery then antidote for heparin, Protamine was given, 20cc blood was aspirated via pericardiocentesis, multiple fluid boluses were given, and kept on inotropic support, but a patient left against medical advice (LAMA) from that hospital and came to the emergency department of one of the tertiary care hospitals of Karachi on 21/11/2024. Upon workup, the patient was diagnosed with 2-vessel coronary artery disease and iatrogenic LAD perforation. The patient was shifted from the Emergency department to the Coronary Care Unit (CCU) for further management. After standard pre-operative optimization and preparation, the patient was shifted to the operating room where she underwent CABG × 2 (LIMA to LAD; RSVG to PDA) on 26/11/2024. Intra-operative findings included hematoma surrounding the mid-LAD. However, no active bleeding was reported from the LAD. Chest tubes and pacing wires were placed.

Post-operatively, the patient was kept on inotropic support and was shifted to the CICU in a vitally stable condition. The patient was successfully extubated on the same day. The patient was then shifted to the Step-down unit on 29/11/2024. Chest tubes and pacing wires were removed and no complications were noted. She was then shifted out to a Telemetry ward bed on 02/12/2024. The patient remained hemodynamically stable and was discharged home on 06/12/2024.

CLINICAL PRESENTATION AND PHYSICAL EXAMINATION FINDINGS

Upon arrival, her vital signs were as follows: blood pressure was 144/68mmHg, heart rate was 82 per minute, respiratory rate was 19 per minute, oxygen saturation was 94%, and she was afebrile. The patient's Glasgow Coma Scale was 15/15, alert, and oriented to time, place, and person. During physical assessment, no apparent pallor, jaundice, edema, cyanosis, clubbing, or lymphadenopathy were observed. On cardiovascular assessment, S1+S2+0 with no added sounds on auscultation. The apex beat was palpable. The chest was clear on respiratory assessment, and there was normal vesicular breathing. The abdomen was soft and non-tender with no visceromegaly. During the review of the system (ROS), no significant finding was noted in any other system.

LABORATORY AND DIAGNOSTIC TEST FINDINGS WITH RATIONALE

Based on the symptoms, there are several diagnostic tests to rule out cardiac tamponade and its associated risk factors. It includes Electrocardiography (ECG) to check for electrical alternans and sinus tachycardia, Echocardiography to confirm the diagnosis, the presence of pericardial effusion and its size, and to check the cardiac function. Chest X-ray or CT chest to rule out an enlarged heart or to pick pericardial effusion. Angiography or Cardiac catheterization to rule out obstructions in coronary arteries. Moreover, multiple blood tests include CBC to rule out infection by WBC and other leukocytes and to check blood loss by hemoglobin. HIV testing due to risk factors in HIV positive patients in causing cardiac

tamponade. ESR, procalcitonin, and C-reactive protein to rule out underlying infection. BUN and Creatinine to check for the Kidney function due to the cardiac disease. Electrolytes to check for electrolyte imbalance due to cardiac disease or ECG changes and volume loss. Trop-I to check for heart damage due to the angina pectoris. Coagulation profile due to blood loss. Tables 1 and 2 present a summary of the diagnostic and laboratory investigations of the patient.

Table 1. Summary of Diagnostic Investigations of the Patient

Diagnostic tests	Results
Electrocardiogram (ECG)	Atrial Fibrillation
Echocardiogram (ECHO)	Ejection Fraction: 35% Mild basal septal hypertrophy Moderately reduced left ventricular systolic function Grade I left ventricular diastolic dysfunction Trace to mild (predominantly anteriorly located) pericardial effusion without echocardiographic evidence of cardiac tamponade. Akinetic apex, mid-septal, basal lateral, and basal mid-posterior segment.
Angiography (LHC)	Left main artery (LM): Normal LAD: Total mid occlusion Circumflex: mild irregularities RCA: Severe diffuse stenosis Impression: 2-vessel coronary artery disease (2VCAD)
Chest X-ray	Evidence of developing edema but cardiac silhouette intact.

Table 2. Summary of Laboratory Investigations of the Patient

Labs	Results	Labs	Results
Trop I	1162 ng/L ↑	HB	10.5 g/dl ↓
Mg	2.1 mg/dl	HCT	33.5% ↓
BUN	17 mg/dl	WBC	19.7 ×10E9/L ↑
Cr	1.1 mg/dl	Neutrophils	89.5% ↑
Na	132 mmol/L ↓	Lymphocytes	7.0% ↓
K	3.6 mmol/L	Eosinophils	0.0% ↓
Cl	104 mmol/L	Monocytes	3.4% ↓
BIC	23.8 mmol/L	PLT	352 ×10E9/L
Ionized Calcium	4.51 mg/dl ↓	PT	11.8 seconds
INR	1.1 ratio	APTT	22.7 seconds ↓
Lactic acid	3.1 mmol/l ↑	Procalcitonin	1.99 ng/mL ↑
C-reactive protein	13.70 mg/L ↑	Blood Culture	No growth
Urine Culture	No growth	Calcium	7.9 mg/dl ↓

Arterial Blood Gas (ABGs) of the patient

Initial ABGs were sent and the results were suggestive of primary respiratory alkalosis with partial metabolic compensation as presented in Table 3.

Table 3. Arterial Blood Gas result of the patient

PH	7.46 ↑	PO2	63.60 mmHg ↓
PCO2	26.80 mmHg ↓	O2 Sat	93.10% ↓
BIC	18.60 mEq/L ↓	BE	-3.5 mEq/L

DIFFERENTIAL DIAGNOSIS FOR CARDIAC TAMPONADE WITH RATIONALE

- Cardiogenic Shock or Hypovolemic Shock is due to hemodynamic instability due to volume loss.
- Acute Myocardial Infarction is due to the 2VCAD on LHC, elevated Trop I in blood, and chest pain.
- Pulmonary Embolism is due to dyspnea and chest x-ray findings of edema.
- Constrictive Pericarditis is due to the pericardial effusion on the echocardiogram.
- Heart Failure is due to the low ejection fraction of 35%.
- Tension Pneumothorax or Hemothorax is due to the accumulation of air or blood in the pericardium or chest.

MANAGEMENT OF THE CARDIAC TAMPONADE

Cardiac tamponade can be treated by removing the pericardial fluid to help reduce the pressure around the heart. Needle pericardiocentesis can be performed at the patient's bedside to accomplish this. One surgical method is to remove the pericardium or create a pericardial window. In traumatic arrests with suspected or confirmed cardiac tamponade, emergency department resuscitation thoracotomy and pericardial sac opening are two possible treatments. Pressor support and volume resuscitation may be beneficial [1].

PHARMACOLOGICAL THERAPY

Several medications were used to treat the patient's condition. Below are the lists of medications given at the time of discharge.

- Aspirin 150mg PO QD
- Clopidogrel 75mg PO QD
- Calcium with Vitamin D 1 Tablet CHEW QD
- Ipratropium Bromide 500mcg Nebs q6hrly
- Fluoxetine HCl 20mg PO QD
- Lipiget 40mg PO HS
- Ispaghol 1 GRM PO Bid
- Movcol Sachet 1 SAC PO Bid
- Perindopril 1mg PO HS
- Cefixime 400mg PO QD
- Tramadol 50mg PO q8hrly
- Paracetamol 1000mg PO q6hrly
- Metoprolol 37.5mg PO q8hrly
- Furosemide 40mg PO BD
- Apixaban 2.5mg PO Bid
- Pantoprazole 40mg PO BBF
- Metoclopramide HCL 10mg PO q8hrly
- Amiodarone 200mg PO q8hrly

DISCUSSION

This case emphasizes a rare but potentially life-threatening complication of angioplasty, that is, iatrogenic left anterior descending (LAD) coronary artery perforation resulting in cardiac tamponade. Even though they are rare, these complications highlight how crucial it is to be vigilant, prepared, and competent when doing invasive cardiology procedures. Unintentional injury to the arterial wall during interventional procedures might result in iatrogenic coronary artery perforation. There are complications associated with coronary interventions. Myocardial infarction, cerebrovascular accidents, arrhythmias, vascular problems, allergic reactions to contrast, heart chamber perforations, and death are among them [4]. It has been reported that the most common injured artery was the LAD artery. Stent placement, angioplasty guiding wires, and balloon

dilations were the causes of perforations [5].

The symptoms of cardiac tamponade, such as tachycardia, hypotension, and high jugular venous pressure, might be mistaken for those of other acute illnesses including pulmonary embolism or myocardial infarction. The diagnosis in this case is confirmed by a bedside echocardiogram, which showed a large pericardial effusion along with the diastolic collapse of the right atrium and ventricle [1]. The management of iatrogenic LAD perforation and tamponade requires a multidisciplinary approach and immediate action. In this case, upon early recognition of the hemodynamic instability and LAD perforation, a central venous catheter (CVC) and arterial line were inserted and fluid resuscitation and inotropic support were given to a patient to maintain volume in the body due to fluid loss by LAD perforation. Moreover, blood was also aspirated via pericardiocentesis, and Protamine was also given to reverse the effect of Heparin. The patient's hemodynamic recovery was made possible by the subsequent care of artery perforation, which included localized balloon inflation, anticoagulation reversal to encourage closure by hemostasis at the injury site, and the immediate insertion of a pericardial drain to remove pericardial effusion [4].

Careful planning and adherence to best practices are the first steps in preventing iatrogenic complications. Having a well-trained team and emergency protocols in place ensures prompt response to complications, and the selection of appropriate guidewires, balloons, and stents based on the patient's anatomy and lesion characteristics is essential. In this case, the successful outcome emphasizes the importance of early diagnosis and the availability of interventional competencies.

CONCLUSION

This case highlights the importance of early recognition, timely intervention, and specialized cardiac care for successful management. Hospitals performing high-risk interventions should implement protocols for the prompt management of cardiac tamponade, such as access to pericardiocentesis kits, covered stents, and surgical backup. Additionally, ongoing education and awareness among interventional cardiology teams are crucial for enhancing patient safety.

Conflict of Interest: There is no conflict of interest.

Author's Contribution:
NJ: Concept & design, writing, final approval of manuscript and responsible for accuracy and integrity of research

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DUPLICATE PUBLICATION

Multiple publication - that is, the publication more than once of the same study, irrespective of whether the wording is the same - is rarely justified. Secondary publication in another language is one possible justification, provided the following conditions are met.

* The editors of both journals concerned are fully informed; the editor concerned with secondary publication should have a photocopy, reprint or manuscript of the primary version.

* The priority of the primary publication is respected by a publication interval of at least 2 weeks.

* The paper for secondary publication is written for a different group of readers and is not simply a translated version of the primary paper; an abbreviated version will often be sufficient.

* The secondary version reflects faithfully the data and interpretations of the primary version.

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ACKNOWLEDGMENT TO REVIEWERS

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