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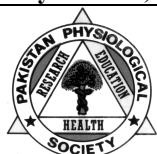
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Email: nkoibuch@gunma-u.ac.jp

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Email: tyar@iau.edu.sa

Youseef Hatem, (Lebanon)
Email: hatem.youssef@bau.edu.lb

NATIONAL (ORGANIZATIONAL)

Farmanullah Wazir
Email: drfarmanwazir@hotmail.com

Hamid Javed Qureshi
Email: hj.qureshi@yahoo.com

Idrees Farooq Butt
Email: idreesfb@yahoo.com

Masood Anwar Qureshi
Email: maqureshi_78666@hotmail.com

Muhammad Abdul Azeem
Email: azenmu@gmail.com

Muhammad Hamayun Ikram
Email: hamayunikram@gmail.com

Mumtaz Ali Memon
Email: prof_mumtaz@hotmail.co.uk

Saadat Ali Khan
Email: sasaali3y@gmail.com

Shahnaz Javed Khan
Email: shehnazjkhani1@gmail.com

Tehseen Iqbal
Email: prof.tehseeniqbal@gmail.com

NATIONAL (EXTRA-ORGANIZATIONAL)

Abdul Khaliq Naveed
Email: khaliqnaveed2001@yahoo.com

Akhtar Sherin
Email: akhtarsherin@yahoo.com

Farooq Azam Rathore
Email: farooqrathore@gmail.com

Jamshaid Akhtar
Email: jamjim88@yahoo.com

Junaid Sarfraz Khan
Email: junaidsarfraz@hotmail.com

Khadija Qamar
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Email: mirfan78@yahoo.com

Saba Sohail
Email: drsabasohail@hotmail.com

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Shaukat Ali Jawaid
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EDITORIAL

IN QUEST OF A UNIVERSAL DONOR BLOOD FOR TRANSFUSION

Tehseen Iqbal

Department of Physiology, CMH Multan Institute of Medical Sciences, Multan Cantt., Pakistan

Long ago, man noticed the relationship of blood with vitality and vigour of animals and humans. Early scientists, before the knowledge of blood groups, attempted transfusion of animal blood to humans but with discouraging results. Now, modern transfusion services are an integral part of all national healthcare services. The major problems faced by the transfusion services are to match donated blood with the patient's blood and maintaining a voluntary donors' list for continuous supply of donated blood. Considering these problems, scientists are searching for a universal donor blood by attempting to remove A and B antigens from the donated blood and also trying to manufacture artificial or altered red blood cells having no antigens. Removing a terminal sugar from antigen A or B by using enzymes glycosidases are now possible. Some studies to form new red blood cells having no antigens have also become successful. Scientists used haemoglobin removed from expired blood and packed it in new envelopes, artificial red blood cells, which have no blood group antigens. Successful research results and ongoing clinical trials give us hope that a universal donor blood will be available in near future.

Keywords: Artificial red blood cells, Blood group antigens, universal donor blood group

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Many thousand years ago, man noticed the relationship of blood with vitality and vigour of animals and humans. Humans observed that when animals were wounded and sufficient amount of blood was lost, animals die or can be captured and so they developed sharp-edged weapons for hunting and wars. The earliest reported 'successful' attempts of transfusing lamb blood to humans were reported by Jean-Baptiste Denis in France and Richard Lower in England separately in 1667 but transfusing the blood of animals to humans became prohibited by law because of severe reactions. After the discovery of ABO and Rh blood group systems, human blood transfusions became safe on a large scale.¹

With many other developments in blood collection, blood storage and transportation, modern transfusion services are now an integral part of all national healthcare services. Currently, blood transfusions are facing two important problems: matching of the available human blood for transfusion as antigens on red blood cells may cause serious reactions; a continuous supply of human blood. The continuous recruitment and retention of healthy blood donors is essential for blood banks.

Three genes control the expression of the ABO antigens: H, ABO, and Se genes. The H gene codes for the production of an enzyme transferase that attaches L-fucose to the already present RBC membrane-anchored oligosaccharide chain. If no A or B gene or enzyme is present, the H specificity remains, and the individual is of blood group O. In the presence of the A gene-encoded transferase, N-acetyl-galactosamine is attached with the terminal galactose, which forms 'A' blood group. In the presence of the B gene-encoded transferase, galactose is added to the terminal galactose and it confers 'B' specificity. If A and B genes or

transferases are both present, the same RBC has both types of terminal carbohydrates, i.e., N-acetyl-galactosamine and galactose, and 'AB' is the blood type. The secretor gene (Se) controls the individual's ability to secrete soluble A, B, and H antigens into body fluids and secretions.²

Blood group A and B antigens differ only by a single carbohydrate attached to the H-type oligosaccharide chain of blood group O. Blood group O is considered a universal donor type. In blood group A, terminal carbohydrate attached to the H-type oligosaccharide chain is N-acetyl-galactosamine and in blood group B, terminal carbohydrate attached to the H-type oligosaccharide chain is galactose.³ (Figure-1).

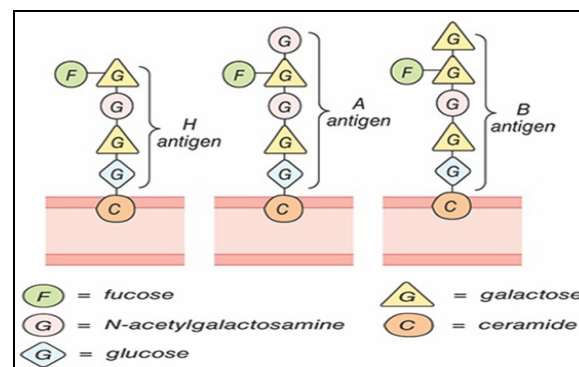


Figure-1: Chemical nature of ABO blood group antigens³

The process of converting blood group A or B to blood group O (universal donor) involves the enzymatic removal of specific antigens from the surface of red blood cells (RBCs). The conversion process relies on enzymes that cleave the terminal sugars of the A and B antigens, effectively transforming them into the H antigen, which is characteristic of blood group O.⁴

There are two techniques to convert blood group A and B type RBCs to universal O red blood cells. The first is the enzymatically converted group O (ECO) technique. The enzyme alpha-N-acetylgalactosaminidase can be used to remove N-acetyl-galactosamine, the A antigen, from RBCs. Similarly, the enzyme beta-galactosidase can be used to remove the terminal galactose, the B antigen from RBCs to transform them into O type.¹ Identification of novel bacterial glycosidases has greatly advanced the field. The second technique is antigen masking by using hydrogels, e.g., polyethylene glycol (PEGs) that binds to the surface of red blood cells. PEG is a flexible and biocompatible compound. Because of this coating the host's immune system cannot recognize coated RBCs after transfusion. These two methods are promising and have been extensively studied to help supply blood banks.⁵

To meet the current shortage of blood supplies, many approaches are being experimented. Many promising attempts to create artificial blood proved unsafe on clinical trials. By far the greatest number of research efforts have focused on manipulating the structure of haemoglobin so that it can be effectively and safely administered as a substitute for whole-blood transfusions. Some scientists attempt to synthesize chemicals that act as haemoglobin. Genetically engineered haemoglobin is also under research. One promising strategy encapsulates haemoglobin within liposomes-membrane-wrapped containers. A more recent strategy under development is a water-soluble, synthetic plastic version of haemoglobin. The newest technique being explored is using haemopoietic stem cells to "grow" a supply of transfuseable red blood cells. Synthetic O₂ Carriers are also being researched. Some researchers also attempted to increase the life of red blood cells.⁶

The researchers at the University of Maryland, School of Medicine in Baltimore extracted haemoglobin from expired blood and enclosed it in a bubble of fat, essentially creating artificial red blood cells. The scientists then freeze-dry the artificial red blood cells into a powder form which is shelf-stable for years. The powder can also be easily transported. Freeze-dried artificial blood developed in the lab can be reconstituted with water and infused when required. This artificial blood is still to be tested in clinical trials.⁷

Recent developments are reported from USA and Japan. Both of them used the same approach. The artificial blood is made from haemoglobin extracted

from expired donor blood and encased in a protective synthetic shell. At Maryland scientists developed synthetic blood called ErythroMer. ErythroMer is a powder-based product that, when mixed with water, transforms into a liquid that can deliver oxygen to tissues when transfused. The product still needs to be tested on humans.⁸ Japanese researchers have started clinical trials in March 2025, to explore the effectiveness and safety of a universal artificial blood. Their approach involves extracting haemoglobin from expired donor blood which is then encased in a protective shell to create stable, virus-free artificial red blood cells. Unlike donated blood, these artificial cells have no blood type, eliminating the need for compatibility testing and making them invaluable in emergencies. Notably, donated blood has a shelf life of just 42 days, while this artificial blood can be stored for up to two years at room temperature. The researchers are hopeful for wider clinical use by 2030.⁹ In view of ongoing research we can hope to see a universal donor blood group for transfusion to all blood types.

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Address for Correspondence:

Dr Tehseen Iqbal, Professor of Physiology, CMH Multan Institute of Medical Sciences, Multan Cantt., Pakistan.
Cell: +92-333-6144799

Email: prof.tehseeniqbal@gmail.com

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ORIGINAL ARTICLE

EFFECTS OF LONG-TERM ITOPRIDE HYDROCHLORIDE TREATMENT ON RAT PROXIMAL CONVOLUTED TUBULES AND SERUM GLUTATHIONE LEVELS

Aasma Hashmi, Hamd Binte Shahab Syed*, Muhammad Ali Rabbani**, Ayesha Irfan***, Zoha Hashmi[†]Department of Anatomy, CMH Multan Institute of Medical Sciences, Multan, *DG Khan Medical College, DG Khan, **Nishtar Medical University, Multan, ***Multan Medical and Dental College, Multan, [†]Department of Medicine, CMH, Multan, Pakistan

Background: Functional dyspepsia is a chronic gastric motility disorder marked by upper gastrointestinal symptoms; itopride hydrochloride, a prokinetic benzamide derivative acting via acetylcholinesterase and dopamine D₂ receptor inhibition, is widely used, yet evidence on its long-term systemic effects remains limited. Objective of this study was to evaluate the effects of long-term administration of itopride hydrochloride on renal histomorphology and serum glutathione levels in male Wistar albino rats. **Methods:** This laboratory-based experimental study was conducted in Anatomy Department, CMH Multan Institute of Medical Sciences, Pakistan. Sixty adult male Wistar albino rats were divided into control and experimental groups (n=30 each). Controls received distilled water, while the experimental group received itopride hydrochloride (4.4 mg/Kg) orally three times a day for 15 days. Kidneys were processed, paraffin embedded, and stained with haematoxylin and eosin. Proximal convoluted tubule (PCT) height and luminal diameter were measured using image. Serum glutathione was assessed with ELISA. Data were analyzed using Student's *t*-test. **Results:** The experimental group showed a significant reduction in PCT epithelial height and a significant increase in luminal diameter compared to controls ($p=0.001$). Serum glutathione levels were also significantly decreased in experimental groups as compared to controls ($p=0.001$). **Conclusion:** Long-term administration of itopride hydrochloride adversely affects renal tubular histomorphology and reduces serum glutathione levels in Wistar albino rats.

Keywords: Functional dyspepsia, Glutathione, Luminal diameter, Proximal convoluted tubule

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INTRODUCTION

Functional dyspepsia (FD) is a chronic disorder that is characterized by various symptoms that are related to indigestion, especially in the upper digestive tract. The sensation referred to in FD includes abnormalities in gastric motility (peristalsis). Specifically, individuals with FD may experience symptoms such as a burning sensation in the epigastrium, bloating, early satiety, postprandial fullness, and nausea.¹ One derivative of prokinetic benzamide is itopride hydrochloride. These medications have a gastropromotile effect and inhibit the acetylcholine esterase and dopamine enzymes.² Itopride can be used to treat functional dyspepsia as well as other gastrointestinal conditions such as gastroparesis (slow stomach emptying), anorexia, heartburn, bloating, regurgitation, nausea, and vomiting.

Itopride inhibits acetylcholinesterase and dopamine D₂ receptors, which raises acetylcholine concentrations. Increased acetylcholine levels promote gastric motility, speed up stomach emptiness, raise the lower oesophageal sphincter pressure, and enhance gastro-duodenal coordination.³ Itopride is rapidly and extensively absorbed when taken orally, reaching a peak in blood plasma levels in just 35 minutes.⁴ Itopride is mainly excreted by the kidneys, where its half-life is roughly six hours.⁵

Dopamine is present in significant amounts in the gastrointestinal tract, and it has many inhibitory effects on motility. It can decrease lower oesophageal sphincter pressure.⁴ Dopamine receptor antagonists are effective as prokinetic agents.⁶

Renal dopamine is produced by the cells of the proximal convoluted tubules (PCTs) and is subsequently secreted through the apical and basolateral membranes. It expresses its hormonal and local paracrine actions on distal nephron segments with the help of circulation.⁶ Dopamine signals via five known receptors. They are grouped into D₁-like (D₁ and D₅ receptors) and D₂-like (D₂, D₃, and D₄) receptors.⁷ D₃ receptors are the predominant renal D₂-like receptors and are expressed in PCTs, thick ascending limbs, and the cortical collecting duct.⁸

Dopamine is synthesized by the kidneys which is important in the regulation of renal function and blood pressure.⁸ In addition to that, dopamine controls inflammation and the generation of reactive oxygen species. Reactive oxygen species play a role in the progression of renal damage and eventually, the development of hypertension. In mice with insufficient intrarenal dopamine, there is evidence of elevated oxidative stress as well as increased indicators of tubular injury and inflammation.⁹ When there is decreased renal

dopamine production, it aggravates angiotensin-II mediated renal injury. Dopamine reduces renal Na^+ retention in the body when normal Na^+ intake occurs, counteracting the effects of the Renin-Angiotensin-Aldosterone System (RAAS).⁹ In a study in which mice were generated with selective deletion of dopamine receptors, led to increased renal injury.¹⁰

Proximal tubules rely on aerobic metabolism and have more mitochondria with a more oxidized state. If there are reduced dopamine receptors, proximal tubules become vulnerable to mitochondrial dysfunction leading to an increase in renal microvascular loss, oxidative stress, and eventually renal failure.¹¹

Glutathione is an important antioxidant. There are studies which prove the relationship between decrease serum glutathione levels and increase rate of multi morbidity development like diabetes mellitus, chronic liver injury and neurodegenerative diseases.¹² Hypoxia, DNA and mitochondrial damage and high levels of oxidative stress can lead to an imbalance either in the production of glutathione or there could be an increased consumption of this enzyme.

The effects on kidney after administration of itopride hydrochloride have a strong association with the production of reactive oxygen species (ROS). When there is an imbalance between the production of pro-inflammatory and anti-inflammatory markers, there will be an increase in the oxidative stress, and this can lead to production of ROS.

As itopride hydrochloride is also a dopamine receptor (D2) blocker, this study explores the effects of its administration on the height and luminal diameter of PCT as well as serum glutathione levels in the kidneys of Wistar albino rats.

METHODOLOGY

It was an experimental study, and the animal model used in this study was a male Wistar rat. The study was conducted at Anatomy Department, CMH Multan Institute of Medical Sciences, Multan, Pakistan from Sep 2020 to Mar 2022 after approval from the Institutional Review Board and Ethical Committee vide letter No. TW/25/CIMS.

It was a simple random sampling. A total of 60 healthy male Wistar rats, aged 13–15 weeks and weighing 200–300 grams each, were included in the study. The rats were divided into two groups. The control group, group A, received 2 mL/100 g of distilled water via oral gavage three times a day for 15 days.¹³ The experimental group, group B, received 4.4 mg/Kg of itopride hydrochloride dissolved in 2 mL/100 g body weight of distilled water via oral gavage three times a day for the 15-day period. The dose selection for Group B was based on converting the human dose of itopride to the Animal Equivalent Dose (AED) for rats, which was calculated to be 4.4 mg/Kg/dose.^{14,15}

After seven days of acclimatization period, every rat was kept in a controlled environment of a 12-hour light-dark cycle, $25 \pm 2^\circ\text{C}$ temperature, and 50–70% humidity. Water was available *ad libitum* to the rats, along with a usual pellet diet. Rats with any physical abnormalities or those older than 15 weeks were excluded from the study.

After 15 days of drug administration, all rats from both groups were sacrificed. Following euthanasia, the abdomen was opened, and the kidneys were dissected, trimmed, washed in 0.9% normal saline, and then weighed on an electrical balance. Subsequently, the organs were placed in 10% formalin for fixation. The selection of the 15-day duration for the study was after a reference articles in which itopride hydrochloride was administered for a similar period.¹⁶ The kidneys were placed in 10% formalin for 24 hours for fixation. After being cut transversely from the middle area of the right kidney, the organ was cleared in xylene and put through an escalating series of alcohol concentrations from 70 to 100%. For embedding, paraffin wax with a melting point of $56\text{--}58^\circ\text{C}$ was utilized. To let the paraffin wax solidify, the tissue was put into the mould and set over a small cooling tray. Paraffin blocks were numbered 1–30 for each group. Approximately seven microns thick sections were cut with a rotary microtome. The sections were stained with haematoxylin and eosin for light microscopy. The stained slide photographs were taken using the mobile camera installed with Adobe Photoshop Lightroom through the Olympus binocular microscope at $100\times$ oil immersion lens.

The luminal epithelium height and diameter of lumen of PCTs in the micro-meter were measured using Image J software. The SPSS-26 was used to statistically analyse the data. Student's *t*-test was applied to quantitative variables to detect any significant differences between experimental and control groups.

Blood samples were obtained by cardiac puncture after euthanizing of animals and collected in test tubes containing heparin as anticoagulant. Serum glutathione levels were measured using rat ELISA kit of Bioassay Technology Laboratory (BT LAB).

RESULTS

The rat's luminal epithelium height of proximal convoluted tubules and diameter of lumen of proximal convoluted tubules appeared to be different between control and experimental groups shown in Figure-1.

The student's *t*-test showed that the luminal epithelium height of proximal convoluted tubule of the control group was significantly higher than that of the experimental group ($p < 0.001$). The Student's *t*-test showed that the luminal diameter of proximal convoluted tubule of the experimental group was significantly higher than that of the control group ($p < 0.001$) (Table-1).

The serum glutathione levels were calculated shown in Table-2. The student's *t*-test showed that the Glutathione level of the control group was significantly higher than that of the experimental group ($p < 0.001$).

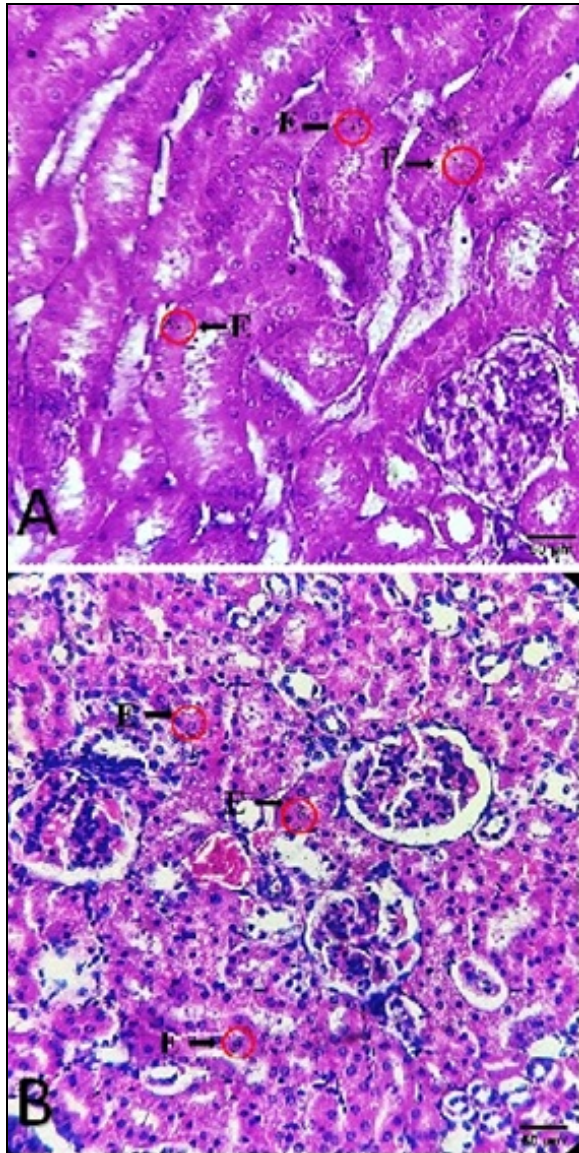


Figure-1: Photomicrograph of rat kidney showing epithelium height and luminal diameter in proximal convoluted tubules of control (A) and experimental (B) groups. (E=Epithelium, H & E stain)

Table-1: Comparison of histological variables of kidney between control and experimental groups

Variables	Mean±SD		<i>p</i>
	A (n= 30)	B (n= 30)	
Height of the Proximal Convoluted Tubule Luminal Epithelium (µm)	26.14±4.4	22.6±2.65	0.001*
Proximal Convoluted Tubule Lumen Diameter (µm)	15.53±2.69	28.09±5.43	0.001*

*Significant

Table-2: Comparison of serum glutathione levels between control (A) and experimental (B) groups

Variable	Mean±SD		<i>p</i>
	A (n=30)	B (n=30)	
Serum Glutathione (mg/L)	293.57±31.3	259.36±27.89	0.001*

*Significant

DISCUSSION

The current study evaluates the adverse effects of Itopride hydrochloride on histomorphology and biochemical analysis on kidney.

There was a statistically significant difference between control and experimental groups in the proximal convoluted tubule luminal epithelium and diameter. The luminal epithelium height of PCT of experimental group was significantly decreased as compared to control group. The diameter of the PCT lumen was considerably larger in experimental group as compared to the control group. This is in agreement with Zhang *et al*¹⁷ and Nikolić-Kokić A *et al*¹⁸.

Serum glutathione was decreased in experimental group as compared to the control and it is in agreement with other studies conducted by Nikolić-Kokić A and Chang GR *et al*.^{18,19} Our study showed that deficient D2-receptors are a main cause of mitochondrial dysfunction and lead to increase in renal microvascular loss, oxidative stress, and renal failure.¹¹

Itopride's mechanisms of action involve inhibiting dopamine and acetylcholine esterase, leading to increased acetylcholine concentrations, which promote gastric motility and enhanced coordination within the gastro-duodenal region.³ Although Itopride hydrochloride is effective in treating gastrointestinal disorders due to its prokinetic properties, it may also lead to potential adverse effects, especially concerning the renal system.⁸ As a blocker of dopamine receptors, Itopride hydrochloride affects gastrointestinal motility because dopamine is a key regulator of digestive processes. Dopamine plays a key role in managing renal function, regulating blood pressure, and controlling inflammation.⁹

Research has documented dopamine's role in decreasing motility, such as lowering the pressure of the lower oesophageal sphincter, that is why dopamine receptor antagonists are used to promote gastrointestinal movement.³ Itopride hydrochloride, by blocking dopamine receptors, could impact kidney health.

Dopamine produced in the proximal convoluted tubules of the kidneys plays a vital role in regulating renal function and blood pressure. Dopamine acts in both hormonal and local paracrine capacities on the distal parts of the nephron. It engages with various receptors, particularly D1-like (D1 and D5) and D2-like (D2, D3, and D4) receptors. Of these, D3 receptors are the most prevalent renal D2-like receptors, located in the

proximal tubules, thick ascending limbs, and the cortical collecting duct.⁷

A decrease in renal dopamine production can worsen kidney damage caused by angiotensin-II and increase oxidative stress, which may contribute to the development of hypertension. Dopamine has been shown to regulate inflammation and the production of reactive oxygen species, which play a role in the progression of renal damage.¹⁷

Considering that Itopride hydrochloride acts as a dopamine receptor antagonist, our research sought to explore its impact on renal histology, particularly examining luminal height and luminal epithelium of proximal convoluted tubules in the kidneys of Wistar albino rats. Our findings suggest that long-term use of Itopride hydrochloride may notably influence kidney structure and potentially alter the function of kidney.

The results emphasize the necessity for continued research to explore the mechanisms and clinical significance of the kidney's histomorphological changes observed with long-term use of Itopride hydrochloride exposure. Regular monitoring of kidney function is essential during Itopride hydrochloride therapy to safeguard patient health.

CONCLUSION

Extended use of Itopride hydrochloride appears to alter luminal epithelium height and luminal diameter of proximal convoluted tubules in the kidneys of Wistar albino rats. It also affects levels of serum glutathione suggesting potential implications for renal function.

RECOMMENDATIONS

The study highlights the need for more research to unravel the mechanisms and clinical effects of these histomorphological and biochemical changes in the kidneys, which could contribute to a deeper understanding of the drug's safety and its impact on renal health.

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Address for Correspondence:

Dr Asma Hashmi, Department of Anatomy, CMH Multan Institute of Medical Sciences, Multan, Pakistan. **Cell:** +92-335-7338382

Email: hafeez_aasma@yahoo.com

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Contribution of Authors:

AH: Concept, data analysis and discussion
MAR: Interpretation of data and proof reading
ZH: Analysis and discussion

HSS: Critical review and final approval
AI: Interpretation of data and referencing of articles

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ORIGINAL ARTICLE

ADDITIVE EFFECTS OF ALTERNATE NOSTRIL BREATHING WITH PHARMACOLOGICAL MANAGEMENT ON DYSPNOEA AND CONTROL PAUSE IN PATIENTS WITH BRONCHIAL ASTHMA

Bazkha Tariq Aslam Khawaja, Shakar Nazir*, Alia Rehman**, Sidra Khalid***, Muhammad Usman Sajid[†], Muhammad Waseem^{††}, Amadah Mir^{†††}

Department of Physiotherapy, Rifah General Hospital, Dadyal, *Department of Orthopedics, Riphah International Hospital Rawalpindi,

Department of Pharmacology, Mohtarma Benazir Bhutto Shaheed Medical College, Mirpur, *Al-Aleem Medical College, Lahore,

[†]Department of Medicine, CMH Kharian Medical College, Kharian, ^{††}Department of Pulmonology, Sahiwal Medical College, Sahiwal,

^{†††}Department of Anatomy, CMH Kharian Medical College, Kharian, Pakistan

Background: Bronchial asthma is a chronic respiratory disease characterized by airway inflammation and constriction, leading to breathlessness and wheezing. This study aimed to compare the effects of Alternate Nostril Breathing (ANB) combined with pharmacological management versus pharmacological management alone on dyspnoea and control pause in patients with bronchial asthma. **Methods:** A non-blinded randomized controlled trial was conducted at Foundation University College of Physical Therapy, Foundation University Islamabad, and Fauji Foundation Hospital, Rawalpindi from February 2024 to January 2025. Thirty-two patients diagnosed with bronchial asthma were recruited after pulmonologist referral. Participants with Grades 0–4 on the Modified MRC Dyspnoea Scale were included. The control group received pharmacological management, whereas the interventional group performed ANB in addition to standard therapy for four weeks, with two supervised and five home sessions per week. Dyspnoea was assessed using the Dyspnoea-12 Questionnaire and control pause using a stopwatch. All measurements were taken at baseline and after four weeks. Data were analysed using SPSS-23. **Results:** Between-group analysis showed a statistically significant difference in dyspnoea and control pause, favouring the interventional group. Within-group analysis revealed significant improvement in both groups after four weeks, with greater gains in the interventional group. **Conclusion:** Incorporating Alternate Nostril Breathing alongside pharmacological management is more effective than medication alone for improving dyspnoea and control pause in patients with bronchial asthma.

Keywords: Asthma, Breathing exercises, Dyspnoea

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INTRODUCTION

Bronchial asthma, a chronic inflammatory disorder of the airways, has been recognized as a major global health challenge since the 1970s.¹ According to the World Health Organization (WHO), bronchial asthma affects about 339 million people globally, with over 400,000 deaths annually.² It is prevalent among both children and adults, with around 7 million children, 10 million men and 14.6 million women affected worldwide.^{3,4} According to the Global Asthma Report 2022, the prevalence in Pakistan was 4.3%.⁵ Bronchial asthma is a chronic inflammatory disorder of the airways characterized by reversible narrowing, mucus hypersecretion, and airway hyper-responsiveness, resulting in dyspnoea, wheezing, and cough that often worsen at night or early morning.⁶ Multiple triggers such as allergens, infections, smoking, and environmental pollutants contribute to airway inflammation and remodelling, which ultimately increase airflow resistance and impair lung function.^{6,7}

Among various non-pharmacological approaches, the Buteyko Breathing Technique (BBT) has gained attention as an adjunct therapy for asthma

management. Developed by Dr. Konstantin Buteyko in the 1950s, this method aims to correct chronic hyperventilation by encouraging slow, shallow nasal breathing and incorporating breath-holding exercises, known as ‘control pause’, to improve carbon dioxide retention and airway relaxation. Studies suggest that regular practice of Buteyko Breathing can reduce asthma symptoms, improve control of dyspnoea and lower the need for bronchodilators by normalizing breathing patterns and enhancing respiratory efficiency.^{8,9} Specific breathing techniques benefit individuals with bronchial asthma, particularly Alternate Breathing Exercise (ABE) also known as Anulom-vilom Pranayama/Nadi-suddhi pranayama have emerged as a widely used and an effective method. This technique involves alternate inhalation and exhalation through left and right nostrils. It regulates respiratory rate, improves lung function, reduces shortness of breath, and relieves fatigue in asthmatic patients.^{10,11} Each nostril is connected to the contra-lateral brain hemisphere. Breathing through the left nostril stimulates the parasympathetic nervous system, which promotes relaxation and improves dyspnoea and respiratory rate,

while the right nostril stimulates the sympathetic nervous system, which triggers alertness.¹²

Breathing techniques, alongside traditional medical treatments, can effectively manage respiratory symptoms by correcting hyperventilation, normalizing carbon dioxide levels, stabilizing breathing patterns, optimizing oxygen delivery and strengthen respiratory muscles. Inhaled corticosteroids and bronchodilators remain the mainstay therapies for asthma, as they reduce airway inflammation, improve lung function, and prevent bronchoconstriction and disease exacerbations.¹³ While, evidence supports the efficacy of Alternate Nostril Breathing for bronchial asthma. Research is limited regarding its combined effects with standard management. This study aims to evaluate the additive effects of Alternate Nostril Breathing along with pharmacological management versus pharmacological management alone on dyspnoea and control pause in patients with bronchial asthma.

MATERIAL AND METHODS

A non-blinded randomized controlled trial was conducted at Foundation University College of Physical Therapy, Foundation University, Islamabad, and Fauji Foundation Hospital, Rawalpindi from February 2024 to January 2025. Ethical approval was taken from the Foundation University Medical College (ERC No. FF/FUMC/215-443/phy24). The trial was registered at clinicaltrials.gov (CTRI No. NCT06609941) and written informed consents were taken.

Individuals were recruited through non-probability purposive sampling due to the limited availability of clinically stable asthma patients who met the inclusion criteria and could commit to supervised breathing sessions. Participants were then randomized into Control and Interventional groups using the sealed envelope method to minimize allocation bias. The sample size was calculated using G*Power software version 23.0 based on an independent *t*-test, assuming an effect size of 0.8 (large effect), α level of 0.05, and a power of 80%, resulting in a total of 32 participants (16 in each group).

Subjects of either gender aged 18–45 years, with Grades 0–4 on the Modified Medical Research Council (mMRC) Dyspnea Scale and asthma severity classified as intermittent, mild persistent, moderate persistent, or severe persistent according to the National Asthma Education and Prevention Program (NAEPP) 2020 guidelines² were included in the study. Patients with COPD, exarabated status asthmaticus, acute infections or unable to follow instruction were excluded.

The Control group received pharmacological management, including Short acting bronchodilators (Albuterol, Levalbuterol etc.), Long acting bronchodilators (Salmeterol, Formoterol, Tiotropium etc.) and others (Inhaled corticosteroids,

Anticholinergic, Leukotriene inhibitors and Xanthine's etc.). The Interventional group performed ANB daily alongside same pharmacological management. Medications were prescribed stepwise by pulmonologist based on symptoms and severity. For ANB, patients sat comfortably and breathe normally for about 2–3 minutes. They used the right thumb to close the right nostril, inhaled through the left nostril for 4 Sec. Held their breath for 2–3 Sec, then exhaled through right nostril. They then inhaled through right nostril for 4 Sec, held breath for 2–3 Sec. and exhale through the left nostril for 6 Sec. The cycle was repeated¹⁵.

In weeks 1–2, the frequency was 1 session/day, with 2–3 Sec of breath holding and 10 min duration. In weeks 3–4 it increased to 2 sessions/day, with 5–6 Sec of breath holding and 15 min duration. Two sessions/week was performed under supervision and 5 days at home. Outcome measures included Dyspnoea-12 Questionnaire (ICC=0.94) to assess severity of dyspnoea and a stopwatch to measure control pause.¹⁶

Data was entered and analysed using SPSS-23. Continuous variables were reported as Mean $\pm$ SD. Categorical variables as frequencies and percentages. The Shapiro-Wilk test was used that indicated that the data were not normally distributed ($p<0.05$); therefore, non-parametric tests were applied. Between-group comparisons were analysed using the Mann-Whitney U-test, while within-group (pre-post) comparisons were analysed using the Wilcoxon Signed-Rank test.

RESULTS

Mean age of participants of whole sample ($n=32$) was 30.3 ± 7.1 years. The average weight of all participants was 67.1 ± 13.1 Kg and average height was 163.9 ± 9.82 Cm. (Table-1). The Shapiro-Wilk test was used to assess normality, which indicated that some variables were normally distributed ($p>0.05$), while others showed non-normal distribution ($p<0.05$). Therefore, non-parametric tests were applied for consistency. Between-group comparisons were analysed using the Mann-Whitney U test, while within-group (pre-post) comparisons were analysed using the Wilcoxon Signed-Rank test. (Table-2)

Between-group analyses showed a statistically significant difference in dyspnoea and control pause, with the intervention group showing greater improvement ($p<0.05$). (Table-3). Within group analysis indicated a statistically significant improvement in the intervention group after four weeks of treatment ($p<0.05$). (Table-4).

Table-1: Demographic characteristics of control and interventional groups using the independent sample *t*-test ($n=32$)

Variables	Mean $\pm$ SD		<i>p</i>
	Control Group	Interventional Group	
Age (Years)	29.2 $\pm$ 5.87	31.3 $\pm$ 8.32	0.41
Weight (Kg)	66.1 $\pm$ 9.66	68.1 $\pm$ 16.2	0.67
Height (Cm)	163.5 $\pm$ 13.7	164.3 $\pm$ 13.17	0.83

Table-2: Normality test results on data

Variables	p	
	Control Group	Interventional Group
Pre dyspnoea score	0.130*	0.031
Post dyspnoea score	0.007	0.001
Pre control pause	0.001	0.126*
Post control pause	0.158*	0.540*

Table-3: Dyspnoea scores and control pause between control and interventional groups (Median±IQR)

Variable	Control Group	Interventional Group	p
Pre dyspnoea score	11.50 (12.5)	15.50 (20.7)	0.762
Post dyspnoea score	3.50 (10.0)	0.00 (2.75)	0.006*
Pre control pause	15.00 (4.0)	19.00 (4.0)	0.031
Post control pause	20.00 (5.0)	30.00 (1.75)	<0.001*

*Between-group comparisons were analyzed using the Mann-Whitney U test. A $p < 0.05$ was considered statistically significant.

Table-4: Within group analysis of control and interventional group

Group	Variable	Assessment Time	Median (IQR)	p
Control Group	Dyspnoea score	Baseline	11.50 (12.5)	0.001*
		After 4 weeks	3.50 (10.0)	
	Control pause	Baseline	15.00 (4.0)	0.001*
		After 4 weeks	20.00 (5.0)	
Interventional Group	Dyspnoea score	Baseline	15.50 (20.75)	<0.001*
		After 4 weeks	0.00 (2.75)	
	Control pause	Baseline	19.00 (4.0)	<0.001*
		After 4 weeks	30.00 (3.75)	

Within-group (pre-post) comparisons were analysed using the Wilcoxon Signed-Rank test. *Statistically significant.

DISCUSSION

To manage bronchial asthma by integrating breathing exercises with pharmacological treatment is a composite approach particularly in aggravated symptoms such as dyspnoea and improving control pause. Although the pharmacological treatments have good results and control but the synergistic effects of combining specific breathing techniques, such as Alternate Nostril Breathing (ANB), with standard medical therapies remain underexplored. We investigated the comparative efficacy of ANB combined with pharmacological management versus pharmacological management alone in improving dyspnoea and control pause among patients with bronchial asthma.

Our results are supported by a similar study conducted by A. Ibrahim *et al*¹⁷ highlighting effects of breathing exercises on dyspnoea. The results of their study revealed that the total mean score of dyspnoea in Alternate Nostril Breathing group significantly improved after 4 weeks of intervention ($p < 0.05$).¹⁷ Same in our study improvement in intervention group was seen with patients doing ANB alongside medications showed more reductions in dyspnoea compared to those receiving only pharmacological treatment. It is may be due to the fact that Alternate Nostril Breathing balances the autonomic nervous system by stimulating parasympathetic response through left nostril and sympathetic response through right nostril. It is a controlled breathing exercise which stimulates

parasympathetic nervous system and has its improving effects on respiratory pathway and sympathetic activity decreases which alleviates shortness of breath.^{12,18} ANB's controlled breathing pattern may increase the functions of diaphragm by optimizing the oxygen delivery, all this is augmented by the bronchodilatory and anti-inflammatory effects of medications such as corticosteroids and bronchodilators.¹⁹

Our study also demonstrates the contrast results for control pause⁹, a method used to measure the breath-holding capacity that reflects respiratory control and lung function. Our findings indicate significantly more improvements in control pause in the intervention group compared to the control group after four weeks. These results are similar to a study conducted by David and Patil²⁰ who observed control pause. In accordance to our findings, their results also showed that Buteyko breathing was more effective to improve control pause but in control group there was insignificant change.

Notably, our study showed significant change in control group which received only pharmacological management. Control pause in control group was improved as we excluded severe persistent asthmatic patients and older adults because despite pharmacological treatment age and asthma classification may limit lungs function, making difficult to achieve longer control pause.²¹ A comparable study by Vagedes K *et al*⁹ investigated the effects of Buteyko breathing compared to standard treatment on control pause. The results of their study demonstrated a significant improvement in control pause in Buteyko group. Conversely, the group which received standard treatment showed minimal improvement.⁹

Pharmacological management helped to improve control pause, yet the improvement was significantly higher in patients practicing ANB along with pharmacological management. The possible mechanism behind control pause improvement might be the mechanism behind breathing exercise as it reduces hyperventilation and normalizes level of CO₂ and medications relieving symptoms of respiratory distress helping to improve control pause.⁸

The findings highlight that ANB combined with pharmacological management offers a simple, low-cost, and non-pharmacological adjunct that can be easily integrated into pulmonary rehabilitation programs. Incorporating such breathing techniques may enhance symptom control, promote patient self-management, and support a more holistic approach to the long-term management of chronic respiratory diseases.

LIMITATIONS OF STUDY

Due to the short duration, the long-term effects could not be evaluated. The small sample size and single-centre recruitment may limit the generalizability of the findings. Use of non-probability purposive sampling was

considered a limitation of the study as it might have introduced selection bias and reduced the generalizability of the findings. Follow-up of patients was quite difficult, particularly to ensure that home based breathing exercise plan was regularly followed up.

CONCLUSION

Addition of Alternate Nostril Breathing along with standard pharmacological management is more effective compared to pharmacological management alone for improving dyspnoea and control pause in patients with bronchial asthma. Incorporation of ANB in daily practice can aid in managing bronchial asthma by fostering relaxation, alleviating stress and enhancing lung functions through controlled breathing.

RECOMMENDATIONS

1. Effects of intervention of longer duration could be studied to determine the persistent effects of ANB.
2. Future studies could also incorporate different nasal breathing exercises with pharmacological management to determine their combined effectiveness in patients suffering from other respiratory conditions such as COPD and hyperventilation syndrome etc.
3. Home based breathing exercises should be prescribed for asthmatic patients
4. Study could ensure assessment of respiratory function.

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Address for Correspondence:

Dr Amaidah Mir, Department of Anatomy, CMH Kharian Medical College, Kharian, Pakistan. **Cell:** +92-330-5842835

Email: amaidahmir@gmail.com

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Contribution of Authors:

BTAK: Concept and Study design

SN: Writing discussion section

AR: Data collection, Proof reading

SK: Manuscript writing, Pharmaceutical work

MUS: Results compilation, Patient management

MW: Referencing, Statistical analysis

SAM: Rephrasing of whole article

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ORIGINAL ARTICLE

EFFECT OF INCREASED WORKLOAD AND PHYSICIAN BURNOUT ON
TURNOVER INTENTION OF DENTISTS IN TERTIARY CARE DENTAL
HOSPITALS OF PAKISTANSaeeda Zia, Areesha Noor, Danish Zafar*, Muhammad Fayyaz**,
Faiza Akram***, Hamza Javed***Department of Dentistry, Riphah International University, Islamabad, *Department of Ophthalmology, **Prosthodontics, Dental Section,
***Radiology, Ayub Medical College and Teaching Hospital, Abbottabad, Pakistan

Background: Increased workload is one of the leading causes of physician burnout of dentists in tertiary care hospitals of Pakistan resulting in an increased turnover intention. This study reviews the effect of increased workload on burnout and turnover intention in dentists working in the private and public dental hospitals of Islamabad and Rawalpindi. **Methods:** This quantitative, cross-sectional study was conducted in Islamabad and Rawalpindi, from Jun to Jul 2022. The target audience was selected with simple random sampling. An online survey was conducted and a total of 100 PMDC-registered dentists filled the survey questionnaire. Indexes used for assessment of burnout, turnover intention, and workload were the Copenhagen Index Scale (Tis-6), and NASA task load index respectively. **Results:** The correlation between workload and turnover intention can be seen as strongly positive ($r=0.419$, $p<0.01$). The correlation between the workload and dependent turnover intention can be seen as strongly positive ($r=0.419$, $p<0.01$). The results showed that an increase in workload leads to an increased physician burnout which in turn causes an increased rate of turnover intention in dentists. **Conclusion:** Dentists in Islamabad and Rawalpindi are facing the problem of increased workload during working hours, resulting in physical and psychological burnout leading to an increased turnover intention.

Keywords: Emotional burnout, Physical burnout, Turnover intention, WorkloadPak J Physiol 2025;21(4):11–4, DOI: <https://doi.org/10.69656/pjp.v21i4.1595>

INTRODUCTION

In Pakistan, the dentist-population ratio is one of the largest health concerns in the present years. According to the National Institute of Health, in urban areas, the dentist-patient ratio is 1 dentist for 42,000 patients. In the rural areas, this ratio further worsens to 1:500,000.¹ This deficit in the number of dentists throughout the country has increased the workload on the dental community in the few tertiary care hospitals in Pakistan. According to WHO, oral disease is the fourth most expensive disease to treat globally.¹ In a developing economy, the majority of the community relies on tertiary care dental hospitals for their dental treatments as they are severely more cost-effective than private dental care. There are very few tertiary care dental hospitals in Pakistan, so this ratio is multiplied several fold. The roles of dentists in such hospitals are not confined to patient dealing but dentists' are also directly associated with maintaining, managing, and supervising various roles around the hospital. This increased workload and continuous pressure cause severe physical and emotional exhaustion, further leading to burnout.

Physician burnout is one of the major determinants of job satisfaction and self-efficacy among dentists. Burnout caused by continued professional expectations and exhaustion that is not adequately managed has three aspects: emotional exhaustion, depersonalization, and decreased sense of personal

accomplishment.² The major cause of burnout among dental professionals is the physical workload, of dealing with patients as well as the emotional workload due to other perceived responsibilities. As explained by Morrill, when the work requirement of an individual exceeds their working capacity or an individual is required to complete certain activities for which the given time is insufficient, they tend to push their physical and mental boundaries.³ This unnecessary exertion to complete tasks in a shorter period causes the body to shut down and not being able to bear any more stress is called workload. Recent studies have shown that increased workload has been directly linked with burnout.⁴

Another key aspect associated with workload, and physician burnout is the turnover intention. Turnover intention can be described as an individual's perspective and attitude towards voluntarily quitting their job and looking for other jobs where their perceived needs are met.⁴ Increased workload and burnout are a direct determinant of turnover intention in not only medical and dental employees but in any sort of employment all over the world.

Referring particularly to the dental community in Pakistan, previously mentioned data has shown that there is a significant gap in the ratio of dentists to patients. This leads to burnout, one of the major factors contributing to dentists' intention to quit working in hospitals and establish better-paying private practices

with a controlled workload. Burnout and turnover intention are directly linked.⁵ If the burnout is increased, the intention to quit will be higher too, and *vice versa*. The high workload is a major factor contributing to increasing turnover intention in hospitals and increasing dentists' preference to work in private practices with controlled patient flow. Another important reason for turnover intention among dentists is migration to countries that have better doctor-patient ratio, controlled clinical workloads and better compensation, which is termed an emergency in the Asia-Pacific region.⁶

There have been multiple works that relate workload and burnout to turnover intention. It is known that increased burnout due to long working hours in hospitals tends to increase the turnover intention of doctors and nurses.⁷ However, there are not many studies targeting specifically the dental community that do not share the same attributes. Even though in Pakistan, dentists are not required to work 24 or 36-hour shifts, still, the turnover intention remains high due to high volume to patients receiving free care in tertiary hospitals which greatly effects the doctor to patient ratio and significantly increases burnout. As research indicates, in Pakistan, 62% of the dentists experience some sort of burnout.¹ Another study in China reveals that the most predictive aspect of turnover intention was the chance to work in a privately owned clinic, which was preferred by most dentists.² Majorly due to the fact that private setup had a controlled patient flow and did not cause burnout. There is a significant gap in the studies that address dentists. There are several types of job stressors for dentists, including financial troubles, private practice problems, patient obstacles, and emotions of time pressure and strain, which can be connected to dentists' career objectives and turnover intentions.⁸

In Pakistan, the working hours of the dental hospitals are less compared to general hospitals, and more patients are to be treated in a short period which leads to the excessive workload on the dentist and they suffer daily from both physiological as well as psychological exhaustion. Due to the greater workload, they are physically exhausted which in turn leads to neck, shoulder, and wrist disorders.⁹ In the long run due to this most dentists tend to retire prematurely or shift their field from clinical to teaching side. Moreover, in a dental hospital, a dentist is not only required to deal with the patients but also managerial duties, time management, and supervisory duties are also performed which increase additional non-clinical workload and create emotional and physical burnout.

The salary of dentists is quite low to meet their financial end in many practice clinics this occupies their family time, the personal time leading to psychological stress.¹⁰ Due to excessive workload, stress, and burnout suicide rate is also increasing in the dental profession. A

study in UK revealed that studies surveying suicide and occupation showed a high suicide rate among dentists compared to other professions and general public.¹¹

The role of the limited dental community is significant in Pakistan considering the high number of oral diseases prevailing in the rural as well as the urban areas. This work aims to expand the existing knowledge about job stressors such as workload and burnout and their effects on turnover intention specifically highlighting it in dentist community of Pakistan.

MATERIAL AND METHODS

It was a quantitative, descriptive, cross-sectional study. The target audience of a total of 100 dentists was selected by simple random sampling and was calculated using the WHO calculator. An online survey was conducted and a total of 100 PMDC-registered dentists filled the survey questionnaire. The participants were categorized into Faculty members of teaching hospitals, House officers, General dentists, PG trainees, and Specialists working in public and private sector dental hospitals in Islamabad.

A questionnaire was designed that included questions related to demographic details and other work-related characteristics like working hours, duties that you perform in your workplace, patients treated per day, job satisfaction, and level of exhaustion.

The Copenhagen Burnout Inventory (CBI) scale was used to measure burnout in the participants.¹² It is a standardized questionnaire that scores burnout in 3 different categories: personal burnout, patient-related burnout, and work-related burnout. Each question consists of a Likert-type response, i.e., 1 representing the least and 5 representing the highest burnout score.

To measure workload, the NASA Task Load Index scale was used.¹³ Designed by Stavelands, this questionnaire measures workload on a seven-point scale. For measuring Turnover Intention, a shortened six-item versioned Turnover Intention Scale (TIS 6) was used. This scale has six items and measures on a five-point scale, where 1 is the lowest and 5 is the highest.

Based on an extensive study of the existing literature, four hypotheses were developed for this study.

- H1: Increased workload is positively associated with turnover Intention.
- H2: Increased workload is positively associated with physician burnout.
- H3: Burnout is positively associated with turnover intention.
- H4: Burnout mediates the relationship between workload and turnover intention.

RESULTS

The correlation between the independent variable workload and dependent variable turnover intention were as strongly positive. ($r=0.419$, $p<0.01$). (Table-1).

There was a strong positive association between workload and burnout ($r=0.168$, $p<0.05$) and burnout also had a direct positive relationship with turnover intention ($r=0.329$, $p<0.01$). However, after mediation analysis, it was seen that there was a positive indirect relationship (via burnout) between workload and turnover intention that was much stronger than the previous direct relationship between workload and turnover intention. (Table-2).

Table-1: Mean±SD, and correlation between workload, burnout and turnover intention

Parameter	Mean±SD	WL	BO	TI
WL	4.31±0.47	1		
BO	4.35±0.47	0.168*	1	
TI	4.30±0.50	0.419**	0.329**	1

* $p<0.05$, ** $p<0.01$, WL=Workload, BO=Burnout, TI=Turnover Intention

Table-2: Direct and indirect mediation effects between workload, burnout and turnover intention

Parameter	BO	LL	UL
Direct Effects			
WL-TI	0.14	-0.01	0.3
WL-BO	0.51*	0.31	0.49
BO-TI	0.28*	0.21	0.35
Indirect Effects			
WL-BO-TI	0.16*	0.09	0.17

* $p<0.05$, LL=lower limit, UL=upper limit

DISCUSSION

This study has provided crucial evidence on the existing workload profile, burnout, turnover intention, and related linkages among dentists in Islamabad's private and public sector hospitals. Overall, dentists were reported to be unsatisfied with most aspects of their work and working experience, particularly job workload and organizational management. A significant number of dentists were suffering from severe burnout syndrome, which included decreased physical competence and emotional tiredness. Furthermore, some dentists indicated a strong inclination to leave. The workload increase showed a large direct influence on physician burnout, and burnout had a significant positive direct effect on turnover intention. Furthermore, the workload had a strong direct influence on turnover intention via burnout as a mediator.

Previous studies have also observed a positive correlation between increased workload, low personal accomplishment and turnover intention. For example, one study concluded that 63.9% of occupational physicians in France deal with feelings of low personal accomplishment as a result of burnout.¹⁴ Additionally, a study conducted in Khyber Pakhtunkhwa revealed that two-thirds of dental professionals experienced some form of mental disturbance due to job stressors, leading to higher turnover intention.¹⁵ Similarly, a study in China found that job dissatisfaction and burnout syndrome significantly affected the turnover intention of physicians, with emotional exhaustion playing a partial

mediating role.¹⁶ Our findings are consistent with these studies, indicating that increased workload leads to higher burnout and turnover intention among dentists.

The correlation between workload and burnout is supported by multiple studies across different regions. A study conducted in Taiwan found that workload significantly predicted burnout and turnover intention among hospital dentists.⁸ Additionally, research in the UK highlighted that dentists often experience professional burnout, anxiety disorders, and clinical depression due to the demands of clinical practice and personality traits commonly found in individuals who choose dentistry as their profession.¹⁷ These findings align with our results, showing that increased workload leads to higher burnout levels and, consequently, higher turnover intention.

Our study revealed that burnout serves as a mediator between workload and turnover intention. This mediating effect has been documented in previous literature. For instance, a study in Hubei, China, showed that occupational burnout mediated the relationship between job satisfaction and turnover intention among physicians.² Our findings suggest that addressing burnout could mitigate the impact of workload on turnover intention, providing a crucial intervention point for healthcare organizations.

The implications of these findings are significant for healthcare management. The high turnover intention observed among dentists due to workload and burnout suggests the need for organizational changes to reduce workload and support the mental health of dental professionals. Strategies such as increasing staff numbers, providing mental health resources, and implementing workload management programs could help alleviate burnout and reduce turnover rates. This study contributes to the existing literature by specifically focusing on the dental community in Pakistan, a group that has been less studied in previous research.

PRACTICAL IMPLICATIONS

This study enhances the body of knowledge regarding dental professionals. The findings of this study can help healthcare organizations establish healthcare systems that benefit the physical and mental health of dental professionals. By addressing the factors contributing to burnout and turnover intention, organizations can improve job satisfaction and retention rates among dentists, benefiting the healthcare system as a whole.

LIMITATIONS

This study was carried out only in the region of Islamabad and Rawalpindi. The sample size was small, and the study duration was short. Data from dentists working in general hospitals and private clinics were not included. A larger sample size and a more diverse

population should be included to provide a more comprehensive understanding of the issue. Longitudinal studies could help determine the long-term effects of workload and burnout on turnover intention.

CONCLUSION

Dentists in Islamabad and Rawalpindi are facing the problem of increased workload during working hours, resulting in physical and psychological burnout leading to an increased turnover intention. Many dentists are changing their field, and some have taking early retirement since their physical condition is not allowing them to work under such loads. Addressing these issues is crucial for improving the job satisfaction and retention of dental professionals, ultimately enhancing the quality of dental care provided to patients.

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Address for Correspondence:

Dr Danish Zafar, Department of Ophthalmology, Ayub Medical College and Teaching Hospital, Abbottabad, Pakistan. **Cell:** +92-315-9119555
Email: deezafar.dz@gmail.com

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Contribution of Authors:

SZ: Concept, Study design and manuscript writing, approval of the final manuscript

AN: Concept, literature search, data Collection and Interpretation

DZ: Concept, Proofreading and review

MF: Data interpretation

FA: Data analysis, data interpretation, Proof reading, approval of the final manuscript

HJ: Proof reading, writing and editing

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ORIGINAL ARTICLE

COLONOSCOPY-BASED DIAGNOSTIC TRENDS IN COLORECTAL DISEASES: EVIDENCE FROM A TERTIARY CARE HOSPITAL IN KARACHI, PAKISTAN

Aina Marzia Syed, Marium Fatima Waqar*, Zeeshan Ali*, Shabnam Naveed*, Saleem Shehzad*,
Syed Masroor Ahmed*

3rd Year MBBS Student, Sindh Medical College, *Department of Medicine, Jinnah Postgraduate Medical Centre, Karachi, Pakistan

Background: Colonoscopy is an essential diagnostic and therapeutic modality for evaluating a wide range of colorectal diseases, including polyps, inflammatory bowel disease (IBD), intestinal tuberculosis, haemorrhoids, and colorectal malignancies. This study aims to evaluate the spectrum of colonoscopic findings at a tertiary care hospital in Karachi and explore their association with patients' age and gender. **Methods:** It was a retrospective cross-sectional review conducted in the endoscopy suite of Medical Unit III, Ward 7, Jinnah Postgraduate Medical Centre, Karachi. The data of 527 patients who underwent colonoscopy from 1st Jan 2020 to 31st Dec 2022 was recorded. Collected data was analysed through SPSS-25, and data were tabulated as frequencies and percentages. **Results:** Out of a total of 527 patients of mean age of 37.09 years, 209 (39.7%) were female patients. Abdominal pain 168 (31.9%), followed by per rectal bleed 165 (31.3%) were the commonest presenting complaints, 83 (15.7%) patients had chronic diarrhoea. The most frequent finding of colonoscopy was internal haemorrhoids in 140 (26.6%) patients, followed by IBD 44 (8.4%). Intestinal tuberculosis (TB) was 25 (4.7%), colon cancer was 17 (3.2%), rectal cancer was 13 (2.5%), and anal cancer was 7 (1.3%). **Conclusion:** The most common colonoscopic finding was internal haemorrhoids, followed by IBD and intestinal tuberculosis. Malignancies including colon, rectal, and anal cancers were also identified, though less frequently. These findings emphasize the diverse spectrum of colorectal diseases in clinical practice.

Keywords: Colonoscopy, Colorectal cancer, Haemorrhoids, Inflammatory bowel disease

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INTRODUCTION

Colorectal diseases (CRD) encompass a wide range of medical conditions, spanning from benign anomalies to potentially life-threatening malignancies, representing a significant global health challenge. The morbidity and mortality rates associated with CRD vary by geographic region due to a combination of factors such as age, ethnicity, lifestyle, diet, genetics, and environmental exposures.¹

Colonoscopy, a versatile and indispensable medical procedure, emerges as a cornerstone in both the diagnosis and treatment of CRD.² It facilitates the detection and management of premalignant colorectal polyps, ulcers, haemorrhoids, and other significant findings. A study conducted in Sukkur, Sindh, Pakistan reported haemorrhoids to be the most common finding.³ Given its capacity to provide real-time insights into the colon's condition, it can accurately differentiate between conditions like ulcerative colitis and Crohn's disease in 85% to 89% of the patients, where early diagnosis is critical.⁴

Isolated ulcers might either be incidentally discovered during a screening colonoscopy or manifest with symptoms such as abdominal pain, haematochezia, chronic gastrointestinal bleeding, and in rare instances, perforation. Among the prevalent causes of isolated colonic ulcers lies the usage of

nonsteroidal anti-inflammatory drugs (NSAIDs) and notably, these ulcers tend to appear in the cecum and right colon.⁵ Colon ulcers are also often the first sign of Crohn's disease.^{6,7}

Detection of polyps through colonoscopy is particularly significant. Colonic TB is known to present on colonoscopy, as ulcerative or nodular lesions, strictures, and, less frequently, as colon polyps.^{8,9} Colonoscopy is essential for screening individuals at risk for colorectal cancer, starting at age 45, as the incidence of colorectal cancer increases with age, with 94% of new cases occurring in adults 45 or older.² High-risk individuals, such as those with inflammatory bowel disease, a family history of colorectal cancer before age 60, or hereditary syndromes, may require earlier screenings.¹⁰ Colonoscopy carries a risk of serious complications, the most severe being intestinal perforation. This can cause gut contents to leak into the peritoneal cavity, leading to significant adverse outcomes, with mortality rates reported up to 5%.¹¹

Local literature offered limited insight into the findings of colonoscopy. This study aims to address this gap by comprehensively evaluating the diverse findings of colonoscopy and its association with presenting symptoms in patients being referred to the endoscopy suite at our department.

METHODOLOGY

This was a cross-sectional review of retrospective data used to assess the diagnostic patterns revealed through colonoscopy procedures performed on patients presenting with gastrointestinal symptoms. The study was conducted at the endoscopy suite of Medical Unit-III, Ward-7, Jinnah Postgraduate Medical Centre (JPMC), Karachi. The study protocol was reviewed and approved by Institutional Review Board (IRB) of JPMC (Reference No. F.2-81/2023-GENL/226/JPMC).

The study population comprised patients aged above 12 years who underwent colonoscopy at JPMC between January 1, 2020, and December 31, 2022. Patients were referred not only from multiple healthcare centres within Karachi but also from the remote areas of interior Sindh and other cities of Pakistan by physicians, surgeons and general practitioners, thereby ensuring a diverse representation of the population. The required sample size was calculated using OpenEpi software to be 385, with a 95% confidence interval and a 5% margin of error. The final study included 527 patients. All patients underwent standard bowel preparation with polyethylene glycol solution (Movcol)¹² as per institutional protocol.

Demographic details, presenting complaints, and colonoscopic findings were retrieved from hospital records. For a subset of patients undergoing biopsy during colonoscopy, histopathological examination reports of the obtained specimens were also collected and documented for diagnostic confirmation.

Data were compiled, coded, and analysed using SPSS-25. Descriptive statistics, including frequencies and percentages, were calculated for categorical variables such as gender, presenting complaints, and colonoscopic findings.

RESULTS

Table-1 shows the baseline characteristics of studied patients. There were 327 patients aged 37.09±16.2 years, 280 (53.1%) were aged 35-years or less and 209 (39.7%) of them were female patients.

Table-2 shows the frequency of presenting complaints of the patients, the commonest complaint was abdominal pain 168 (31.9%), followed by per rectal bleed 165 (31.3%). Eighty-three (15.7%) of the patients had complaint of chronic diarrhoea.

Table-3 reports the diagnosis of patients. Internal haemorrhoids were seen in 140 (26.6%) patients, inflammatory bowel diseases in 44 (8.4%), intestinal TB in 25 (4.7%), colon cancer in 17 (3.2%), rectal cancer in 13 (2.5%), and anal cancer in 7 (1.3%). Normal colonoscopic findings were found in 32.8% cases.

Table-1: Baseline characteristics of studied patients (n=527)

Parameters	n	%
Age Group	≤35 Years	280
	>35 Years	247
	Age (Mean±SD)	37.09±16.2
Gender	Male	318
	Female	209

Table-2: Patients' presenting complaints

Presenting complaints	n	%
Abdominal pain/discomfort	168	31.9
Per rectal bleed	165	31.3
Chronic diarrhoea	83	15.7
Constipation	55	10.4
Mucous discharge in stool	20	3.8
Weight loss	18	3.4
Fever	18	3.4

Table-3: Diagnosis based on colonoscopic findings

Diagnosis	n	%
Normal mucosa	173	32.8
Internal Haemorrhoids	140	26.6
Inflammatory bowel disease	44	8.4
Polyps	30	5.7
Intestinal TB	25	4.7
Colitis	25	4.7
Colon cancer	17	3.2
Solitary rectal ulcer syndrome	14	2.7
Rectal cancer	13	2.5
Anal cancer	7	1.3

DISCUSSION

This cross-sectional review provides valuable insight into colonoscopy-based diagnostic trends in colorectal diseases at a tertiary care hospital in Karachi, reflecting both the local burden of disease and patterns seen among patients referred from other parts of Pakistan. In this context, colonoscopy emerges as a pivotal diagnostic and therapeutic tool for managing these conditions. Colonoscopy is considered the mainstay for screening and surveillance of colorectal cancer, making it an indispensable procedure in the management of colorectal diseases.¹³ The observed trends emphasize the need to strengthen endoscopic services and public awareness programs across Pakistan to enhance accessibility and encourage timely evaluation of gastrointestinal symptoms.

In our data, the mean age of 37.09±6.2 years highlights a relatively young study population, with over half of the patients being 35 years old or younger. This demographic distribution suggests a cohort potentially predisposed to gastrointestinal issues at a younger age. Factors such as lifestyle, dietary habits, and genetic predispositions are crucial considerations in understanding the onset and progression of diseases in this group.¹⁴

Gender distribution revealed a predominance of male patients, indicating a gender disparity that may influence disease prevalence or presentation within the study cohort. This observation aligns with existing

literature suggesting different manifestations of gastrointestinal disorders between genders, underscoring the need for gender-specific approaches in clinical management and research.¹⁵

Normal colonoscopic findings were seen in 32.8% patients, which is lower than the rate seen in a Turkish study¹⁶ (40.6%) and 42.1% in a study conducted in UK¹⁷. On the other hand, the rate of normal colonoscopy in our study was higher compared to a local study from Sukkur³ 25.42%.

Per rectal bleed was the most reported symptom, affecting 31.3% patients. Most of these patients were referrals by surgeons and physicians from other departments and institutes for colonoscopy after their evaluation and initial examination. The admitted patients in our ward with the same complaint were also thoroughly evaluated before the procedure. Per rectal bleeding is a symptom that can be indicative of various underlying conditions such as haemorrhoids, anal fissures, inflammatory bowel disease, or colorectal malignancies. Studies have shown that colorectal cancer can be associated with rectal bleeding and is the first symptom for left-sided tumours in young-onset colorectal cancer emphasizing the need for prompt evaluation when this symptom is present.¹⁸ Internal haemorrhoids were the most frequent finding in our patients which was similar to the study conducted by Mohammad S *et al*³ and Ali F *et al*¹⁹. This number also included the incidental finding of haemorrhoids while performing colonoscopy for complaints other than per rectal bleed.

The solitary rectal ulcer syndrome (SRUS) was reported in only 2.7% patients which was much lower than 6.8% stated in a study from Multan²⁰ and 6.6% in a study from Peshawar²¹. On the other hand, Kutluana U *et al*²² reported SRUS to be just 0.6%.

Chronic diarrhoea, reported in 15.7% of patients is a result of gastrointestinal motility disturbances or chronic inflammatory conditions such as Crohn's disease or ulcerative colitis.²³ Abdominal pain or discomfort, reported in 31.9% of patients, is a multifactorial symptom that can stem from different causes including functional gastrointestinal disorders, infections, or structural abnormalities, necessitating a thorough clinical evaluation and diagnostic workup.²³

The diagnosis of intestinal tuberculosis in 4.7% of patients emphasizes the need to consider infectious causes in cases of chronic diarrhoea, especially in endemic areas or high-risk populations. Intestinal TB closely mimics Crohn's disease, can affect any part of the gastrointestinal tract, indicating the need to evaluate patients with symptoms such as abdominal pain, anaemia, and diarrhoea thoroughly. Distinguishing between intestinal tuberculosis and other conditions like Crohn's disease can be challenging. However, histopathological features such as confluent granulomas,

a high number of granulomas per biopsy site, and the presence of caseous necrosis can aid in differentiation.

The IBD was found in approximately 8.4% of our patients unlike Italian study²⁴ which mentioned overall frequency of IBD to be 0.32%. On the contrary Ali F *et al*¹⁹ reported the combined frequency of IBD to be 14.46%. Considering the increasing trend of IBD in our local studies, we should take measures to assess its risk factors and provide early management of IBD.

The frequency of colorectal malignancies in our study was 5.7% which is much lower than that reported (11.9%) by a study from Oman²⁵. National cancer institute in United States stated the rate of new cases of colorectal cancer was 37.1 per 100,000 men and women per year.²⁶ In our study, just the frequency of neoplastic growth in the caecum was around (0.6%) out of total cases of malignancy, indicating that screening colonoscopy is extremely crucial to detect such cases as early as possible in order to reduce mortality resulting from colorectal carcinomas. The presence of haemorrhagic erosions in the sigmoid colon (0.9%) highlights its vulnerability to inflammatory conditions such as diverticulitis or ischemic colitis, necessitating tailored diagnostic approaches.

The limitations of this study include its single-centre, retrospective design, which may limit the generalizability of the findings. In addition, the study did not include follow-up data after diagnosis, thereby restricting assessment of disease progression or treatment outcomes. As the majority of patients in our data were relatively young, the results may not accurately represent the pathological spectrum seen in older populations, where colorectal diseases are typically more prevalent.

CONCLUSION

Internal haemorrhoids emerged as the most frequent finding, followed by inflammatory bowel disease and intestinal tuberculosis, while colorectal malignancies were also identified, though less commonly. The records showed higher number of male patients undergoing colonoscopy compared to female patients indicating possible gender related differences in the presentation of colorectal diseases.

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Address for Correspondence:

Dr Marium Fatima Waqar, Department of Medicine, Medical Unit III, Ward 7, Jinnah Postgraduate Medical Centre, Karachi, Pakistan. **Cell:** +92-334-3751893

Email: mariumwaqar5@gmail.com

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Contribution of Authors:

AMS: Data collection, organising, Participation in Data Interpretation and article writing

MFW: Concept and design, supervision of data collection, interpretation of results and drafting of article

ZA: Concept, data analysis and interpretation, critical review

SN: Data interpretation, analysis, article review, formatting

SS: Data collection, discussion, drafting

SMA: Supervision, data analysis and critical review

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ORIGINAL ARTICLE

EFFECTIVENESS OF ANATOMICAL DISSECTION TABLE VERSUS TRADITIONAL ANATOMICAL MODELS IN STUDENTS OF GOMAL MEDICAL COLLEGE, DI KHAN

Shehla Aman, Muhammad Hassan Khan*, Mutaal Azeem*, Faizullah Kundi*, Jibran Zaman*, Huzaifa Zahid*, Aimal Miankhel*, Shayr Ali Shah*, Hassan Gul*, Shabab Rabbani*

Department of Anatomy, *Medical Students, Gomal Medical College, Dera Ismail Khan, Pakistan

Background: Very few studies have been conducted comparing the effectiveness of students for anatomical dissection table learning and traditional model based learning. In this study a direct comparison of anatomical dissection table learning and traditional models-based learning has been made which provides valuable insights into their strengths and weaknesses. **Methods:** This randomized parallel group experimental study was conducted on 1st year MBBS students in Department of Anatomy, Gomal Medical College, DI Khan from March to May 2025. Students included were randomly assigned into two different groups. Group A (n=58) were taught using virtual anatomical dissection table, and Group B (n=58) were taught using traditional models. Both groups had no prior experience with anatomical dissection table and anatomical models. At the end of the study the post evaluation test based on MCQs was conducted. **Results:** The analysis demonstrated a statistically significant difference in the mean post-test scores between the two groups. Students taught using the virtual anatomical dissection table (Group A) achieved significantly higher scores compared to those taught using traditional anatomical models (Group B), ($p<0.001$), indicating highly significant differences. **Conclusion:** The teaching methodology utilizing the Anatomage Table is significantly more effective than the traditional methods.

Keywords: Anatomic models, Anatomical dissection table, Gross anatomy, Teaching methodology

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INTRODUCTION

Anatomy is one of the subjects taught when a student first enters a medical school. It opens windows to the intricate study of organs, tissues and cells from the macroscopic details to the microscopic ones.¹ Having a strong grip on the anatomical organisation of the human body lays the foundation to excel in various fields of medical science like radiology, surgery, medicine, etc.² Being the cornerstone of medical science, it demands to bring innovative teaching methods to the forefront of medical sciences.³

During the earlier days teaching and learning human anatomy was more or less limited to cadaveric dissections.⁴ Even today, in the era of scientific and technological advancement many anatomists still advocate for the inclusion of cadaveric dissections as part of learning human anatomy.⁵ However, as the demand for doctors and thus the establishment of new medical colleges grew, it eventually led to the shortage of cadavers for dissections.⁶ Moreover, the use of human bodies for dissection and learning raised various ethical concerns.⁷ As science advanced, the use of plastic models for demonstrating the basic structures and their relations increasingly came into practice.⁸ Today, in the era of artificial intelligence and technological advancement, we see the use of virtual anatomical dissection table becoming popular as it not only allows the students to understand the structures and

the relations of various organs but also allows to visualise minute details easily.⁹

There had been many researches which prove that the use of virtual anatomical dissection table is indeed beneficial for the learning and the knowledge retention of the students.¹⁰ Some of the researchers compared the use of virtual anatomical dissection table with the traditional cadaveric dissections and found that students find the virtual anatomical dissection table easy to operate and understand.¹¹ However there has been limited research for evaluating the learning of human anatomy through the use of plastic models as compared to learning with the virtual anatomical dissection table.

This study aims to evaluate and compare the effectiveness of teaching with virtual anatomical dissection table in comparison to the traditional method of teaching with anatomical models. It aims to determine the most efficient method for learning human anatomy whether it is in the form of anatomical models, virtual anatomical dissection table or perhaps a combination of both.

MATERIAL AND METHODS

The study was conducted in Department of Anatomy, Gomal Medical College, Dera Ismail Khan, Pakistan after getting ethical approval from Ethical Review Committee, Gomal Medical College, DI Khan, Pakistan vide No. 253/GJMS/JC.

This study used a randomized parallel group experimental census-based study to evaluate the effectiveness of virtual anatomical dissection table versus traditional anatomical models. The participants were all 1st Year MBBS students. The inclusion criteria were students enrolled in the anatomy course, with informed consent, and no prior experience with Anatomage Table. The excluded students were those with visual or cognitive impairments, those that previously failed the anatomy course and those having low attendance during the study. The 116 eligible students were randomly divided into two groups; Group A and Group B of 58 students each by simple random sampling technique.

Group A was taught using the virtual methods by the visualisation of structures on Anatomage Table. Group B was taught using the traditional methods of teaching with the anatomical models. Both the groups were exposed to pre-decided topics of curriculum including gross anatomy of upper limb for a duration of two and half months from 1 March 2025 to 15 May 2025. To reduce the bias the same one instructor taught both the groups.

After completion of study duration, a post evaluation test was conducted based on MCQs related to the discussed topics. A total of 58 students from group A and 58 students from Group B appeared for the test. The final results were analysed using IBM SPSS-23. The descriptive variables are presented as Mean $\pm$ SD. Estimation of parameters for population is presented as confidence interval at 95% confidence level for mean.

RESULTS

Each group consisted of 58 students. An independent samples *t*-test was conducted to compare the post-test scores of students taught using the Anatomage Table (Group A) and those taught using the traditional method (Group B). The analysis demonstrated a statistically significant difference in mean scores between the two groups ($p < 0.001$). The standard deviation of post-test scores was 17.56 in Group A and 38.72 in Group B (Table-1). This result indicates that students taught using the Anatomage Table performed significantly better on the post-test than those taught using traditional methods.

Table-1: Post-test scores of students in Group A and Group B

Teaching method	N	Mean	SD	SEM	<i>p</i>
Anatomage table	58	50.2374	17.55821	2.30551	<0.001
Traditional method	58	38.7166	19.06473	2.50332	<0.001

There was a significant effect of teaching methodology on student performance. The mean score in Group A was significantly higher than that of Group B suggesting the Anatomage Table was more effective for learning anatomy.

DISCUSSION

This study aimed to compare the effectiveness of the Anatomage Table versus traditional anatomical models among the students at Gomal Medical College, Dera Ismail Khan, Pakistan. The findings indicate that students exposed to Anatomage Table demonstrated a significantly stronger understanding of the anatomical structures compared to those who used traditional models, as evidenced from the post-evaluation test scores.

The better learning of students by using Anatomage Table is because of its 3D visualization features, which allow interactive study of the human body. These features provide a more active and immersive learning experience potentially improving retention and comprehension, especially of complex anatomical relations. These findings are in accordance with the results of previous studies^{4,10,13-15} which have also concluded that digital anatomy learning can enhance students learning.

Some other cross-sectional studies^{12,16} reported no statistically significant differences between the two groups. Yet another study by Totlis T *et al* conducted on students' perception of teaching by traditional methods compared to online learning and modern techniques revealed that traditional methods were more effective.¹⁷

This study has certain limitations that should be considered when interpreting the results. It was conducted at a single institution, limiting the generalizability of results to other medical colleges. The sample size used for the study is relatively small as the sanctioned total number of students in a class for our institution is 120. Future studies should consider multicentre trials with larger cohort. Finally, no qualitative data was collected regarding students' perceptions, preferences or satisfaction with the learning modalities.

This study opens doors for future researches to find better ways of teaching human anatomy to undergraduate students at medical schools. This study paves the way for highly advanced researches like the use of hologram technology in this field.

Considering the findings reviewed, the Anatomage Table offers a great benefit compared to traditional anatomy learning methods using anatomical models. The current study shows that the Anatomage Table can improve spatial awareness, retention of anatomical learnings, and it reduces ethical issues associated with cadavers.

CONCLUSION

The teaching methodology utilizing Anatomage Table was superior to traditional methods in improving students' academic performance.

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Address for Correspondence:

Dr Shehla Aman, Associate Professor, Department of Anatomy, Gomal Medical College, DI Khan, Pakistan. **Cell:** +92-335-0401514

Email: shehlakhan7272@gmail.com

Received: 17 Jun 2025

Reviewed: 16 Dec 2025

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Contribution of Authors:

SA: Concept, Study design, Final approval

FK: Data collection

AM: Original drafting

SR: Review and Editing

MHK: Literature search and Review

JZ: Data computation

SAS: Critical proofreading

MA: Literature search and Review

HZ: Results tabulation

HG: Review and Revision

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ORIGINAL ARTICLE

HARNESSING THE THERAPEUTIC POTENTIAL OF SYNBIOTIC CONSUMPTION: MITIGATING STRESS AND ENHANCING NEURAL PLASTICITY IN MALE SPRAGUE DAWLEY RATS

Aysha Mushtaq, Shazia Ali*, Tooba Jamal*, Shagufta Feroz**,
Ayesha Zafar***, Mehvish Ashfaq†

Department of Physiology, HBS Medical and Dental College, Islamabad, *Islamic International Medical College, Riphah International University, Rawalpindi, **Riphah Institute of Lifestyle Medicine, Riphah International University, Islamabad, ***Dental College, HITEC-IMS, Taxila, †HITEC-IMS Taxila, Pakistan

Background: The hypothalamic-pituitary-adrenal (HPA) axis regulates homeostasis, and chronic stress triggers cortisol release, contributing to metabolic, cardiovascular, and neuropsychiatric disorders. Brain Derived Neurotrophic Factor (BDNF) plays a vital role in neural plasticity and stress adaptation. Objective was to determine and correlate serum cortisol and BDNF levels in rats consuming standard, probiotic, and synbiotic diets under stressors of immobilization and fasting. **Methods:** A randomized controlled trial was conducted at the National Institute of Health, Islamabad. Fifty male Sprague Dawley rats were divided into Control (Group A) and Interventional (Group B; subgroups B1–B4). Group A received a standard lab diet, whereas subgroups B1–B4 were exposed to immobilization and fasting stress with varying dietary interventions: standard diet (B1, B2), probiotic yogurt (B3), and synbiotic yogurt+legumes (B4). Serum cortisol and BDNF were measured at baseline, 4, and 10 weeks using ELISA. Data were analysed with SPSS-21 and $p < 0.05$ was considered significant. **Results:** After 10 weeks, Group B3 and B4 showed significantly decreased cortisol ($p < 0.001$) and increased BDNF ($p < 0.001$) compared to Group B2. A strong negative correlation was found between cortisol and BDNF ($r = -0.738$, $p < 0.001$). **Conclusion:** Synbiotic supplementation mitigated stress-induced neuroendocrine changes by lowering cortisol and elevating BDNF levels, suggesting that dietary modulation with probiotics and synbiotics may improve stress resilience and neural health.

Keywords: BDNF, Cortisol, HPA axis, Stress, Synbiotics

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INTRODUCTION

Stress is an inevitable element of modern life and a major contributor to disease progression. Chronic exposure to stress triggers maladaptive physiological responses, increasing the risk of cardiovascular, inflammatory, metabolic, and neuropsychiatric disorders.¹ The body perceives stress as a threat to homeostasis, engaging the hypothalamic-pituitary-adrenal (HPA) axis, which mediates the secretion of cortisol.² Persistent activation leads to metabolic dysregulation, inflammation, and impaired neural function.³

Decades of research have shown that stress has a role in gastrointestinal disease pathogenesis. Gut Dysbiosis associated with stress, alters the secretory activity, motility, and visceral sensitivity of the GI tract, as well as the permeability of the gut barrier.⁴ This goal is achieved through the auto-regulatory neural and hormonal systems, which work closely with the central and peripheral clocks to achieve this goal. A key regulatory pathway in the maintenance of these homeostatic processes is the HPA Axis.⁵

Circadian rhythms are mental, physical, and behavioural changes that follow a daily cycle, which respond primarily to light and darkness in an organism's environment. Timing of food abstinence and intake may affect circadian rhythms.⁶ Dysregulation of the circadian

cortisol rhythm is one marker that appears to coincide with the deleterious effects of chronic stress.⁷ Chronic and severe psychological and physical stress leads to HPA hyperactivity and cortisol hypersecretion.⁸

The scaffolding of the Gut-Brain axis consists of CNS, ENS, autonomic nerve systems, neuroendocrine and neuro-immune systems, and gut microbiota that has recently emerged as a critical regulator of gut-brain axis, particularly under times of stress. The gut micro biome has been associated to anxiety, depression, and irritable bowel syndrome.⁹ The introduction of Probiotics, Prebiotics or Synbiotic into human diet is favorable for the intestinal microbiota.¹⁰

There is a pulsatile pattern in which cortisol is secreted. The hypothalamic-pituitary-adrenal (HPA) pathway is involved in the rise of cortisol in response to physical and psychological stress. The hypothalamus stimulates corticotropin-releasing factor (CRF), which boosts adrenocorticotropin hormone (ACTH) production in the pituitary.¹¹ ACTH causes cortisol secretion from the adrenal glands. Long-term stressors induce on going cortisol production and so malfunction. The negative feedback mechanism causes neuronal degeneration, inflammation, hippocampal volume loss, anxiety and depression-like behaviours, increased susceptibility to infections, metabolic syndrome, obesity, mental health

disorders, cancer, cardiovascular diseases, insomnia, severe mood swings, depression, and severe hypotension.¹²

BDNF (Abrineurin) is a protein essential for synaptic transmission, neuroplasticity, and cognitive development. Low BDNF levels are linked to cognitive decline, while high levels boost cognitive function.¹³ Lifestyle factors like poor diet and physical inactivity can negatively impact mental and cognitive health. Dietary changes, such as consuming probiotics and prebiotics, may help increase BDNF levels and preserve cognitive and metabolic health.¹⁴ Probiotic and prebiotic supplements have been developed to manage intestinal micro ecological environment.¹⁵

Probiotics have been shown to prevent obesity, inflammatory diseases, cancer, and degenerative diseases. They positively influence innate immunity, exert antiviral properties, and impact mood, cognition, and gut microbiome. Probiotics also enhance gut barrier functions, stimulating B cells and influencing cytokine production. Consuming probiotic-rich yogurt and prebiotic legumes has been linked to cardio-metabolic benefits, reduced obesity and diabetes, and improved biomarkers of chronic diseases, including oxidative stress and inflammation.

In 1995, Gibson and Roberfroid introduced the term ‘Synbiotic’, defining it as a mixture of probiotics and prebiotics that benefits the host by improving the survival and introduction of live microbial dietary supplements. This concept has led to the development of therapeutic approaches targeting intestinal microflora to treat stress-related diseases. However, these treatments often have adverse effects and are unaffordable for many. Fortunately, we can now modify health through dietary regimes and lifestyle modifications, measuring effects through microbial or metabolic changes.¹⁵

Research on probiotics and prebiotics as well as the creation of synbiotics is the need of hour. There is a possibility that future research will find that certain components have beneficial impacts on human health. This research project serves the purpose by combining synbiotics (yogurt and legumes) and synchronizing their consuming time with circadian rhythm. Limited data is available in which this combination is used as a shield against stress. It is unclear whether probiotics might affect cognitive performance independent or dependent of the detrimental effects of stress.¹⁶

There is needed to understand the link between gut microbiota, stress, and neuropsychiatric disorders. This study investigates cortisol and BDNF levels in response to stressful lifestyles and co-morbidities. Large-scale clinical trials are necessary to determine the efficacy of synbiotic-based interventions in stress-related disorders, which could shed light on the impact of

microbiota perturbations on chronic stress and cognitive-related disorders.

MATERIAL AND METHODS

This randomized controlled animal study was conducted in collaboration with the Animal House, National Institute of Health (NIH), Islamabad, after approval from the Institutional Ethics Review Committees (Riphah/IIMC/IRC/21/65, NIH No. F.1-5/ERC/2021).

Fifty male Sprague Dawley rats weighing 250–300 g were randomly allocated into Control (A) and Interventional (B) groups. Group B was subdivided into 4 subgroups of 10 each. All rats were acclimatized for 7 days at 22±0.5 °C under a 12-hour light/dark cycle and fed a standard lab diet.

Stressors:

Immobilization (2 h/day, 5 days/week) and overnight fasting (10 PM–10 AM) for 10 weeks.

Dietary interventions:

B1: Prolonged fasting+immobilization (standard diet)

B2: Fasting+immobilization (standard diet, control for intervention)

B3: Standard diet+probiotic yogurt (8 g/day)

B4: Standard diet+synbiotic (yogurt 8 g/day+legumes 75 g/day)

Yogurt contained *Lactobacillus acidophilus* and *Streptococcus thermophilus*, verified at NARC Islamabad. Legumes (*Phaseolus vulgaris*, *Cicer arietinum*, *Lens culinaris*, *Vigna radiata*) were authenticated and cooked before mixing with the standard diet.

Blood samples were collected at baseline, 4, and 10 weeks. Serum cortisol and BDNF levels were measured using ELISA. Data were expressed as Mean±SD and analysed using ANOVA and Pearson correlation in SPSS-21, and $p \leq 0.05$ was considered significant.

RESULTS

The Mean±SD of serum levels of cortisol (ng/mL) of all the groups on day 0, 4th and 10th week are shown in Table-1. The Mean±SD of serum levels of BDNF (ng/mL) of all the groups on day 0, 4th and 10th week are shown in Table-2.

A strong negative correlation was also found between serum Cortisol and BDNF levels at week 10 (Pearson Correlation Coefficient= -0.738, $p \leq 0.001$)

Table-1: Serum levels of cortisol in male Sprague Dawley rats exposed to stressors of immobilization and overnight fasting at day 0, 4th and 10th week

Cortisol (ng/mL)	Group A (Control)	Group B (Interventional)			
		Group B1	Group B2	Group B3	Group B4
0 week	21.02±1.97	15.58±3.16	19.82±3.48	16.64±5.09	13.83±3.30
4 th week	21.69±1.74	92.29±8.31	73.20±9.67	69.30±11.62	70.60±9.47
10 th week	20.72±3.42	99.39±12.99	71.69±5.94	45.78±5.79	28.82±6.76

Table-2: Serum levels of BDNF in male Sprague Dawley rats exposed to stressors of immobilization and overnight fasting at day 0, 4th and 10th week

BDNF (ng/mL)	Group A (Control)	Group B (Interventional)			
		Group B1	Group B2	Group B3	Group B4
0 week	26.01±0.94	26.96±1.35	26.20±0.93	26.28±1.45	26.57±0.98
4 th week	26.05±0.94	16.09±1.34	19.17±0.95	16.96±1.28	17.38±1.22
10 th week	26.32±0.96	14.37±1.82	18.41±1.89	28.99±2.87	34.26±2.14

DISCUSSION

Stress is how a person reacts to external or internal issues and challenges. The organism employs various strategies to coordinate adaptive responses at the systemic and cellular levels.¹⁷ Chronic stress disrupts biological rhythms contributing to cerebrovascular illness, obesity, diabetes, poor neuronal plasticity, inflammation and uncontrollable eating disorders.¹⁸

The present research offers a variety of modalities for modifying one's lifestyle that may be practiced in the privacy of the individual's home and at a reduced cost to mitigate the negative consequences of chronic stress.¹⁹ Findings of current study showed that, serum cortisol of interventional Group-B after exposure to stresses at 1st experimental level were significantly raised at 4 weeks as compared to Day 0 and also compared with Control Group-A. This is in agreement with Sharma *et al*²⁰. Findings of this study showed that chronic stress increased serum cortisol levels when exposed to stresses of immobilization and fasting. The finding is consistent with the findings of a Buynitsky T *et al*²¹ and Noushad S *et al*²² that rise in serum cortisol was significant after restraining the rats as compared to other stressors.

The cortisol levels of Group B2 also remained significantly raised at 10 weeks but values were less than B1 indicating that prolonged stress and skipping morning meal could keep the cortisol levels highly raised. These findings are similar to study by Bonnet JP *et al*²³ that hyper activation of HPA axis due to chronic stress results from impaired negative feedback control, thus the system remains elevated for a long time once triggered resulting in increased levels of cortisol.

The mean cortisol levels of Group B3 and B4 were significantly decreased at 10 weeks as compared to that at 4 weeks due to synbiotic supplementation in regulating the serum cortisol levels close to baselines and preventing its increase.²⁴ These findings are also consistent with study conducted by Tulk HM *et al*²⁵.

Work by Fumagalli *et al*²⁶ found that restraint stress leads to a significant decrease in BDNF protein levels in the prefrontal cortex and striatum of males when they reach adulthood. Our study is in agreement with that study.

Current study is contradictory to work by Zuena *et al*²⁷ who found that restraint of the pregnant rat led to no change in BDNF expression in the female but

an increase in BDNF expression in male rat. In current study BDNF levels were markedly lowered after chronic stress. This indicates that early life stress can have long lasting effect on gene expression associated with neural development and ongoing neural plasticity.

In this study, serum levels of BDNF of Group B1 and of Group B2 remained significantly decreased at 10 weeks as compared to other groups due to stresses. The serum BDNF levels of Group B3 and B4 were significantly raised at 10 weeks with synbiotic treatment. This is due to the fact that gut bacteria affect BDNF levels via the creation of neurotransmitters, neuroactive short-chain fatty acids (SCFAs), secondary bile acids, and other physiologically active small molecules. By activating G protein-coupled receptors, SCFAs may regulate several brain areas (GPCRs).

According to Nazanin Heidarzadeh-Rad *et al*²⁸ post-intervention serum BDNF levels in the probiotics group were considerably higher than in the prebiotic placebo groups. That study investigating the impact of probiotics on BDNF levels in animal models is consistent with our findings. Yong SJ *et al*²⁹ discovered that injection of *L. helveticus* NS8 to rats with chronic stress increased Hippocampal BDNF mRNA, suggesting putative antidepressant-like effects.

Eight-week probiotic supplementation (composed of *L. acidophilus*, *Lactobacillus casei*, and *B. bifidum*) resulted in a larger reduction. In the present investigation, in conjunction with the findings of Mohammad Morshedi *et al*³⁰, probiotics/synbiotics treatment significantly increased BDNF levels. It may be argued that combining multiple strains into a single product could be more effective. By altering the intestinal microbiota, prebiotics can affect the brain and behaviour via microbe-derived molecules such as SCFAs and tryptophan metabolites, neuroactive molecules such as neurotransmitters, and neuronal signalling via stimulation of the vagus nerve, all of which play a role in reducing the inflammatory state and increasing the serum levels of BDNF.³⁰

CONCLUSION

Synbiotic supplementation significantly modulated stress-related biomarkers in rats exposed to chronic stress. A daily intake of probiotic yogurt and legumes normalized cortisol and elevated BDNF, promoting neuroplasticity and stress resilience.

RECOMMENDATIONS

Human-based, large-scale studies are required to confirm these findings. Molecular and microbiome analyses should be incorporated to elucidate mechanisms. Time-sequence stool collection scan be performed on individually housed animals, providing opportunity to assess changes in colonic microbiota over time.

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Address for Correspondence:

Dr Ayesha Zafar, Department of Physiology, HITEC-Institute of Medical Sciences, Taxila, Pakistan. **Cell:** +92-336-5601133
Email: ayeshezafar_30@hotmail.com

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Contribution of Authors:

AM: Methodology, Data analysis, interpretation, critical review, revision of manuscript, Final approval, final proof to be published

SA: Conceptualization, study design, methodology, data analysis, and Writing Draft

TJ: Conceptualization, Study Design, Methodology, data analysis, interpretation and Writing Draft

SF: Methodology, Data analysis and interpretation

AZ: Study Design, writing draft

MA: Methodology, Data analysis and interpretation and writing draft

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ORIGINAL ARTICLE

COMPARISON OF SERUM LIPID PARAMETERS IN NORMAL, DIABETIC AND TURMERIC TREATED DIABETIC RATS

Javaria Latif, Aysha Zaheer*, Mah e Jabeen Sear**, Saima Mukhtar**, Iram Qamar**, Sara Naeem**

Department of Physiology, CMH Institute of Medical Sciences, Bahawalpur, *Services Institute of Medical Sciences, Lahore, **Rahbar Medical & Dental College, Lahore, Pakistan

Background: Alteration in lipid profile is a common complication of diabetes leading to life threatening conditions. Aim of this study was to compare serum lipid profile parameters in control, diabetic and diabetic animals given turmeric powder and to determine the improvements in lipid profile in diabetic rats with the use of turmeric powder. **Methods:** In this experimental study, carried out at Postgraduate Medical Institute Lahore, 45 albino rats were randomly divided into three equal groups (normal control, diabetic and diabetic receiving turmeric therapy). Initially, Alloxan was administered to all the animals except normal control to produce diabetes. After confirmation of diabetes, one diabetic group was selected to be treated with turmeric powder dissolved in water in dosage of 250 mg/Kg body weight. Blood samples were obtained from rats after 12-hour fasting period at the start of experiment after confirmation of diabetes, week eight and week twelve. **Results:** When comparison was made, mean values of lipid profile parameters were significantly higher for diabetic control and diabetic animals receiving turmeric therapy as compared to normal control during week eight but the difference between both the diabetic groups was also significant. By the end of week twelve the difference between normal control and diabetic animals receiving turmeric therapy became non-significant with improvement in lipid profile parameters of diabetic rats receiving turmeric powder. **Conclusion:** Therapy with turmeric powder induces improvement in lipid profile of diabetic rats with dyslipidemia.

Keywords: Curcumin, Diabetes Mellitus, Lipid parameters

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INTRODUCTION

According to the report of ‘International Diabetes Federation’ approximately 537 million individuals in between 20 to 79-year of age are having diabetes, expected to rise by 783 million in 2045.¹ Middle East and South East Asia are becoming high disease prevalent countries due to sedentary life styles, obesity and unhealthy diets.^{2,3}

Alteration in lipid profile parameters (dyslipidemia) is common in diabetics, exhibiting poor glycemic control.^{4,5} Deficiency of insulin and impaired insulin sensitivity are the reasons to develop altered lipid metabolism.⁶ Increased levels of total serum cholesterol, serum phospholipids and low serum HDL cholesterol are major risk factors for development of cardiovascular complications in diabetic individuals.⁷ By providing proper diet regimen, making appropriate lifestyle changes including exercise and keeping the stability of blood glucose levels in normal range, complications associated with diabetes (dyslipidemia) can be prevented.^{7,8}

Turmeric plant since primordial times is found to have medicinal properties and is commonly available in tropical (Asian) countries.⁹ According to the recent research Curcumin, an active ingredient of turmeric is helpful to maintain normal blood lipid levels by controlling the absorption, transport and excretion of cholesterol.¹⁰ Turmeric is believed to maintain

cholesterol homeostasis by increasing the expression of enzyme CYP7A1, which is involved in cholesterol metabolism.

Through its anti-inflammatory and anti-oxidant effects, turmeric (curcumin) is able to prevent development of intractable complications induced by diabetes like atherosclerosis and ischemic heart disease.¹¹ By reducing the levels of inflammatory indicators (hs-CRP, TNF- α and IL-6), curcuminoids have protective effect on the beta cells of pancreas and improvement in insulin resistance thus beneficial to maintain blood glucose levels of diabetics and indirectly preventing the abnormal alterations in serum lipid levels.¹²

This study was focused to compare some of main serum lipid profile parameters among normal, untreated diabetic, and diabetic rats on turmeric therapy, and to find out some dietary supplement which can reduce the chances of having complications like dyslipidemia in diabetic patients.

MATERIAL AND METHODS

Forty-five Sprague-Dawley rats with average age of 11 weeks, were selected for this study. Sample size was calculated using resource equation method for one-way ANOVA by using the formula $n = \frac{DF}{k} + 1$ to obtain maximum number of animals per group. Rats were acclimatized in animal house of Post-Graduate Medical Institute, Lahore for one week. All the rats had free

access to the rat chow diet and water. Animals were kept at 24 ± 5 °C with 12-hour light/dark cycle. Total duration of this experiment was 4 months, approval was granted by Ethical Committee of Animal Sciences of the Institute.

After completion of acclimatization period, all 45 rats were randomly divided into 3 equal groups of 15 using simple random sampling with balloting method. All animals except normal controls were administered intraperitoneal injection of alloxan 130 mg/Kg body weight as one-time dose, dissolved in normal saline after overnight fast. Diabetes was confirmed in animals after 5–7 days of alloxan injection on tail vein blood with glucometer. Animals having blood glucose levels >200 mg/dL were included in the experiment.

For the next 12 weeks, healthy rats of normal control group and the animals of diabetic control group were given normal synthetic rat diet and 3 mL distilled water per day. The third group animals were given powdered rhizomes of *Curcuma longa* (turmeric) 250 mg/Kg body weight per day dissolved in 3 mL of distilled warm water.

Blood samples (1.5–2.5 mL per animal) of all animals were taken from saphenous vein after a fasting period of 12 hours. Blood was collected initially when diabetes was confirmed, then after 8 weeks and finally by the end of 12th week.¹³ Total serum cholesterol, total serum phospholipids, LDL-c and HDL-c were measured by direct quantitative (enzymatic colorimetric method).¹⁴ Automated chemistry analyser was used for tests performed in Chemical Pathology Lab of PGMI Lahore.

Data analysis was done using SPSS-23. Quantitative data were expressed as Mean $\pm$ SD. To compare lipid profile parameters among groups, one-way ANOVA was used. For comparison of all the possible pairs of means, Post hoc Tukey test was applied, and $p\leq 0.05$ was considered statistically significant.

RESULTS

At the start of experiment, mean total serum cholesterol level for animals in healthy control group was 73 ± 7 mg/dL, which remained in normal range during twelve-week time period and was 64 ± 7 mg/dL at the end. The total serum cholesterol level for diabetic group and diabetic animals having turmeric therapy, increased to 143 ± 13 mg/dL and 131 ± 15 mg/dL respectively, after induction of diabetes. The total serum cholesterol level of rats receiving turmeric declined during experiment with mean total serum cholesterol level 91 ± 12 mg/dL at week 8 and 64 ± 19 mg/dL at last day of study. An increase in total serum cholesterol level for diabetic control animals was recorded with mean total serum cholesterol level 214 ± 22 mg/dL at the end (Table-1).

When comparison was made among groups at different times, it was observed that mean total serum cholesterol levels were significantly different ($p<0.001$).

By the end of week eight, diabetic control animals and those having turmeric therapy had significantly higher mean values ($p<0.001$) as compared to normal control, and the difference between the diabetic control and turmeric receiving diabetics was also significant ($p<0.001$). Mean total serum cholesterol level of diabetic control animals raised significantly as compared to normal control ($p<0.001$) at the end of the experiment and was also significantly higher from the diabetic animals receiving turmeric powder ($p<0.001$). The difference between normal control and diabetics having turmeric treatment was found insignificant ($p=0.987$), at the end of week 12. (Table-1).

The mean total serum phospholipids level of animals in normal control group was 103 ± 8 mg/dL at the start and 92 ± 7 mg/dL at the end. The serum phospholipids level increased to 110 ± 11 mg/dL and 126 ± 14 mg/dL for the other two groups after diabetes. The serum phospholipids level gradually decreased for animals receiving turmeric throughout the experiment with mean value 90 ± 15 mg/dL by the end of week 12. Gradual increase in serum phospholipids level of diabetic control animals was observed with mean serum phospholipids level 129 ± 21 mg/dL and 170 ± 38 mg/dL at week 8 and 12. (Table-2).

The pair-wise comparison explained a higher mean value in turmeric treated animals as compared to the other two groups ($p<0.001$ respectively) and the difference between normal control and diabetic control was not significant ($p=0.297$) at the start of study. At week 8 the diabetic control had significantly higher average of total serum phospholipids by 31.4 mg/dL and 26.9 mg/dL ($p<0.001$) as compared to normal control and animals receiving turmeric therapy. By the end of week 12, mean serum phospholipids level of animals in diabetic control increased by 78.5 mg/dL as compared to normal control ($p<0.001$) and was significantly higher by 80.9 mg/dL from diabetic treated animals ($p<0.001$). The difference of 2.4 mg/dL between diabetics and diabetics with turmeric treatment was recorded which was insignificant ($p=0.957$).

At the start of experiment, the mean value of LDL/HDL ratio observed for animals in healthy control group was 2.83 ± 0.60 , which declined a bit during 12-week time and was 2.44 ± 0.49 at the end. The LDL/HDL ratio for animals in other two groups increased to 5.80 ± 1.78 and 7.72 ± 4.69 respectively after diabetes. The LDL/HDL ratio of animals declined for diabetic animals having turmeric treatment during the experiment with mean value of 4.53 ± 2 at week 8 and 2.62 ± 1 at the end. The LDL/HDL ratio for diabetic control animals was observed to be increased with mean LDL/HDL ratio 11.06 ± 5.7 at week 8 and 19.18 ± 6.9 at week 12. When groups were compared at different measurement times, the mean ratios were found statistically significant ($p<0.001$). (Table-3).

Initial pair-wise comparison done by post-hoc Tukey test showed a higher mean value of LDL/HDL ratio in diabetic control animals and those receiving turmeric when compared to healthy control animals ($p<0.05$ and <0.001 respectively). The diabetic control animals had significantly higher average ratio ($p<0.001$) as compared to the other two groups by week 8, and the difference between the normal control group and diabetic turmeric treated group was not significant ($p=0.319$). By the end of week 12, the mean LDL/HDL ratio of diabetic control animals was higher by 16.74 compared to normal control ($p<0.001$) and was significantly higher by 16.56 from rats having turmeric therapy ($p<0.001$). The difference of 0.18 between normal control and turmeric receiving diabetic animals was observed which was not statistically significant ($p=0.991$).

Table-1: Comparison of total serum cholesterol levels of animals at given times (mg/dL, Mean $\pm$ SD)

Animal Groups	start of study (after diabetes)	8 th week	12 th week
Healthy control	73 $\pm$ 7	69 $\pm$ 6	64 $\pm$ 7
Diabetic control	143 $\pm$ 13	185 $\pm$ 15	214 $\pm$ 22
Diabetic+turmeric treated	131 $\pm$ 15	91 $\pm$ 12	64 $\pm$ 19
<i>p</i>	<0.001	<0.001	<0.001

Table-2: Comparison of serum phospholipids levels of animals at given times (mg/dL, Mean $\pm$ SD)

Animal groups	start of study (after diabetes)	8 th week	12 th week
Healthy control	10 $\pm$ 8	98 $\pm$ 9	92 $\pm$ 7
Diabetic control	110 $\pm$ 11	129 $\pm$ 21	170 $\pm$ 38
Diabetic+turmeric treated	126 $\pm$ 14	102 $\pm$ 17	90 $\pm$ 15
<i>p</i>	<0.001	<0.001	<0.001

Table-3: Comparison of LDL/HDL-cholesterol ratio of animals at given times (mg/dL, Mean $\pm$ SD)

Animal groups	start of study (after diabetes)	8 th week	12 th week
Healthy control	2.83 $\pm$ 0.60	2.66 $\pm$ 0.70	2.44 $\pm$ 0.49
Diabetic control	5.80 $\pm$ 1.78	11.06 $\pm$ 5.70	19.18 $\pm$ 6.99
Diabetic+turmeric treated	7.72 $\pm$ 4.69	4.53 $\pm$ 2.01	2.62 $\pm$ 1.03
<i>p</i>	<0.001	<0.001	<0.001

DISCUSSION

This study's findings emphasize the notable dyslipidemia linked to diabetes and illustrate the possibility of turmeric powder as a therapeutic measure to alleviate these metabolic disorders. The enhanced blood lipid profile characteristics reported in diabetic control rats at week eight correspond with established data that hyperglycaemia intensifies lipid irregularities by facilitating lipolysis, augmenting free fatty acid flow, and disrupting lipoprotein metabolism.¹⁵ Notably, the diabetic group receiving turmeric exhibited a significant reduction in lipid parameters compared to the untreated diabetic group by week eight, suggesting an early but partial therapeutic effect. However, the normalization of lipid profiles in the turmeric-treated group by week 12, were close to the non-diabetic controls emphasizing the time the time-dependent efficacy of turmeric in restoring metabolic homeostasis.¹⁶

Curcumin, the bioactive compound of turmeric is ascribed for the gradual modification of lipid picture after extended use due to its influence on lipid metabolism through different mechanisms.¹⁷ Another study indicates that the expression of peroxisome proliferator-activated receptor gamma (PPAR- γ) and liver X receptors (LXRs) both essential regulators of cholesterol release and lipoprotein metabolism, are increased in response to curcumin.¹⁸ Helping to lower oxidative stress is curcumin's antioxidant properties. By lowering lipid peroxidation and enhancing the body's natural antioxidant defences, this oxidative stress is vital in the development of dyslipidemia connected to diabetes.¹⁹ By week twelve, the lipid levels are seen to rise in diabetic control group whereas the turmeric treated diabetic group has significant decrease in lipid profile. The findings conform to the study by Muhammed WI, with the difference that dyslipidemia was introduced by intraperitoneal dexamethasone.²⁰

These results support earlier studies showing curcumin's ability to lower total cholesterol, triglycerides, and LDL-C while raising HDL-C in diabetic mice.²¹ A meta-analysis²² of preclinical studies stressing the duration-dependent efficacy of phytochemicals in metabolic diseases supports the conclusion that sustained administration is necessary for attaining clinically significant outcomes as observed in the current study. The normalization of lipid markers in the turmeric-treated group matches clinical observations showing better cardiovascular risk profiles in diabetic patients on curcumin supplementation.²³

Despite these positive results, the study used an animal model which does not fully reflect human metabolic complexity. Future research should look into turmeric's translational potential in human trials, particularly with relation to long-term effects on diabetic dyslipidemia and cardiovascular outcomes. Clinical trials with the use of purified curcumin instead of raw turmeric powder can produce much better effects.

CONCLUSION

The improvements in lipid profile parameters (total serum cholesterol, phospholipids, and LDL/HDL ratio) are observed in this study with the use of turmeric powder when comparison was made among normal control, diabetic control, and diabetic rats treated with turmeric (curcuminoids).

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Address for Correspondence:

Dr Aysha Zaheer, Associate Professor, Department of Physiology, Services Institute of Medical Sciences, Lahore, Pakistan. **Cell:** +92-333-4222413
Email: ayshazaheer33@gmail.com

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Contribution of Authors:

JL: Conceptualizing, data collection, literature review, drafting manuscript

AZ: Critically reviewing the manuscript

MJS: Interpretation of data

SM: Statistical analysis

IQ: Editing of manuscript

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ORIGINAL ARTICLE

FREQUENCY, RISK FACTORS, AND AWARENESS ABOUT ORAL CANCERS AMONG PATIENTS PRESENTING AT TERTIARY CARE HOSPITALS IN LAHORE

Hafiz Waqas Ahmed, Asghar Ali, Ayesha Rais*, Iqra Sarwar**, Shoaib Zuberi***, Muhammad Afraz Naeem[†], Ferheen Shahbaz^{††}

Department of Oral and Maxillofacial Surgery, Mayo Hospital, Lahore, *Bolan Medical University, Quetta, **Department of Surgery, Lahore Medical and Dental College, Lahore, ***Gambat Institute of Medical Sciences, Gambat, [†]King Edward Medical University, Lahore, ^{††}Department of Public Health, University of Punjab, Lahore, Pakistan

Background: Oral squamous cell carcinoma (OSCC) presents a substantial health challenge in areas where betel nut chewing and tobacco use are prevalent. This study aims to evaluate the contributing risk factors of oral cancers (OC), to know the awareness of the disease in patients, and to attribute knowledge towards early management. **Methods:** It was a cross-sectional survey using closed-ended questionnaires to collect data from 120 patients aged 18 years or older who had been diagnosed with oral cancer, after approval of the IRB. Details of tobacco, betel quid, and *Gutka* (گٹکا) use, and awareness about disease and its management were recorded. Data were tabulated as frequencies and percentages. **Results:** Male patients in the study were affected more with OC than females. Patients aged above 40 years were more prevalent. The most common and significant risk factors were tobacco and betel nut. Oral cancer was seen more in patients with low socio-economic status (SES) and uneducated people belonging to urban areas. Level of awareness was very low among the patients. **Conclusion:** Oral Squamous Cell Carcinoma occurs more frequently in males with the highest incidence in 4th decade of life. Using tobacco was identified as the predominant risk factor, followed by betel nut and *Gutka* consumption. Enhancing public awareness may facilitate earlier detection, improved treatment outcomes, and ultimately lead to a better quality of life for affected individuals.

Keywords: Betel quid, Education, Oral cancer, Risk factors, Socio economic status, Tobacco

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INTRODUCTION

Oral cancer (OC) is among the top ten cancers globally and it is lethal. It is one of the most common types of cancers in Southeast Asia due to habit of chewing betel nuts, smoking, and drinking alcohol.^{1,2} Despite its high frequency, cancer of the oral cavity has been generally overlooked since symptoms occur late, resulting in restricted advances in diagnosis and therapy.³ In Pakistan, the cancer of head and neck is the most frequent type of cancer. Unhealthy practices, such as areca nut eating, betel nut, and smoking are significant risk factors for oral squamous cell carcinoma (OSCC).⁴

Pervasive sites of OSCC are tongue and oral cavity tumours, followed by lip and palate malignancies.⁵ OCSS has a significant death rate due to spread, with an overall 5-year survival rate of 50%. Half of those diagnosed die within their initial years of diagnosis.⁶ The diagnosis is based on the clinical, radiological, and histological examination. The different methods included in the diagnosis are OPG, CT dent scan, MRI, bone scans, ultrasound, and PET CT.

The stage of oral cancer depicts its severity, the extent of cancer, and the tendency to spread, and is determined by clinical and pathological staging. TNM staging is the widely used method. The significance of staging is that it helps in decision-making and provides optimal treatment regimen.^{7,8} The degree to which the

cancerous cells mimic healthy ones and how they react to therapy are the two main factors used to grade oral cancer. Treatment options differ based on the site, degree, local, and regional metastases.⁹

Oral cancer is a major health concern worldwide, and WHO expects that global incidences of mouth cancer will rise substantially in the next decades. The increasing occurrence of OC is alarming situation, and the basic risk factors and pathogenesis of this deadly illness should be better understood.¹⁰ It is vital to understand that risk factors play a crucial role in growth of a certain type of oral cancer. It is vital to eliminate these risk factors to avoid an outbreak of oral cancer.¹¹

Because people are ignorant of the most serious effects and risk factors for the disease and the reporting symptoms with a low chance of survival, there is need for more research and resources to tackle this lethal sickness. The current study aimed to explore prevalence of OSCC and gender differences, as well as risk factors for it.

METHODOLOGY

This cross-sectional study was conducted at Mayo Hospital, Lahore, Alle Fatima Hospital and other tertiary care hospitals from Jun to Nov 2022. The study was approved by the Institutional Review Board of Alle Fatima Hospital, Lahore (Ref. No. AFH-IRB-07-144,

dated 7 Feb 2022. Written informed consent was obtained from all patients.

The sample size was calculated to be approximately 120 patients using the Raosoft sample size calculator, with a 95% confidence level, 5% margin of error, and an assumed response distribution of 50%. Patients aged 18 years or older with a history, physical examination, and histologically confirmed diagnosis of OSCC were included using non-probability consecutive sampling technique.

Data were collected on age, gender, duration of symptoms, type of lesion, pattern of clinical presentation, and risk factors such as use of tobacco, betel nut, *gutka* (گٹکا), alcohol, sunlight exposure, and sharp teeth.

RESULTS

A total number of 120 patients were included of which 83 (69.17%) were male and 37 (30.83%) were female. The male-to-female ratio was 2.2:1. The patients with different age groups were included, i.e., 18–25 years were 6 (5%), 26–40 years were 18 (15%), and >40 years were 96 (80%). (Table-1).

The most common risk factor was tobacco use 86.7%, the second most common was betel quid and *gutka* (گٹکا) 75%, repeated trauma due to sharp teeth was seen in 68.3%, loss of fitted dentures was 62.5%, poor oral hygiene cases were 46.6%, exposure to sunlight was seen in 25%, alcohol use in 15% and malnutrition in 8.3%. (Table-2).

Only 12.3% of participants had an idea about oral cancer. Whereas 84.2% and 83.3%, respectively believed that oral cancer was neither preventable nor treatable. Only 16.7% believed that oral cancer is curable. (Table-3).

Table-1: Demographics of the population

Variable	Category	n (%)
Age	18–25 years	6 (5.0)
	26–40 years	18 (15.0)
	>40 years	96 (80.0)
Gender	Male	83 (69.17)
	Female	37 (30.83)

Table-2: Predisposing risk factors for oral cancer among study participants (n=120)

Risk Factor	Category	n (%)
Tobacco use	High	104 (86.7)
	Low	16 (13.3)
Betel quid and <i>Gutka</i> (گٹکا)	Yes	90 (75)
	No	30 (25)
Repeated trauma due to sharp cusp teeth	High	82 (68.3)
	Low	38 (31.7)
Loose-fitted dentures	Yes	75 (62.5)
Poor oral hygiene	Present	56 (46.6)
Exposure to sunlight	Yes	30 (25)
Alcohol use	Present	18 (15)
Malnutrition	Present	10 (8.3)

Table-3: Awareness and perceptions about oral cancer among participants [(n (%))]

Question	Yes	No
Are you aware of oral cancer?	15 (12.5)	105 (87.5)
Is it possible to prevent oral cancer?	19 (15.8)	101 (84.2)
Is it possible to treat oral cancer?	20 (16.7)	100 (83.3)

DISCUSSION

Oral squamous cell carcinoma accounts for nearly 90% of all head and neck cancers and can arise from any part of the upper aerodigestive tract, including the lip, oral cavity, nasopharynx, oropharynx, hypopharynx, and larynx.¹² Each sub-site demonstrates distinct clinical behaviour in terms of local spread, nodal metastasis, and treatment response. For instance, lower alveolar OSCC is particularly associated with cervical lymph node metastases, especially in the submandibular triangle and upper jugular nodes.¹³ In such cases, palpable, painful, and fixed lymph nodes, particularly those exceeding 2 Cm are indicators of metastatic involvement. The prognosis of OSCC is favourable when detected early, especially for well-differentiated, non-metastatic lesions. However, majority of cases are diagnosed at advanced stages.¹⁴ Recent advances in treatment, such as laser-based techniques, photodynamic therapy, immunotherapy, and gene therapy, are now being explored to improve outcomes in early-stage OSCC.¹⁵

Hernández-Guerrero *et al*¹⁶ reported a male-to-female ratio of 1.4:1 in Mexico. In our study, the male-to-female ratio was 2.2:1, which is comparable to the study conducted by Khaleel ME *et al*¹⁷ who also found that males were more prone to OSCC. The middle-aged group (45–65 years) was most affected in our study, which aligns with the findings of Javed *et al*¹⁸ where the majority of OSCC patients were aged 47.62±12.18 years. Anwar *et al*¹⁹ also reported that patients above 40 years were significantly more affected.

Tobacco use was identified as the most significant risk factor in our study. This aligns with the findings of Balaram *et al*²⁰ who noted that over 90% of OSCC cases reported tobacco use. Madani *et al*²¹ observed that tobacco acts as an independent risk factor, increasing gingival blood flow, arterial blood pressure, and heart rate, with an OSCC occurrence rate 11 times higher among users compared to non-users. Our findings support these studies, reinforcing the central role of tobacco in pathogenesis of OSCC.

Another risk factor observed in our population was chronic use of ill-fitting dentures, causing long-term mucosal irritation. Several studies have indicated that wearing dentures for over 15 years without regular dental consultations is strongly associated with OSCC.^{22–24} Our results also reflect this association.

Only 12.3% of respondents were aware of oral cancer, and a mere 15.9% and 17.0% believed it was preventable and treatable, respectively. These figures are consistent with previous research by Mangalath *et al*²⁵ and Zhou XH *et al*²⁶ who found that public knowledge regarding oral cancer prevention and treatment remains poor across many low- and middle-income countries. These low awareness levels reflect a serious gap in health education and underline the need

for effective community outreach programs.

There is urgent need to educate the general public about OSCC risk factors, especially tobacco, betel quid, and poor oral hygiene, to facilitate behavioural change. Harmful habits are still common, and knowledge regarding cancer prevention and early detection is limited. Lack of information contributes to late-stage diagnoses, as many individuals seek medical attention only after symptoms have progressed significantly, when prognosis is often poor.

Our findings emphasize the importance of regular dental checkups and early consultations for any suspicious oral lesions. Awareness campaigns and school- and community-level education programs could play a vital role in enhancing public understanding, dispelling myths, and promoting early diagnosis and treatment-seeking behaviour.

CONCLUSION

Oral Squamous Cell Carcinoma occurs more frequently in males with the highest incidence in 4th decade of life. Using tobacco was identified as the predominant risk factor, followed by betel nut and *Gutka* (گٹکا) consumption. Enhancing public awareness may facilitate earlier detection, improved treatment outcomes, and ultimately lead to a better quality of life for affected individuals.

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Address for Correspondence:

Dr Hafiz Waqas Ahmed, Department of Oral and Maxillofacial Surgery, Mayo Hospital Lahore, Pakistan. Cell: +92-300-4111241

Email: Dr.hafizwaqas@yahoo.co.uk

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ORIGINAL ARTICLE

FREQUENCY OF MINOR BLOOD GROUP ANTIGENS —A STEP TOWARDS SAFER TRANSFUSION

Saadia Saad, Raheela Pyar Ali*, Sana Soomro**, Uzma Najam**, Asaad Javaid***

Department of Biological and Biomedical Sciences, Aga Khan Medical College, Karachi, *Consultant, Hussaini Institute of Haematology, Karachi,

Department of Physiology, United Medical and Dental College, Karachi, *Baqai Medical University, Karachi, Pakistan

Background: ABO and Rh blood typing is done routinely prior to transfusion, but weaker blood group antigens like Kell, Duffy, and Kidd also have clinical relevance because of their involvement in haemolytic transfusion reactions (HTRs) and haemolytic disease of the foetus and newborn (HDFN). There is sparse data regarding the frequency of these antigens in Pakistanis. This study aimed to find the prevalence of minor blood group antigens—Kell, Duffy, and Kidd—among male O blood group donors. **Methods:** A cross-sectional study was carried out in 200 male O blood group donors from Hussaini Blood Bank during April to June 2024. Routine serological methods were used to identify Rh (excluding ‘e’), Kell (K, k), Duffy (Fya, Fyb), and Kidd (Jka, Jkb) antigens. Frequencies are presented as percentages and compared with pertinent Pakistani studies of the past decade. **Results:** Of all Rh antigens, D was most common (86%), followed by C (74%), c (68%), and E (28%). ‘K’ antigen was present in 4% of donors, while ‘k’ was present in 98%. Fya and Fyb antigens were present in 78% and 64% respectively. Jka and Jkb antigens were present in 77% and 68% of donors. These results were consistent with earlier national and regional findings. **Conclusion:** A sufficiently greater prevalence of clinically significant minor blood group antigens underscores the importance of prolonged antigen characterization in blood banks for improving transfusion safety.

Keywords: Blood banks, Duffy blood group protein human, Kell blood group protein human

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INTRODUCTION

Blood transfusion remains a foundation of modern medical practice, vital for managing a variety of clinical conditions ranging from surgical interventions to traumatic injuries and haematological disorders. The selection of compatible blood for transfusion is paramount, primarily focusing on the ABO and Rh blood group systems, which play a critical role in preventing haemolytic transfusion reactions (HTRs).¹ However, beyond these major blood groups, numerous minor blood group antigens exist, which, despite their nomenclature, possess significant clinical implications.²

The International Society of Blood Transfusion (ISBT) recognizes approximately 43 blood group systems encompassing 349 red cell antigens. Among these, the Kell, Duffy, and Kidd systems are notable for their clinical significance.³ Antibodies to these blood group antigens have been implicated in immediate and delayed HTRs and in Haemolytic disease of the foetus and newborn (HDFNs), frequently characterized by a decrease in post-transfusion haemoglobin levels.^{4,5} Consequently, patients with a history of alloimmunization or those requiring long-term transfusion support may necessitate antigen-free blood to lessen the risk of these complications.

The prevalence of minor blood group antigens varies significantly across different ethnicities and geographical regions.⁶ Therefore, establishing

population-specific data is crucial for improving blood transfusion practices and ensuring patient safety. In Pakistan, there is a paucity of comprehensive data regarding the prevalence of clinically significant minor blood group antigens. Recognizing this gap, this study aimed to investigate the frequency of Kell, Duffy, and Kidd antigens in male donors having O blood group. Furthermore, this study compared the findings with other researches conducted within the Pakistani population over the past 10 years. This approach allows us to better understand the local distribution of these antigens and its implications for transfusion medicine.

The selection of O blood group donors, known for their universal compatibility due to the absence of A and B antigens, was predicated on their critical role when matching blood is unavailable. While they lack major antigens, minor blood group antigens present in O blood can still trigger alloimmunization and HTRs, particularly in patients with transfusion histories.⁷ Therefore, having comprehensive data on the prevalence of these antigens in this population is essential for developing strategies to provide antigen-negative blood to sensitized patients.

METHODOLOGY

This cross-sectional study, conducted at Hussaini Blood Bank from April to June 2024, after ethical approval from Baqai Medical University (ERB# 2024/0028) included 200 blood donors. Only

individuals with O blood type were selected after taking informed consent. To ensure a homogenous study population, only male blood donors meeting standard transfusion criteria, possessing a normal haemoglobin level (13.5–18 g/dL), and a negative DAT (direct anti globulin test) were included. O blood group was the sole inclusion criterion for blood type regardless of their Rh status. Female donors were excluded due to prevalent anaemia, and non-O blood groups were excluded to maintain focus on the ‘antigen free’ blood group.

ABO and Rh blood typing was conducted using the tube technique. Rh antigen detection was comprehensive, with the exception of ‘e’ antigen (due to reagent unavailability). Indirect anti-globulin testing, using Lorne Laboratories kits, was employed to analyze the Kell (K, k), Duffy (Fya, Fyb), and Kidd (Jka, Jkb) minor blood group antigens.

For statistics, SPSS-25 was used. The prevalence of minor blood group antigens was expressed in frequencies and percentages and were compared with other studies from Pakistan conducted in the last decade.

RESULTS

The study included 200 male blood donors having mean age of 28.56 ± 7.38 . The frequency of Rh antigens in the whole population showed 86% of D antigens followed by C (74%), c (68%) and E (28%). The antigen ‘e’ could not be explored because of the non-availability of reagents. (Table-1).

Out of 200 blood donors, 172 (86%) were Rh-positive and 28 (14%) were Rh-negative. When the individuals were segregated into Rh⁺ and Rh⁻ separately, the order of frequency in Rh⁺ was C>c>E.

Table-2: Frequency of minor blood group antigens and comparison with other Pakistani studies

Antigens	Current Study	Study from Karachi ⁸	Study from Islamabad ⁹	Study from Lahore ¹⁰	Study from Rawalpindi ¹¹	Study from Rawalpindi ¹²
(Kell) K	8 (4%)	0%	4%	3.6%	4.05%	N/A
(Kell) k	196 (98%)	100%	N/A	96.3%	98.9%	N/A
(Duffy) Fy ^a	156 (78%)	N/A	58.24%	N/A	N/A	N/A
(Duffy) Fy ^b	128 (64%)	N/A	39.84%	N/A	N/A	N/A
(Kidd) Jk ^a	154 (77%)	N/A	65.28%	N/A	N/A	73.2%
(Kidd) Jk ^b	136 (68%)	N/A	42.24%	N/A	N/A	75.4%

N/A= Not available

Table-3: Phenotype frequency of minor blood group antigens and comparison with other Pakistani studies

Phenotype	Current Study	Study from Karachi ⁸	Study from Islamabad ⁹	Study from Rawalpindi ¹¹	Study from Rawalpindi ¹²
K ⁺ k ⁻	4 (2%)	0%	N/A	0.3%	N/A
K ⁺ k ⁺	192 (96%)	100%	N/A	95.15%	N/A
K ⁻ k ⁺	4 (2%)	0%	N/A	3.75%	N/A
K ⁻ k ⁻	0	0%	N/A	0.8%	N/A
Fy ^{a+} Fy ^{b-}	64 (32%)	N/A	34.56%	N/A	N/A
Fy ^{a+} Fy ^{b+}	40 (20%)	N/A	15.36%	N/A	N/A
Fy ^{a+} Fy ^{b+}	76 (38%)	N/A	27.04%	N/A	N/A
Fy ^{a-} Fy ^{b-}	0	N/A	23.04%	N/A	N/A
JK ^{a+} JK ^{b-}	44 (22%)	N/A	40%	N/A	23.6%
JK ^{a+} JK ^{b+}	16 (8%)	N/A	13.6%	N/A	25.7%
JK ^{a+} JK ^{b+}	88 (44%)	N/A	27.52%	N/A	49.6%
JK ^{a-} JK ^{b-}	8 (4%)	N/A	18.88%	N/A	1.1%

N/A= Not available

However, in Rh⁻ donors, all individuals showed ‘c’ antigen on their RBCs and none had ‘C’ or ‘E’ antigen, showing association of ‘c’ antigen with Rh⁻ blood group. Similarly, ‘C’ antigen was found to be more associated with Rh⁺ blood group than Rh⁻ (86% and 0% respectively).

In the Kell blood group system, the ‘K’ antigen was observed at a frequency of 4%, while the ‘k’ antigen was 98%. Within the Duffy system, the ‘Fya’ antigen displayed a frequency of 78%, and the ‘Fyb’ antigen as 64%. In the Kidd system, the ‘Jka’ antigen was found at 77%, and the ‘Jkb’ antigen at 68%. The observed frequencies of Duffy and Kidd antigens (Fya, Fyb, Jka, and Jkb), ranging from 64% to 78%, indicate a high prevalence of these antigens within our study population. For the Duffy system, a single comparable study conducted in Islamabad aligns with our finding of a higher ‘Fya’ prevalence compared to ‘Fyb’.

Phenotype frequency analysis demonstrated that K⁺k⁺ was the most prevalent phenotype in the Kell blood group system, followed by K⁺k⁻ and K⁻k⁻. In the Duffy system, Fy^{a+}Fy^{b+} was the most common phenotype, observed in 38% of samples, while Fy^{a+}Fy^{b-} and Fy^{a-}Fy^{b+} were found in 32% and 20% of the samples, respectively. The Jka⁺Jkb⁺ phenotype was the most frequent in the Kidd system, followed by Jka⁺Jkb⁻ and Jka⁻Jkb⁺ in this study.

Table-1: Frequency of Rh antigens in Rh⁺ and Rh⁻ donors separately

Antigens	Rh ⁺ donors [n=172 (86%)]	Rh ⁻ donors [n=28 (14%)]	Antigen frequency in population
C	148 (86%)	0 (0%)	74%
C	108 (62.8%)	28 (100%)	68%
E	56 (32.6%)	0 (0%)	28%

DISCUSSION

Our findings for the Rh blood group system revealed a D antigen frequency of 86%, aligning with the expected high prevalence of Rh-positivity in most populations.^{13,14} The ‘e’ antigen unfortunately could not be assessed due to reagent unavailability, although it is the most prevalent Rh antigen in Asian population.¹⁵ The order of frequency for other Rh antigens was C>c>E. Similar results were seen in other Asian population where among C, c and E Rh antigens, C was the most prevalent Rh antigen and E was the least.¹⁶⁻¹⁸ Interestingly, when the population was segregated by Rh subgroup, all Rh⁺ donors exhibited the ‘c’ antigen and lacked ‘C’ and ‘E’ antigens. This is in line with previously reported trends in Rh⁺ individuals, where c antigen was the most predominant antigen suggesting an association between the ‘c’ antigen and the Rh⁺ phenotype.^{13,18} This observation warrants further investigation with larger sample sizes to confirm this trend within this population and explore its potential implications for Rh typing and antibody screening in Rh⁺ individuals.

The prevalence of Kell blood group antigens among the Pakistani population, revealed a high frequency of the ‘k’ antigen (98%) and a low frequency of the ‘K’ antigen (4%) in the Kell system. These findings align with previous Pakistani studies and are consistent with international data. For instance, a study in Saudi Arabia reported a ‘K’ antigen prevalence of 6.52% and ‘k’ antigen of 99.28% among blood donors.¹⁹ A research in Eastern India found the ‘K’ antigen in 2.4% of donors with anti-K alloantibody being the 3rd most common, detected in multi-transfused thalassemia and sickle cell (SCD) patients.²⁰ These similarities suggest a consistent distribution pattern of Kell antigens across these regions.

In the Duffy blood group system, our study observed ‘Fya’ and ‘Fyb’ antigen frequencies of 78% and 64%, respectively. Only 1 comparable study from Islamabad was reported from Pakistan in the last 10 years showing dominance of Fya antigen over Fyb.⁹ These results are comparable to findings from a study which reported ‘Fya’ and ‘Fyb’ frequencies of 66% and 83% among Caucasians, and 10% and 23% among Black individuals.²¹ The higher prevalence of Duffy blood group antigens in our population aligns more closely with the Caucasian data, indicating potential genetic similarities or admixture.

Regarding the Kidd blood group system, our findings showed ‘Jka’ and ‘Jkb’ antigen frequencies of 77% and 68%, respectively. These frequencies are consistent with data from other Pakistani studies.^{9,12} Approximately similar frequencies of Jka and Jkb antigens are seen in studies from our neighbouring countries.^{22,23}

The study’s strengths include its contribution to the limited local data on minor blood group antigens, offering a baseline for both clinical practice and future research. The use of standardized serological methods ensured consistent antigen detection, and ethical, systematic sample collection further ensured the validity of the findings. These results have practical implications for blood bank inventory management and donor screening policies, potentially reducing the incidence of transfusion-related complications.

Nevertheless, the study has certain limitations that include its modest sample size and lack of ethnic stratification, which may affect the generic findings across Pakistan’s diverse population. Sampling from selected centres may introduce bias, and the exclusive focus on Kell, Duffy, and Kidd antigens, omits other clinically relevant groups. The use of serological methods, rather than molecular techniques, may affect detection accuracy. The absence of clinical outcome data prevents assessment of the direct impact on alloimmunized patients.

CONCLUSION

The observed antigen frequencies in our study have significant implications for transfusion medicine. This underscores the need for expanded antigen profiling in the Pakistani population and highlights the importance of region-specific data in improving transfusion compatibility. Future studies with larger sample size, incorporating molecular techniques, and ethnic diversity are warranted to build upon these findings and further optimize transfusion safety.

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Address for Correspondence:

Dr Saadia Saad, Department of Biological and Biomedical Sciences, Aga Khan Medical College, Karachi, Pakistan. Cell: +92-333-1268248

Email: saadia.saad@aku.edu

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Contribution of Authors:

SS: Drafting of manuscript and statistical analysis
UN: Review of draft

RPA: Project conceptualization and sample collection
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ORIGINAL ARTICLE

BACTERIAL PROFILE AND ANTIBIOTIC SENSITIVITY PATTERNS IN CHRONIC SUPPURATIVE OTITIS MEDIA: A STUDY FROM LOW- AND MIDDLE-SOCIOECONOMIC COMMUNITIES IN ISLAMABAD

Hameed Mumtaz Durrani, Awais Abdullah*, Aamna Munir Ahmed*, Badar Shahbaz*, Fatima Basharat Chaudhary*, Suha Amir*, Syed Irfan Raza**

Department of, Community Medicine, Shifa College of Medicine, Islamabad, *MBBS Student,

**Department of Biochemistry, HBS Medical College, Islamabad, Pakistan

Background: Chronic Suppurative Otitis Media (CSOM) is a significant cause of preventable hearing loss, particularly in children from resource-limited settings. This study aimed to identify the causative microorganisms and their antibiotic sensitivity patterns through ear discharge cultures in affected patients. **Methods:** This cross-sectional study was conducted at a tertiary care hospital in Islamabad, targeting patients from low- and middle-socioeconomic communities. A total of 106 patients diagnosed with CSOM were enrolled using a structured questionnaire. Ear discharge samples were collected and subjected to bacterial culture and antibiotic sensitivity testing to identify causative organisms and guide appropriate antimicrobial therapy. **Results:** Mucosal CSOM was more common (76.4%) than the epithelial type (23.6%). Among 102 patients, males (56) were slightly more affected than females (50), with 31.1% of cases occurring in children and young adults. Culture-positive samples identified *Enterobacter* as the common pathogen. Culture/sensitivity testing showed Imipenem to be the most effective agent, with 100% sensitivity across all isolates. **Conclusion:** CSOM was predominantly mucosal and commonly associated with upper respiratory tract infections, persistent ear discharge, and tympanic membrane perforation. *Enterobacter* was the most frequent isolate, while imipenem showed the highest sensitivity.

Keywords: Antibiotics, Cell culture, Chronic Suppurative Otitis Media, *Enterobacter*, Tinnitus

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INTRODUCTION

Chronic Suppurative Otitis Media (CSOM) is a persistent and long-standing infection that affects the middle ear and its structures. Abbreviated as CSOM, this disease is characterised by recurrence and can lead to many intra- and extra-cranial complications. CSOM is typically seen in areas with low hygiene standards, water quality problems and overcrowded living conditions. Among children globally, CSOM has been recognized to be a common cause of avoidable hearing loss.¹ According to a report by the World Health Organisation (WHO), 65–330 million people are suffering from ear discharge worldwide.² Patients with CSOM typically present with painless otorrhoea persisting for 2–6 weeks and conductive hearing loss due to tympanic membrane perforation.³

The disease is classified into two types: Safe Type (without Cholesteatoma) and Unsafe Type (with Cholesteatoma). It is also classified based on whether it affects the pars flaccida or the pars tensa of the tympanic membrane, known as Atticoantral and Tubotympanic CSOM, respectively. CSOM causes inflammation in the middle ear cavity and the mastoid, sometimes persisting for more than 2 months. As the disease progresses, it perforates the eardrum. CSOM usually arises from recurrent or persistent acute otitis media. It should be distinguished from tympanostomy tube otorrhoea, a post-procedure complication. It is also linked to

congenital anomalies and allergies that often cause Eustachian tube dysfunction, impairing middle ear function.^{4,5}

Despite its high frequency, there is limited local data from Islamabad linking CSOM types with demographic factors, complications, and antibiotic resistance. In foresight, we hope that this information will help doctors and researchers by providing epidemiological data to guide appropriate antibiotic selection and improve prognosis. Misuse of antibiotics has also contributed to these changes. Many medical practitioners also resort to using these antibiotics indiscriminately, which has resulted into a chronic effect on the bacterial flora. The emergence of many resistant bacterial strains has also become a concern. We aim to provide localised data from a tertiary care hospital dealing with these communities regarding the incidence, type of pathogens, and specific antibiotics used.

The objectives of this study were to identify the specific aetiological agents responsible for CSOM among patients from low- and middle-socioeconomic communities in Islamabad, and to evaluate ear discharge culture findings for antibiotic sensitivity.

METHODOLOGY

This cross-sectional study was conducted in a low socioeconomic population to assess the clinical and demographic features of Chronic Suppurative Otitis

Media. The study targeted a population from a remote village in Islamabad, ensuring representation across diverse age groups. The study duration was 6 months. The study was approved by the Institutional Review Board of HBS Medical and Dental College (IRB letter-SUB/24/25). Informed consent was obtained from all participants or guardians of minors. The study was conducted in accordance with Declaration of Helsinki.

Convenience sampling was used to summarise the clinical and demographic data. Participants who presented with symptoms of CSOM were included in this study. Non-willing patients, who did not have a complete medical record, or had symptoms of Acute Suppurative Otitis Media or other diseases were excluded from the study.

The data from the patients were collected using a specially designed proforma, and clinical examination was performed using an otoscope to identify the abnormality in the ear canal. Age, gender, area of residence, and occupation were recorded. Duration of disease, causes, other associated diseases, symptoms, findings, diagnosis and means of diagnosis were also recorded. Ear discharge samples were collected from selected male CSOM patients for culture and antibiotic sensitivity testing. The female patients were not willing to provide samples.

The data collected was analysed on SPSS-25. Data were presented as frequencies and percentage, and sensitive (S), resistant (R), and increased exposure (I).

RESULTS

Chronic Suppurative Otitis Media (CSOM) appears to be most common in two age groups: males aged 13–25 years (21.7%) and females aged 6 months–5 years

(18.87%), highlighting that both young adults and young children are particularly vulnerable. The 25–60 years age group also showed a substantial proportion of cases, especially among females (17.9%), indicating that the condition significantly affects the adult population as well. In contrast, CSOM is relatively uncommon among 6–12-year-olds (1.89% in males, almost negligible in females) and in those aged 60 years and above (5.7% in males, 0.9% in females). Overall, CSOM is slightly more prevalent in males (52.8%) than in females (47.2%), suggesting a marginally higher susceptibility in males. (Table-1).

From the total of 106 patients with CSOM, 22 were specifically selected for ear discharge culture testing. All of these patients were male, either children or young adults, and had experienced recurrent episodes of CSOM. At the time of sample collection, none of these patients were taking any antibiotics. Antibiotic sensitivity testing showed Imipenem to be the most effective agent, with 100% sensitivity across all isolated organisms. High sensitivity was also observed with Amikacin and Cefoperazone-Sulbactam (~81%), while Cefixime, Ceftriaxone, and Ciprofloxacin demonstrated high resistance rates, particularly among *Enterobacter*, *E. coli*, and *Klebsiella* species. Fluoroquinolone sensitivity was variable, with notable resistance observed for levofloxacin.

Table-1: Age and gender distribution [n (%)]

Age Group (Years)	Male	Female	Total
6 months–5 Years	13 (12.26)	20 (18.87)	33 (31.1)
6–12 Years	2 (1.89)	0 (0.0)	2 (1.89)
13–25 Years	23 (21.7)	10 (9.43)	33 (31.1)
25–60 Years	12 (11.32)	19 (17.92)	31 (29.2)
≥60 Years	6 (5.66)	1 (0.94)	7 (6.6)

Table-2: Sensitivity patterns of cultured bacteria against various antibiotics

Antibiotics	<i>Enterobacter Spp.</i> n=8	<i>Escherichia coli</i> n=4	<i>Klebsiella Spp.</i> n=6	<i>Proteus Spp.</i> n=2	<i>Pseudomonas aeruginosa</i> n=2	NR
Amikacin	S=8, R=0, I=0	S=2, R=2, I=0	S=6, R=0, I=0	S=2, R=0, I=0	S=0, R=2, I=0	0
Amoxicillin Clavulanic Acid	S=6, R=2, I=0	S=2, R=2, I=0	S=2, R=2, I=2	S=2, R=0, I=0	S=0, R=0, I=0	2
Cefixime	S=0, R=6, I=2	S=0, R=4, I=0	S=0, R=6, I=0	S=2, R=0, I=0	S=0, R=0, I=0	2
Cefoperazone + Sulbactam	S=6, R=2, I=0	S=4, R=0, I=0	S=6, R=0, I=0	S=2, R=0, I=0	S=0, R=0, I=0	2
Ceftriaxone	S=2, R=6, I=0	S=0, R=4, I=0	S=0, R=6, I=0	S=2, R=0, I=0	S=0, R=0, I=0	2
Imipenem	S=8, R=0, I=0	S=4, R=0, I=0	S=6, R=0, I=0	S=2, R=0, I=0	S=2, R=0, I=0	0
Levofloxacin	S=4, R=4, I=0	S=0, R=4, I=0	S=4, R=2, I=0	S=0, R=0, I=0	S=2, R=0, I=0	2
Tobramycin	S=6, R=0, I=2	S=2, R=2, I=0	S=6, R=0, I=0	S=0, R=2, I=0	S=0, R=0, I=0	2
Ciprofloxacin	S=2, R=6, I=0	S=0, R=4, I=0	S=2, R=4, I=0	S=0, R=2, I=0	S=0, R=2, I=0	2

S= Sensitive, R= Resistance, I= Increased Exposure, NR= Not Reported

DISCUSSION

Our study analyzed demographics and bacteriological characteristics of a total of 106 CSOM patients, a population not previously investigated. The most affected age groups were children (6 months to 5 years) and young adults (13–25 years). In a previous study conducted in a population from Karachi, the most affected group was 19–35 years⁵, while a Malaysian study reported peaks in 1–10 years and >41 years⁶. Gender distribution in our study showed a slight male

predominance, whereas the Karachi study reported more females (145 vs 55 males)⁵, and an Indonesian study also showed female predominance (67 vs 55 males)⁷. These findings highlight demographic variations locally and internationally.

Cultures were obtained from 22 CSOM patients, all male children or young adults who had experienced recurrent episodes of CSOM and were not receiving any antibiotics at the time of sampling. Gram-negative organisms predominated, with *Enterobacter* species being the most frequently isolated pathogens. In

contrast, a study from Ethiopia⁸ reported only 4 *Enterobacter* isolates among 50 Gram-negative organisms. In the current study, most of the patients had received ciprofloxacin during their initial episode of CSOM, ear discharge was collected for culture before starting any antibiotics in the recurrent episode. The results showed that the isolates were not sensitive to ciprofloxacin but were sensitive to imipenem. Co-amoxiclav showed sensitivity in 12 of the 22 isolates. Combined antibiotic therapy along with aural toilet has been reported as effective in other studies^{9,10}.

A Pakistani study⁹ showed gram-negative bacteria were resistant to Ciprofloxacin, while a study conducted in Egypt¹⁰, *Pseudomonas aeruginosa* (in 84.4% cases) was sensitive to ciprofloxacin. In contrast to these findings in the current study, sensitivity for imipenem was seen in 100%, for amikacin 81.2%, and for Cefoperazone+Sulbactam it was seen in 81.4%. The safest route for the treatment of CSOM should begin with the conduction of culture tests before prescribing antibiotic medications. With culture results, an appropriate line of treatment can be selected regarding causative agent and its sensitivity towards antibiotics.^{11,12} Use of ciprofloxacin should only be preferred in case of *Pseudomonas aeruginosa* and should be avoided in cases with *Enterobacter spp*; the latter being the leading causative agent in the low socioeconomic settings of Islamabad. Despite better efficacy results, drugs like imipenem should be used cautiously to combat rising incidence of antibiotic resistance in gram negative bacteria, including *Pseudomonas aeruginosa* which poses a serious threat to future of treatment for bacterial diseases. Such antibiotic may be reserved for complicated cases only.¹³

The findings demonstrate considerable demographic and bacteriological variability in CSOM with *Enterobacter* as the predominant pathogen. The observed mismatch between empirical antibiotic use and culture sensitivity highlights the need for routine microbiological testing to guide drug therapy. Adopting culture-based treatment strategies may improve clinical outcomes while helping to curb inappropriate antibiotic use and emerging resistance.

CONCLUSION

Enterobacter emerged as the leading pathogen, and

routine empirical use of ciprofloxacin was not consistently supported by culture findings. These results emphasize the need for early diagnosis and culture-guided, rational antibiotic therapy to reduce complications. Imipenem demonstrated the highest *in vitro* sensitivity among the isolates.

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Address for Correspondence:

Dr. Syed Irfan Raza, Department of Biochemistry, HBS Medical College, Islamabad, Pakistan. **Cell:** +92- 335-5840852
Email: Siraza.pk@gmail.com

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Reviewed: 25 Dec 2025

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Contribution of Authors:

HMD: Patient selection, Manuscript Preparation

BS: Data Acquisition and Data Analysis

SIR: Critical review and Final approval

AA: Manuscript writing, data analysis

FBC: Data acquisition and Cell culture

AMA: Data acquisition and analysis

SA: Data Collection

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ORIGINAL ARTICLE

COMPARISON OF PERIAPICAL HEALING FOLLOWING NON-SURGICAL ROOT CANAL TREATMENT VS INJECTABLE PLATELET RICH FIBRIN IN REGENERATIVE ENDODONTIC TREATMENT OF NECROTIC IMMATURE PERMANENT ANTERIOR TEETH

Hira Anmol, Mustafa Sajid, Amina Ghaffar*, Muhammad Ahmad**, Amira Shahid***, Amara Nazir, Afsheen Mansoor[†], Mudassar Mushtaq Jawad Abbasi^{††}

Department of Operative Dentistry and Endodontics, College of Dentistry, Bakhtawar Amin Medical College Multan, *Department of Paedodontics, Nishtar Institute of Dentistry Multan, **Department of Operative Dentistry and Endodontics, Multan Medical and Dental College, Multan, ***Department of Operative Dentistry and Endodontics, University Medical and Dental College, Faisalabad, [†]Department of Science of Dental Materials, Shaheed Zulfiqar Ali Bhutto Medical University Islamabad, ^{††}Health Services Academy, Islamabad, Pakistan

Background: Necrosis of dental pulp can act as bacterial ingress source causing periapical infection leading to tooth loss. Regenerative Endodontics is the desired technique for replacing damaged pulpal structures with normal physiology and function. Objective of this study was to compare the periapical healing following non-surgical root canal treatment using blood clot formation versus regenerative endodontic treatment utilizing injectable platelet-rich fibrin (i-PRF) in necrotic immature permanent anterior teeth. **Methods:** This comparative study was conducted at Department of Operative Dentistry, Bakhtawar Amin Dental Hospital, Multan, from May 2023 to April 2024. A total of 164 patients meeting the inclusion criteria were recruited and randomly assigned into two groups: Group-I (blood clot scaffold) and Group-II (i-PRF scaffold), with 82 patients each. Standardized clinical protocols were followed for canal disinfection and scaffold placement. **Results:** Both groups showed significant improvement over time; however, Group II (i-PRF) demonstrated a significantly greater reduction in periapical lesion size compared to Group-I at all follow-up intervals ($p < 0.05$). At 12 months, the mean lesion perimeter was 5.6 ± 4.7 mm² in Group-I and 2.8 ± 3.5 mm² in Group-II ($p < 0.001$). The i-PRF group exhibited faster clinical symptom resolution and a higher rate of complete radiographic healing (86.6% vs 73.2%). **Conclusion:** Injectable platelet-rich fibrin significantly improves clinical and radiographic healing outcomes compared to traditional blood clot induction in regenerative endodontic treatment of necrotic immature permanent anterior teeth, and provides a biologically active scaffold, enhancing the regenerative potential of endodontic therapies.

Keywords: Endodontic treatment, Healing, Injectable platelet-rich fibrin, Tooth

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INTRODUCTION

Children at the age of 7 to 9 years are considered most notorious for dental traumatic injuries.¹ Anterior teeth are more vulnerable to fracture during road accidents or sports activity.² At this age the anterior permanent teeth have immature apex and complicated crown fractures of these teeth make the treatment more complicating and challenging.³ In immature complicated crown fracture old treatment modality is Ca(OH)₂ apexification in which Ca(OH)₂ make a barrier in the apex leaving the apex thin and weak.^{4–6} After that Mineral Trioxide Aggregate replaces the old Ca(OH)₂ apexification but this later treatment does not solve the issue of weakness of thin roots.^{7–9} Now-a-days regeneration or revascularization of pulp has gained the popularity regarding increasing the strength of roots.^{8–12}

Necrosis of the dental pulp following trauma, caries, or previous dental procedures not only affects tooth survival and preservation, but can also act as a source of bacteria leading to the infection of periapical tissues.¹³ Regenerative Endodontics is a technique aimed at replacing damaged dentino-pulpal structures,

and restoring the vitality and continued normal physiologic development of root in case of necrotic immature (teeth with open root apices) permanent anterior teeth.¹⁴ Blood clot revascularization is the most common and first revascularization method.¹³ Studies conducted in the past showed that platelet concentrates like platelet rich plasma (PRP) and platelet rich fibrin (PRF) can be used as a scaffold for regeneration.¹⁵ Different types of PRF with variable properties were introduced, however, the solid state of PRF limits its application. Following the low-speed centrifugation concept, injectable platelet rich fibrin (i-PRF) was developed as a novel liquid blood derivative, which is rich in platelets, leukocytes, and growth factors.¹³

In a recent study there have been implications of i-PRF in regenerative endodontics. Ibrahim *et al*¹⁶ evaluated the comparative efficacy of non-surgical root canal treatment and i-PRF to treat teeth with necrotic pulp in 30 adult patients with an age range of 18–45 years. After 12 month follow-up period there were non-significant differences between control and intervention groups.¹⁶

Platelet rich plasma are a useful scaffold material for regenerative endodontics, it favourably leads to positive vitality test and apical closure.¹⁷ In another study by Nara *et al*¹⁸, 10 children of 8–13 years of age with no sex predilection were included for comparative evaluation of efficacy of i-PRF with blood clot in root completion of immature permanent teeth. The mean and standard deviation of pre-operative periapical radiolucency (mm) was 2.81 ± 1.14 and 2.25 ± 1.27 for group I and II respectively, while the mean and standard deviation of post-operative periapical radiolucency (mm) was 0 ± 0 and 0.00 ± 0.00 for group I and II respectively. The decrease in postoperative radiolucency was not statistically significant after 18 months of follow-up.¹⁸ Compared to PRF, i-PRF results in better elimination of endodontic infection, hence vitality and continued normal physiologic development of root can be achieved. In young population this can be of great significance in terms of long-term tooth survival and preservation, thereby improving quality of life.^{19,20}

The objective of this study was to compare the mean post-operative periapical radiolucency perimeter in non-surgical root canal treatment versus i-PRF.

METHODOLOGY

This comparative study was conducted at the Department of Operative Dentistry, Bakhtawar Amin Dental Hospital, Multan, from May 2023 to April 2024. A non-probability, consecutive sampling technique was used. The sample size was calculated as per parameters of study of Ibrahim *et al*¹⁶. The power of this study was kept at 80%, and the confidence interval was kept at 95%. This gave a sample size of 82 subjects in each of the two groups, thus making a total sample size of 164.

Inclusion Criteria

1. Age: 8 to 15 years, both male and female.
2. Teeth diagnosed with pulp necrosis based on thermal and electrical pulp testing.
3. Teeth having open root apices evident on radiograph.
4. Teeth presenting periapical radiolucency on radiographic examination.
5. Radiologic confirmation of a single-rooted tooth with a single root canal.

Teeth with root fracture, assessed radiographically were excluded.

Ethical approval was obtained from the Institutional Ethical Review Board of Bakhtawar Amin Medical and Dental College, Multan (Ref No. 414/22/COD). The study was carried out on patients visiting the Operative Department of Bakhtawar Amin Dental Hospital for root canal therapy. Fulfilling the inclusion criteria, 164 patients were included and divided into two groups with 82 patients in each group (Group I: blood clot, Group II: i-PRF). Baseline demographic data including age, gender, and tooth number were recorded on the Patient Record Sheet.

Clinical and radiographic findings were recorded at baseline, and at 1, 3, 6, and 12 months after treatment. Periapical radiographs were taken using cone beam computed tomography (CBCT). Baseline findings such as periapical lesion dimensions were recorded. Access opening was performed on the involved tooth. The canal was instrumented with 20 mL of 1% sodium hypochlorite solution and dried with paper points. Triple antibiotic paste was placed within the canals below the cemento-enamel junction (CEJ) to minimize crown staining. The access cavity was temporarily sealed with glass ionomer cement (GIC). Patients were scheduled for a second visit. After 3 weeks, if the tooth was found asymptomatic, the antibiotic paste was removed, and irrigation was done with 17% EDTA solution for 5 minutes. The canal space was dried with sterile paper points. After this procedure, patients were split into two groups.

For Group I, using a No. 20 K-file, apical bleeding was induced and allowed to form a blood clot up to the cemento-enamel junction. Following this, white mineral trioxide aggregate (MTA) was placed to a thickness of 3 mm, followed by restoration with GIC and composite resin.

For Group II, i-PRF was prepared using Choukroun's method. Freshly prepared i-PRF (0.5 mL) was placed in the coronal third of the canal. MTA was also placed in the coronal third of the root canal, and the tooth was restored with GIC and composite. All patients were recalled at 1, 3, 6, and 12 months for clinical evaluation of signs and symptoms, and radiographic assessment of the decrease in the size of the periapical lesion. All data were recorded on patient's proforma.

Data were analysed on SPSS-25. Descriptive statistics were presented for both quantitative and qualitative variables. Mean $\pm$ SD were calculated for age, duration of symptoms, and periapical lesion perimeter preoperatively and postoperatively at the 12-month follow-up period. Frequencies and percentages were calculated for gender and tooth number. Data were stratified concerning age, gender, duration of symptoms, and tooth number. Independent sample *t*-test was applied to compare the mean measurements of the periapical lesion perimeter of both groups, and $p \leq 0.05$ was considered statistically significant.

RESULTS

Data were collected from 164 patients. The mean age in Group I was 11.4 ± 2.2 years and in Group II it was 11.6 ± 2.0 years, with a male-to-female ratio of 47/35 in Group I and 45/37 in Group II. The most commonly treated teeth were tooth numbers 11 and 21 in both groups. At baseline, the mean periapical lesion perimeter was 17.1 ± 7.9 mm² for Group I and 17.0 ± 8.0 mm² for Group II. Group II showed a greater reduction in lesion size compared to Group I: at 1 month

(13.1±6.8 mm² vs 15.2±7.5 mm², $p=0.03$), 3 months (9.5±6.0 mm² vs 12.4±6.9 mm², $p=0.01$), 6 months (5.9±5.2 mm² vs 8.8±6.0 mm², $p=0.001$), and 12 months (2.8±3.5 mm² vs 5.6±4.7 mm², $p<0.001$). (Table-1).

In Group I, absence of pain was reported in 80 (97.6%) patients compared to 82 (100%) patients in Group II ($p=0.24$). Absence of swelling was seen in 77 (93.9%) patients in the blood clot group and in 81 (98.7%) patients in Group II ($p=0.09$). Regarding sinus tract healing, 75 (91.5%) patients in Group I and 80 (97.5%) patients in Group II showed complete resolution ($p=0.08$). The overall clinical success was slightly higher in Group II at 98.7% compared to 95.1% in Group I ($p=0.19$). The differences were not statistically significant. (Table-2).

Radiographic assessment at 12-month follow-up revealed that complete healing was achieved in 60 (73.2%) patients in Group I and in 71 (86.6%) patients in Group II, ($p=0.03$). Partial healing was observed in 15 (18.3%) patients in the blood clot group and 9 (11%) patients in Group II ($p=0.18$). No healing or failure was noted in 7 (8.5%) patients in Group I compared to 2 (2.4%) patients in Group II, ($p=0.04$). (Table-3).

The mean time for pain resolution was 3.1±1.2 weeks in Group I and 2.4±1.0 weeks in Group II ($p=0.002$). Swelling resolved in 3.6±1.5 weeks in the blood clot group and in 2.7±1.1 weeks in Group II ($p=0.001$). Sinus tracts closure occurred at an average of 4.2±1.7 weeks in Group I and 3.0±1.2 weeks in Group II, ($p<0.001$). (Figure-1).

Table-1: Baseline demographic data

Variable	Group I (Blood Clot)	Group II (i-PRF)	<i>p</i>
Mean Age (Years)	11.4±2.2	11.6±2.0	0.54
Gender (M/F)	47/35	45/37	0.71
Common Tooth	11 (41%) 21 (39%)	11 (43%) 21 (38%)	0.89
Periapical lesion			
Baseline	17.1±7.9	17.0±8.0	0.92
1 month	15.2±7.5	13.1±6.8	<0.05*
3 months	12.4±6.9	9.5±6.0	<0.01*
6 months	8.8±6.0	5.9±5.2	<0.001*
12 months	5.6±4.7	2.8±3.5	<0.001*

(*Statistically significant)

Table-2: Clinical success rates at 12 months [n (%)]

Clinical Finding	Group I (Blood Clot)	Group II (i-PRF)	<i>p</i>
Absence of pain	80 (97.6)	82 (100)	0.24
Absence of swelling	77 (93.9)	81 (98.7)	0.09
No sinus tract	75 (91.5)	80 (97.5)	0.08
Total clinical success	78 (95.1)	81 (98.7)	0.19

Table-3: Radiographic healing outcomes at 12 months [n (%)]

Radiographic Status	Group I (Blood Clot)	Group II (i-PRF)	<i>p</i>
Complete Healing	60 (73.2)	71 (86.6)	0.03*
Partial Healing	15 (18.3)	9 (11)	0.18
No Healing/Failure	7 (8.5)	2 (2.4)	0.04*

(*Statistically significant)

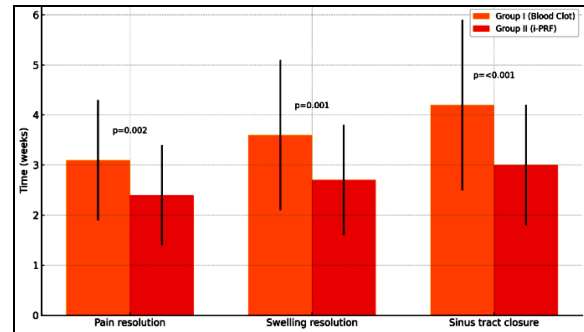


Figure-1: Mean time to clinical resolution of symptoms

DISCUSSION

This study compared the periapical healing following non-surgical root canal treatment with blood clot induction and regenerative endodontic treatment using i-PRF in necrotic immature permanent anterior teeth. The i-PRF significantly enhanced clinical and radiographic outcomes compared to the conventional blood clot technique. From baseline to the 12-month follow-up, patients treated with i-PRF exhibited greater reductions in periapical lesion size, faster clinical symptom resolution, and a higher percentage of complete radiographic healing. The i-PRF offers a biologically superior alternative to blood clot formation in regenerative endodontic therapy.¹⁸ At the start of the study, no significant differences were observed between the two groups in terms of demographic characteristics or baseline lesion dimensions. Over time, however, distinct differences emerged. By the first month, the i-PRF group had already shown significantly greater reductions in lesion size compared to the blood clot group, and this trend¹⁹ continued through the 3rd, 6th, and 12th months. The i-PRF group demonstrated quicker resolution of pain, swelling, and sinus tract closure, underlining the regenerative and anti-inflammatory potential of this biomaterial.^{21,22}

The biological superiority of i-PRF may be explained by its rich composition of growth factors like PDGF, VEGF, and TGF-β, which are crucial for angiogenesis, stem cell proliferation, and tissue regeneration.²³ Unlike the traditional blood clot scaffold, which relies heavily on natural clot formation and host response, i-PRF provides a dense, fibrin-rich environment that facilitates cellular migration and tissue formation. This aligns with prior findings, who observed enhanced outcomes with platelet concentrates in regenerative endodontics.^{24,25}

The main strengths of this study was its design, which minimized selection bias and improved the reliability of the findings. An adequate sample size was calculated and achieved. Standardized clinical protocols were followed for both groups. Despite these strengths, the study had certain limitations. It was a single-centre study, limiting generalizability of results. Histological

analysis was not performed. The 12-month follow-up period may not fully capture the long-term success and durability of regenerated tissues. There could be a potential variability in preparation of i-PRF, which may influence concentration of growth factors and regenerative efficacy. Future implications of this study include true pulp regeneration, superior vital pulp therapy, and increased tooth survival, which will increase confidence of the dentists on this procedure.

CONCLUSION

Regenerative endodontic treatment using i-PRF results in significantly better clinical and radiographic outcomes compared to traditional blood clot-based techniques in management of necrotic immature permanent anterior teeth. Patients treated with i-PRF demonstrated faster resolution of clinical symptoms, greater reduction in periapical lesion size, and higher rates of complete radiographic healing over a 12-month follow-up period.

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Address for Correspondence:

Dr Afsheen Mansoor, Department of Science of Dental Materials, School of Dentistry, Shaheed Zulfiqar Ali Bhutto Medical University Islamabad, Pakistan. **Cell:** +92-321-5879166

Email: drafsheenqamar@gmail.com

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Contribution of Authors:

HA: Concept, Data collection

MS: Supervision, Mentorship

AG: Literature review

MA: Study design

AS: Critical revision

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ORIGINAL ARTICLE

VIDEO-AIDED LEARNING EFFICIENCY IN ELUCIDATING
PHYSIOLOGICAL CONCEPTS USING KIRKPATRICK'S MODEL

Hina Munir, Shamaila Manzoor*, Sidra Jabeen**, Sana Majeed***,

Athar Abdullah[†], Poshmall Shakeel

Department of Physiology, *Medical Education, AJK Medical College, Muzaffarabad, **Department of Physiology, HITEC-Institute of Medical Sciences, Taxila, ***Department of Physiology, Mohiuddin Islamic Medical College, Mirpur, AJK, [†]Department of Physiology, Shalimar Medical and Dental College, Lahore, Pakistan

Background: The use of video-aided learning is increasingly adopted in medical education to simplify complex physiological concepts and improve student engagement. Despite its growing use, systematic evaluation of its educational impact remains limited. Objective was to evaluate the effectiveness of video-assisted learning in the elucidation of physiological concepts using Kirkpatrick's Model. **Methods:** A total of 84 medical students in 1st year MBBS were included in the study. At the end of the Musculoskeletal module, a pre-test of 25 MCQs was conducted. The pre-test was followed by a video session comprising the same topics being asked in the pre-test. After that, a post-test of the same 25 MCQs was given. A feedback proforma was filled out by all participant students. Data was analyzed on SPSS-25. Scores of pre- and post-test were compared using paired sample *t*-test and a $p \leq 0.05$ was considered statistically significant. Data obtained from feedback from students for closed-ended questions was expressed as percentages, whereas, the data obtained for open-ended questions was thematically analysed. **Results:** The post-test scores of the participants were significantly higher statistically ($p=0.000$) compared to pre-test responses. Most of the students agreed that the video session was an effective way of clearing concepts of physiology. **Conclusion:** Teaching physiology by using video sessions as a tool was found very beneficial for understanding and clarification of concepts.

Keywords: Effectiveness, Kirkpatrick's Model, Video-assisted learning

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INTRODUCTION

Making a value judgement regarding the information gathered is part of the evaluation process.¹ Programmes for health profession education must be comprehensively and thoroughly evaluated if they are to continue developing and improving.² The systematic gathering and analysis of data pertaining to the creation, execution, and results of a programme with the aim of tracking and improving the program's calibre and efficacy is known as the programme evaluation process.³ The requirements of medical education accreditation groups and financial sources that encourage innovative education are among the more significant reasons for programme review.³

Kirkpatrick's approach, the Logic Model, the Context/Input/Process/Product (CIPP) model, and the experimental/quasi-experimental approach are the four often used models for evaluating programmes.³ The Kirkpatrick hierarchy has influenced programme evaluation in the health professions for almost 40 years due to its widespread adoption.⁴ Originally developed as a framework for assessing human resources training, a variety of its four outcome-levels are currently used in many studies assessing health sciences programmes.

It encompasses four levels, level-1 constitute Reaction which measures participants' responses

including their level of satisfaction, level-2 constitute learning which encompasses the changes in knowledge that reveal the effectiveness of the teaching strategy, level-3 demonstrates behaviour which appraises the changes in behaviour in the working environment and level-4 comprises of results which indicates the overall impact on organisational performance.³ The model's dominance can be clearly attributed to the fact that it offers a straightforward taxonomy for making evaluation decisions through the use of a simple structural hierarchy that prioritizes the outcomes of highest interest. It is an outcomes-driven evaluation strategy that can produce data demonstrating the 'work' of our initiatives.⁵

The effectiveness of video-aided learning in this research was evaluated using the first two levels of Kirkpatrick's Model. Level-1: Reaction focused on students' immediate response to the video-based session. A brief feedback form was administered to assess satisfaction, clarity of content delivery, engagement, and perceived usefulness of videos in supporting understanding of physiological concepts. This provided an overview of learners' acceptance of the instructional method. Level-2: Learning examined the change in knowledge following the intervention. A pre-test was conducted to determine baseline understanding, followed by a post-test after the video

session. Comparison of pre- and post-test performance helped determine the extent to which the video-aided approach enhanced comprehension of the targeted content.

Previously teaching in pre-clinical years was through the traditional methods of teaching, which targeted students who were unable to organize their work and were dependent on the teachers for instructions.⁶ It was observed that this mode of teaching places constraints on the student's learning process by imposing cognition overload on the students.⁷ They lose interest and concentration within the first twenty minutes of the lecture, making it challenging to teach today's generation of doctors and medical students.⁸

Different teaching modalities are now being practiced in the current medical education system to uplift medical knowledge. Adapting technology-based multiple curriculum delivery methods into the educational environment can improve the learning of medical students. It is assumed that the implementation of visual aids like footage, videos, and projectors can be effective in the course of teaching. Visual aids create a thought-provoking and engaging environment that enhances student interest, along with improvement in their vocabulary and clarification of difficult concepts while decreasing cognitive overload.^{9,10} They pay attention to the presented material, mentally organizing the presented material into a coherent structure and integrating the presenting material with existing knowledge.¹¹

The rationale of conducting this study was to determine the effect of video sessions on learning Physiological concepts by conducting pre-tests and post-tests at the end of the Musculoskeletal module and to determine the impact of video sessions on students' learning.

METHODOLOGY

This Quasi-experimental study was conducted in AJK Medical College, Muzaffarabad after the approval from the ethical review committee vide Ref # ERC/Phy/17.

A total number of 84 medical students of first-year MBBS were included in the study through convenience sampling. Informed consent was taken from all the students. The cognitive abilities were tested at the end of the ongoing module of musculoskeletal physiology by a pre-test of 25 MCQs. After this, an educational video session of 30 minutes was carried out on the taught topics being assessed in the pre-test. A post-test of the same 25 MCQs was taken after the video session. After the post-test, students provided feedback through an 11-item Likert-scale questionnaire and two open-ended questions to assess their perceptions of the video-based learning approach.

Qualitative data were analysed thematically, and quantitative results were summarized using Mean $\pm$ SEM, percentages, and paired *t*-tests to evaluate the effectiveness of the intervention. To minimize the biased responses, no identity disclosure was asked from the participants.

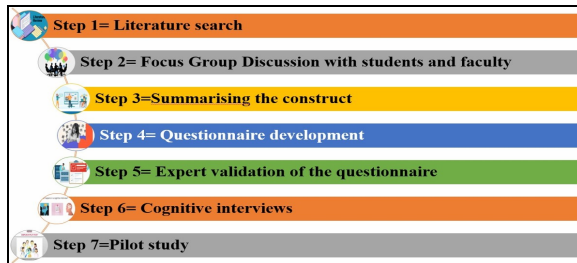
Feedback from students was obtained by developing a feedback proforma using the steps mentioned in AMEE Guide 87, Developing Questionnaire for Educational Research.¹²

In the first step, literature search was done and some constructs were identified regarding the impact of video-assisted learning in medical education.⁹⁻¹¹ In step-2, a focus group discussion was arranged between the chosen representatives of 1st year students which included a number of 5 students and the faculty of physiology was also part of this focus group discussion. Different constructs which were deducted from this focus group discussion included effectiveness, attitudes and integration of video-assisted learning, quality of video content, engagement and convenience and interactive learning.

In Step-3, the information that was being collected in first two steps was used to summarize the final constructs that would form the basis of the questionnaire development. In step-4, a proforma questionnaire was developed which included 11 closed-ended questions and the participants were asked to record their responses on a 5-point Likert scale ranging from strongly disagree to strongly agree. There were two open-ended questions in the feedback proforma in which participants wrote their viewpoints regarding the usefulness of video-assisted learning and the areas of improvement in its incorporation during the course of teaching and learning medical education.

Level-1 of Kirkpatrick's model which constitutes the reaction and level of satisfaction was addressed through the feedback proforma which was then analysed through quantitative and qualitative data analyses.¹³ Results of closed-ended questions in the proforma were analysed by determining the percentages of the responses for each of the 5-points on the Likert scale. The open-ended questions in the feedback proforma were analysed by content analyses guided by a procedure outlined by Malor *et al.*¹⁴ The open-ended questions included number 12 and number 13 and the responses were viewed and labels constituting key words and phrases were established through open coding. Labels were unified into categories using the axial coding. Finally the categories were grouped into the themes.

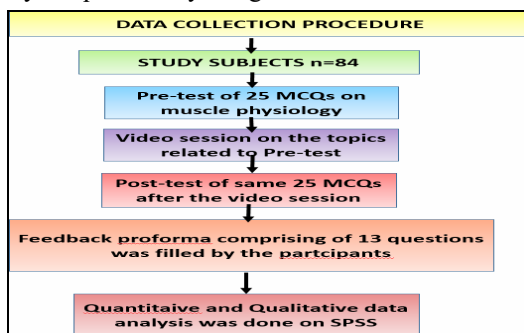
In step-5, the content validity of the feedback proforma was confirmed by two Professors of Physiology and their Content Validity Index was calculated. Step 6 and step 7 were not done due to time limitation.



Flow Chart-1: Steps of questionnaire development

Level-2 of Kirkpatrick's model which constitutes learning, was addressed by taking a pre and post-test of the participants with the intervention of video-assisted learning in-between, to assess the participant's knowledge and understanding of the core concepts.¹³

The data was analysed using SPSS-25. Mean±SEM of the pre-test and post-test were compared using paired sample *t*-test and $p < 0.05$ was considered statistically significant. Feedback proforma was analysed by determining percentages of the responses and the open-ended questions of the feedback proforma were analysed qualitatively using codes and themes.



Flowchart-2: The data collection procedure

RESULTS

A total of 84 medical students of 1st Year MBBS were recruited in the study after informed consent. There were 68 female and 16 male students in the study. Mean±SEM post-test (54.96±3.067) scores showed significant ($p < 0.001$) improvement compared to Pre-test (49.64±3.372) scores. Figure-1 shows the comparison of the pre-test mean with the post-test mean among the male and the female participants which shows significant improvement in results. A paired sample *t*-test was used to determine the Mean±SEM.

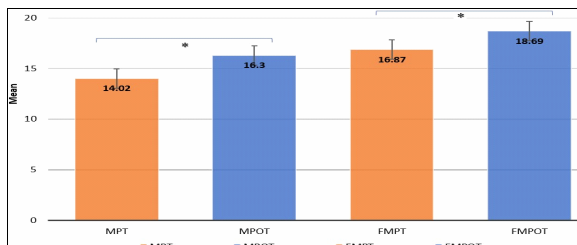


Figure-1: Comparison of pre- and post-test scores

MPT= Male pre-test mean, MPOT= Male post-test mean, FMPT= Female pre-test mean, FMPOT= Female post-test mean. * $p < 0.000$

The feedback questionnaire comprised of 13 questions in total, of which 11 were closed-ended and Q:12 and Q:13 were open ended questions. The feedback responses to closed ended questions were analyzed using the percentages of each of the responses on 5 point Likert scale. Figure-2a and 2b shows the percentages of feedback responses to the first 11 closed-ended questions on the effectiveness of video-assisted learning in the elucidation of concepts of physiology. Figure-2a showing the percentages of feedback responses to first 6 questions while Figure-2b showing the percentages of feedback responses from question 7–11.

Open-ended questions of feedback proforma were qualitatively analyzed by thoroughly reviewing the responses. Each response of question 12 was coded into 13 categories and out of these categories 4 themes were generated. Similarly, responses to question 13 were coded into 9 categories and 2 themes were generated as shown below in Table-2a and Table-2b.

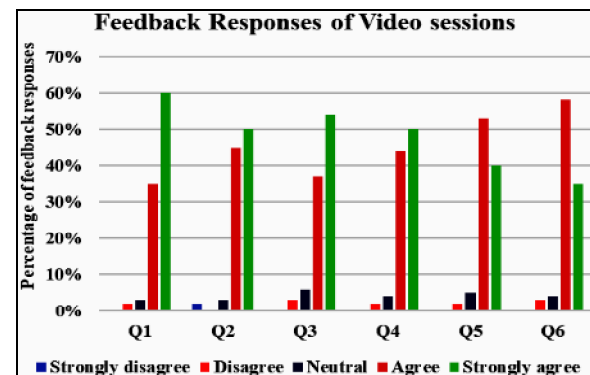


Figure-2a: Feedback responses after a video-assisted learning session to 1st Year MBBS students at the end of Musculoskeletal Module

Q1: Content of Video session, Q2: Video session for reinforcement, Q3: Working audiovisual aids, Q4: Session alignment with module, Q5: Adequate time allocation, Q6: Understanding of difficult topics

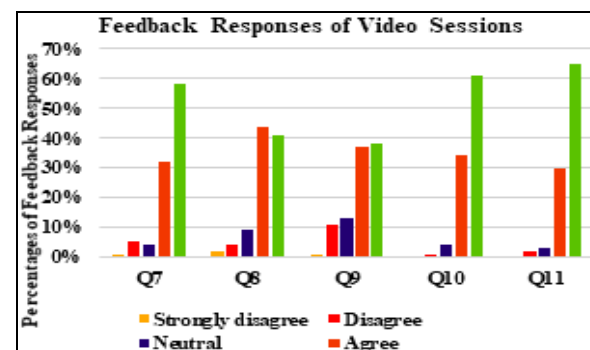


Figure-2b: Feedback responses after a video-assisted learning session to 1st Year MBBS students at the end of Musculoskeletal Module

Q7: Focus during video session, Q8: Application of concepts in problem based learning, Q9: Impact in confidence uplifting, Q10: Helpful in long-term retention, Q11: Recommendation of use of video session

Table-2a: Content analysis of open-ended question 12 in feedback proforma: ‘What are the factors that enhanced learning during the video session?’

Theme 1	Categories/coding
Good quality audiovisuals	Clear visuals
	• Good sound quality
	• Interesting visuals
	• Adequate speed of video
Theme 2	Categories/coding
Video content	• Relevant content
	• Adequate cognitive load
	• Short video sessions
	• Captions are helpful
Theme 3	Categories/coding
Visual Learners	• Enhanced student engagement
	• Augments retention of information
	• Beneficial for visual learners
Theme 4	Categories/coding
Comprehension	• Complex concepts simplified
	• Highlights the importance of the topic

Table-2b: Content analysis of open-ended question 13 in feedback proforma: ‘What are the factors that hampered learning during the video session?’

Theme 1	Categories/coding
Poor quality Audiovisuals	• Poor internet connectivity
	• Bad sound quality
	• Blur visuals
	• Noisy environment
	• Improper room lighting
Theme 2	Categories/coding
Video content	• Irrelevant content
	• Huge cognitive load
	• Longer duration video sessions
	• Lack of focus

DISCUSSION

The study was conducted to evaluate the impact of video sessions in enhancing the learning abilities of medical students using Kirkpatrick’s first two levels. Physiology encompasses some arduous concepts which can better be understood when they are visually seen. This can empower the students to strengthen their concepts as human physiology is immensely important for preparing medical students for their clinical practice.

Incorporating video session in the curriculum after the module can boost student learning and revamp their performance. The dominant reason is that the content taught during the module through lectures was reinforced at the end of module by showing the same content in the form of videos. This was also observed in a study¹⁵ in which two batches of 3rd year were shown a video lecture as well as a didactic lecture on bipolar disorders and students underwent a pre- and post-test demonstrating a significant improvement in the post-test scores. This finding is similar to our study which also showed significant improvement in the post-test means conducted in the musculoskeletal module of first year.

Another study by El-Sayed R *et al*⁹ assessed the learning outcomes and satisfaction of video-assisted learning in 27 nursing students. They concluded that video-based lectures offer more successes and reduce failures in the immediate and follow-up measures compared to traditional method of teaching anatomy

and physiology that was based on printout illustrations and also rated highly, all the items assessing their acceptance and satisfaction with video-based lectures. That finding is similar to our findings which also showed students’ satisfaction in video-assisted learning. The difference in that and our study is that they didn’t opt for a pre- and post-test.

There are several advantages of visual images over verbal communication. Videos can clarify difficult concepts, are able to provide more useful information in a short time interval, and provide an effective way of getting the audience attention and interest to gain more knowledge. Yunus *et al*¹⁶ used a questionnaire as well as face-to-face interviews to determine the effects of visual aids in enhancing students interest and recommended use of visual aids. This is also reflected in our study in which 65% respondents strongly agreed in recommending the use of visual aids in teaching. Their study was qualitative only while we used both quantitative and qualitative analysis to reach the conclusion.

Incorporation of visual images into teaching process enhances learning retention. One study compared the results of showing only video sessions, delivering lectures only, and combined effect of delivering lectures and showing its visuals. After that, the students were asked to recall the lesson at 3 hours and after 3 days in 3 groups. The results were significant for the third group proving that visual images enhanced learning retention.¹⁷ Our study also showed this in the feedback proforma in which 61% of the students strongly agree that video sessions enhance memory retention although we didn’t take the post-test more than once to check the memory retention that was done in the study by Shivaraju¹⁷.

Feedback from the students can improve teaching methods and the suggestions can be incorporated into the modules for better performance of the students. The present study also focused on the feedback about video sessions which were incorporated within a module after the interactive lectures. The results showed 50% of the students strongly agreed and 45% agreed that incorporation of video session enhanced their learning. This finding is similar to a study¹⁸ which compared the results of giving interactive lectures alone and interactive lectures with audiovisual aids.

A recent study conducted by Ashour¹⁹ on medical students studying at the University of Jordan using a web-based questionnaire adapted from Student Evaluation of Educational Quality Survey. Participants perceived greater benefit in terms of learning, instructor enthusiasm, content organization and breadth of teaching, when using video-based learning. Our study also showed a significant number of positive responses when video-assisted learning was compared with traditional learning. Ashour *et al* used only the questionnaire to determine the effectiveness while we

used both pre- and post-test and a feedback questionnaire to assess the effectiveness of video sessions.

Another study by Yang and Oh²⁰ used an experimental, pretest-posttest design. Ninety-eight medical students (54 in the video-assisted education group and 44 in the traditional classroom education group) were recruited in a paediatric CPR education. The level of knowledge of paediatric CPR, the level of paediatric CPR practice skills, and the satisfaction score of each student were evaluated and found to be significantly higher than their pre-test scores. The satisfaction scores of the students in both groups were similar.²⁰ Their finding of improved post-test scores is in conjunction with the findings in our study but the finding of satisfaction scores is in contrast to our study.

LIMITATIONS OF STUDY

The small sample size used was a limitation to the study. The feedback of video sessions can be compared with different teaching strategies. A control group could have been added. Future studies may be directed towards comparison between video sessions and other learning strategies.

CONCLUSION

The use of video-based instruction contributed to improved understanding and clarification of selected physiological concepts among first-year medical students. Students' feedback supported the intervention, with many reporting that video sessions facilitated comprehension of difficult topics and enhanced their learning experience. Integrating video-assisted learning as a supplementary component to conventional teaching may be beneficial in Physiology. Designing video sessions aligned with specific learning objectives and curricular needs may further strengthen conceptual understanding and promote better knowledge retention.

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Address for Correspondence:

Dr Hina Munir, Department of Physiology, AJK Medical College, Muzaffarabad, Pakistan. **Cell:** +92-335-5819393
Email: hinatahir1126@gmail.com

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Contribution of Authors:

HM: Data collection, analysis, and interpretation, Medical writing

SJ: Literature search and data analysis

AA: Data analysis and interpretation

SM: Study design and methodology

SM: Data analysis and medical writing

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ORIGINAL ARTICLE

PERCEPTION AND BARRIERS TO MEDICAL RESEARCH AMONG MEDICAL STUDENTS OF A PRIVATE MEDICAL COLLEGE

Mohi Ud Din, Maryam Saeed*, Maria Shaukat*, Memona Iftikhar*, Iqra Faryal*, Zainab Shahzad*

Department of Community Medicine, *House Officer, Aziz Fatimah Medical & Dental College, Faisalabad, Pakistan

Background: Research is a core component of medical education, yet its practice among students is often influenced by their perceptions and constrained by institutional, academic, and personal barriers. Objective of this study was to assess these parameters in students of a private medical school. **Methods:** This analytical cross-sectional study was carried out from July 2023 to April 2024, with a sample of 493 MBBS students at Aziz Fatimah Medical and Dental College, Faisalabad. The data were collected using a validated questionnaire aimed at assessing perception about research, personal and institutional barriers. Descriptive statistics were used to summarize data. The normality of data was determined using the Shapiro-Wilk test. Mann-Whitney U-test was used for two-group comparison, Kruskal-Wallis test for multiple-group comparison, and Spearman's ρ test for correlation analysis. **Results:** The mean perception score was moderately positive (3.41 ± 0.76), while personal (3.12 ± 0.89) and institutional (3.20 ± 1.10) barrier scores were relatively high. The age of students was associated with higher personal barriers ($U=22,959.5$, $p<0.001$). Day scholars reported more positive perceptions than hostelites ($U=16,907.5$, $p=0.006$). Across classes, perception ($H=19.84$, $p=0.001$) and personal barriers ($H=33.58$, $p<0.001$) demonstrated significant differences, with first-year students reporting higher perception and senior students reporting higher barriers. The Spearman's correlation identified weak but significant positive associations of perception with both personal ($p=0.167$) and institutional barriers ($p=0.169$) and a strong positive correlation of personal with institutional barriers ($p=0.549$; $p<0.01$). **Conclusions:** Students showed generally positive perception toward medical research but faced significant personal and institutional barriers.

Keywords: Medical, Perception, Practice, Research, StudentsPak J Physiol 2025;21(4):49–52, DOI: <https://doi.org/10.69656/pjp.v21i4.1880>

INTRODUCTION

Medical research is the backbone of advancements in healthcare and leads to innovations for better patient outcomes and improved treatment protocols as well as deeper knowledge of diseases. Involvement in medical research activities helps medical students nurture critical thinking, analytical expertise, and curiosity, which are all prerequisites for the medical profession.¹ Numerous obstacles may hinder participation of medical students in research activities, particularly in private institutions.

Private medical colleges often prove to be different environments from what are in public institutions, having their own privacies and perspectives. Although they may possess adequate modern facilities, private institutions are often criticized for high tuition fees and for lacking a strong research culture compared to public universities.² Knowing the perceptions of medical students on research in such contexts is important to devise ways to encourage them for their involvement in research and reduction of barriers.

Many studies have identified factors influencing medical students' involvement in research.³ These factors include the availability of mentors⁴, access to funding for the research⁵, existence of research-oriented curricula⁶, and the perceived value of research in their future careers. Nevertheless, these factors may

exist on a very different scale in private medical colleges owing to the level of infrastructure, faculty expertise, and institutional priority.⁷

The challenges to research engagement are diverse and may be broadly categorized into individual, institutional, and systemic domains.⁸ Individual barriers include rigorous academic schedules denying students time for research; lack of motivation⁹, less-than-adequate skills for accomplishing research tasks and limited awareness of the benefits of research¹⁰. Institutional barriers may be inadequate research infrastructure, limited access to experienced mentors, and lack of institutional support for student-led research initiatives.¹¹ Systemic barriers encompass issues such as insufficient integration of research into the medical curriculum and a general lack of support from the medical education system.¹² This study aims to explore the perceptions and barriers to research among students at a private medical college.

MATERIAL AND METHODS

After approval of the Ethical Committee vide No. IEC/238-23, students from MBBS classes were included through a convenience sampling method after their informed written consent. Data was collected through a validated questionnaire on students' perception of

research, personal barriers, and institutional barriers to research.¹³

The tool consisted of several items rated on a 5-point Likert-type scale ranging from 'strongly disagree' to 'strongly agree'. Perception toward research was assessed using a set of Likert-scale questions exploring students' views on the importance, relevance, and benefits of research in medical education. These included items on the role of research in the medical field, its inclusion in the curriculum, teamwork, and long-term career goals. Personal and institutional barriers were assessed through questions addressing lack of time, motivation, supervision, training opportunities, and institutional support for conducting research. Composite scores were computed for each of the domains as an average of the item responses, with higher scores indicating stronger perceptions or barriers.

The data were analyzed using SPSS-25. Descriptive statistics were computed for socio-demographic variables and scale scores. The normality assumption was assessed by the Shapiro-Wilk test. The Mann-Whitney U-test was used to compare the scores between two groups. Kruskal-Wallis test was used to compare scores among three or more groups. A post-hoc pair-wise comparison with Bonferroni adjustments was conducted only for results that were significant. The association between perception, personal and institutional barriers was assessed with Spearman's *rho* correlation. Effect size (*r*) for Mann-Whitney U-test was computed to determine the magnitude of differences, and $p \leq 0.05$ was considered statistically significant.

RESULTS

Total number of participants was 493 (response rate=76%). The majority of participants were from the 4th year (130, 26.4%), followed by the 3rd year (111, 22.5%), 2nd year (106, 21.5%), 1st year (100, 20.3%), and final year (46, 9.3%). The sample comprised of 303 females (61.5%) and 190 males (38.5%). There were 285 participants (57.8%) aged above 21 years, and 208 participants (42.2%) aged 21 years or below. Day

scholars were 387 (78.5%) and boarders were 106 (21.5%) in number. Majority were from urban areas (403, 81.7%) while 90 (18.3%) belonged to rural areas.

Students showed a moderately positive perception toward research (mean 3.41 ± 0.76). However, relatively higher mean scores for personal (3.12 ± 0.89) and institutional (3.20 ± 1.10) barriers suggest that both individual and institutional factors hindered their participation in research. It was determined that there was no significant difference in perception scores between male and female students ($p=0.764$). No significant gender differences were observed for either personal barriers ($p=0.195$) or institutional barriers ($p=0.156$). (Table-1).

Mann-Whitney U-test revealed no significant differences in perception scores between younger and older students ($p=0.057$, $r=0.086$). However, older students reported significantly higher levels of personal barriers ($p<0.001$). No significant difference was observed for institutional barriers ($p=0.208$). (Table-2).

Day-scholars medical students had significantly more positive perceptions about research compared to boarders. There were no statistically significant differences among groups regarding personal and institutional barriers. (Table-3).

The perception and personal barriers differed significantly between MBBS classes ($p=0.001$ and $p<0.001$ respectively) but not institutional barriers ($p=0.550$). In post-hoc analysis, the perception score of 1st year students was significantly higher than that of 2nd and 3rd year students, while 4th and final-year students reported significantly higher personal barriers as compared to 1st and 2nd year students. No other pair-wise differences were statistically significant. (Table-4).

Table-5 presents the Spearman's *rho* correlation results. Research perception had weak but statistically significant positive correlations with personal barriers and institutional barriers. There was a strong positive correlation between personal and institutional barriers.

Table-1: Perception and barriers toward research among medical students (Mann-Whitney U-test)

Variable	Gender (n)	Mean Rank	U	Z	p	Effect size (r)
Perception score	Male (190)	249.43	28,322.5	-0.301	0.764	0.014
	Female (303)	245.47				
Personal barriers	Male (190)	236.53	26,796.0	-1.296	0.195	0.058
	Female (303)	253.56				
Institutional barriers	Male (190)	235.53	26,605.5	-1.418	0.156	0.064
	Female (303)	254.19				

U= Mann-Whitney test statistic. Z= Standardized test statistic for Mann-Whitney U

Table-2: Perception and barriers towards research between age groups (Mann-Whitney U-test)

Variable	Age Group	Mean Rank	U	Z	p	Effect size (r)
Perception score	Group 1 (208)	261.28	26,670.5	-1.903	0.057	0.086
	Group 2 (285)	236.58				
Personal barriers	Group 1 (208)	214.88	22,959.5	-4.290	<0.001	0.193
	Group 2 (285)	270.44				
Institutional barriers	Group 1 (208)	256.44	27,675.5	-1.259	0.208	0.057
	Group 2 (285)	240.11				

U= Mann-Whitney test statistic. Z= Standardized test statistic for Mann-Whitney U

Table-3: Mann–Whitney U test for perception and barriers by current residence

Variable	Residence	Mean Rank	U	Z	p	Effect size (r)
Perception	Day-scholar (387)	256.31	16907.5	-2.776	0.006	0.13
	Boarder (106)	213.00				
Personal barriers	Day-scholar (387)	249.65	19484.5	-0.792	0.428	0.04
	Boarder (106)	237.32				
Institutional barriers	Day-scholar (387)	249.44	19566.5	-0.728	0.467	0.03
	Boarder (106)	238.09				

Table-4: Kruskal-Wallis test for perception and barriers by MBBS class

Variable	MBBS Class	Mean Rank	H (χ^2)	df	p
Perception	1 st Year (100)	300.30	19.84	4	0.001
	2 nd Year (106)	221.46			
	3 rd Year (111)	228.44			
	4 th Year (130)	239.67			
	Final Year (46)	255.50			
Personal Barriers	1 st Year (100)	208.41	33.58	4	0.000
	2 nd Year (106)	214.29			
	3 rd Year (111)	238.55			
	4 th Year (130)	300.12			
	Final Year (46)	276.53			
Institutional Barriers	1 st Year (100)	243.83	3.05	4	0.550
	2 nd Year (106)	229.16			
	3 rd Year (111)	260.51			
	4 th Year (130)	253.77			
	Final Year (46)	243.26			

Table-5: Correlation between perception and barriers toward research among medical students

Variables	Perception Mean (ρ/p)	Personal Barriers (ρ/p)	Institutional Barriers (ρ/p)
Perception Mean	1.00/—	0.167**/0.001	0.169**/0.001
Personal Barriers	0.167**/0.001	1.00/—	0.549**/0.001
Institutional Barriers	0.169**/0.001	0.549**/0.001	1.00/—

ρ = Spearman's correlation coefficient

DISCUSSION

It was observed that although perceptions toward medical research were moderately positive, the students reported considerable personal and institutional barriers to their research engagement. Specific demographics, i.e., year of study, age, and residence were associated with various levels of perception and barrier scores.

The perception mean shows that students generally appreciate the value of research; however, the personal and institutional barrier means were comparatively high. This scenario was previously reported in Egypt and Pakistan also, wherein students regarded research as an important activity, yet identified lack of training, mentorship, and resources as major hindrances.^{14–16} Older students from our study reported significantly higher personal barriers. This finding aligns with reports from Egypt¹⁴, where the senior students had encountered higher barriers by increments of workload and less facilitation by the supervisor. First Year students had a higher score for perception compared with the latter classes, while the fourth and final Year students reported a higher score for personal barriers. One of the studies from Pakistan¹⁷ also reported the finding of the barriers increasing later in years, particularly by academic overload and limited opportunity for mentoring.

Days-scholars in this study had considerably greater positive perception than boarders. Though limited research compares these two groups immediately, prior evidence suggests personal circumstances, access to facilities, and institution sponsorship might dictate research participation opportunities.¹⁸ We observed little significant gender variation between barriers and perceptions. This is in contrast with some Pakistani studies¹⁶ which indicated subtle gender differences for awareness and research attitudes. Our finding may indicate a favourable condition of equity between the genders for opportunities at our institution.

Correlation analysis further revealed a significant relationship between students with elevated perception scores and elevated personal and institutional barriers. This suggests valuing research does not necessarily result in fewer barriers but potentially highlights research awareness instead. The significant association between the personal and institutional barriers reveals how system-level factors, such as the absence of an appropriate base for mentoring or a lack of funding, could lead to personal barriers.^{14,15,19} The combination of moderate perception and high barrier scores suggests that despite valuing research, students are often unable to engage in it meaningfully. Adding protected research time, formal mentorship, and early skills workshops may encourage students' engagement.^{20,21} Given that barriers to undertaking research were greatest among senior medical students, contextualized support throughout the clinical years may be needed. It is also important that institutions address any infrastructure gap, offer academic (statistical) support, and provide applications/financial assistance to bridge personal and institutional barriers.^{22,23} In the present study, lack of time, inadequate supervision or mentorship, and limited institutional support emerged as key barriers. These findings are consistent with those reported in Saudi Arabia²⁴, where it was found that lack of mentorship and guidance were the most cited obstacles to student research participation. Khan *et al*¹⁹ in Pakistan identified insufficient research training and time constraints as major limiting factors.

The study involved a vigorous sample across all years of the MBBS, employed a validated questionnaire and appropriate non-parametric analysis for data. However, the cross-sectional nature limits drawing causal inference and being from a single institution limits generalizability. Self-reported measure

may be impacted by recall or social desirability bias. In future studies, it would be beneficial to be multi-centric across public and private colleges, longitudinal transferral work outcome with perception across academic years, and qualitative measures to better understand the personal and institutional aspects. Interventional research is suggested to determine the longitudinal impact of structured mentorship and or workshops, along with institutional changes to improve student engagement with research.

CONCLUSION

Medical students in our study showed generally positive perception toward medical research but faced significant personal and institutional barriers. To foster a stronger research culture, medical colleges must integrate research skill-building early in curricula, strengthen mentorship, and provide institutional supports such as funding and protected time.

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Address for Correspondence:

Dr Mohi Ud Din, Department of Community Medicine, Aziz Fatimah Medical and Dental College, Faisalabad, Pakistan.

Cell: +92-343-4128392

Email: dr.md8924@gmail.com

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Contribution of Authors:

MUD: Methodology, Data analysis, interpretation, critical review, revision of manuscript, Final approval, final proof to be published

MS: Conceptualization, study design, methodology, data analysis, and Writing Draft

MS: Conceptualization, Study Design, Methodology, data analysis, interpretation and Writing Draft

MI: Methodology, Data analysis and interpretation

IF: Study Design, writing draft

ZS: Methodology, Data analysis and interpretation and writing draft

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ORIGINAL ARTICLE

KNOWLEDGE ABOUT THE USE OF ARTIFICIAL INTELLIGENCE AND ITS ETHICAL IMPLICATIONS AMONG MEDICAL STUDENTS

Qurat Ul Ain Zulfi, Sadia Rehman*, Raheela Rafique*, Nazneen Fatima**,
Ayesha Mehwish***, Aakash Kumar[†]

Department of Community Medicine, Sialkot Medical College Sialkot, *Department of Biochemistry, **Final Year Student, ***Department of Anatomy, Bahria University of Health Sciences, Karachi, [†]Department of Surgery, Jinnah Postgraduate Medical Centre, Karachi, Pakistan

Background: Artificial Intelligence (AI) is changing healthcare practices at a rapid pace. As future medical professionals, medical students must comprehend its applications and ethical implications. The research is intended to evaluate the knowledge, familiarity, and attitudes of medical students towards Artificial Intelligence (AI) in medicine, with particular emphasis on its ethical aspects and possible influence on healthcare. **Methods:** This analytical research was carried out from 1 Jan to 30 Jun 2024, at Sialkot Medical College. Three hundred and sixty (360) medical students, from first to final year, were recruited using convenience sampling method. Data were gathered using a structured questionnaire on Google Forms, addressing demographic information, knowledge about AI, ethical issues, and self-efficacy in AI applications. Chi-square test was applied to assess associations between categorical responses, and $p < 0.05$ was considered statistically significant. **Results:** Only 40% of students rated intermediate familiarity, indicating insufficient knowledge, even though 60% of students attended AI lectures. While strong worries about data privacy (85%) and accountability (80%) remained, no significant connections were detected on Chi-square analysis. The majority (85%) identified medical imaging as the primary application of AI, and 75% thought it improves patient outcomes. **Conclusion:** The results show increased mindfulness of AI in medical students and stresses the necessity of specific education on its ethical and clinical implications to ensure the responsible implementation of AI in medical practice.

Keywords: Artificial Intelligence, Medical education, Medical Students

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INTRODUCTION

Artificial intelligence (AI) evolved over time in sporadic fashion, but more recently gained popularity with the innovation of deep learning and artificial neural networks (machine learning models composed of many layers of interconnected artificial neurons that can automatically learn patterns from data and make predictions). ‘AI’ as a term was first used by John McCarthy in 1955.¹ It has been defined as a machine that can exhibit intelligent behaviour, like perception, reasoning, learning, or communication, and be able to execute tasks that human beings normally accomplish. Artificial intelligence (AI) consists of three fundamental paradigms: symbolic (logic- and knowledge-based), statistical (probabilistic methods, machine learning), and sub-symbolic (embodied intelligence, search). Several problem domains (perception, thinking, knowledge, planning, and communication) are addressed by these paradigms.

Medical applications of AI remain an emotive issue that scientists are highly interested in, and it is being developed and enhanced continuously.² The application of AI in education has evolved considerably over the last 25 years, with technological developments such as ‘teacher bots,’ a teaching assistant responsible for presenting content, providing feedback, and tracking progress. This increasingly prevalent use in the educational sector has shown promise to assist students

in identifying areas of knowledge deficit and receive targeted assistance, freeing teachers from routine tasks and enabling them to adapt students in a manner that facilitates personalized and adaptive learning process.³

Artificial intelligence (AI) is fast being used in medical and dental education to the advantage of both students and teachers. Simulated training and teaching using AI is one major application of AI in the field. With AI, the trainee can perform intricate surgeries on virtual patients without risking real patients’ lives.⁴ The type of practical learning is also flexible, allowing learners to follow the track on their own until they understand them. AI algorithms are a method of machine learning that can search vast amounts of health data to identify patterns and enhance diagnosis.⁵ However, challenges in implementing AI into teaching medicine and dentistry need to be overcome.

There are fears that there can be a shortage of empathy and human interaction in medical therapy and diagnosis, and there is also a fear that students will be too dependent on AI and do not understand the importance of problem-solving and critical thinking. The reliability and unbiased operation of AI systems can also be compromised, possibly leading to wrong diagnoses or treatment plans.⁶ The use of AI in dentistry education has shown promising outcomes in enhancing the teaching process and patient care. Virtual simulations allow

dentistry students to conduct complex procedures like filling and root canal therapy without injuring actual patients. The adaptability of this type of hands-on training permits students to work at their own speed and repeat procedures until proficient.⁷ Nevertheless, implementing AI into clinical and dental education is not without challenges. There can be concerns regarding the lack of human touch and compassion in medical diagnosis and treatments, whereas there is the risk that students can become overly dependent on AI and fail to hone their analytical and problem-solving skills.⁸

Students can choose to submit tasks they have not completed using automatic essay writers and online cheating software, and by modifying the scoring scale, they can artificially inflate their grades. Academic institutions are responsible for developing policies to avert such situations and uphold the integrity of the learning process.⁹ Inclusion of AI in the curriculum of medical education offers pros and cons. The assessment of medical student's knowledge and competencies may be made unbiased, objective, and uniform through using AI algorithms while generating questions. To enhance the learning of students, AI algorithms can also make tests more individualized by reviewing student performance information and creating questions that focus on areas of weakness.¹⁰

This study attempts to evaluate medical students' knowledge and attitudes toward the application of Artificial Intelligence (AI) and its ethical issues in medicine. Through their level of familiarity and concerns, the research aims to determine areas of gaps in education and equip future health professionals with the readiness to accept AI integration. This will inform curriculum development and ethical education in medical training.

MATERIAL AND METHODS

This analytical study was carried out at Sialkot Medical College from Jan 1, 2024, to Jun 30, 2024 after taking ethical approval (MRC/IRB/24001). A total of 360 medical students were recruited by using a convenience sampling method after determining the sample size by Open epi website calculator.³ The study population included students of the 1st, 2nd, 3rd, 4th, and final years of their medical course. Inclusion criteria involved being currently enrolled in the medical program, having completed at least one year of study, and having no prior formal education in applying Artificial Intelligence in medical practice. Students who refused to participate or had not satisfied the enrolment or study completion criteria were removed from the study. Data were collected through a guided questionnaire sent through Google Forms and evaluated the students' knowledge, acquaintance, and ethical aspects of AI in medicine. Participants were asked to rank their familiarity and frequency through Likert-scale questions.¹⁰

- Not familiar: 'I have little or no knowledge of AI; I cannot describe basic concepts or examples'.
- Slightly familiar: 'I have heard of AI and can recognize basic terms but cannot explain how it is used in clinical practice.'
- Moderately familiar: 'I can explain basic AI concepts, name some clinical applications, and interpret simple AI outputs with guidance.'
- Very familiar: 'I can critically appraise AI methods, apply AI tools in practice, and explain strengths/limitations to colleagues.'

The gathered data were then analysed through relevant statistical procedures to make conclusions about the perceptions and knowledge of students concerning AI in medicine. Data obtained through the research were analysed through relevant statistical procedures to provide meaningful and reliable results. Descriptive statistics were computed in terms of frequencies and percentages to characterize the demographic background of the respondents, their level of knowledge, familiarity, and attitudes towards AI and ethical considerations of AI in medicine. Chi square tests were used and $p < 0.05$ was considered to be statistically significant.

RESULTS

The study surveyed a diverse group of medical students, with the majority aged 21–23 years (35%) and slightly more females (55%). Most were in their 3rd or 4th year of study. (Table-1).

Most participants are moderately familiar with AI (40%) and 60% have attended an AI seminar. AI is widely recognized for its applications in medical imaging (85%) and diagnostics (80%). Confidence in AI varies, with the majority rating their confidence level as 3 out of 5 (40%). There were no statistically significant differences in familiarity or seminar attendance ($p = 0.475$). (Table-2).

The majority of participants perceived that AI could potentially improve patient outcomes (75%, $p = 0.0006$), reflecting their understanding of AI's clinical potential rather than any direct observation, as the respondents were medical students, not practising clinicians. Students' views on AI ethics were assessed using a structured Likert-scale questionnaire, where they rated the importance of AI ethics education. Half (50%) rated training on AI ethics as 'very important' ($p = 0.0001$), highlighting strong recognition of ethical literacy as essential to responsible medical practice. The significance values were derived using the Chi-square test, comparing categorical variables to determine associations between AI familiarity, ethics awareness, and perceived outcomes. Key ethical concerns included data privacy (85%) and accountability for AI errors (80%), whereas only 20% believed AI should play a direct role in clinical

decision-making ($p=0.0000$). Slightly over half (55%) had encountered AI ethics in their education, but this finding was not statistically significant ($p=0.317$). (Table-3).

The majority of participants did not believe that AI will replace doctors (85%, $p=0.000$). Improved accuracy in diagnosis is seen as the most significant advantage of AI (50%). Ethical concerns (40%) and privacy issues (30%) are the top personal concerns regarding AI. Most participants view the overall impact of AI on healthcare as somewhat positive (60%, $p=0.000$). (Table-4).

Table-1: Demographics of study participants

Category	Sub-category	Percentage
Age Group (years)	1–20	25
	21–23	35
	24–26	20
	27–29	15
	30 and above	5
Gender	Male	45
	Female	55
Year of Study	1 st Year	10
	2 nd Year	20
	3 rd Year	30
	4 th Year	25
	5 th Year	15

Table-2: Knowledge about AI in medicine

Category	Sub-category	Percentage	<i>p</i>
Familiarity with AI	Not familiar	10	0.475
	Slightly familiar	30	
	Moderately familiar	40	
	Very familiar	20	
Attended AI Seminar	Yes	60	0.475
	No	40	
Areas AI can be Applied	Diagnostics	80	
	Treatment planning	70	
	Personalized medicine	60	
	Medical imaging	85	
	Administrative tasks	50	
	Other	10	
Confidence in AI Applications (1-5)	1 (Not confident at all)	5	
	2	15	
	3	40	
	4	25	
	5 (Very confident)	15	

Table-3: Ethical implications of AI in medicine

Category	Sub-category	Percentage	<i>p</i>
Believe AI improves patient outcomes	Yes	75	0.0006*
	No	25	
Main ethical concerns	Data privacy & security	85	
	Bias in AI algorithms	70	
	Job displacement	55	
	Accountability for AI errors	80	
	Other	5	
AI role in clinical decisions	Yes	20	0.0000*
	No	65	
	Maybe	15	
Importance of training on AI ethics	Not important	15	0.0001*
	Moderately important	35	
	Very important	50	
Encountered AI ethics in education	Yes	55	0.317
	No	45	

Table-4: Personal opinions and future perspectives

Category	Sub-category	Percentage	<i>p</i>
AI Replacing Doctors	Yes	15	0.000*
	No	85	
Significant Advantage of AI	Improved accuracy in diagnosis	50	
	Faster data processing	25	
	Reduction in human error	15	
	Cost efficiency	10	
Personal Concerns about AI	Ethical concerns	40	
	Privacy issues	30	
	Dependence on technology	20	
	Loss of jobs	25	
	Lack of personal interaction	15	
	Other	5	
Overall Impact of AI on Healthcare	Negative	15	0.000*
	Neutral	25	
	Somewhat positive	60	

DISCUSSION

The findings of this study provide valuable insights into the current level of awareness and perceptions of AI among medical students. The statistics indicate that 40% of the students are quite familiar with AI, and 20% of them self-report that they are very familiar. This is consistent with results by Al Saad *et al*¹¹, who noted that 47% of students were generally aware of AI and 68.4% thought that AI training must be mandatory among medical students. The increasing interest can be observed, as 60% of the respondents in our survey were present at an AI seminar, which supports the rationale behind the necessity of further studies on the 10% who stated that they were unaware of AI.

In terms of application fields, medical imaging (85%) and diagnostics (80%) were found to be the most significant fields where AI can be utilized, followed by treatment planning (70%) and personalised medicine (60%). These results concur with the literature, as the study by Park *et al*¹² highlighted the promise of AI in transforming medical imaging and diagnosis. Nonetheless, enthusiasm regarding the abilities of AI should be tempered with prudence, as the study by Pinto dos Santos D *et al*¹³, reported that AI's promise is exaggerated, and its real-world applications are limited.

Confidence levels in AI applications were moderate among participants (40%), which is similar to findings by Pinto dos Santos D *et al*¹³, where students acknowledged AI's potential but expressed concerns about data privacy and reliability. In our study, 75% agreed that AI enhances patient outcomes, echoing Ahmed *et al*⁴, who found that 76.7% of respondents supported integrating AI into medical curricula for its promise in improving healthcare outcomes.

Ethical issues are a significant concern, with 85% of our students being concerned with data privacy and 80% with accountability for AI mistakes. These results are in line with those of the Chan *et al*¹⁴ study, which also reported similar concerns among clinicians regarding the ethical implications of AI in clinical

practice. The need for training on AI ethics is further underscored by the fact that 50% of students in our study find it very important, supporting Park *et al*¹² and Chan and Zary¹⁴, who stressed that medical education should include both technical and ethical dimensions of AI for responsible clinical use.

Majority of students said they were taught AI ethics reflecting integration of AI-related learning materials into medical education. Nevertheless, the insignificant $p=0.317$ indicates that exposure is not consistent among the institutions. This result is consistent with Pinto dos Santos D *et al*¹³ as well as with the findings of other researchers in the recent past like Roy *et al*¹⁵ who highlighted the fact that medical students would prefer more formal and systematic education on AI and its ethical aspects. Only 15% of respondents believed AI could replace doctors, whereas 85% disagreed ($p=0.000$). This is in line with Roy E *et al*¹⁵, who stressed that AI should supplement human clinical judgment among aspiring doctors, and Pinto dos Santos D *et al*¹³, who found that students see AI as a tool rather than a replacement for clinicians.

Students found some key benefits of AI, most notably in increasing diagnostic accuracy (50%) and accelerating data processing (25%). But these advantages are balanced by worries regarding ethical concerns (40%) and privacy (30%), which indicate a guarded optimism regarding AI's potential in healthcare. Overall, the attitude towards AI's influence on healthcare is largely positive, with 60% of students perceiving it as somewhat positive. This suggests that despite concerns, students generally acknowledge AI's revolutionary potential in improving healthcare outcomes.

The study had strength that the sample was quite representative of all years of medical study. Structured questionnaire was used to ensure consistency in data collection. However, the information is self-reported and can be biased and the sample is restricted to a single institution which may have implications on the generalizability to other medical schools or regions.

CONCLUSION

Medical students are aware of the role of AI in medicine, specifically in diagnostics and imaging, but have serious ethical concerns. AI is considered as an assistant, not a replacement for physicians. There is need to improve AI education as part of medical curricula in order to balance its advantages and ethical issues.

Address for Correspondence:

Dr Aakash Kumar, Department of Surgery, Jinnah Postgraduate Medical Centre, Karachi, Pakistan. Cell: +92-331-2515974
Email: akashladkani@gmail.com

Contribution of Authors:

QAZ: Study concept, critical review and supervision

RR: Data analysis result interpretation

AM: Literature review and discussion drafting

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SR: Study design, methodology and final review

NF: Data collection and manuscript writing

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REVIEW ARTICLE

STRATEGIES TO IMPROVE LEARNING OUTCOMES AND COMPETENCIES IN UNDERGRADUATE MEDICAL EDUCATION

Tooba Noor, Mozaffer Rahim Hingorjo*, Sadiqa Syed, Rehana Rehman**

Department of Physiology, Dow International Medical College, *Dow Medical College, Dow University of Health Sciences,

**Department of Biological and Biomedical Sciences, Aga Khan University, Karachi, Pakistan

Outcome-based education (OBE) is a performance-based approach that identifies educational outcomes, after which curriculum content, teaching methods, assessment processes, and educational environment are defined. The model is based on specific, measurable, achievable, relevant, and time bound learning outcomes stated by Bloom's taxonomy to inform learners and teachers about the content of learning. Based on these outcomes, the desired learning content is delineated, embodied, and integrated into the curriculum with a focus on coherence and logical understanding. The pedagogical approaches are modern teaching aids, including simulators and e-learning are incorporated to promote cognitive and psychomotor skills. Engaging students through standardized patients, virtual, and real cases, coupled with role-playing, serves as a vital affective component within the framework of OBE enhancing emotional and attitudinal preservation in learners. Knowledge retention is employed by spaced strategies, mnemonics, and e-learning. Self-directed learning, peer-teaching are used to promote understanding and improve retention. Psychomotor skills are elicited through motor learning phases. Diverse assessments, including quizzes and work-based evaluations, are aligned with learning outcomes to ensure a comprehensive evaluation of students' understanding and application of acquired knowledge and skills. Early clinical skill development and digital literacy prepare students for evolving healthcare challenges. Therefore, by integrating these strategies in medical education enhances the overall learning experience, equipping students for the complexities of the medical profession in a dynamic healthcare landscape.

Keywords: Competence, Educational outcomes, Learners, Learning environment, Medical education, Outcome-based education

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INTRODUCTION

Outcome-based education (OBE) is a performance-based approach that specifies educational outcomes, after which curriculum content, teaching method, assessment process, and educational environment is defined.¹ This approach has gained prominence in contemporary pedagogy as a departure from traditional methods, emphasizing the end goals of education rather than solely focusing on the means of instruction.

During the last three decades, medical education has strongly emphasized on OBE and learning-centred education (LCE) in order to prepare young doctors to practice in an increasingly complex healthcare conditions with changing patient and public expectations.² Outcome based education offers many advantages as it encourages the teachers and the students to share responsibility for learning and emphasizes relevance in curriculum and accountability. Learning-centred education provides a curriculum that includes multiple methodologies to promote interactive, student-centred education and lifelong learning skills.³

Learning outcomes (LO) typically state what knowledge should be known at the time of graduation. It includes integration of knowledge, reasoning, critical thinking, abilities and mindful reflection learned in a course more quantitatively; whereas competency is the

ability to perform a professional task to a specified standard and is more qualitative. It integrates the relevant cognitive, psychomotor and affective skills required to progress from a novice to an expert as indicated by Miller's pyramid.⁴

Since the information learned by medical students is easily forgotten, it is important to design methodologies that enable longer periods of retention by application of educational strategies, instructional design and cognitive learning science to the field of medical education.^{5,6} An ideal curriculum bridges the gap in learning from inception to outcome without being too heavy, with too much depth and information overload.⁷ The present integrated PBL-based curriculum in vogue in most of the medical colleges of world proceeds by working backwards from outcome to the other elements such as content, teaching learning strategies etc (Figure-1).⁸

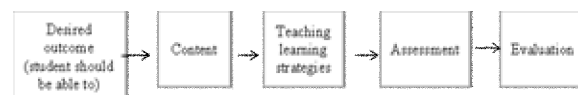


Figure-1: Components of a backward design curriculum framework

In Pakistan, the instructors lack the ability to revise their instructions, devise new learning

experiences or apply active instructional methods to achieve learning goals.⁹ In view of this deficiency, strategies are being presented for improving learning outcomes involving the learner, the learning task/environment and the context of learning being practiced. It is expected to raise awareness among teachers, better training of medical students and upgrade the system of medical education in public and private sector universities.

In a few educational institutions, many instructors lack the capacity to revise instruction, design active learning experiences, or adopt innovative teaching methods. To address this, strategies focusing on learners, learning environments, and contextual relevance are proposed to enhance outcomes and modernize medical education in both public and private sectors. These include setting clear SMART learning outcomes, mapping and reframing curriculum, sequencing the topics, using interactive lectures, simulations, e-learning tools, and promoting early clinical exposure, peer teaching, and feedback. Together, these measures aim to enhance better student engagement, retention, and clinical competence outlined in Figure-2 and discussed below.

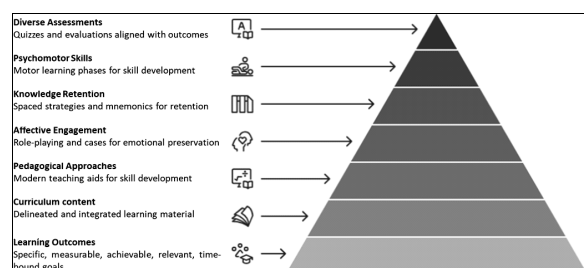


Figure-2: Framework of outcome based education

METHODOLOGY

A comprehensive literature review was conducted on Google Scholar, PubMed, Scopus, and Web of Science, Education Resources Information Center and official website of Association of Medical Education in Europe for best practice guidelines using the keywords: Outcome-based education, undergraduate medical education, educational outcomes, learning environment, and learners. Snowball searching techniques was applied from the references harvested using the keywords like, simulation in medical education, self-directed learning, mentorship and problem based learning and clinical exposure. Only English-language articles addressing undergraduate medical education and the strategies to achieve defined learning outcomes or develop specific competencies were recruited. Research articles (original studies, reviews), conceptual papers, opinion pieces, and authoritative guidelines from relevant organizations were used to propose the suggestions. While not strictly limited, preference was given more to recent literature to reflect current trends,

alongside seminal works and potentially with some attention to the context of local literature available. Articles not in English, studies focusing solely on postgraduate medical education or allied health sciences, clinical research without an educational component and low-impact studies on well-established concepts, unless they offered a unique perspective were excluded for this review paper. For each selected article, the strategy, key outcomes and its practical implementation with limitation were briefly discussed in this paper. A detailed flowchart using PRISMA diagram showing the number of articles search and refined is given in Figure-3.

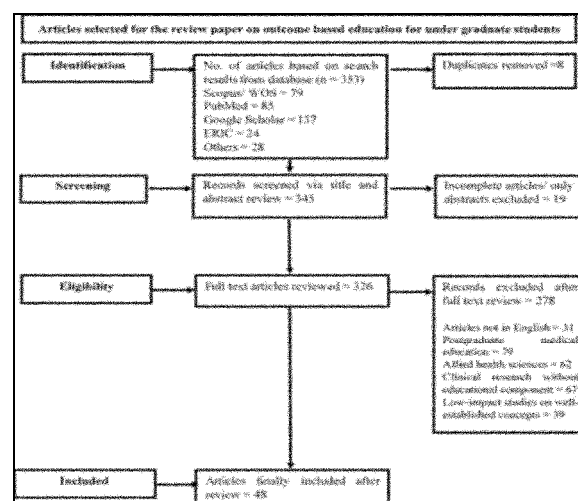


Figure-3: Prisma flowchart showing how the articles for the review paper on outcome-based education for under graduate students

1: Setting clear learning outcomes

Outcome based education places paramount importance on clearly defined and measurable learning outcomes. These outcomes articulate what students should know, understand, and be able to do by the end of a particular educational program. These outcomes serve as foundation upon which the entire educational process is built.¹⁰

Setting LOs is a central activity for both basic and clinical teachers. The concept of predetermined intended outcomes reinforces all teaching, learning and assessment activities like lectures, tutorials, demonstrations and case-based learning etc.¹¹

Learning outcomes should be written either following the three domains of Bloom's taxonomy or ABCD model (audience, behaviour, conditions, degree of mastery needed) and should be SMART, i.e., specific, measurable, achievable, relevant, and time bound. They inform learners what they should achieve and inform teachers about what they should help learners to achieve. Before writing the objectives, it is important to determine the level of learner and the most effective learning approach to attain it.¹⁰

2: Design Curriculum and Plan a comprehensive, interactive lecture to enhance learning

Curriculum development in OBE is an iterative process that starts with the identification of desired outcomes. The curriculum is then structured to align with these outcomes, ensuring that every aspect, from content selection to instructional strategies, contributes to the achievement of the predefined goals.^{1,2}

Faculty should be trained in proper formatting and designing of power point presentations with emphasis on important points. Mechanisms and processes should be explained by animations and videos. Start the lecture by stimulating recall of prior learning and knowledge, stop in the middle of lecture and ask questions and again at the end of lecture summarize and clarify with an enhanced level of understanding of the teaching-learning relationship. Students should be motivated to take notes during lectures. Teacher should know if the students have learned by asking questions and taking feedback, enhancing level of understanding of the teaching-learning relationship.¹²

Information theory suggests that students must know certain prerequisite information and that new information should be presented in a way that facilitate encoding and fills the gap between knowledge and outcome. In addition to lectures, interactive methods of learning include brief writing exercises, Think-pair-share, flipped class room, gamification, small group discussion, and debates etc.¹² Cognitive functions can be enhanced by use of pre- and post-test assessments before, during or after the sessions, incorporation of pop-up quizzes, mnemonics, trigger questions and spaced repetition.¹²

3: Sequencing of topics within and between subjects

OBE emphasizes integration between subjects and in the curriculum. Boundaries between subjects are barrier to understanding; thus, students are unable to derive a coherent understanding from a list of disjointed courses.^{1,2}

The theory of 'Constructivism' explains that knowledge is actively constructed by the learner and not passively received from an outside source. Moreover, brain has limited capacity for cognitive load and working memory should not be overloaded. This can be achieved by determining a theme for every week and proper sequencing of topics of different subjects. All the tutors involved in teaching should discuss the content of their lectures and identify the fundamental link that is missing in sequence between the same and different disciplines. They should filter out the irrelevant material so that important points are learned only.¹³

Teachers of different disciplines should coordinate their efforts for developing strategies useful for building educational blocks step by step, logically organizing chunks of information, with increasing

difficulty, complexity, clinical application, exposure and readiness for practice. These constructive pedagogical approaches bridge the gap in learning from inception to outcome.¹⁴

4: Use modern teaching aids, and e-learning resources

Cognitive learning can be improved by modern teaching aids such as simulators, skills lab, audiovisual material in smart labs, while psychomotor skills and learning can be enhanced by demonstrations and practice on models, mannequins and simulators. Practice on simulators provide effective learning especially in clinical years if it is associated with proper feedback, repetitive practice with clinical variations, increasing level of difficulty and integration of overall curriculum. A study documented that simulation program in skill labs enhanced the experience of students in clinical settings and helped them to develop critical thinking, decision making and clinical competency.¹⁵

E-learning is the use of new electronic technologies and internet to facilitate learning and is certainly one of the most important developments in the delivery of medical education. It includes offline (CDs, DVDs) and online resources, video links on bulletin boards, discussion forums, instant chats, online tutoring, mentoring and assessment and online delivery of course content, lectures, quizzes etc.¹⁶ Visualization of a process or mechanism by 3-D smart lab enhances semantic learning. Students prefer to learn by watching animations to have clear concepts. Availability of medical dictionary in tablets or mobile phones of learners for quick referral during discussion is also very useful.¹⁵

E-learning help improves retention qualities and reinforcement of knowledge as it can be repeated on demand. Well-designed e-learning content has high level of interactivity and cognitive engagements, increased recall and application.¹⁷ Learners using computer-based instructions generally learn in less time with the help of images, videos and flow charts etc. Video links with presentation and explanation of a procedure with in a clinical case seem to help students learn in context to understand its clinical importance.¹⁸ However, transition to e-learning models for course delivery requires an effective change in strategy with establishment of an appropriate learning culture.¹⁹

5: Arrange standardized, virtual and real patients and organize role play

History taking and examinations of real or standardized patients should be routinely practiced during small group discussions as it promotes long term retention of knowledge. Standardized patients help in understanding the clinical presentations of various diseases while virtual patients with addition of a video clip on multimedia to illustrate patient's findings or procedures

performed is a unique way of learning.²⁰ Bed-side teaching with history and examination of real patients in clinical settings motivates learners and enhances learning by its relevance and through active participation. It is the only setting where clinical reasoning, decision making, empathy and professionalism can be taught.²¹

Affective and attitude retention can be influenced by history taking, reflective writing and role play. Role modelling where learner takes the role of healthcare professional and interactively diagnoses and treats the patient is also very important because if a teacher respects a patient, the student also learn to respect him. Professional thinking, behaviour and attitudes are 'modelled' by teachers.²¹

6: Enhance retention and transfer of knowledge: Spaced retention

The term 'Spaced retention' describes educational interventions that are built in order to make use of spacing effect to enhance retention.⁵ A meta-analysis confirmed that educational interventions that are distributed and repeated over time results in more efficient learning and retention; recall of previous information and linking it to new concept during lectures is highly advantageous.⁵

The interventions include spaced education games, delivery of content by e-mail, blended approaches composed of face-to-face sessions and spaced contacts with online materials.²² Long term retention can also be achieved by developing mnemonics for a list of causes, microorganisms, differential diagnosis because during encoding of mnemonics, information is transferred from working memory to long term memory with an organized mental representation. Students should be taught to make concept or mind maps in which one schema represents a concept and two schema containing concepts are linked together.²³

7: Elicit performance for psychomotor skills

Three phases of motor learning skills have been identified; the early cognitive phase in which learner attempts to understand the executive routine; an intermediate phase during which learner practice sub-skill alternately with practice of total skill and final autonomous phase in which skill performance becomes automatic.²⁴

During practical, tutorial, or demonstration sessions, learners should actively perform clinical skills like examination of pulse, elicitation of reflex, measurement of blood pressure so that corrections in the performance are carried out at the spot.

8: Utilize self-directed learning (SDL) and peer-teaching effectively

Self-Directed Learning can be very effectively utilized for enhancing retention of knowledge. For that learners

should be motivated to develop self-directed traits, which include ability to be disciplined, logical, analytical, collaborative and independent. The students should plan their own learning by developing and applying strategies and appropriately using learning resources.²³ Students learn best not only by receiving knowledge but also by interpreting it. They learn by discovering the queries themselves and this involvement in learning leads to experiential learning which is retained for longer periods. Learners should be given opportunity and support to use self-direction as they become active contributors to the educational process.

Thus, involving students in teaching sessions would definitely lead to long term retention of knowledge. It has been documented that when students assume the role of peer educator for small group sessions, they require a deep learning, improvement in knowledge acquisition as they become aware of their knowledge deficits.²⁵ By interacting with their peers in class rooms, they can accurately assess their own knowledge and retention as well as gain insight into which concept they need to study further.²⁶

9: Assess learning by a suitable format of questions

Assessment in OBE is closely linked to the identified learning outcomes. Assessment methods are designed to evaluate not only the students' knowledge but also their ability to apply that knowledge in real-world scenarios.²⁷

Assessment drives students' learning and facilitates continuous rather than episodic learning with better memory retention. A study suggested that after an initial contact with the learning material, it is more beneficial to test rather than re-study the material.²⁸ Traditionally, assessment has focused on testing acquisition of knowledge or the demonstration of certain competencies in controlled settings.²⁹ With OBE comes a shift to work-based assessment, that take into account the impact of students' competence on the quality of care provided to the patient.³⁰ The meaningful impact of competency-based assessment can only be accomplished by the use of right assessment at the right time for the right purpose, using multiple assessors, involving active participation of learners.³¹

Assessment measures learning outcomes, provide direction and motivation for further learning, and promote and reward successful students. However, choosing the most appropriate type of written exam for a certain purpose is often difficult. Various methods can be used at different occasions including quizzes, multiple choice questions with one correct option, multiple true and false, short answer open ended questions, short essays and extended matching questions.³² Many online examination tools are available for quick assessment of students along with spontaneous checking and analysis of answers. Medical students are expected to develop a broad range of skills and educators must use diverse and frequent

assessments to accurately evaluate their ability to function as clinicians.³³

10: Provide a constant and informative feedback to learners

Feedback (FB) is a process in which part or whole of the learner's performance is provided to the learner in order to enhance and facilitate the future performance. Feedback helps learners to evaluate their own knowledge, identify their strengths and weaknesses, to understand the expectations of teachers and to plan to improve performance. It also improves clinical performance by reinforcing positive behaviour and correcting undesirable behavior.³⁴

The FB also benefits teachers by allowing them to recognize a student's progress, modify teaching methods, encourage their interactions with students, and build a productive working and learning relationship. Quantitative FB is provided in the form of grades gained after any exam. It is advisable to discuss the results of test papers with students so that they learn by their mistakes and have notion about effectiveness of their strategic efforts for better understanding.³⁴

A study reported three formats of FB given to students on their performance after formative and summative Objective Structured Clinical Examination (OSCE). The FB includes: Domain FB based on knowledge (quantitative); Hot FB written by examiner about indicator of performance and Cohort FB for the whole year focusing on performance trends across all students (qualitative).³⁵ Another study demonstrated that providing additional FB using qualitative analysis is beneficial for both students and educators as students receive adequate tool to improve on their skills through self-reflection.³⁶

11: Develop effective problem based and case-based skills

Problem Based Learning (PBL) and Case Based Learning (CBL) should be constructed in such a way that provides the learners with tangible goals of applying their knowledge to solve a concrete problem. During the session's students should be allowed to discuss all the aspects of a case, activating their prior learning, generating hypothesis with simultaneous construction of their knowledge. They should be motivated to gather information from a wide range of sources.³⁷

The PBLs and CBLs are focused on experiential learning organized around the presenting complaints, investigations, explanations and resolution of meaningful problems. Students reflection on the case helps them to correlate their new knowledge to their prior understanding and to identify gaps in their awareness and to develop a more coherent understanding.³⁸ Since PBL and CBL sessions are marked by numbers so students are motivated to gather every bit of information related to the problem and

become more confident in their presentation. Psychological research theory suggests that when students learn through the experience of solving problems they can learn both content and thinking strategies. Unfortunately, due to lack of resources and dearth of faculty these sessions are not conducted properly in most of the medical colleges.³⁹

12: Arrange (offer) mentoring

During the past decade, mentoring programs have become an integral part of medical education where the role of mentor is to provide motivation, psychological support, professional and personal development. Mentoring creates a relationship between an experienced, highly regarded, neutral empathic person (the mentor) and another individual (the mentee) who receives individual personal and professional guidance with continuity throughout the educational program.⁴⁰

As a novice in medical school, the students have no idea about competencies they have to acquire as a medical graduate. Mentoring as well as early clinical exposure allows them to imagine their future life as a physician and give meaning to theoretical studies. The students understanding of professional competence and behaviour evolves during the mentorship and they progress towards understanding the wholeness of the profession.³⁶ Mentoring provides longitudinal guidance in context of tips for learning, adjustments in college environment, handling different situations, understanding the demands of profession and to find a balance between life and profession. A successful mentoring program not only enhances learning abilities but also an early and directed focus on the non-medical aspects of the professional role.⁴¹

13: Impart clinical skills in pre-clinical years

The term 'clinical skills' encompasses history taking, physical examination, using diagnostic reasoning, effective communication, and teamwork.⁴² Early introduction of these skills using automated manikins, simulators, role play, 3D animation and various artificial intelligence (AI) tools would facilitate the integration of clinical and basic science knowledge and in the development of clinical competence.⁴³ Previously, medical education was primarily based on rotations in different wards during the clinical years to train clinical skills, while the preclinical period was mainly used to teach the basic sciences. Because of the limited clinical exposure in clinical years, students face difficulties in handling a simple case of diarrhoea when they are posted in emergency or clinics during their house job. As a result, their confidence and decision-making skills as a consultant shatter.⁴⁴

The literature also supports that students feel more prepared when clinical skills are introduced early in their curriculum.⁴⁵ It increases their confidence, improves performance, makes them 'feel' like doctors,

and also helps them to best prepare for their clerkship phase. Thus, there is a need of advanced technologies to bridge the gap between traditional teaching based on lectures, and laboratory session in pre-clinical years and bed side consultation during clinical years.⁴⁶

14: Familiarize students with digitalization of medical education

One of the main domains of OBE is to master the medical students with current trends in technology to enable them to meet the ever-evolving challenges of medical field when they professionally start their career.⁴⁷ Despite rapid evolution in medical education in last few years, little time is spent on familiarizing medical students with new technologies in clinical training such as AI, mobile healthcare applications and telemedicine.⁴⁸

Artificial intelligence is a scientific discipline that is gaining alarming momentum in healthcare and focuses on understanding and creating computer algorithms which can perform tasks that are usually characteristics of humans. It is currently being used in health care for quick and precise diagnosis, reducing human errors, minimizing medical cost and assisting in radiology and minimal invasive surgeries.⁴⁹ However, as AI and its applications become mainstream in healthcare, medical students, need to have knowledge of AI, data sciences, ethical and legal issues concerning AI to become a competent doctor of the future. Thus, it is suggested that medical schools need to include them as part of the curriculum; otherwise, the integration of AI into routine clinical practice is going to be a challenge if it remains untouched by medical educationists.

CONCLUSION

Outcome-Based Education represents a paradigm shift in the field of education, emphasizing the importance of clearly defined outcomes, student-centred approaches, and continuous improvement. While facing challenges, the benefits and potential for positive transformation make OBE a compelling framework for educators and institutions seeking to prepare students for success in the 21st century. As the educational landscape continues to evolve, OBE stands as a dynamic and adaptable approach that holds promise for the future of learning. Healthcare faculty should adopt active learning strategies and novel teaching techniques to improve educational outcome. Faculty training programs should be continued to enable clinicians to think innovatively and create technology enabled training of medical students. This proactive approach will contribute significantly to comply with international academic equivalency and accreditation standards.

AI Disclaimer:

Napkin AI was used for some guidance and language formatting.

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Address for Correspondence:

Sadiqa Syed, Department of Physiology, Dow International Medical College, Dow University of Health Sciences, Karachi, Pakistan. **Cell:** +92-335-6256555

Email: sadiqa.syed@duhs.edu.pk

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TN: Data curation and first draft of manuscript

MRH: Aligned the points useful for OBE

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INFORMATION FOR AUTHORS

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Name	Email	Name	Email
Aamer Ubaid	aamerubaid@gmail.com	Rashid Iqbal	profrashidiqbal@gmail.com
A B Sheikh	absheikh@iau.edu.sa	Rashid Mahmood	drashid62@gmail.com
Afsheen Mansoor	drafsheenqamar@gmail.com	Rehana Rehman	drrehana7@gmail.com
Ahmed Badar	badarabbott@hotmail.com	Ricardo B Bandeira	ricardoban@gmail.com
Aiza Saadia	aiza2483@gmail.com	Rita Khadka	rita.khadka@gmail.com
Aleena Arshad	aleenaarshad81@gmail.com	Roman Ashraf	drromaan.ashraf@gmail.com
Aleshba Saba Khan	aleshba.saba@hotmail.com	Sadaf Fasih	sweetsadaf1981@yahoo.com
Alruba Taimoor	medicolodhi@outlook.com	Sadaf Konain Ansari	sdf_ansari@yahoo.com
Ammar Bin Saad	ammarbinsaad1@yahoo.com	Sadia Zaheer	dr.sadiazaher@gmail.com
Aneeqa Rashid	dr.aneeqa@hotmail.com	Sahar Farhat	saharfarhat615@gmail.com
Arifullah Khan	khan55578@hotmail.com	Sahibzada Nasir Mansoor	drnasirmansoor@gmail.com
Asima Mehboob Khan	khanasima@gmail.com	Saima Gillan	drsaimagillani@gmail.com
Asma Jabeen	drasmajabeen@gmail.com	Samia Perwaiz Khan	samiaphk@gmail.com
Ayesha Irfan	ayesha.organ41@gmail.com	Sana Akram	sana.akram1986@gmail.com
Bushra Riaz	bushra_riaz@ymail.com	Sara Haider Malik	sarahaidermalik@gmail.com
Bushra Shaheen	drbushrashaheen@gmail.com	Sara Sadiq	dr.sarabhathi@gmail.com
Bushra Sherwani	bushrasherwani@hotmail.com	Sarah Amin	sarahadnanmalik@gmail.com
Faiza Alam	faiza.orakzai@gmail.com	Sarmad Latif Awan	sarmadawan786@hotmail.com
Farhan Muhammad Quresh	drfarhanqureshi@hotmail.com	Seema Mumtaz	seema.mumtaz@kimsmlir.edu.pk
Fauzia Aitazaz	doctorfauzia@gmail.com	Shabana Naz	drshabananaaz@yahoo.com
Haidar Zaman	haidar100zz@gmail.com	Shagufta Manzoor	drshagufta86@yahoo.com
Huma Naqeeb	huma.naqeeb@wumardan.edu.pk	Shahab Ud Din	drshahab728@hotmail.com
Huma Shahzad	humashahzad.1983@gmail.com	Shandana Jadoon	shandana86@gmail.com
Humaira Ali	Dr.Humaira.Ali@lnh.edu.pk	Sheeba Shabbir	drsheebakhan@ymail.com
Humera Adeeb	adeebhumera@yahoo.com	Sher Afghan Khan	sher_ak@hotmail.com
Iram Sarwar	irum@ayubmed.edu.pk	Sidra Humayun	drsidrafarooq4@gmail.com
Irfan Raza	siraza.pk@gmail.com	Sidra Shaukat	sidrasalman877@gmail.com
Javed Iqbal	iqbal007javed@gmail.com	Sumaira Javed	sumaira@ayubmed.edu.pk
Khurram Irshad	khurram.scm@stmu.edu.pk	Syed Hamid Habib	dr.hamidhabib@gmail.com
Kumayl Abbas Meghji	dr.kumaylabbas@gmail.com	S. Yasir Hussain Gilani	drgilani78@yahoo.com
Madiha Khattak	drmdihakhattak26@gmail.com	S. Zubair Hussain Shah	zubair@amc.numspak.edu.pk
Mahvash Khan	mahvashkhan8@gmail.com	Syeda Sadaf Kazmi	dr.sadafkazmi@gmail.com
Mahwish Gul	dr.mahwishayub@gmail.com	Tallat Naureen	drtallat7@gmail.com
Malik Mahmood Ahmed	ahmedfm59@hotmail.com	Tariq Feroz Memon	drtariqferoz@gmail.com
Mamoon Mushtaq	mamoonamushtaq@gmail.com	Ulfat Sultana	shalley72@hotmail.com
Mawra Hyder	mawrahyder90@gmail.com	Uzma Hafeez	druznahafeez@gmail.com
Muhammad Amjad Khan	drmkhan@gmail.com	Wajida Perveen	wajopri@gmail.com
Muhammad Idris	midris63@yahoo.com	Waqas Hameed	waqham@hotmail.com
Muhammad Jamil	mjamilsana1989@gmail.com	Wasim Ahmad	dr.wasimahmad@yahoo.com
M. Mansoor Majeed	mmansoormajeed@gmail.com	Yasmeen Bibi	ysmnanwar@yahoo.com
Muhammad Mohsin Javaid	mohsinjavaid734@gmail.com	Zahid Azeem	paym_zahid@yahoo.com
Muhas C	drmuhasc@gmail.com	Zainab Khattak	zainabkhattakgkmc@gmail.com
Munir Abbasi	munir@ayubmed.edu.pk	Zara Khalid Khan	doczara.khan20@gmail.com
Mustafa Sajid	drmustafasajid84@gmail.com	Zeeshan Haroon	zeeshanharoon@yahoo.com
Nasar Um Min Allah	nz.zulfiqarali@gmail.com	Ziyad Afzal Kayani	ziyadkayani@hotmail.com
Noaman Ishaq	noamanishaq@yahoo.com	Zulfiqar Ali Laghari	zulfiqar.laghari@usindh.edu.pk
Rana Khurram Aftab	dranakhurram81@outlook.com		

