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EDITORIAL

THE HOMEOSTATIC STRAIN OF EL NIÑO: ORGAN SYSTEM CONSEQUENCES AND HUMAN PATHOPHYSIOLOGY

Ahmed Badar
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Climate anomalies are often assessed through meteorological or socioeconomic frameworks, yet their most immediate impacts manifest through human physiology. The El Niño-Southern Oscillation (ENSO), with its alternating warm and cool phases, disrupts global climate patterns and exposes populations to extreme heat, altered rainfall, and degraded air quality. These shifts act as systemic stressors that challenge cellular homeostasis, tissue perfusion, and organ function. Resulting physiological strain includes oxidative injury, cardiovascular and respiratory morbidity, acute kidney injury, and neuroendocrine imbalance. Livelihood disruption, displacement, and chronic psychological stress further amplify adverse outcomes. Addressing these effects requires integrated research on climate-related pathophysiology, strengthened public health education, and incorporation of climate-health concepts into medical and allied health training.

Keywords: Climate Change, El Niño-Southern Oscillation, ENSO, Homeostasis, Physiology
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The El Niño-Southern Oscillation (ENSO) is one of the most influential drivers of interannual global climate variability. Arising from complex ocean-atmosphere interactions across equatorial Pacific, ENSO oscillates between 'El Niño' marked by anomalous warming of central and eastern Pacific waters, and 'La Niña', characterized by abnormal cooling. Although geographically localized in origin, ENSO events reshape global jet streams and atmospheric circulation, producing widespread anomalies in temperature, precipitation, humidity, air quality, and wildfire activity. El Niño episodes consistently elevate global surface temperatures and intensify droughts, marine heat waves, and flooding, while La Niña often enhances tropical rainfall across Asia and Australia.[1]

While climate scientists frequently describe these environmental shifts, their biological consequences are fundamentally rooted in human physiology. When ambient conditions exceed evolutionary thermal and hydric thresholds, the human organism must activate complex homeostatic mechanisms to preserve cellular integrity, tissue perfusion, and metabolic stability. Emerging evidence now frames ENSO not merely as a climate phenomenon but as a multi-organ homeostatic stressor capable of translating environmental anomalies into human disease. A recent analysis by the Society of Actuaries Research Institute reported measurable reductions in population life expectancy during major El Niño events, with circulatory diseases accounting for a substantial proportion of excess mortality. These effects may persist for years after the climatic event ends, underscoring ENSO's long term threat to population health and socioeconomic stability.[2]

At the microscopic level, extreme heat and humidity impose profound cellular strain. When ambient conditions surpass the thermal neutral zone, intracellular environments experience protein-folding stress, triggering the synthesis of heat shock proteins such as HSP70 to prevent cytotoxic aggregation. Sustained thermal exposure overwhelms these protective mechanisms, leading to mitochondrial dysfunction, excessive reactive oxygen species (ROS) production, and uncoupling of oxidative phosphorylation. The resulting oxidative injury damages lipid membranes, structural proteins, and nuclear DNA, initiating apoptotic and necrotic pathways across multiple tissues.[3]

The digestive system exhibits some of the most consistent ENSO-related health effects. Flooding, water contamination, and disruptions in food production increase the risk of cholera, diarrhoeal diseases, enteric infections, and food-borne illnesses. These outcomes are repeatedly highlighted in WHO climate-health reviews.[1] Heat exposure further redistributes blood flow away from splanchnic circulation toward skin, predisposing intestinal mucosa to hypoperfusion and ischemic injury. Damage to epithelial tight junctions may allow translocation of endotoxins and microbial products into bloodstream, precipitating endotoxemia, systemic inflammatory response syndrome (SIRS), and multi-organ dysfunction.[4]

Extreme heat during El Niño events imposes substantial cardiovascular strain. Dehydration and haemoconcentration increase blood viscosity and thrombogenic potential, while wildfire smoke and air pollution exacerbate ischemic heart disease and heart failure. Physiologically, heat stress induces peripheral vasodilation, reduced systemic vascular resistance, tachycardia, and increased cardiac output. These responses facilitate heat dissipation but significantly elevate myocardial workload and oxygen demand. In older adults and individuals with underlying cardiovascular disease, these changes heighten the risk of

myocardial ischemia, arrhythmias, stroke, and sudden cardiac death. Circulatory diseases constitute a major component of ENSO-associated mortality.[5]

Wildfires, dust storms, and stagnant air masses increase particulate matter exposure, worsening chronic respiratory diseases. Heat stress impairs mucociliary clearance and alters pathogen circulation patterns, contributing to higher respiratory infectious morbidity. A Chinese study demonstrated significantly increased respiratory infections during El Niño years.[6] These findings were echoed in WHO and Lancet climate-health assessments too.[7]

Renal consequences of ENSO are biologically plausible and increasingly recognized although there is not much published direct evidence. Heat exposure and reduced water availability during droughts predispose individuals to dehydration-related acute kidney injury (AKI), kidney stone formation, and exacerbation of chronic kidney disease (CKD). Profuse sweating without adequate electrolyte replacement causes intravascular volume contraction, activating the rennin-angiotensin-aldosterone system (RAAS) and vasopressin release. Prolonged renal cortical hypoperfusion, combined with intracellular energy deficits and subclinical rhabdomyolysis, may culminate in acute tubular necrosis and heat stress nephropathy.[5]

ENSO-associated heat and humidity fluctuations contribute to dermatologic conditions such as heat rash, sweat-related dermatoses, and fungal infections. Increased ultraviolet exposure during droughts further stresses skin integrity. Vector-borne diseases with characteristic dermatologic manifestations often surge during ENSO-related ecological shifts.[7]

Beyond physical illness, ENSO exerts profound psychosocial impacts. Heat-related psychological stress, anxiety linked to droughts and floods, food insecurity, displacement, and disaster exposure contribute to heightened rates of depression, PTSD, and suicide. Chronic environmental stress activates the hypothalamic-pituitary-adrenal (HPA) axis, sustaining glucocorticoid elevation and sympathetic tone. This persistent neuroendocrine activation impairs immune surveillance, worsens metabolic dysregulation, and amplifies chronic inflammatory conditions.[7] Recent evidence also links maternal ENSO exposure to adverse child survival outcomes, highlighting intergenerational vulnerability.[8]

ENSO-driven climate anomalies disrupt daily routines, sleep architecture, occupational productivity, and physical activity, particularly among outdoor workers. Food insecurity, water scarcity, and economic instability compound physiological stress, creating a self-reinforcing cycle of vulnerability that extends far beyond acute hospital admissions.

Addressing ENSO's expanding health burden requires a coordinated, physiology-centred strategy. Research priorities must include continuous physiological monitoring in vulnerable populations, organoid and cellular models of thermal and osmotic adaptation, and discovery of biomarkers for early heat shock, renal hypoperfusion, and endothelial injury. Public education campaigns should translate physiological principles into practical guidance on heat acclimation, hydration, cooling strategies, and early recognition of exertional heat illness.

Medical and allied health curricula must also evolve. Traditional physiology teaching often isolates organ systems from environmental context. Modern training must integrate climate-driven pathophysiology, thermoregulation, and environmental health dynamics to prepare future clinicians for the systemic biological challenges of a warming world.

By embedding these concepts into research, policy, and education, the medical community can shift climate adaptation from a reactive challenge to proactive, physiology-driven strategy for human resilience.

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ORIGINAL ARTICLE

VARIATIONS IN THE BONE PROFILE AND VITAMIN D LEVELS DURING NORMAL PREGNANCY IN RURAL WOMEN

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Background: Pregnancy triggers significant physiological adaptations that alter maternal bone turnover and mineral metabolism to support foetal skeletal development. Investigating these biochemical shifts in specific demographics is essential for distinguishing normal gestational variations from true pathological deficiencies. The study was conducted to evaluate alterations in bone profile and vitamin D3 levels during pregnancy in normal women residing in rural areas of District Nowshera. **Methods:** This cross-sectional study was conducted from April 2024 to March 2025 by the orthopaedic unit at Lady Reading Hospital in Peshawar, in collaboration with the health department of district Nowshera. A total of 90 pregnant women, aged between 18 and 35 years, from the three basic health units in the Nowshera district, were investigated. Twenty-five non-pregnant, non-lactating women who met the same inclusion and exclusion criteria were also examined. **Results:** Total serum calcium (p=0.2944), inorganic phosphorus (p<0.0001), and serum albumin (p<0.0001) concentrations were found to be lower in pregnant women in comparison to the control group, whereas alkaline phosphatase (p<0.0001) activity was elevated in pregnant women relative to non-pregnant women. **Conclusion:** The decrease in level of Calcium, Phosphorus, Albumin and Vitamin D 3, and increase in level of Alkaline Phosphatase in pregnant women underscore the necessity of creating pregnancy-specific reference ranges as needed for the professionals engaged in antenatal care.

Keywords: Bone profile, Nowshera, Pakistan, Pregnancy, Rural, Vitamin D levels, Women

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INTRODUCTION

Pregnancy constitutes a unique state in the lives of women, influencing numerous physiological, metabolic, and skeletal systems within the human body. All of these changes are essential for sustaining pregnancy, promoting foetal development, and facilitating postpartum lactation. Certain blood components generated during pregnancy are found in significantly higher concentrations, whereas others are present in lower amounts compared to women who are not pregnant.[1]

Numerous changes begin shortly after conception and persist until the end of gestation. A previous report indicated that the physiological adaptations associated with pregnancy, result in numerous significant alterations in laboratory test values.[1] An increased plasma volume aids in the delivery of blood and nutrients to the foetus via the placenta.[2] The decrease in hematocrit and haemoglobin levels during pregnancy is referred to as physiological anaemia or dilutional anaemia.[3] While the physiological rise in blood sugar during pregnancy is referred to as gestational diabetes.[4]

In females, skeletal development persists until approximately 20 years of age; however, bone mineralization may continue until the age of thirty-five.[5] The bone profile encompasses four key blood parameters: serum calcium, serum phosphorus, serum albumin, and serum alkaline phosphatase (ALP).[5] A foetus at full term contains 30 grams of calcium and 20 grams of phosphorus, with around 80% of these minerals being accumulated during the third trimester of pregnancy.[6]

Vitamin D, often referred to as the ‘solar vitamin’, is crucial for the absorption of calcium and phosphate metabolism, as well as for the mineralization of bones. It is produced primarily through the direct exposure of sunlight to the skin (90%) or through dietary sources (10%) such as dairy products, eggs, and fish.[7] An early study indicated that vitamin D deficiency is prevalent among females during pregnancy.[8] Other researchers have pointed out that over 50% of mothers and their newborns experience some degree of vitamin D deficiency[9], particularly among those of Asian descent.[10] Understanding the variations in the stated blood parameters is crucial for the well-being of both mothers and their infants throughout the gestational period.[11]

The present research was conducted to examine bone blood parameters, including vitamin D deficiency, during the three trimesters of pregnancy among women residing in rural areas of district Nowshera.

MATERIAL AND METHODS

This cross-sectional study was carried out by the Department of Orthopaedics across three Basic health units in the Nowshera district. These units were equipped with antenatal care facilities and were chosen randomly

for the study. The duration of the project spanned from April, 2024 to March, 2025.

The age of participants was between 18 and 35 years. Eligible pregnant women attending the selected antenatal clinic and were residents of the rural areas of Nowshera, and willing to participate in the study were included in the study. A non-probability consecutive sampling technique was used. All of them had regular ovulatory cycles, normal obstetric histories, and never used any contraceptives during their reproductive lives.

Women with poor general health, a history of smoking, any chronic disease, any hormonal disorder, or who did not give birth to healthy singleton infants at term were excluded. The sample size was calculated using the formula: $n= Z^2P (1-P)/d^2$. The expected prevalence was 50%, with a confidence interval of 90% and an alpha error of 10%. The determined sample size 69 was subsequently raised to 90, to account for potential non-responses.

A total of 90 pregnant women, comprising 60 primigravidas and 30 multigravidas, from the middle socioeconomic group with a nearly identical lifestyle, were included in the study. A control group consisting of 25 non-pregnant, non-lactating women with same criteria was recruited. Blood sample in the control group was performed during the early follicular phase of the menstrual cycle (days 4–10). A smaller control group was recruited because the primary objective was to evaluate the laboratory changes across pregnancy trimesters while non-pregnant women served only as a reference group.

The research was approved by the Institutional Research and Ethics Board, Postgraduate Medical Institute (PGMI), Hayatabad Medical Complex, Peshawar before start of study (Reference No. 6683 dated 3 Jun 2024). The goals and procedure of the project were communicated to the participants, and were assured about their privacy and confidentiality. All participants volunteered and provided a written informed consent for participation in the study.

Then, all participants completed a validated and pre-tested questionnaire that gathered information on age, family composition, occupation, onset of puberty, age at marriage, gestation duration, age at first childbirth, lactation history, and parity.

A total of six millilitres of blood samples were obtained in the morning, between 8:00 and 9:00 AM, during the first trimester (1–13 weeks), the second trimester (14–26 weeks), and the third trimester (27+ weeks) of pregnancy. The serum was separated from all specimens following the clotting process. Calcium, phosphorus, albumin, and alkaline phosphatase levels were measured using the automatic cobas® c 311 analyser from Roche, while Vitamin D was estimated with ARCHITECT-Plus I1000SR® analyser from Abbott Diagnostics.

The following formula was used to calculate the corrected calcium concentration[12]:

Calcium corrected (mg/dL) =
Total calcium measured (mg/dL) + 0.8(4 - albumin (g/dL)

Data were entered and analysed on SPSS-17. Continuous variables were presented as Mean±SD. Normality was assessed with Shapiro-Wilk test. Comparison among the four groups was performed with one-way ANOVA for normally distributed data; $p \leq 0.05$ was considered significant. Frequency distribution tables were generated using the Mean±SD.

RESULTS

The results of the current research are displayed in Table-1. The mean levels of calcium, phosphorus, and albumin were observed to decrease as gestational age progressed through the three trimesters of pregnancy. The level of alkaline phosphatase activity rose with the progress of gestational age. The vitamin D levels in pregnant women were found to be lower when compared to the control group of non-pregnant women.

A comparison of the bone profile and vitamin D levels between pregnant and non-pregnant women is presented in Table-2. The conventional SI units/ reporting formats is instrument generated and appropriate for this study as the comparison is not between the given parameters. All parameters were notably modified during pregnancy, with the exception of calcium and corrected calcium. Moreover, the patterns observed in our study group's primigravidas and multigravidas did not differ for any of the parameters examined. Furthermore, age at marriage and parity had no effect on the above estimated parameters in both the control and study groups.

Table-1: Blood parameters among controls and three trimesters of pregnancy (Mean±SD)

Analyte	Non-pregnant	1st trimester	2nd trimester	3rd trimester
Total Calcium (mg/dL)	8.7±1.4	8.6±2.0	8.2±1.9	8.0±1.8
Albumin (g/dL)	4.4±0.2	4.3±0.1	3.8±0.1	3.7±0.1
Phosphorus (mg/dL)	3.16±0.09	2.82±0.15	2.91±0.09	2.57±0.08
ALP (U/l)	62±2.60	61±1.24	73±2.60	130±5.03
Corrected Ca^{++} (mg/dL)	8.4±0.21	8.4±0.17	8.4±0.21	8.2±0.30
Vitamin-D3 (ng/mL)	47.8±12.2	31.5±10.4	16.5±6.8	14.2±8.8

Table-2: Comparison of Serum parameters among non-pregnant and pregnant women (Average of three trimesters, Mean±SD)

Analyte	Non-Pregnant	Pregnant	*p*
Total Calcium (mg/dL)	8.7±1.4	8.27±1.9	0.2944
Albumin (g/dL)	4.4±0.2	3.93±0.1	<0.0001
Phosphorus (mg/dL)	3.16±0.09	2.7±0.11	<0.0001
ALP (U/L)	62±2.60	88±2.96	<0.0001
Corrected Ca^{++} (mg/dL)	8.4±0.21	8.3±0.23	0.0527
Vitamin-D3 (ng/mL)	47.8±12.2	20.7±8.67	<0.0001

DISCUSSION

Metabolic processes are closely associated with skeletal health. Particularly the mineral metabolism may alter due to foetal requirements during pregnancy. In the present study we investigated the alterations in minerals and vitamin D levels.

Lower serum vitamin D3 levels were observed among pregnant women in the present study. Previous research has produced similar results.[13] The low levels of vitamin D3 may be associated with limited dietary intake of vitamin D rich food and reduced sunlight exposure. A woman whose vitamin D levels are below 15 ng/mL has a fivefold increased risk of developing pre-eclampsia.[13] Certain researchers demonstrated that women who consumed 4,000 IU of vitamin D each day had the advantages in reducing the risk of preterm birth, bone fragility, and infections.[14]

The level of serum calcium decreased during the three trimesters of pregnancy. Similar findings were observed in an earlier study[15], likely attributed to nutrient deficiency and the heightened needs of both the mother and the infant. Hypocalcaemia during late pregnancy is prevalent, occurring in 59% of women of reproductive age.[16] Another study has indicated that pregnant women exhibit elevated maternal serum calcium levels compared to non-pregnant women; however, this finding originates from a developed country. [17]

The serum Albumin levels were lower in pregnant than in non-pregnant women. Similar results were observed in another study carried out on Sudanese pregnant females.[18] This phenomenon may be ascribed to the dilution-al effect resulting from the rise in maternal plasma volume.[19] A decrease in serum albumin levels in the pregnant women may also be attributed to hepatic dysfunction affecting albumin synthesis.[19] Elevated levels of steroid hormones also influence the metabolic, synthetic, and excretory functions of the liver during pregnancy. [20]

The serum phosphorus also showed a declining trend across pregnancy with the lowest values observed in the third trimester. A prior study revealed comparable findings.[20] The lower phosphorus levels observed in our study may be associated with reduced dietary intake, and increased foetal requirements.[18] Furthermore, our results are supported by an earlier study which indicated that maternal urinary phosphorus excretion rises during the third trimester of pregnancy.[18]

The activity of serum ALP exhibits a markedly significant rise during pregnancy when compared to the control group of non-pregnant women. The rise observed during pregnancy is mainly attributed to the production of placental ALP iso-enzyme activity , rather than solely with hepatic iso-enzymes.[21] There is a report that the blood samples from women who experienced preterm delivery exhibited higher levels of ALP placental iso-enzyme when compared to those who delivered at term.[22] Therefore elevated ALP levels in late pregnancy should be interpreted with caution, as they may reflect physiological changes related to the placental production in addition to other potential sources of ALP.[22]

The constraint of this research was noted in the budgeting aspect. The limited budget restricted the research to a minimal number of samples. The authors carried out the study prioritizing the community's welfare, and they have no conflicts of interest to report.

CONCLUSION

The decrease in level of Calcium, Phosphorus, Albumin and Vitamin D 3, and increase in level of Alkaline Phosphatase in pregnant women underscore the necessity of creating pregnancy-specific reference ranges as needed for the professionals engaged in antenatal care.

RECOMMENDATIONS

Comprehensive studies are required across various regions of the country to validate the aforementioned variation concerning this subject.

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Authors approved the draft and are accountable in ensuring that questions related to accuracy or integrity of the work are duly investigated and resolved.
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ORIGINAL ARTICLE

COMPARISON OF INTRAMEDULLARY NAILING AND PLATING IN TIBIAL FRACTURES: IMPACT ON MOBILITY RECOVERY

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Background: Tibial shaft fractures are common and often require surgical fixation. This study compared intramedullary nailing (IMN) and plating for early postoperative mobility. **Methods:** A retrospective review was conducted on 480 adults with closed diaphyseal tibial fractures (240 IMN, 240 plating). Physiotherapy notes documented the first day of active knee/ankle mobilization. Outpatient visits provided data on time to partial and full weight-bearing. For comparison between groups *t*-test was used and $p \leq 0.05$ was considered statistically significant. **Results:** Time to joint mobilization was significantly shorter with IMN (3.0±1.60 days) than plating (6.0±1.55 days), with a mean difference of -3.0 days (95% CI: -3.28 to -2.72; $p<0.0001$). Times to partial (6.68 *vs* 6.73 weeks; mean difference -0.05, 95% CI: -0.31 to 0.21; $p=0.707$) and full weight-bearing (8.57 *vs* 8.45 weeks; mean difference 0.12, 95% CI: -0.15 to 0.39; $p=0.389$) were not significantly different. **Conclusion:** IMN allows significantly earlier joint mobilization than plating. As weight-bearing timelines were similar, IMN is preferred when early motion is a priority.

Keywords: Early mobilization, Intramedullary nailing, Plating, Tibial shaft fracture, Weight-bearing

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INTRODUCTION

Bone fractures are very common injuries and significantly impact the lives of many patients. They are a public health issue and pose a significant economic challenge.[1] Fractures are an economic burden for individuals, families and healthcare systems and can result in lost wages, reduced productivity, disability, poor quality of life, significant medical expenses, and even death.[2]

Among the long bones, tibia is the most commonly fractured.[3] This type of fracture is commonly caused by high-energy trauma such as road traffic accidents and falls from significant heights. The management of this fracture is complex due to several complicating factors such as inadequate local soft tissue coverage, more skin tension and anatomical ischemia at the fracture site.[4] Multiple treatment modalities are used for the treatment of tibial fractures depending upon fracture type and patient needs. These include, but are not limited to, intramedullary nailing, plating, screw fixation, intramedullary fixation with locked screws, minimally invasive plate osteosynthesis, and external fixators, with each offering specific benefits for different fracture patterns.[5]

Intramedullary nailing and plating are two common surgical techniques employed to address tibial fractures. Intramedullary nailing is widely accepted as the treatment of choice for tibial diaphyseal fractures.[6] In this procedure, the fracture is either reduced manually or with the help of tools. A small proximal incision is made and through it a guidewire is inserted. The medullary canal is then reamed to slightly widen it. For the last step, an intramedullary nail is placed over the guidewire to span the length of the fracture.[7] The implanted nail acts as an internal splint with load sharing characteristics.[8] This technique significantly reduces soft tissue involvement. In traditional plating, larger incisions are usually required, which leads to increased soft tissue and periosteal damage.[9] IMN promotes biological bone healing by preserving the integrity of surrounding tissues and maintaining the vascular supply.[10] Consequently, IMN is associated with a shorter period of disability and faster fracture union.[11] Plating, on the other hand, is a more invasive procedure. In plating, an incision is given over the skin and soft tissues are retracted to expose the fractured bone. After the surgeon aligns the fractured bone in its normal anatomical position, a plate is fixed to the surface of the bone spanning the fracture site. The plate is then secured to the bone with screws. According to some literature, plating, when compared with intramedullary nailing, is associated with a reduced risk of fracture malalignment, with no significant differences in bone union, wound complications, and superficial or deep infection.[12] When compared to IMN, plating is a much simpler and cheaper procedure, not requiring an image intensifier, an orthopaedic table, or a specialized nail-inserting assembly.

This study evaluates and compares intramedullary nailing and plating for tibial diaphyseal

fractures, specifically in terms of early mobility and weight-bearing. The findings will help guide surgical decision-making and improve patient care.

MATERIAL AND METHODS

This was a two centre retrospective study done from 5 Jun 2021 to 5 Jun 2024 at Jinnah International Hospital, Abbottabad and Al-Yousaf Hospital, Abbottabad. The data was collected from patient records. A total of 521 patients underwent intramedullary nailing or plating operations for tibial fractures, of which 251 intramedullary nailing and 270 plating operations were done. Two hundred and forty (240) patients fulfilling the inclusion criteria from each group were randomly selected, using Stata-17, to ensure equal group sizes for balanced statistical comparison.

Patients who were skeletally mature at the time of diagnosis (18 years or older), had a closed diaphyseal tibial fracture with or without ipsilateral fibula involvement, had a minimum follow-up duration of 6 months and had undergone either IMN or plating were selected in this study. All patients who had fractures involving proximal or distal intra-articular regions of tibia, compound (open) or pathological fractures of the tibia, any associated fracture apart from ipsilateral fibula fracture and uncontrolled diabetes mellitus or hypertension were excluded from the study.

All patients underwent surgery under the same standardized protocol. Before the procedure, patients underwent a detailed history and physical examination, and the injured limb was immobilised with a back slab. Intraoperative records confirmed that all intramedullary nailing and plating procedures followed institutional guidelines for fracture reduction, fixation, and hardware placement. After the procedure, patients received intravenous antibiotics (ceftriaxone) for three days, followed by seven days of oral therapy. Fracture classification was performed on radiographs according to the AO system by the operating surgeon. Daily physiotherapy notes were reviewed to identify the first day on which patients achieved active knee and ankle mobilization. After discharge, routine outpatient follow-up visits occurred biweekly. Physiotherapy notes and data on progress toward weight-bearing milestones were reviewed from their medical files.

For categorical variables, frequencies and percentages were calculated. For quantitative variables, independent sample *t*-test was applied, assuming equal variances, to compare the mean time for knee and ankle mobilization in days, partial weight bearing, and full weight bearing in weeks between the nailing and plating groups, and $p \leq 0.05$ was considered statistically significant. Results for continuous outcomes are presented as Mean±SD, and the mean differences between groups are reported with their 95% confidence interval.

RESULTS

There were a total of 352 male and 128 female patients. Among the male patients, 184 underwent plating and 168 underwent nailing. Among the female patients, 72 underwent nailing while 56 of them underwent plating. This reveals that a higher proportion of males underwent both nailing (70%) and plating (76.67%) compared to females, who comprised only 30% and 23.33% of the respective groups.

The nature of injury among patients varied across both treatment groups. Road traffic accidents were the most common cause, accounting for 112 cases (46.67%) in the nailing group and 128 cases (53.33%) in the plating group. Blunt trauma was responsible for 64 cases (26.67%) in the nailing group and 48 cases (20.00%) in the plating group. Falls were reported in 40 patients (16.67%) who underwent nailing and 48 patients (20.00%) who underwent plating. Physical assault accounted for 8 cases (3.33%) in each group, while sports injuries were found in 16 patients (6.67%) in the nailing group and 8 patients (3.33%) in the plating group. This shows that road traffic accidents were the predominant cause of tibial fractures in both treatment groups.

Table-1 highlights the age distribution of patients treated for tibial fractures using nailing and plating. Most cases were in the younger age groups, particularly between 18–37 years, accounting for 66.67% of nailing and 70% of plating cases, with the 28–37 age group being the most common. As age increased, the number of cases significantly declined, with only 10.00% of plating and 6.66% of nailing performed in patients over 58 years.

Table-2 shows the distribution of tibial fracture cases based on the AO classification for both nailing and plating procedures. It shows that AO42-A1 fractures were the most common in both groups, representing 36.67% of nailing and 33.33% of plating cases. AO42-A2 and AO42-A3 were also common, with the former being more frequent in plating (26.67%) and the latter in nailing (20.00%). Complex fractures (AO42-C3) occurred only in the nailing group, while AO42-B2 and AO42-B3 were fairly evenly distributed between the two groups.

The comparison of postoperative recovery metrics is shown in Table-3. The time to knee and ankle mobilization was significantly shorter in the IMN group than in the plating group, with a mean difference of -3.00 days (95% CI: -3.28 to -2.72; $p<0.0001$). In contrast, there were no statistically significant differences in the time to partial weight-bearing (mean difference -0.05 weeks; 95% CI: -0.31 to 0.21; $p= 0.707$) or full weight-bearing (mean difference 0.12 weeks; 95% CI: -0.15 to 0.39; $p= 0.389$).

Table-1: Age distribution among the cases

Age Group (years)	Nailing		Plating	
	Cases	Percentage	Cases	Percentage
18–27	64	26.67	80	33.33
28–37	96	40.0	88	36.67
38–47	40	16.67	32	13.33
48–57	24	10.0	16	6.66
58–67	8	3.33	16	6.66
68–77	8	3.33	8	3.33
Total	**240**	**100**	**240**	**100**

Table-2: Distribution of cases according to AO classification

AO Type	Nailing	Percentage	Plating	Percentage
AO42-A1	88	36.67	80	33.33
AO42-A2	40	16.67	64	26.67
AO42-A3	48	20.00	24	10.00
AO42-B2	32	13.33	40	16.67
AO42-B3	16	6.67	24	10.00
AO42-C2	8	3.33	8	3.33
AO42-C3	8	3.33	0	0.00
Total	240	100	240	100

Table-3: Comparative postoperative recovery metrics (IMN *vs* Plating)

Outcome measure	IMN group	Plating group	Mean difference (95% CI)	*p*
Knee/ankle mobilization (days)	3.00±1.60	6.00±1.55	-3.00 (-3.28 to -2.72)	<0.0001
Partial weight bearing (weeks)	6.68±1.50	6.73±1.41	-0.05 (-0.31 to 0.21)	0.707
Full weight bearing (weeks)	8.57±1.54	8.45±1.51	0.12 (-0.15 to 0.39)	0.389

DISCUSSION

In this study, the majority of the cases were found to be in the younger age groups, between 18–37 years of age. As the age increased, the number of cases decreased, with only 10.00% of plating and 6.66% of nailing performed in patients over 58 years. This can be explained as people in younger age groups are more physically active and thus more prone to trauma. Another study suggests that tibial shaft fractures follow a bimodal distribution, with peaks at ages 20 and 50.[13]

In our current study, the majority of the patients were males in both nailing (70%) and plating (76.67%) groups. This is consistent with previous literature that shows that the incidence of tibial fracture is more in males.[14] A possible explanation could be that in general males are more involved in activities that expose them to high energy trauma.

This study suggests that road traffic accidents were the most common cause of tibial fractures in both groups, accounting for 46.67% of nailing and 53.33% of plating cases. This finding is consistent with previous literature which also shows RTA to be the most prevalent cause.[15,16] In another study, fall from height was the most common cause.[17] In our current study, AO42-A1 fractures were the most common in both groups, representing 36.67% of nailing and 33.33% of plating cases. This finding is consistent with previous literature which also shows that the fracture type AO42-A1 is the most common.[14] However, another study revealed that the fracture type AO42–A2 is the most common. [18]

This study shows that patients treated with nailing had a shorter mean time for knee and ankle mobilization (3±1.60 days) compared to those treated with plating (6±1.55 days). This difference was statistically significant (p=<0.0001). This finding is consistent with previous research which also shows that patients who underwent IMN had a shorter knee and ankle mobilization time. [19] In our study, mean time for partial weight bearing is nearly identical for both groups, with nailing at 6.68±1.50 weeks and plating at 6.73±1.41 weeks. This difference was not statistically significant (p=0.707). Similarly, mean time for full weight bearing is similar for patients treated with nailing (8.57±1.54 weeks) and plating (8.45±1.51 weeks). This difference was also found to be statistically insignificant (p=0.389). Regarding these weight bearing outcomes, the literature is mixed. This finding in our study deviates from other studies which shows that nailing results in quicker return to weight bearing.[4,9,20,21] However, the findings in our research align with other research, which shows that there is no significant difference in time to weight bearing. [11]

As with all research studies, there are certain limitations in our study. The imbalance in AO fracture classification between IMN and plating groups (Table-2), represents a confounding factor. Variation in patient compliance postoperatively, and individual variability in healing could impact recovery times, which may not be fully accounted for in the present study

CONCLUSION

The IMN provides a statistically significant advantage in knee and ankle mobilization time, with patients achieving mobility in 3±1.60 days on average compared to 6±1.55 days for those treated with plating. This means that there is a clear advantage of IMN in early mobilization. However, there was no significant difference between the groups in time taken to partial and full weight-bearing. These findings suggest that while IMN may facilitate earlier joint mobilization, both IMN and plating had statistically similar time frames for weight bearing recovery.

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SAQ: Study design, data collection, analysis and interpretatin
SQMS: Study design, data analysis and proofreading
SKK: Proofreading and data interpretation
SDQ: Proofreading and data interpretation
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ORIGINAL ARTICLE

ASSOCIATION OF SERUM IRISIN WITH GESTATIONAL DIABETES MELLITUS

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Background: Gestational diabetes mellitus (GDM) is a condition in which there is intolerance to glucose with first recognition in pregnancy with an elevated risk of perinatal morbidity. Irisin has a role in the metabolism of glucose and lipids which may prove to be an early diagnostic marker for future GDM development. The aim of this study was to compare the levels of irisin in pregnant women having GDM and healthy controls, for any correlation between glycaemic factors and irisin. **Methods:** This case-control study was performed at the Gynaecological OPD, National Medical Centre, Karachi between January and June 2023. Eighty-eight pregnant women were recruited in the study. Serum-irisin levels of both the case and control groups were estimated with ELISA kit collected at 24th to 28th weeks of gestation. The correlations were evaluated using statistical tests such as *t*-test and Pearson's correlation coefficient. **Results:** There were significant differences in fasting blood glucose and postprandial glucose levels between control and GDM groups. The average serum irisin level in control group was substantially greater than the GDM group. There was a significant inverse linear association between serum irisin levels and fasting and postprandial glucose levels. Fasting insulin and HOMA-IR levels were negatively correlated with serum irisin. **Conclusion:** Lower serum irisin levels may be connected to the development of GDM This study confirms the potential of serum irisin as an early diagnostic marker and clarifies its function in the pathophysiology of GDM.

Keywords: GDM, Gestational diabetes mellitus, Glucose, Insulin, Irisin, Metabolic, Metabolism

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INTRODUCTION

Gestational diabetes mellitus or (GDM) is defined by the American Diabetic Association as any degree of intolerance to glucose along with its onset or recognition, primarily during pregnancy.[1] The prevalence of GDM ranges from 1% to 14% among all pregnancies, based on the population that is under study as well as the diagnostic test applied.[2] One of the leading causes of maternal and foetal morbidity as well as mortality is GDM along with its complications worldwide.[3] GDM has a multi-factorial pathogenesis and may include genetic and environmental factors. Gestational diabetes mellitus stands to be a predictor for future development of type-2 Diabetes Mellitus (T2DM).[4]

Gestation in humans is evidently characterized by features like weight gain along with a progressive decline in the sensitivity for insulin, which in turn coincides with foeto-placental-unit growth and insulin resistance in pregnant women during later months of gestation.[5] The low insulin-sensitivity is mainly due to a post-receptor defect which results in poor insulin capability in order to cause mobilization of GLUT4 from the cell interior to the surface of the cell.[6] Resistance to insulin hormone in pregnancy could be a potential cause of a number of pathogenic effects such as development of GDM, compromised utero-placental circulation, Pregnancy Induced-Hypertension (PIH) and intrauterine growth retardation (IUGR) etc.[7]

Irisin, a 22 kD protein, is a newly discovered hormone which has lately been characterized as a product formed due to cleavage of the cell membrane protein (transmembrane) fibronectin type-III domain containing protein-5 (FNDC5).[8] In the year 2012, a study demonstrated the role of physical exercise in the increased expression on skeletal muscles of various genes which are involved in the expenditure of energy, particularly the metabolism of glucose and lipids; one of the prominent genes discussed was FNDC5 gene, which is located on the locus 1p35.1, expressed due to consequential activation of PGC-1α (transcription co-activator of PPAR-γ); also, the FNDC5 protein (32 kD) is further cleaved and released as irisin in the circulation.[9] A number of studies suggest that the heart as well the skeleton release irisin molecules in response to exercise which in turn act as tissue messengers, including skeletal tissue, heart, liver, and the brain.[10] Expression of FNDC5 gene by PGC1-α mediates a variety of biological actions which are related to metabolism and energy and modulates the expression of a protein known as uncoupling protein-1 (UCP1) along with its role in thermogenesis in brown fat. PGC1-α is also a source of resistance to dystrophy of skeletal muscles, age related obesity, diabetes and longevity as shown by increased expression in transgenic mice; it in turn suggests the stimulation of the secretion of certain skeletal muscle factors which are responsible for affecting other tissue functions.[11]

Multiple studies suggest that irisin plays a significant role in diseases of metabolism such as obesity, coronary artery diseases, lipid metabolism, T2DM, non-alcoholic fatty liver disease, and polycystic ovary syndrome etc.[12] Therefore, in the context of a common metabolic disease of pregnancy, it may play a role in becoming an early diagnostic marker or a strong predictor of gestational diabetes mellitus. Wang *et al*[13] associated the lower circulating irisin levels in the first trimester with the higher risk of GDM, suggested that it might be help in early identification of women at risk for the future development of GDM, which ultimately could be an early prevention strategy.[13]

This study has compared concentrations of serum irisin in the sera of pregnant women with and without gestational diabetes mellitus to check if irisin could prove to be an early diagnostic tool for GDM.

METHODOLOGY

The protocol was approved by the ethical research committee of Bahria University of Health Sciences Karachi. It was a case control study conducted in Gynaecology OPD, National Medical Centre, Karachi, for a period of 6 months (Jan–Jun 2023). Pregnant women (age 20–40 years) diagnosed with GDM as per WHO diagnostic criteria between 24–28 weeks of gestation were included as cases and without GDM were selected as controls. Females with known diabetes mellitus, multiple pregnancies, glucose intolerance and comorbidities were excluded. The sample size was calculated considering a maximum acceptable error of 5% power of 80% equal to 1.0 ratio between the two groups using Epi Info Version 3.01. The calculated sample size came out to be 44 patients in each of the Case group and Control group, whereas the sampling technique was non-probability convenient sampling.

Pregnant women visiting the OPD of National Medical Center Karachi, underwent oral-glucose tolerance test (OGTT, 75 g 2 h) in routine, out of which, 44 patients diagnosed with GDM and 44 healthy women with normal glucose tolerance (NGT), matched for age and week of gestation, were recruited for this study. Diagnosis of GDM was made if the plasma levels of glucose increased during a 75 g, 2 h OGTT as per the diagnostic criteria of WHO. Written informed consent was obtained from all participants before enrolment and subject evaluation forms were filled via interviews and physical assessment. Overnight fasting venous blood samples were obtained from all participants to analyse serum irisin and insulin levels in the second trimester (24^{th}–28^{th} weeks of gestation). All samples were stored at room temperature for at least 30 min to allow the blood to clot, followed by centrifugation at 2,500 rpm, for 15 min, at 4 °C in order to separate serum. Serum specimens were aliquoted and stored at -80 °C until the analysis. Insulin levels were determined using a chemiluminescent assay (AccessDxI800; Beckman Coulter, Inc., Fullerton, CA). Homeostatic model assessment of insulin resistance (HOMA-IR) was calculated using fasting glucose (mmol/L)×fasting insulin (IU/mL)/22.5. Serum irisin and insulin levels were quantified using commercially available ELISA kits. The sensitivity of the assay was 23 ng/mL, and inter- and intra-assay coefficients of variation both were ≤10%. All samples were analysed in duplicate. Results were expressed as ng/mL.

Data were analysed using SPSS-20. Independent samples *t*-test was used to compare serum irisin levels and other factors among GDM and control groups. The Pearson's correlation coefficients were calculated to explore the direction and strength of linear relationship between the irisin levels and other factors and $p \leq 0.05$ was considered statistically significant. The multiple linear regression model was used for building a model for irisin levels on the basis of several other factors.

RESULTS

The ages of the subjects were 20–40 years in both groups. The mean age in the GDM group (30.36±5.13 Years) was slightly higher than that in control group (28.10±4.87 Years). Minimum and maximum number of pregnancies ranged from 1 to 5 in the control group and 1 to 4 in the GDM group. Majority (59, 74.4%) of previous deliveries were performed via LSCS, while 17 (21.3%) had spontaneous vaginal delivery (SVD) and 3 (4.3%) had SVD with assistance of a vacuum extractor (SVD TAP). Only a small number (9, 11.5%) had a history of GDM in the previous pregnancies. The BMI ranged from 22.21 to 39.41 in control group, while in GDM group, it ranged from 19.81 to 42.46. The BMI appeared to be less scattered in the control group compared to GDM group. The average BMI was higher in the GDM group (29.67±5.00) compared to the control group (27.98±4.22).

There were significant differences between control and GDM groups in fasting blood glucose and glucose levels at 1 and 2 hours postprandial. The average glucose levels were consistently and significantly higher in the GDM group. In comparison to the control group, the mean values of serum insulin and HOMA-IR were greater in the GDM group. It was discovered that the control group's average serum irisin level was substantially greater than the GDM group (Table-1). There was an inverse link between irisin levels and fasting blood glucose in this study, proving a significant inverse linear association between serum irisin levels and fasting blood sugar, postprandial glucose after 1 and 2 hours. The fasting insulin and HOMA-IR levels were found to be negatively correlated with serum irisin, with a non-significant inverse link between them (Table-2).

Table-1: Comparison of factors between control and GDM group using independent samples *t*-test

Factors	Control	GDM	*p*
Age	28.10±4.87	30.36±5.13	0.042
BMI	27.98±4.22	29.67±5.00	0.491
Pulse	102.90±15.73	104.55±14.31	0.000
Blood Pressure Diastolic	82.75±7.84	80.91±7.09	0.000
Blood Pressure Systolic	126.65±11.30	124.77±13.38	0.000
Fasting Blood Glucose	78.23±7.92	97.23±12.53	0.000
Glucose (1 Hr)	123.70±21.02	178.64±21.34	0.000
Glucose (2 Hr)	102.15±19.29	152.93±23.12	0.000
Serum Irisin	13.53±6.40	8.80±7.39	0.002
Fasting Insulin Level	1.08±0.53	1.63±0.72	0.002
HOMA-IR	6.53±6.10	15.02±11.53	0.000

Table-2: Correlation of serum irisin with other factors using Pearson's correlation coefficient and multiple regression coefficient

Factors	Correlation Coefficient	*p*	Multiple Regression Coefficient	*p*
BMI	-0.130	0.237	-0.170	0.309
Fasting Blood Glucose	-0.349	0.001	-0.024	0.793
Glucose (1 Hr)	-0.323	0.003	-0.030	0.300
Glucose (2 Hr)	-0.269	0.013	-0.016	0.578
Fasting Insulin Level	-0.046	0.675	0.200	0.108
HOMA-IR	-0.120	0.277	-0.834	0.134

DISCUSSION

The findings of this study reinforce the significance of early identification and prevention for GDM owing to the potential hazards it presents to both the mother and foetus. The mean age of participants in the GDM group was noticeably greater than that of participants in the control group, indicating that being older may be linked to a higher chance of developing GDM. This result is consistent with a cross-sectional study in Peshawar, that found a greater prevalence of GDM in older mothers.[14] BMI was not found to differ significantly between the two groups in the present study. However, the mean value was higher among the cases as compared to the control group, consistent with another study.[15] It has also been reported that obesity is linked to an increase in the number of Type-2-Diabetes Mellitus and GDM which are related to excess body weight.[16] In comparison to the control group, the GDM group had reduced mean values for both diastolic and systolic blood pressure. These results go against earlier research that claimed GDM was linked to higher blood pressure.[17]

The present study also found significant differences between control and GDM groups, which were seen in fasting blood glucose and postprandial glucose levels at 1 hour and 2 hours. These average glucose levels were consistently higher in the GDM group. These results are in concordance with a study that showed that glycaemic variability in pregnant women with GDM was higher than in normal gravid women. The detected variations lend credence to the reduced insulin sensitivity and poor glucose control linked to GDM.[18]

In comparison to the control group, the mean values of serum insulin and HOMA-IR were greater in the GDM group, these results support another study.[19]

It was discovered that the control group's average serum irisin level was substantially greater than the GDM group, similar to findings of another study[4] that revealed maternal serum irisin levels significantly lower in patients with GDM compared to the levels in healthy pregnant controls. It may be a possibility that GDM may affect the expression of PGC-1a or functions in muscles, which supports the existence of irisin as a possible marker for the early identification and prognosis of GDM.[20] However, contrasting results proving no significant difference between GDM and control group in terms of serum irisin level, fasting blood glucose, oral glucose tolerance test, insulin, insulin resistance index as well as BMI were reported by another study.[21] Recently, various studies have suggested that circulating irisin levels in plasma may be related to obesity or increased BMI.[22]

There is an inverse link between the irisin levels and fasting blood glucose in this study, proving a significant inverse linear association between the serum irisin levels and fasting blood sugar, postprandial glucose in 1 and 2 hours. These results suggest that fasting and postprandial blood glucose levels tend to rise when serum irisin levels drop. These results are in accordance with a study in China which revealed that fasting insulin, HbA1c along with the albumin/globulin ratio were negatively associated with serum irisin level with statistical significance.[17] Some reported a negative association between irisin and postprandial glucose in patients with type 2 diabetes.[23]

The fasting insulin levels and HOMA-IR levels were found to be negatively correlated with serum irisin, with a non-significant inverse link between them in the present study. Another study also found the serum irisin levels negatively correlated with fasting insulin, HOMA-IR and the metabolic parameters including Waist Circumference, Waist Hip Ratio, and serum creatinine.[24] The negative association between irisin and HOMA-IR could be because of the secondary results of impaired PGC-1α function.[25]

These results have significant implications for identification and management of GDM. The sharp fall in irisin levels seen in the GDM group suggests that it may be useful as a diagnostic tool to identify women who are at risk of developing GDM, enabling early intervention and therapy.[4]

CONCLUSION

The findings have highlighted the potential of serum irisin as a diagnostic marker for GDM as well as its therapeutic implications. The significant differences in serum irisin levels between the GDM and the control groups suggest that lower serum irisin levels may be connected to the development of GDM.

FUTURE RECOMMENDATIONS

- Conduct long-term research to evaluate how serum irisin levels and glycaemic markers vary over time in pregnant women with GDM.
- Examine the underlying processes through which irisin influences insulin sensitivity and glucose metabolism in GDM.

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ORIGINAL ARTICLE

ASSOCIATION OF BODY MASS INDEX WITH HYPERTENSION AND DEMOGRAPHIC CHARACTERISTICS IN PATIENTS WITH END-STAGE RENAL DISEASE UNDERGOING MAINTENANCE HAEMODIALYSIS: A CROSS-SECTIONAL STUDY

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Background: End-stage renal disease (ESRD) is associated with a high burden of cardiovascular complications, particularly hypertension. Although body mass index (BMI) is an established indicator of nutritional status and cardiovascular risk, its association with hypertension among patients with ESRD undergoing maintenance haemodialysis remains inadequately studied in Pakistan. This study was conducted to determine the association of BMI with hypertension and demographic characteristics in patients with end-stage renal disease undergoing maintenance haemodialysis. **Methods:** This observational cross-sectional study was conducted in the Department of Nephrology, Holy Family Hospital, Rawalpindi, from Dec 2022 to Jun 2023 after ethical approval from CPSP. A total of 196 patients aged 18–75 years with ESRD undergoing maintenance haemodialysis for at least three months were recruited through non-probability consecutive sampling. Demographic characteristics, duration of ESRD, duration of haemodialysis, BMI, and blood pressure were recorded. Data were analysed using SPSS-25, and $p \leq 0.05$ was considered statistically significant. **Results:** Hypertensive patients had a higher mean age than non-hypertensive patients (51.2±11.4 *vs* 43.5±10.7 years). Males constituted 65.1% of hypertensive patients, while females were 34.9%. Underweight patients had a higher prevalence of hypertension than overweight patients. Mean systolic blood pressure was highest (166±13 mmHg) in underweight patients and lowest (139±7 mmHg) in obese patients. **Conclusion:** Body mass index was significantly associated with hypertension and haemodynamic parameters in patients with ESRD undergoing maintenance haemodialysis. Higher BMI was associated with relatively favourable cardiovascular profiles.

Keywords: Body mass index, End-stage renal disease, Hypertension, Maintenance haemodialysis

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INTRODUCTION

Chronic kidney disease (CKD) is defined as irreversible and progressive loss in structure and functions of kidneys persisting for more than 3 months.[1] It is commonly diagnosed by reduced glomerular filtration rate (GFR) or persistent albuminuria and can lead to end-stage renal disease (ESRD).[2] In ESRD the kidneys are unable to maintain normal metabolic and physiological homeostasis. The survival of an individual depends only on renal replacement therapy. Haemodialysis is the most widely used renal replacement therapy for patients of ESRD and plays an essential role in improving survival and quality of life.[3] Due to increasing prevalence, associated cardiovascular complications and substantial healthcare burden chronic kidney disease has emerged as a major global public health problem. According to recent WHO and Global Burden of Disease (GBD) data, approximately 674–850 million people worldwide are affected by kidney disease, which is about 8–10% of the total global population. According to a record, up to 2040 CKD will be the leading cause of years of life lost globally. Due to increase prevalence of hypertension, diabetes mellitus and obesity the burden of CKD is increasing day by day.

Diabetes mellitus and hypertension remain the leading causes of ESRD worldwide and are responsible for a major proportion of patients requiring long-term dialysis therapy.[4] In low- and middle-income countries, limited access to early screening, healthcare facilities, and renal replacement therapies further contribute to increased morbidity and mortality associated with kidney disease.

In patients of maintenance haemodialysis, the most common complication is hypertension.[5] It is defined as persistent elevation of systemic arterial blood pressure above 130/80 mmHg.[6] In patients of ESRD, it is an important contributor to cardiovascular morbidity and mortality. Fluid overload, activation of renin-angiotensin-aldosterone system, endothelial dysfunction, increased sympathetic activity and arterial

stiffness are among the major mechanisms responsible for hypertension in dialysis patients.[7] Poor blood pressure control is associated with left ventricular hypertrophy, heart failure, cerebrovascular disease and increased mortality. Cardiovascular disease therefore remains the leading cause of death in ESRD patients receiving maintenance haemodialysis.[8]

Body mass index (BMI) is an anthropometric parameter commonly used to assess the composition of body and nutritional status. BMI is calculated as weight in kilograms divided by height in meters squared (Kg/m²), and individuals are categorized as underweight (BMI <18.5 Kg/m²), normal weight (18.5–24.9 Kg/m²), overweight (25.0–29.9 Kg/m²) and obese (≥30.0 Kg/m²).[9] In the general population, elevated BMI is strongly associated with hypertension, diabetes mellitus, cardiovascular disease and increased mortality risk. Obesity contributes to increased cardiovascular workload, vascular dysfunction, insulin resistance and metabolic disturbances, thereby increasing the risk of chronic diseases.[10] But its relationship with clinical outcomes in patients undergoing maintenance haemodialysis appears to be different. Recent studies have reported that BMI can influence cardiovascular risk, blood pressure control, and survival differently in patients with ESRD, giving rise to the concept of the 'obesity paradox'.[11] Despite increasing international evidence on this association, data from Pakistan regarding the relationship between BMI, hypertension, and demographic characteristics among maintenance haemodialysis patients remain limited. This study was conducted to determine the association of BMI with hypertension and demographic characteristics in patients undergoing maintenance haemodialysis.

METHODOLOGY

This observational cross-sectional study was conducted in the Department of Nephrology, Holy Family Hospital Rawalpindi over a period of six months from Dec 2022 to Jun 2023 after ethical approval from the College of Physicians and Surgeons Pakistan Ref No. CPSP/REU/NEP-2022-123-678. The objective of the study was to determine the association of BMI with hypertension and demographic characteristics in patients undergoing maintenance haemodialysis. A sample size of 196 patients was calculated using the WHO sample size calculator based on a confidence level of 95%, anticipated prevalence of hypertension among haemodialysis patients of 86.2%, and margin of error of 7%.[12] A non-probability consecutive sampling technique was employed to recruit participants. Patients aged 18–75 years of either gender undergoing maintenance haemodialysis for at least three months were included in the study. Patients with congestive cardiac failure, active malignancy, recent change in dry weight and those receiving peritoneal dialysis were excluded. Written informed consent was obtained from all participants prior to enrolment and confidentiality of patients' information was maintained throughout the study.

After enrolment, demographic and clinical information including age, gender, duration of haemodialysis, body mass index and blood pressure status were recorded on a structured pro forma. BMI categories were classified according to the World Health Organization (WHO) classification as underweight (<18.5 Kg/m²), normal weight (18.5–24.9 Kg/m²), overweight (25.0–29.9 Kg/m²), and obesity (≥30.0 Kg/m²).[9] The association of BMI categories with hypertension and demographic variables including gender and duration of haemodialysis was evaluated.

All patients continued to receive standard haemodialysis treatment according to departmental protocols during the study period. Data analysis was performed using SPSS-25. Quantitative variables including age, BMI and duration of haemodialysis were presented as Mean±SD, while categorical variables including gender, BMI categories and hypertension status were expressed as frequencies and percentages. Independent sample *t*-test was applied for comparison of quantitative variables, while chi-square test was used to assess association between categorical variables, and $p \leq 0.05$ was considered statistically significant.

RESULTS

A total of 196 patients with end-stage renal disease undergoing maintenance haemodialysis were included in the study, of whom 126 (64.3%) were hypertensive and 70 (35.7%) were non-hypertensive.

Table-1 summarizes the demographic and clinical characteristics of the study participants according to hypertension status.

The association between BMI categories and hypertension is presented in Table-2, while the comparison of haemodynamic parameters across BMI categories is shown in Table-3.

Table-4 presents the stratified analysis of hypertension according to gender and duration of maintenance haemodialysis.

Table-1: Demographic and clinical characteristics of haemodialysis patients according to hypertension status

Variable	Hypertensive (n=126)	Non-Hypertensive (n=70)	Test value	*p*
Age (Yrs, Mean±SD)	51.2±11.4	43.5±10.7	t= 4.08	0.001
Male Gender [n (%)]	82 (65.1)	36 (51.4)	χ^2= 4.11	0.037
Female [n (%)]	44 (34.9)	34 (48.6)	χ^2= 3.76	0.044
Mean BMI (Kg/m²)	24.1±3.8	27.3±4.2	t= 3.92	0.002
Duration of Haemodialysis (Yrs)	2.8±1.5	1.9±1.1	t= 2.76	0.006

Statistical Test Applied: Independent sample *t*-test and Chi-square test

Table-2: Distribution of BMI categories among hypertensive and non-hypertensive patients

BMI Category	Hypertensive n (%)	Non-Hypertensive n (%)	χ^2	*p*
Underweight	20 (83.3)	4 (16.7)	6.18	0.029
Normal Weight	68 (87.2)	10 (12.8)	8.94	0.011
Overweight	28 (37.8)	46 (62.2)	10.36	0.002
Obese	10 (50.0)	10 (50.0)	5.81	0.041

Table-3: Comparison of haemodynamic parameters across BMI categories (One-way ANOVA)

	Mean±SD				
BMI Category	SBP (mmHg)	DBP (mmHg)	Pulse Pressure	Heart Rate	*p*
Underweight	166±13	101±8	65±7	97±5	0.001
Normal Weight	154±10	94±6	60±5	91±4	0.008
Overweight	142±8	85±5	57±4	84±3	0.003
Obese	139±7	82±4	57±3	81±3	0.001

Table-4: Stratification of hypertension according to duration of haemodialysis and gender

Variable	Hypertensive n (%)	Non-Hypertensive n (%)	χ^2	*p*
Male	82 (69.5)	36 (30.5)	4.28	0.039
Female	44 (56.4)	34 (43.6)	3.62	0.047
Duration of Dialysis				
<1 year	46 (76.7)	14 (23.3)	6.91	0.018
1–3 years	52 (60.5)	34 (39.5)	4.83	0.033
>3 years	28 (56.0)	22 (44.0)	3.95	0.049

DISCUSSION

The present study evaluated the association of body mass index with hypertension and demographic characteristics among patients undergoing maintenance haemodialysis. Hypertension remains one of the most important cardiovascular complications in end-stage renal disease patients and contributes significantly to increased morbidity and mortality.[7] The findings of the present study demonstrated significant associations between BMI categories, blood pressure parameters and demographic variables among haemodialysis patients.

In our study, the mean age of hypertensive patients on haemodialysis was 51.2±11.4 years as compared to non-hypertensive patients with mean age 43.5±10.7 years. These findings indicate that hypertension was more among older haemodialysis patients. The reason behind this can be that increasing age is associated with vascular rigidity, endothelial dysfunction and decreased arterial compliance, all of this leads to elevated blood pressure especially in ESRD patients.[13] Similar observations have been reported in previous nephrology studies by Bae *et al*, where advanced age was associated with poor blood pressure control and increased cardiovascular complications in dialysis patients.[14] Male predominance was also observed among hypertensive patients in our study, with 65.1% males of hypertensive cases compared to 51.4% among non-hypertensive patients, whereas females represented 34.9% and 48.6% of hypertensive and non-hypertensive groups respectively. Similar gender-based differences have been reported in previous studies evaluating cardiovascular risk factors in ESRD populations by Mohamud *et al*.[15] The higher prevalence of hypertension among male haemodialysis patients can be due to increased prevalence of cardiovascular risk factors, smoking, sedentary lifestyle and negligence regarding health and living standard common in males.[16] In our results a significant association between duration of haemodialysis and hypertension was seen. Hypertensive patients had a relatively longer duration of dialysis compared to non-hypertensive patients. Due to prolonged haemodialysis following changes can happen: alteration in morphology of blood vessels, i.e., arterial calcification, persistent fluid overload and activation of neuro-hormonal pathways leading to hypertension. Progressive cardiovascular remodelling and increased arterial stiffness are the other common pathologies, which may explain the higher prevalence of hypertension in patients undergoing prolonged dialysis therapy.[17,18]

In our study, overweight patients showed lower prevalence of hypertension than underweight and normal-weight patients. Underweight patients showed hypertension in 75.0% cases, whereas overweight patients demonstrated hypertension in only 40.5% cases. A statistically significant association was observed between BMI categories and hypertension status. These findings support the concept of reverse epidemiology frequently described in nephrology literature. Several mechanisms have been proposed to explain this paradoxical relationship. Higher BMI in dialysis patients may reflect improved nutritional reserves, greater muscle mass and better tolerance to chronic catabolic stress. In patients of ESRD its very common to experience protein-energy wasting, chronic inflammation, anorexia and metabolic disturbances that contribute to poor nutritional status.[19] In underweight patients due to malnutrition and reduced physiological reserve, cardiovascular instability and poor blood pressure regulation is very common.[20] Study of Motofelea *et al*[19] has also suggested that overweight patients on haemodialysis may exhibit relatively better survival and cardiovascular outcomes due to improved haemodynamic stability and enhanced tolerance to dialysis-related stress.

The present study further evaluated haemodynamic parameters across BMI categories. Underweight patients demonstrated the highest systolic and diastolic blood pressure values, with mean systolic blood pressure of 166±13 mmHg and mean diastolic blood pressure of 101±8 mmHg. In comparison with overweight and obese patients showed relatively lower blood pressure values. Mean systolic blood pressure decreased to 142±8 mmHg in overweight patients and 139±7 mmHg in obese patients. Similarly, diastolic blood pressure declined from 101±8 mmHg in underweight patients to 82±4 mmHg in obese patients. These findings indicate improved haemodynamic

stability among patients with higher BMI. In patients with increased BMI, pulse pressure and heart rate decreased that showed improvement of cardiovascular system in overweight and obese haemodialysis patients.[21] All these observed relationship between BMI and blood pressure may be influenced by several physiological factors. Overweight patients may have increase in intravascular volume buffering capacity and better nutritional reserve, decrease chances of fluctuations in haemodynamic status during dialysis sessions.[11] Chronic inflammation and protein-energy wasting are more commonly observed in underweight ESRD patients leading to endothelial dysfunction and cardiovascular instability. Similar findings have been reported in study of Kang *et al*[22] evaluating obesity paradox in dialysis populations, where higher BMI was associated with improved cardiovascular tolerance and reduced mortality risk.

Stratification analysis in the present study demonstrated higher prevalence of hypertension among patients undergoing dialysis for less than one year, i.e., 76.7% of patients. This may be related to inadequate fluid control and incomplete cardiovascular compliance during early dialysis periods. Hypertension gradually decreased among patients who were on dialysis since long, possibly due to improved fluid management and treatment optimization with passage of time.[5]

LIMITATIONS & RECOMMENDATIONS

- It was a single-centre cross-sectional study, further multi-centre prospective studies are recommended.
- Dietary habits, inflammatory markers, dialysis adequacy parameters and antihypertensive medication compliance were not evaluated that should be focused in future.
- BMI was not accurately differentiated between adipose tissue and lean body mass in ESRD patients that can be considered.
- Our study did not assess the duration of end-stage renal disease before initiation of maintenance haemodialysis, which can influence the observed association between body mass index and hypertension. It is recommended to be focused on in further studies.

CONCLUSION

This study demonstrated a significant association between body mass index and hypertension among patients undergoing maintenance haemodialysis. Underweight and normal-weight patients exhibited comparatively higher blood pressure levels and greater haemodynamic instability than overweight and obese patients. Higher body mass index was associated with relatively improved cardiovascular tolerance and favourable haemodynamic parameters, supporting the concept of reverse epidemiology in end-stage renal disease patients.

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ORIGINAL ARTICLE

DIGITAL INFLUENCE: NAVIGATING SCREEN TIME AND COGNITIVE GROWTH IN ADOLESCENTS AND YOUNG STUDENTS

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Background: Adolescents' screen exposure has increased substantially with the expansion of digital technology, raising concerns about its effects on cognitive and social development. Our aim was to examine the relationship between screen-time exposure and selected cognitive and social outcomes among school-aged students and to assess the effect of an educational intervention on overall awareness of healthy screen use. **Methods:** A quasi-experimental pre-test/post-test study was conducted from May to Aug 2024 using a pre-validated questionnaire. The instrument assessed non-educational screen activities, including video games and cartoons, as well as attention deficits, reduced academic performance, and impaired social skills. Stratified random sampling recruited students aged 11–14, 15–18, and ≥19 years from grades 6–12. Students with previously diagnosed mental health conditions were excluded. Participants completed the questionnaire before and after a didactic lecture addressing screen exposure exceeding 2 hours daily. **Results:** Among 170 participants, 88 (51.67%) were female and 82 (48.23%) were male, with mean age 14.0±2.4 years. Before the intervention, moderate screen exposure was significantly associated with reduced creativity (p=0.001), while exposure of two hours daily was associated with adverse outcomes (p<0.001). Following the lecture, participants demonstrated a significant change in reported screen-use practices and awareness (p=0.017). **Conclusion:** Screen exposure exceeding 2 hours daily may adversely affect creativity, attention, academic performance, and social functioning, particularly when unsupervised. Content quality, parental engagement, and duration of use should be considered when developing interventions for adolescents.

Keywords: Attention deficits, Children, Cognitive health, Digital media, Educational content, Parental involvement, Screen time

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INTRODUCTION

Over the past decade, innovation in technology increased exponentially, followed by a surge in adolescent's programming, video games, and access to handheld devices. The relationship between screen usage and cognition was dependent upon the age of first exposure, the type of content, and the duration of engagement.[1] Recent studies raised alarms regarding the correlation between screen exposure and the detriment of cognitive health. For example, a 2020 survey in Lahore found that prolonged exposure at an early age led to adverse developmental outcomes.[2]. Similarly, research in Islamabad and Peshawar associated excessive screen time with behavioural problems and impaired social responsiveness.[3–5]

In the background of this information, it was noted that adolescents were increasingly exposed to ubiquitous screens. While technology provided learning opportunities, concerns grew regarding reduced attention spans and impaired language development resulting from passive stimuli.[5–7] Overabundance of screen time was thought to delay critical skills like problem-solving and creativity. Bedtime exposure interfered with sleep patterns, leading to fatigue and further cognitive impairment.[8–10]

This prompted Medical Education Department of Niazi Medical and Dental College to educate medical undergraduate students during their paediatrics rotation. Fourth-year students conducted this evidence-based research study. The approach involved an educational series of didactic lectures to influence school going adolescent students' perspectives and teach future practitioners how to promote positive behavioural changes.[11,12] A gap was identified in the literature regarding community-based research using educational didactic lecture series to measure changes in adolescents' attitudes. This study aimed to explore digital influences on cognitive growth across three age brackets (11–14, 15–18, and 19+ years).

METHODOLOGY

This study utilized a quasi-experimental design within a cross-sectional framework with a pre-test/post-test intervention to investigate the relationship between screen habits and cognitive growth.[13] Ethical approval from NMDC was obtained vide Ref. # NMDC/ION/0008-08/24-ERB, dated 8 May 2024. The population consisted of students (grades 6–12) from three private schools in Sargodha Division of Pakistan. A stratified

random sampling technique was employed, and sample size was calculated using Cochran's formula.

Data were collected using a pre-validated bilingual (English/Urdu) questionnaire at three intervals: before a 2-hour educational didactic lecture, and at one and four week post-intervention. Data were analyzed using descriptive statistics, Chi-square test, and linear regression using SPSS-23.

RESULTS

The total sample size was 170. Females were 88 (51.76%) and males were 82 (48.23%), with ages ranging from 11 to 21 Years (Mean age: 14.4±2.4 Years). Mothers were the primary caregivers for 103 (60.58%) participants. Regarding self-reported questionnaire response from students about habits, 80 (47.05%) used smart phones and 54 (31.76%) watched TV for more than 2 hours daily. Within this group, 24.3% reported increased aggressiveness, and 22.5% noted rapid weakening of eyesight. Additionally, 11.6% students self-reported that they had lost their appetite for homemade food. Placement of screens near sleeping areas had a profound effect on sleep quality.

Responses for questions like 'Do you think the placement of TV in the room where the child plays/ sleeps can increase or decrease your child's screen time?' showed that 76% agreed to say 'YES' whereas, 24% said 'NO'. When they were asked the question 'Which device do you use for screen time? (Select all that apply)', the responses were diverse and meaningful. Regarding the questions related to placement of TV near children sleeping area, 129 (76%) of 170 students answered 'YES'. In contrast, 41 (24%) reported that television placement does not affect their sleep. The self-reported responses revealed lack of parental rules regarding gadget use in 108 (63.52%) of households. (Table-1).

The distribution of screen time across different devices among 170 students, television was the most commonly reported device, accounting for around 60% of responses. Smart phones followed at about 18%, tablets at 12%, laptops at 8%, and desktop computers at approximately 1%. Chi-square tests from self-reported responses of adolescent students on pre-educational didactic lectures indicated a strong connection between screen exposure exceeding 2 hours and daily activities (p=0.003). (Table-2).

Investigating the true association between screen times and youngster's cognitive health the responses were notable. Data showed remarkable behavioural differences post-educational didactic lectures. Changes were significant regarding academic routine (p=0.000), sleep patterns (p=0.000), and concentration (p=0.007). Linear regression was applied to remove confounding factors. There was a significant positive association (p<0.05) between frequent educational didactic lecture attendance and reduced screen time (model-1: F=5.858, p=0.017, and model-2: F=3.476, p=0.033). (Table-3).

Table-1: Self-reported responses from students on gadget usage rules set by parents (n=108)

Parental rule	Short explanation	n	%
Use at fixed hours	Gadgets are allowed only during set hours	15	13.88
Use at a fixed time	Parents assign a specific time for use	33	30.55
Use privately	Children may use gadgets without close supervision	12	11.11
No gadgets in bed	Gadgets are not allowed at bedtime	5	4.62
Educational use only	Gadgets are mainly used for learning	2	1.85
Other rules	Other rules are followed	4	3.70
No rules	No specific gadget rules are set	37	34.25

Table-2: Average duration of gadget & media use on school days among young students

Programs & Videos in use	Watch TV	Use smart phone	Other gadgets	Write/Draw/Colour	Total	df	p
Watch TV (n)	19	26	4	1	50	6	0.003*
Smart Phones (n)	10	24	23	1	58		
Other Gadgets (n)	11	20	5	0	36		
Writes/Draws/Colours (n)	0	2	0	1	3		
Others (n)	14	8	1	0	23		
Total (n)	59	80	33	3	170		

*Significant

Table-3: Post-educational didactic lecture self reflection on navigating screen time exposures (N=170)

Paired sample t-test	Paired Differences		t	df	p
	Mean	SD			
Between daily outside and on holidays activities	0.06471	0.66300	1.272	169	0.205
Between sleep problem and aggressiveness	0.04118	0.39756	1.350		0.179
Between isolation and impairs concentration	0.09412	0.45178	2.716		0.007*
Between hours of screen time exposure and impair eyesight	-1.72941	0.67742	-33.286		0.000*
Between type of device used and hours of exposures on screen time	-0.91176	1.68824	-7.042		0.000*
Between screen time impacts on academic routine and sleep patterns	0.43529	1.18118	4.805		0.000*
Between learning new skills and increasing knowledge	-0.03529	0.32443	-1.418		0.158
Between completing assignments and learning good habits	-1.62353	0.84932	-24.92		0.000*

*Significant

DISCUSSION

The advent of digital technology transformed the way children interacted with the world around them. While screens provided access to educational resources and entertainment, excessive screen time sparked concerns regarding its impact on adolescents' cognitive health and academics. The present study outcomes also disclose similar effects. Previous work[14] has suggested a significant association between high screen time exposure and declines in cognitive functioning and academic achievement among young people.

This study highlighted the potential negative impact of excessive screen time on teenagers' development and strengthened the previous research outcomes that prolonged screen exposure could negatively affect cognitive health in various ways. For instance, excessive screen time was linked to diminished attention spans, impaired memory, and reduced executive functioning skills.[15] Young people reliant on screens for entertainment often engaged in passive consumption rather than active learning, which obstructed their cognitive development.

This study confirmed that excessive screen uses disrupted sleep patterns —a critical component of cognitive development! This finding is consistent with prior work linking evening screen exposure in children to reduced sleep duration. Besides, sleep deprivation was associated with poorer cognitive performance, affecting attention, learning, and emotional regulation, all essential for academic success.[16]

Other studies[17] have suggested that children who spent more time on screens, particularly for recreational purposes, tended to show declines academically. Digital influence may detract from time spent on homework, reading, and other educational activities, leading to lower grades and diminished enthusiasm for learning. Likewise, when children were immersed in non-educational screen activities, such as video games, TV, or social media, they may have missed out on critical learning opportunities and skills development.[18,19] It is also evident from the present study. As technology became more integrated part of daily life, balancing screen time with educational and interactive activities became increasingly important.

CONCLUSION & RECOMMENDATIONS

While screens were universal tools for learning, uncontrolled use posed a measurable risk to paediatric cognitive development. Dual approach of scientific investigation and proactive public health guidance is deemed imperative to safeguard adolescents in the digital age. Parents, educators, and policymakers should establish strict guidelines and supervision for healthy screen use by children.

LIMITATIONS

The small sample size may limit the generalizability of the findings to a broader population. The reliance on self-reported data introduces potential response bias, as participants may provide socially desirable answers. The cross-sectional design prevents the establishment of causal relationships between variables. The research was conducted within a specific geographic region which might not reflect global trends. Future research should utilize longitudinal designs and more diverse, larger cohorts to validate these preliminary results and enhance external validity.

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SR: Literature search and Data analysis
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ORIGINAL ARTICLE

CLINICAL PROFILE AND OUTCOMES OF SEPTIC SHOCK IN CHILDREN ADMITTED TO A TERTIARY CARE REFERRAL HOSPITAL

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Background: Paediatric septic shock is a major cause of morbidity and mortality, particularly in developing countries. Clinical and biochemical abnormalities contribute to poor outcomes in critically ill children. Objectives of this study were to evaluate demographic characteristics, clinical profile, biochemical parameters and outcomes of children with septic shock and compare clinical and laboratory parameters between survivors and non-survivors. **Methods:** This descriptive cross-sectional study was conducted in Paediatric Intensive Care Unit of a tertiary care hospital over six months. A total of 325 children aged 2 months to 12 years with septic shock were included through non-probability consecutive sampling. Clinical, haematological, biochemical and blood culture data were analyzed using SPSS-25. Multivariable logistic regression was performed to identify factors independently associated with mortality, and $p \leq 0.05$ was considered statistically significant. **Results:** The mean age of the patients was 6.38±3.51 years, 51.4% were males. Elevated liver enzymes, anaemia, thrombocytopenia, and abnormal leukocyte counts were present in 83.7%, 60.9%, 54.2%, and 52.6% of patients, respectively. Overall mortality was 63.7%. Non-survivors had significantly lower haemoglobin, platelet counts, urine output, and systolic blood pressure, but higher leukocyte counts, ALT, AST, heart rate, respiratory rate, and capillary refill time ($p<0.05$). On multivariable analysis, altered mental status remained independently associated with mortality (aOR 1.67, 95% CI 1.01–2.77, $p=0.046$). **Conclusion:** Paediatric septic shock is associated with high mortality and significant clinical and biochemical abnormalities. These parameters may help identify children at increased risk of poor outcomes.

Keywords: Anaemia, Clinical profile, Intensive care, Mortality, Paediatric, Septic shock, Thrombocytopenia

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INTRODUCTION

Septic shock remains one of the leading causes of morbidity and mortality among children worldwide, particularly in developing countries where delayed presentation, limited healthcare resources and inadequate critical care facilities are the contributing factors to poor outcomes.[1,2] Paediatric Intensive Care Unit (PICU) plays a very important role in the care of critically ill children who are at risk for organ dysfunction and mortality.[3]

There are more than 42,000 cases annually in the US, millions worldwide, and 5–30% of sepsis patients develop septic shock. The mortality rate in septic shock patients may be as high as 50%.[4] Sepsis is characterized by a dysregulated systemic inflammatory response to infection that may progress to septic shock, resulting in circulatory failure, tissue hypoperfusion and multi-organ dysfunction due to systemic inflammatory response syndrome (SIRS) in presence of infection.[5]

Shock is an acute life-threatening condition in which the circulatory system fails to deliver sufficient oxygen and nutrients to meet tissue metabolic demands. Persistent tissue hypoxia leads to anaerobic metabolism, impaired cellular energy production, accumulation of intracellular sodium, accumulation of cytosolic calcium, disruption of ionic pumps, efflux of potassium, metabolic acidosis, and eventually leads to cellular injury or death.[6] In order to prevent organ dysfunction and reduce mortality, it is necessary to restore tissue perfusion by early, adequate, and prompt treatment.

In children, septic shock commonly presents with clinical manifestations such as fever, altered mental status, hypotension, tachycardia, prolonged capillary refill time, oliguria and respiratory distress.[5] Despite advances in intensive care management, patients with septic shock are still facing high mortality rate, especially in resource-limited settings.[4] Biochemical and haematological abnormalities play an important role in the assessment of severity of disease and its prognosis in paediatric septic shock. Anaemia, thrombocytopenia, leukocyte abnormalities, and elevated liver enzymes frequently reflect underlying systemic inflammation and organ dysfunction.[7] Parameters such as platelet count, haemoglobin level, liver transaminases, urine output and blood pressure are important indicators of disease progression.

This study aimed to evaluate demographic characteristics, clinical manifestations, biochemical parameters, and outcomes of paediatric patients admitted with septic shock in a tertiary care hospital. The study also aimed to compare clinical and laboratory parameters between survivors and non-survivors to identify factors associated with poor outcomes.

METHODOLOGY

This descriptive cross-sectional study was conducted in Paediatric Intensive Care Unit (PICU) of Benazir Bhutto Hospital, Rawalpindi over a period of six months from Dec 2024 to May 2025 after ethical approval from College of Physicians and Surgeons Pakistan (CPSP), Ref. No. EAC/MUA-PGT-4/216. A sample size of 325 children was calculated using WHO Sample Size Calculator, with 95% CI, anticipated prevalence of 30.23%, and 5% margin of error. Non-probability consecutive sampling was used to recruit participants who were categorized into 3 age groups: 2 months to <1 year, 1–5 years, and 6–12 years. Patients in non-septic shock were excluded. Written informed consent was obtained from parents or guardians prior to enrolment.

Detailed clinical history and examination findings were recorded on a structured proforma. Paediatric sepsis was defined according to the 2024 International Paediatric Sepsis Consensus Conference (Phoenix Sepsis Score) criteria, and septic shock was identified in children with sepsis who had cardiovascular dysfunction.[8] Clinical parameters including fever, altered mental status, hypotension, prolonged capillary refill time, oliguria, tachycardia, and tachypnea were observed and documented.

Biochemical and haematological parameters including haemoglobin level, platelet count, total leukocyte count, alanine aminotransferase (ALT), aspartate aminotransferase (AST) and blood culture reports were recorded. Blood samples for culture were collected preferably before the initiation of antibiotic therapy, and results were recorded as positive when clinically significant bacterial growth was detected and as negative when no growth was reported. The identified organisms, where available, were documented and culture results were subsequently analyzed in relation to clinical outcomes. Thrombocytopenia was defined as platelet count <150,000/µL, anaemia as haemoglobin <10 g/dL, and elevated liver enzymes as ALT >55 U/L and AST >48 U/L.[9] Urine output and systolic blood pressure were also measured and documented.

Data analysis was performed on SPSS-25. Continuous variables were presented as Mean±SD and compared using the independent-samples *t*-test. Categorical variables were expressed as frequencies and percentages and compared using Chi-square or Fisher's exact tests. Multivariable binary logistic regression was performed to identify factors independently associated with mortality, with adjusted odds ratios (aOR) and 95% confidence intervals, and $p \leq 0.05$ was considered statistically significant.

RESULTS

A total of 325 children diagnosed with septic shock were included in the study. The clinical outcomes were assessed according to various demographic, clinical, and laboratory effect modifiers. The distribution of mortality across these categories is presented in Table-1.

Clinical and biochemical parameters were subsequently compared between survivors and non-survivors to identify differences associated with mortality. The comparative findings are presented in Table-2.

Table-1: Outcome of septic shock in children according to various effect modifiers

Variable	Group	Total in subgroups	Mortality [n (%)]	*p*
Age	2 month– <1 year	15	8 (53.3)	0.684
	1–5 years	122	79 (64.8)	
	6–12 years	188	120 (63.8)	
Gender	Male	167	103 (61.7)	0.437
	Female	158	104 (65.8)	
Blood Culture	Positive	106	67 (63.2)	0.899
	Negative	219	140 (63.9)	
Hyperthermia	Yes	207	136 (65.7)	0.319
	No	118	71 (60.2)	
Hypothermia	Yes	32	18 (56.3)	0.357
	No	293	189 (64.5)	
Abnormal leukocyte count	Yes	171	103 (60.2)	0.172
	No	154	104 (67.5)	
Hypotension	Yes	125	80 (64.0)	0.927
	No	200	127 (63.5)	
Prolonged capillary refill	Yes	120	79 (65.8)	0.539
	No	205	128 (62.4)	
Oliguria	Yes	106	68 (64.2)	0.905
	No	219	139 (63.5)	
Tachycardia	Yes	205	128 (62.4)	0.539
	No	120	79 (65.8)	
Tachypnea	Yes	194	128 (66.0)	0.297
	No	131	79 (60.3)	
Altered mental status	Yes	106	72 (67.9)	0.270
	No	219	135 (61.6)	
Elevated Liver enzymes	Yes	272	170 (62.5)	0.311
	No	53	37 (69.8)	
Anaemia	Yes	198	128 (64.6)	0.655
	No	127	79 (62.2)	
Thrombo-cytopenia	Yes	176	110 (62.5)	0.627
	No	149	97 (65.1)	

Table-2: Clinical and biochemical parameters in survivor and non-survivor children with septic shock

Parameter	Survivors (Mean±SD)	Non-Survivors (Mean±SD)	*p*
Haemoglobin (g/dL)	10.4±1.8	9.2±2.1	0.012
Platelet count (/µL)	178,000±54,000	124,000±48,000	0.001
Total leukocyte count (/mm³)	13,800±4,500	18,600±6,200	0.004
ALT (u/L)	68±24	112±39	0.001
AST (u/L)	74±28	129±46	0.001
Urine output (mL/Kg/Hr)	1.4±0.5	0.7±0.3	0.001
Systolic BP (mmHg)	92±11	78±10	0.002
Capillary refill time (Sec)	2.8±0.9	4.6±1.2	0.001
Heart rate (beats/min)	118±16	136±20	0.003
Respiratory rate (breaths/min)	28±6	36±8	0.005

Finally, multivariable logistic regression analysis was performed to identify factors independently associated with mortality after adjustment for relevant clinical and laboratory variables. The results are presented in Table-3.

Table-3: Regression analysis of factors associated with mortality in children with septic shock

Variables	aOR	95% CI	*p*
Age 2 month–<1 Year *vs* 1–5 Year	0.91	0.40–2.06	0.82
Age 1–5 Year *vs* 6–12 Year	1.18	0.72–1.94	0.51
Male gender	0.89	0.56–1.42	0.63
Positive blood culture	1.24	0.71–2.15	0.45
Hyperthermia	1.31	0.78–2.21	0.31
Hypothermia	1.42	0.63–3.18	0.39
Abnormal leukocyte count	1.27	0.79–2.05	0.32
Hypotension	1.16	0.70–1.92	0.55
Prolonged capillary refill	1.35	0.81–2.24	0.25
Oliguria	1.48	0.86–2.54	0.16
Tachycardia	1.09	0.67–1.77	0.73
Tachypnoea	1.26	0.76–2.08	0.37
Altered mental status	1.67	1.01–2.77	0.046*
Elevated liver enzymes	1.38	0.77–2.47	0.28
Anaemia	1.12	0.69–1.82	0.64
Thrombocytopenia	1.29	0.80–2.09	0.29

*Significant

DISCUSSION

The present study evaluated the clinical profile, biochemical characteristics and outcomes of paediatric septic shock patients admitted to a tertiary care hospital. The findings demonstrated a high (63.7%) mortality rate with clinical manifestations including fever, altered mental status, hypotension, tachycardia, tachypnea, prolonged capillary refill time and oliguria. Significant biochemical and haematological abnormalities including elevated liver enzymes, anaemia, thrombocytopenia and abnormal leukocyte counts were observed among critically ill children. The comparison between survivors and non-survivors further highlighted the prognostic importance of several clinical and laboratory parameters.

Out of a total 325 children in the study, majority were aged 6–12 years, followed by children aged 1–5 years. There was a slight predominance of males. Similar demographic findings were reported by Peng *et al*[10] who observed a higher frequency of septic shock among school and non-school going aged children and male patients.

Mortality was slightly higher among children aged 1–5 years and 6–12 years compared to infants (p=0.684). Mortality was somewhat higher among females than males (p=0.437). Mortality was almost similar among children with positive and negative blood cultures (p=0.899). Children with hyperthermia had a higher mortality than others (65.7% *vs* 60.2%).

Mortality was slightly lower among children with elevated liver enzymes than those without this abnormality (62.5% *vs* 69.8%, p=0.311). Similar findings have been reported by Koca *et al*[11] who emphasized that hepatic dysfunction commonly occurs secondary to systemic inflammatory response, impaired tissue perfusion and multi-organ dysfunction in paediatric sepsis.

The high mortality in cases with anaemia and thrombocytopenia in our study may be attributed to inflammatory cytokine release, bone marrow suppression, disseminated intravascular coagulation and increased platelet consumption during septic shock.[12] Among neurological and biochemical abnormalities, children with altered mental status had somewhat higher mortality than those without altered mental status. Similar observations were reported by Shamavu GK *et al*[13] who highlighted neurological dysfunction as an important predictor of severity in septic shock patients.

For clinical indicators of circulatory and respiratory compromise, mortality was higher among children with prolonged capillary refill and tachypnoea, whereas mortality was similar among children with and without hypotension, and oliguria. Mortality was also comparable between children with and without tachycardia. All these factors indicate an impaired tissue perfusion and circulatory compromise, which are hallmark features of septic shock in children.[13]

Comparison between survivors and non-survivors has revealed statistically highly significant differences in multiple parameters. Non-survivors had significantly lower haemoglobin levels and platelet counts compared to survivors, suggesting more severe haematological dysfunction among critically ill patients.

Thrombocytopenia was present in 54.2% cases and was more pronounced among non-survivors. Thrombocytopenia has been widely recognised as an adverse prognostic marker in septic shock due to increased platelet destruction, endothelial injury and coagulation abnormalities. Meliani *et al*[14] also reported lower platelet counts among non-survivors and identified thrombocytopenia as an indicator of poor prognosis. Non-survivors in the present study also demonstrated significantly higher total leukocyte counts and markedly elevated ALT and AST levels. Elevated leukocyte counts may reflect overwhelming systemic inflammation and severe infection, whereas elevated liver enzymes indicate hepatic hypoperfusion and cellular injury secondary to septic shock.[15,16]

Oliguria was present in 32.6% of the children and may reflect renal hypoperfusion and acute kidney injury, while prolonged capillary refill time is considered a simple bedside indicator of inadequate tissue perfusion.[17,18] Tachycardia and tachypnoea were present in 63.1% and 59.7% of children, respectively. These are compensatory physiological responses to hypoxia, metabolic acidosis and impaired oxygen delivery during septic shock. Persistent abnormalities in these parameters despite urgent care may indicate worsening shock and impending cardiovascular failure.[19]

Multivariable logistic regression showed that altered mental status was independently associated with mortality after adjustment for other clinically relevant variables (aOR 1.67, 95% CI= 1.01–2.77, p=0.046). Other assessed factors, including age, gender, blood culture positivity, hypotension, oliguria, tachycardia, tachypnea, anaemia, and thrombocytopenia, did not demonstrate statistically significant independent associations with mortality. These findings suggest that neurological dysfunction may provide additional prognostic information in children with septic shock beyond individual clinical and laboratory abnormalities.

LIMITATIONS & RECOMMENDATIONS

This study was conducted at a single centre, which may limit the generalizability of the findings. Future multi-centre studies with larger sample size are recommended to validate these findings. Serum lactate, procalcitonin, C-reactive protein, and long-term outcomes of survivors were not assessed. Future studies should incorporate these additional biochemical and prognostic parameters, together with long-term follow-up, to improve risk stratification and outcome prediction in children with septic shock.

CONCLUSION

Paediatric septic shock is associated with a high risk of mortality and significant clinical and biochemical abnormalities. Parameters such as anaemia, thrombocytopenia, elevated liver enzymes, hypotension and oliguria were more pronounced among non-survivors, highlighting their importance as indicators of disease severity and poor prognosis. Early recognition, prompt intervention, and close monitoring of clinical and laboratory parameters may help to improve the outcomes in children with septic shock.

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ORIGINAL ARTICLE

HOMOCYSTEINE LEVELS IN STROKE PATIENTS PRESENTING AT A TERTIARY CARE HOSPITAL OF PESHAWAR

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Background: Cerebrovascular disease, is a serious, disabling illness that has a high social burden and a substantial risk of morbidity and death for medical systems. Objective of this study was to determine frequency of elevated homocysteine levels in stroke patients. **Methods:** This cross-sectional study was conducted in Department of Chemical Pathology, Combined Military Hospital, Peshawar from Nov 2023 to Apr 2024. Total 131 ischemic stroke patients were included. Their plasma homocysteine sample was collected in EDTA tube and analysed on Roche Cobas 501 enzymatic assay. Data were analysed on SPSS-26. **Results:** Mean age of the patients was 43.23±9.82 years, and mean homocysteine was 21.25±9.18 µmol/L. The frequency and percentage of elevated homocysteine (>15 µmol/L) was 69 (52.7%). There was significant differences between group having homocysteine >15 µmol/L and ≤15 µmol/L, (p<0.001). The elevated homocysteine level was discriminately higher in age subgroup 51–60 Years as compared to age subgroup 31–40 Years while insignificant differences were observed on multiple subgroup comparison. The gender distribution remained insignificant between groups (p=0.217) in terms of the number of participants. There were insignificant differences between males and females in levels of homocysteine in elevated homocysteine group (p=0.217). **Conclusion:** Elevated homocysteine was frequently observed among patients with ischemic stroke, with higher levels observed in the 51–60 year age subgroup.

Keywords: Cardiovascular disease, Frequency, Homocysteine, Ischemic stroke, Risk equivalent

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INTRODUCTION

Cerebrovascular disease, another name for stroke, is a serious, disabling illness that has a high social burden and a substantial risk of morbidity and death for medical systems. The American Heart Association and the American Stroke Association report that stroke is the second leading cause of mortality in the country, behind cardiovascular disease.[1,2] In Pakistan (Khyber Pakhtunkhuwa, or KP), the prevalence of stroke was reported to be 1.2% (1,200 per 100,000 people).[3] The most frequent type of stroke is an ischemic stroke, which is characterised by persistent focused neurological signs or symptoms lasting longer than twenty-four hours. The obstruction in the blood vessels supplying the brain is assumed to be the origin of an ischemic stroke.[4,5] Impaired cerebral blood flow results in ischemia and the death of brain tissue. This disruption results in ischemia and injury to the brain parenchyma by preventing oxygen and other nutrients from reaching the brain cells.[6] Stroke risk factors include diabetes, smoking, high blood pressure, dyslipidemia, abnormal cholesterol levels, abnormal heart rhythms (often atrial fibrillation), being overweight, and leading a sedentary lifestyle.[7]

An oxidative stressor that can lead to plaque development and vascular inflammation is homocysteine. Methionine serves as the main substrate for the synthesis of homocysteine. The main enzyme deficiencies that cause homocysteinemia are cystathionine-beta synthase (CBS), 5, 10-methylenetetrahydrofolate reductase (MTHFR). Moreover, homocysteine metabolism depends heavily on folic acid and vitamin B12 (methylcobalamin), and deficiencies in these nutrients can result in elevated plasma homocysteine levels.[8] Increased homocysteine levels generate pro-coagulant conditions, induce thrombogenicity, and encourage smooth muscle cell growth.[9,10] Elevated levels of homocysteine are linked to endothelial dysfunction, vascular smooth muscle cell trans-differentiation, and vascular tissue death. This trans-differentiation and cell death cause hydroxyapatite to build up in the blood vessel walls, which causes atherosclerotic constriction of the vessels and stroke.[11]

Although it is thought to be a separate risk factor for myocardial infarction, its connection to ischemic stroke is rarely studied. Although studies have been conducted in the past to ascertain the prevalence of elevated homocysteine levels in stroke patients, the outcomes have been highly inconsistent. It is crucial to carry out more research in this area because the frequency of elevated homocysteine levels in stroke patients varies so much (32–56%).[12,13] This study was, therefore, being conducted with the aim to find out frequency of elevated homocysteine levels in stroke patients.

METHODOLOGY

It was a cross-sectional study carried out at Department of Chemical Pathology, Combined Military Hospital, Peshawar for 6 months fulfilling the STROBE statement for reporting observational studies. Sample size (n=131) was calculated using WHO sample size calculator software with following parameters: confidence level (1-α) with 95% absolute precision (d) 8% and anticipated population proportion (P) 32%.[12] Sample was obtained by non-probability consecutive sampling on data collection proforma. Patients of both gender with age 20–60 years and diagnosed with ischemic stroke (on the basis of presence of focal neurological deficit and hypodensity on CT brain plain) were included in the study and divided into four groups. Pregnant and lactating mothers and patients with hemorrhagic stroke were excluded from the study.

After approval of the study proposal from ethical committee, CPSP, the informed consent of the participants was taken in written form. Once included, blood sample of patients was taken as per standard protocol for assessing blood for plasma homocysteine levels. Patients having history of nil by mouth for at least 8 hours were included in this study. A fresh sample of 4 cc was drawn, put in purple EDTA containing vial and that vial was taken immediately to lab with ice pack for centrifugation to obtain plasma. Homocysteine levels were measured in plasma by an automated analyzer Roche Cobas 501 using enzymatic assay. Homocysteine levels of >15 μmol/L was considered as elevated.[14] Homocysteine level was documented in the standard proforma.

Data analysis was performed using Statistical Package of Social Sciences (SPSS) version 26.0 (IBM Corp. Armonk, NY, USA). The numeric variables (age, homocysteine levels) was presented as Mean±SD, while frequency and percentages was used for categorical variables (gender, presence/absence of elevated levels of homocysteine). Data was stratified by age and gender to deal with effect modifiers. For inferential statistics, independent *t*-test, Chi-square test and one way analysis of variance (ANOVA) and post hoc Tukey's were used. A $p \leq 0.05$ was considered significant.

RESULTS

Among 131 ischemic stroke patients, mean age was 43.23±9.82 years. Their mean homocysteine was 21.25±9.18 μmol/L, in 69 (52.7%) it was >15 μmol/L, and in 62 (47.3%) cases it was >15 μmole/L. Stratification on age showed significant ($p<0.001$) differences between high and low homocysteine groups. The gender distribution remained insignificant between groups (homocysteine >15 μmol/L *vs* ≤15 μmol/L) ($p=0.217$) in terms of the number of patients. Comparison of the two groups is shown in Table-1.

Table-1: Comparison of homocysteine level in study participants (n=131)

Parameter	Homocysteine >15 μmol/L (n=69)	Homocysteine ≤15 μmol/L (n=62)	*p*
Age (Year, Mean±SD)	41.68±11.99	44.95±6.28	0.057*
Age groups [n (%)]			
20–30 Years	15 (22.0)	3 (5.0)	<0.001†
31–40 Years	18 (26.0)	9 (15.0)	
41–50 Years	13 (19.0)	40 (64.0)	
51–60 Years	23 (33.0)	10 (16.0)	
Gender [n (%)]			
Male	56 (81.0)	44 (71.0)	0.217*
Female	13 (19.0)	18 (29.0)	
Past Medical History			
Type 2 DM	41 (60.0)	36 (57.0)	0.672*
Hypertension	21 (30.0)	22 (36.0)	
CVDs	7 (10.0)	4 (7.0)	
Homocysteine Level (μmol/L, Mean±SD)			
Homocysteine	29.43±3.85	12.16±1.90	<0.001†

*Chi-square test, †Independent *t*-test

Comparison of age subgroups did not reveal any significant differences except between age group 31–40 and 51–60 years ($p<0.05$) (Table-2).

Table-2: Age stratified comparison of homocysteine levels in elevated homocysteine group (n=69)

Age group (Years)	N	Homocysteine (μmol/L, Mean±SD)	*p*-value (ANOVA)	Multiple comparison by post hoc Tukey's		
				Compared Age subgroup	Mean difference (95% CI)	*p*
20–30	15	29.31±4.37	0.194	31–40 Years	1.17 (-1.48—3.8)	0.381
				41–50 Years	0.23 (-2.6—3.11)	0.870
				51–60 Years	-1.40 (-3.93—1.11)	0.269
31–40	18	28.13±3.37		20–30 Years	-1.17 (-3.83—1.48)	0.381
				41–50 Years	-0.93 (-3.70—1.82)	0.501
				51–60 Years	-2.58 (-4.97— -0.19)	0.035
41–50	13	29.07±4.51		20–30 Years	0.23 (-3.11—2.64)	0.870
				31–40 Years	-0.93 (-1.82—3.70)	0.501
				51–60 Years	-1.64 (-4.28—0.99)	0.217
51–60	23	30.72±3.27		20–30 Years	1.40 (-1.11—3.93)	0.269
				31–40 Years	2.58 (0.19—4.97)	0.035
				41–50 Years	1.64 (-0.99—4.28)	0.217

DISCUSSION

This study showed that elevated homocysteine level was 52.7% prevalent in ischemic stroke patients, residing in Khyber Pukhtunkhwa province of Pakistan. The elevated homocysteine level was significantly remarkable in middle-age subgroup (51–60 years), while insignificant differences were observed between male and female patients having ischemic stroke.

Consistent with our findings, a study by Wang JX *et al*[15] observed that 50.7% of stroke patients had elevated homocysteine levels. Another study by Ahmad

S *et al*[12] found that 56% of stroke patients had elevated homocysteine levels, which is essentially identical to this study.

In contrast to these investigations, studies by Ali S *et al*[11] and Ahmad S *et al*[12] indicated a substantially lower frequency of elevated homocysteine levels in stroke patients (36%), with nearly identical results seen in another study (32%). Friedman showed elevated homocysteine levels in 40 cases of older patients aged ≥65 years who had atrial fibrillation and stroke.[16]

Prior studies found that patients with hypertension, diabetes, or hyperlipidemia had a higher risk of having an elevated homocysteine level than those without these conditions or those with a normal lipid profile. In our study cardiovascular disease was observed in 10% of participants in the elevated homocysteine group compared to 7% reported by other studies in non-elevated group.[12,17,18]

LIMITATIONS

It was a single-cantered study with small sample size and only included ischemic stroke patients. Inclusion of non-stroke control patients could have been exhibited a better comparison. Recent cardiovascular status, biochemical and related cardio-metabolic assessment during their hospital stay and time of onset of stroke and delay till sample collection for homocysteine were not included.

CONCLUSION

Elevated homocysteine was frequently observed among patients with ischemic stroke, with higher levels observed in the 51–60 year age group. Further studies are recommended to determine the independent association of elevated homocysteine with ischemic stroke.

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ZHH: Concept, study design and analysis
MF: Concept and study design
WA: Study design, citations, data analysis and review
SS: Analysis and interpretation of data
SF: Critical review
AH: Data analysis and manuscript drafting

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ORIGINAL ARTICLE

NERVE CONDUCTION PARAMETERS OF THE MEDIAN AND ULNAR NERVES IN HEALTHY ADULTS FROM NORTHERN PAKISTAN

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Background: Nerve conduction studies (NCS) evaluate peripheral nerve function through nerve conduction velocity (NCV), distal latency and amplitude, and show nerve health, disease diagnosis, and axonal degeneration/demyelination. NCS parameters are influenced by age, gender, BMI, ethnicity, environmental and pathological factors. Standardized NCS values from western countries are used in Pakistan, and local reference values are unavailable. This study aimed to determine normal median and ulnar NCS parameters in healthy adults from Northern Pakistan, and assessed correlations with demographic and body-composition variables. **Methods:** This study was conducted at Ayub Medical College/CMH Abbottabad on 180 healthy adults from Jun 2024 to Nov 2025. Participants underwent neurological examination, laboratory screening and standardized median and ulnar NCS using Nihon Kohden Neuropack. Pearson correlation with 95% CI assessed associations between NCS parameters and demographic/body-composition variables. **Results:** Age showed moderate positive correlations with median motor wrist latency (r=0.48, 95% CI 0.35–0.58, p<0.001) and median sensory latency (r=0.51, 95% CI 0.39–0.61, p<0.001), and negative correlations with amplitudes and sensory NCV. Height showed positive correlations with ulnar motor latency at wrist (r=0.46, 95% CI 0.34–0.57, p<0.001), and elbow (r=0.53, 95% CI 0.42–0.63, p<0.001). Weight/BMI showed weak associations. Several body-composition measures, i.e., body fat, body water, visceral fat, and muscle mass, were significantly correlated with selected ulnar parameters. **Conclusion:** Age and height were important determinants of median and ulnar nerve conduction parameters, while associations with weight, BMI, and body-composition measures were generally parameter specific.

Keywords: Age, Body mass index, BMI, Nerve conduction studies, Median nerve, Ulnar nerve

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INTRODUCTION

Nerve conduction studies (NCS) provide objective measures of peripheral nerve function and assist in distinguishing axonal and demyelinating abnormalities.[1] Interpretation of NCS requires appropriate reference data because latency, amplitude and conduction velocity are influenced by age, sex, height and recording conditions. Temperature, measurement distance and technical factors may also affect results.[2]

Peripheral neuropathy (PN) is a common neurological problem, globally prevalent and frequently encountered by most family physicians. It is characterised by peripheral nerve damage or dysfunctional nerves, consequently causing a wide array of sensory, motor, and autonomic disruptions which may result from a variety of common identifiable causes like diabetes mellitus, nerve compression or physical injury, alcohol abuse, exposure to chemicals/toxin, some hereditary diseases, nutritional deficiencies, medication side effects and metabolic disorders.[3] It can be classified in number of ways, e.g., clinically by anatomic pattern of patient's symptoms and, if designated, by the results of electro-diagnostic studies NCS for axonal and demyelinating disease.[4] The prevalence of PN ranges from 1% to 7% in the general population, with higher rates observed among patients older than 50 years and is idiopathic in 25–46% of cases. Therefore, diagnosis requires a comprehensive history, comprehensive physical, neurological and musculoskeletal examination, as well as vigilant laboratory testing and electro-diagnostic studies (EDX) where mandatory.[5]

In order to study the nerve conduction parameters in multiple diseases, it is necessary to know the normal values of those in particular ethnic population as a baseline. Normal and deranged values of these parameters can determine the site of nerve damage, diagnose polyneuropathy and can differentiate between poly neuropathy and myopathy, in addition to separating different muscle disorders.[6] It has been observed that epidemiological data about NCS parameters and causes of peripheral neuropathies in the geographical regions such as Asia are sparse. Therefore, assessing the normal values of NCS parameters may further help to diagnose, classify and treat the particular types of neuropathies.[7] Despite the

widespread use of standardized NCS values from the United States, Canada, and Europe in Pakistan, local population-specific reference values are not available. This gap is significant as nerve conduction parameters are influenced by demographic and physical factors, including age, gender, BMI, and ethnicity, as well as environmental and pathological conditions.

This study aimed at determining normal NCS parameters of median and ulnar nerves in persons aged 20–70 years and correlation of various demographic/ body-composition factors with these NCS parameters.

METHODOLOGY

Approval of the study was obtained from the Ethical Review Committees of Ayub Medical College and CMH Abbottabad. This was a cross-sectional study performed on 180 healthy subjects aged 20–70 years at Ayub Medical College and CMH Abbottabad from Jun 2024 to Nov 2025.

Sampling was done by convenience sampling. Sample size was calculated by STAT UBA keeping the power of 0.80 and α power of 0.05. Potential participants were selected with no previous history of neuropathy, entrapment, upper-limb injury, systemic disease, medications and other factors affecting NCS and normal neurological examination. People with history of neurological disease, bleeding disorders and pregnant females were excluded from the study. All eligible participants gave written informed consents.

The height, weight, BMI, along with body fat and water content of each participant was recorded using MI® Body Mass Analyser. Blood was taken for fasting blood sugar, urea, creatinine, calcium, ESR, and LFT's. The subject was kept in sitting or lying in supine position while conducting the NCS. A standard technique was used to obtain and record action potentials for sensory and motor functions using NCS data acquisition system (Nihon Kohden Neuropak). Filters for motor studies were set at 2 Hz to 5 kHz and Sweep Speed was kept 5 ms per division. Filters for sensory studies were set at 20 Hz to 3 kHz and Sweep Speed was 2 ms per division. For motor studies the nerves were studied orthodromically. For sensory studies the nerves were studied antidromically. All electrodes were placed on specific and measured distances from each other according to the standard technique given by AANEM.[8]

Stimulus duration was kept between 50 µSec to 1,000 µSec with a current of 0 to 100 mA for effective and maximal stimulation of the nerve. Disc electrodes were used for both the sensory and motor studies. The room temperature was kept between 25 to 35 °C. Gel was applied between skin and electrodes for better conduction and felt pads of stimulator were soaked in water before stimulating the nerve fibre. A specific software compatible with the NC electrodes was used for recording nerve conduction parameters.

RESULTS

Table-1 shows the demographic and body composition of study population. Table-2 presents the motor and sensory nerve conduction parameters of the median and ulnar nerves.

Table-3 shows significant correlations between several demographic and body composition variables and motor nerve conduction parameters. Age positively correlated with median motor wrist latency (r=0.48, p<0.001) and negatively correlated with median wrist amplitude (r= -0.42, p<0.001). Height showed significant positive correlations with ulnar wrist latency (r=0.46, p<0.001) and ulnar elbow latency (r=0.53, p<0.001). Body fat showed significant negative correlations with ulnar wrist latency (r= -0.53, p<0.001) and ulnar elbow latency (r= -0.54, p<0.001). Muscle mass was positively correlated with ulnar wrist latency (r=0.51, p<0.001) and ulnar elbow latency (r=0.55, p<0.001). Overall, BMI demonstrated relatively weak associations with most motor nerve conduction parameters.

Table-4 shows the correlations between demographic/body composition variables and sensory nerve conduction parameters. Age was positively correlated with median sensory latency (r=0.51, p<0.001) and negatively correlated with median sensory amplitude (r= -0.47, p<0.001) and median sensory conduction velocity (r= -0.46, p<0.001). Height was positively correlated with ulnar sensory latency (r=0.41, p<0.001) and negatively correlated with ulnar sensory conduction velocity (r= -0.22, p=0.004). Body fat and body water showed significant associations with several ulnar sensory parameters. In contrast, weight showed no significant correlation with any of the sensory nerve conduction parameters.

Table-1: Demographic and body composition parameters of study participants

Parameter	Mean±SD
Age (Years)	53.83±8.33
Height (Cm)	162.67±7.91
Weight (Kg)	72.59±11.38
BMI (Kg/m²)	27.32±3.68
Systolic BP (mmHg)	117.27±9.67
Diastolic BP (mmHg)	76.87±7.25
Pulse rate (beats/min)	84.11±11.27
Temperature (°C)	37.05±0.23
Respiratory rate (breaths/min)	14.53±12.57
Body fat (%)	32.81±7.85
Body water (%)	46.77±4.99
Basal metabolic rate (Cal/day)	1333.53±208.25
Visceral fat (%)	10.40±3.43
Muscle mass (Kg)	46.02±8.18
Bone mass (Kg)	2.49±0.40

Table-2: Motor and sensory nerve conduction parameters of study participants

Nerve	Wrist latency (mSec)	Wrist amplitude (mV/µV)	Elbow latency (mSec)	Elbow amplitude (mV)	NCV (m/Sec)
Right median motor	3.50±0.46	9.32±2.44	7.75±0.67	8.76±2.54	55.10±3.88
Left median motor	3.34±0.41	9.34±2.60	7.49±0.69	8.90±2.72	56.40±4.53
Right ulnar motor	2.44±0.32	9.23±1.84	6.55±0.60	8.58±1.97	56.10±5.22
Left ulnar motor	2.46±0.33	8.89±1.77	6.43±0.70	8.18±1.82	58.40±5.46
Right median sensory	2.62±0.44	29.22±12.66	---	---	54.74±8.47
Left median sensory	2.48±0.35	33.94±13.71	---	---	57.57±7.81
Right ulnar sensory	2.06±0.41	33.53±15.37	---	---	59.20±9.84
Left ulnar sensory	2.08±0.33	35.70±17.31	---	---	58.09±7.40

Table-3: Correlations of demographic and body composition factors with motor NCS parameters [*r* (95% CI), *p*]

Factor	Median wrist latency	Median wrist amplitude	Median elbow latency	Median elbow amplitude	Median NCV	Ulnar wrist latency	Ulnar wrist amplitude	Ulnar elbow latency	Ulnar elbow amplitude	Ulnar NCV
Age	0.48 (0.35-0.58), <0.001	-0.42 (−0.53–-0.29), <0.001	0.36 (0.23-0.48), <0.001	-0.40 (-0.52–-0.27), <0.001	-0.13 (-0.27-0.02), 0.08	0.16 (0.02-0.30), 0.03	-0.14 (-0.28-0.01), 0.07	0.21 (0.07-0.35), 0.01	-0.16 (-0.30–−0.01), 0.04	-0.15 (-0.29–−0.00), 0.05
Height	0.10 (-0.05-0.24), 0.19	0.21 (0.06-0.34), 0.01	0.39 (0.26-0.51), <0.001	0.21 (0.06-0.34), 0.01	-0.08 (-0.22-0.07), 0.29	0.46 (0.34-0.57), <0.001	0.24 (0.09-0.37), 0.001	0.53 (0.42-0.63), <0.001	0.16 (0.02-0.30), 0.03	-0.08 (-0.22-0.07), 0.30
Weight	0.10 (-0.05-0.24), 0.18	0.06 (-0.09-0.20), 0.46	0.26 (0.12-0.39), <0.001	0.01 (-0.13-0.16), 0.85	-0.08 (-0.22-0.07), 0.31	0.14 (-0.01-0.28), 0.07	0.23 (0.09-0.36), 0.002	0.18 (0.04-0.32), 0.02	0.12 (-0.03-0.26), 0.11	0.01 (-0.14-0.15), 0.92
BMI	0.07 (-0.08-0.21), 0.36	-0.08 (−0.22–0.07), 0.29	0.03 (-0.12-0.17), 0.73	-0.13 (-0.27-0.02), 0.09	-0.02 (−0.17–0.13), 0.77	-0.20 (−0.33–-0.05), 0.008	0.11 (-0.04-0.25), 0.15	-0.18 (-0.32–-0.04), 0.01	0.03 (-0.11-0.18), 0.65	0.05 (-0.10-0.20), 0.49
Body fat	-0.15 (-0.29–-0.00), 0.05	-0.12 (-0.26-0.03), 0.12	-0.30 (-0.43–-0.17), <0.001	-0.20 (-0.34–-0.05), 0.007	0.09 (-0.06-0.23), 0.25	-0.53 (-0.63–-0.42), <0.001	-0.05 (-0.20-0.09), 0.48	-0.54 (-0.63–-0.42), <0.001	-0.06 (-0.21-0.09), 0.41	0.17 (0.02-0.31), 0.02
Body water	0.08 (-0.07-0.23), 0.27	0.10 (-0.05-0.24), 0.18	0.37 (0.23-0.49), <0.001	0.15 (0.00-0.29), 0.04	-0.19 (-0.32–-0.04), 0.01	0.47 (0.35-0.58), <0.001	0.07 (-0.08-0.21), 0.36	0.51 (0.39-0.61), <0.001	0.04 (-0.11-0.19), 0.58	-0.13 (-0.27-0.02), 0.09
BMR	-0.01 (-0.15-0.14), 0.92	0.13 (-0.02-0.27), 0.08	0.19 (0.05-0.33), 0.01	0.13 (-0.02-0.27), 0.10	0.03 (-0.12-0.18), 0.68	0.31 (0.17-0.44), <0.001	0.14 (-0.01-0.28), 0.06	0.32 (0.18-0.45), <0.001	0.05 (-0.09-0.20), 0.48	-0.03 (-0.18-0.12), 0.68
Visceral fat	0.25 (0.11-0.39), <0.001	0.01 (-0.14-0.15), 0.93	0.48 (0.36-0.59), <0.001	0.04 (-0.11-0.18), 0.64	-0.28 (-0.41–-0.14), <0.001	0.34 (0.20-0.46), <0.001	0.29 (0.15-0.42), <0.001	0.39 (0.26-0.51), <0.001	0.21 (0.07-0.35), 0.005	-0.11 (-0.25-0.04), 0.15
Muscle mass	0.18 (0.04-0.32), 0.02	0.09 (-0.06-0.24), 0.22	0.50 (0.38-0.60), <0.001	0.11 (-0.04-0.25), 0.14	-0.19 (-0.33–−0.05), 0.01	0.51 (0.39-0.61), <0.001	0.16 (0.01-0.30), 0.04	0.55 (0.44-0.65), <0.001	0.04 (-0.10-0.19), 0.56	-0.08 (-0.23-0.06), 0.26
Bone mass	0.09 (-0.06-0.23), 0.24	0.19 (0.04-0.33), 0.01	0.38 (0.25-0.50), <0.001	0.20 (0.06-0.34), 0.007	-0.24 (-0.37–−0.09), 0.001	0.44 (0.31-0.55), <0.001	0.22 (0.08-0.36), 0.003	0.41 (0.29-0.53), <0.001	0.10 (-0.05-0.24), 0.19	-0.12 (-0.26-0.03), 0.11

Table-4: Correlations of demographic and body composition factors with sensory NCS parameters [*r* (95% CI), *p*]

Factor	Median sensory latency	Median sensory amplitude	Median sensory NCV	Ulnar sensory latency	Ulnar sensory amplitude	Ulnar sensory NCV
Age	0.51 (0.39-0.61), <0.001	-0.47 (-0.57–-0.34), <0.001	-0.46 (-0.57–-0.33), <0.001	0.30 (0.16-0.43), <0.001	-0.33 (-0.45–-0.19), <0.001	-0.11 (-0.25-0.04), 0.14
Height	0.11 (-0.03-0.26), 0.13	-0.10 (-0.24-0.05), 0.20	0.10 (−0.05-0.24), 0.20	0.41 (0.28-0.53), <0.001	-0.15 (-0.29–-0.01), 0.04	-0.22 (-0.35–-0.07), 0.004
Weight	0.04 (-0.11-0.18), 0.62	-0.03 (-0.17-0.12), 0.71	0.10 (-0.05-0.24), 0.18	0.05 (-0.10-0.20), 0.51	0.00 (-0.14-0.15), 0.97	0.00 (-0.14-0.15), 0.98
BMI	-0.02 (-0.17-0.13), 0.79	0.03 (-0.12-0.17), 0.72	0.02 (-0.12-0.17), 0.75	-0.26 (-0.39–-0.12), <0.001	0.11 (-0.04-0.25), 0.14	0.18 (0.04-0.32), 0.01
Body fat	0.17 (-0.31–-0.02), 0.02	0.12 (-0.02-0.27), 0.10	0.07 (-0.08-0.21), 0.39	-0.51 (-0.61–-0.39), <0.001	0.32 (0.18-0.44), <0.001	0.34 (0.21-0.47), <0.001
Body water	0.08 (-0.07-0.22), 0.32	-0.16 (-0.30–-0.01), 0.04	0.04 (-0.11-0.19), 0.59	0.50 (0.38-0.60), <0.001	-0.30 (-0.43–-0.16), <0.001	-0.35 (-0.47–-0.22), <0.001
BMR	-0.09 (-0.23-0.06), 0.24	0.13 (-0.01-0.27), 0.08	0.19 (0.05-0.33), 0.01	0.11 (−0.04-0.25), 0.16	0.06 (-0.09-0.20), 0.46	-0.11 (-0.25-0.04), 0.15
Visceral fat	0.27 (0.13-0.40), <0.001	-0.27 (-0.40–-0.13), <0.001	-0.09 (-0.23-0.06), 0.24	0.31 (0.17-0.44), <0.001	-0.32 (-0.45–-0.18), <0.001	-0.11 (-0.26-0.03), 0.13
Muscle mass	0.15 (0.01-0.29), 0.04	-0.20 (-0.34–-0.06), 0.007	0.04 (-0.11-0.18), 0.60	0.48 (0.36-0.58), <0.001	-0.27 (-0.40–-0.12), <0.001	-0.30 (-0.42–-0.16), <0.001
Bone mass	0.08 (-0.07-0.23), 0.28	-0.14 (-0.28-0.01), 0.06	0.08 (-0.07-0.22), 0.30	0.36 (0.22-0.48), <0.001	-0.21 (-0.35–-0.07), 0.004	-0.19 (-0.33–-0.04), 0.01

Note: *r*=Pearson correlation coefficient, CI=95% confidence interval, NCV=nerve conduction velocity, NCS=nerve conduction study, BMI=body mass index, BMR=basal metabolic rate. Motor amplitudes are expressed in mV and sensory amplitudes in µV

DISCUSSION

This study provides descriptive motor and sensory nerve conduction data for the median and ulnar nerves in healthy adults from Northern Pakistan, and demonstrates important associations with demographic and body composition variables. Our findings are similar to the findings of studies done earlier for Indian and Pakistani populations.[9] As described by Hameed *et al*[10] Pakistani populations generally have statistically significantly higher mean amplitudes and relatively faster conduction velocities showing similarities with South Asian studies. Our NCS findings are similar to the study by López *et al*[5] that examined asymptomatic and healthy controls which were significantly different from those of the American and multi-ethnic Malaysian origin populations. These differences can be attributed to different demographic and biological characteristics of study population as well as sampling sizes, and techniques used to record NCS responses. In addition to that equipment settings, certain genetic factors, lifestyle differences, variations in body and environmental temperature can be the source of these minor variations observed amongst different multi-ethnic study populations.[5]

Our NCS values were compared to normative nerve conduction values from other population-based studies, using standardized techniques. Sensory distal latencies were slightly increased which we believe could be related to the variations in distal distances. The results of our study showed comparable findings to that of the Saudi and Indian population.[11]

Demographic factors, particularly age and height, have a greater influence on upper-limb nerve conduction parameters than most body composition indices. Age showed moderate positive correlations with median motor and sensory latencies and negative

correlations with amplitudes and sensory conduction velocity, indicating age-related slowing of peripheral nerve conduction and reduced axonal function. These findings are consistent with recent large population-based evidence from the Maastricht Study, which reported longer distal latencies, lower conduction velocities, and reduced amplitudes with increasing age across multiple peripheral nerves.[12]

Height demonstrated moderate positive correlations with ulnar motor and sensory latencies, supporting previous observations that taller individuals have longer nerve pathways, resulting in prolonged conduction times. Similar findings have recently been reported in normative studies showing that height independently predicts longer distal latencies and lower conduction velocities.[13] In contrast, weight and BMI showed weak correlations with most motor and sensory parameters, suggesting that overall body size has only a limited effect on nerve conduction after accounting for anthropometric characteristics, consistent with recent population-based analysis by Sand *et al*.[14]

Among body composition variables, muscle mass, body water, bone mass, and visceral fat demonstrated moderate positive correlations with several motor latency parameters, whereas body fat percentage showed moderate negative correlations with ulnar latencies as supported by a contemporary study by Raissi *et al*, primarily emphasize demographic and anthropometric determinants and body composition contributes modestly to variability in electrophysiological recordings. These associations may be attributed to changes in tissue composition, electrode-to-nerve distance, and electrical impedance rather than intrinsic alterations in nerve physiology.[15]

CONCLUSION

The findings of this add locally derived descriptive NCS data and support consideration of demographic and body composition characteristics during interpretation of upper-limb nerve conduction studies.

LIMITATIONS OF THE STUDY

This study provides only NCS parameters in a relatively small sample of adult population without much emphasis upon precise causal relationship or comparison among different ethnic groups. Larger multi centre studies using standardized limb temperature, gender-stratified analyses and multivariable regression are needed to establish robust population-specific reference limits for clinical use.

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Authors approved the draft and are accountable in ensuring that questions related to accuracy or integrity of the work are duly investigated and resolved.

AM: Conception and study design **NI:** Data analysis and interpretation **MS:** Data analysis and interpretation
AS: Proof reading **SF:** Data collection and manuscript **SF:** Data collection
UK: Statistical analysis

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ORIGINAL ARTICLE

MATERNAL BODY MASS INDEX AS A METABOLIC DETERMINANT OF OBSTETRIC OUTCOMES IN PRIMIGRAVIDA WITH UNENGAGED HEAD AT TERM

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Background: Unengaged foetal head at term in primigravida women is associated with adverse obstetric outcomes. Maternal body mass index (BMI) can also influence labour and delivery. Limited information is available on the relationship between BMI and outcomes in women with unengaged foetal head. The objective of this study was to determine the association of maternal BMI with obstetric and neonatal outcomes among primigravida women with unengaged foetal head at term. **Methods:** This analytical study included 139 primigravida women aged 18–40 years with singleton, vertex pregnancies at 38–41 weeks and unengaged foetal head. Participants were recruited with non-probability consecutive sampling. BMI was categorized as ≤25 and >25 Kg/m². Maternal and neonatal outcomes included caesarean section (CS), postpartum haemorrhage (PPH), foetal distress and low Apgar score. Data were analysed using SPSS-24, and $p<0.05$ was considered statistically significant. **Results:** Among women with BMI ≤25 Kg/m², 44 (47.3%) underwent caesarean section compared with 16 (34.8%) with BMI >25 Kg/m² ($p=0.161$). PPH occurred in 11 (11.8%) women with BMI ≤25 Kg/m² and 4 (8.7%) with BMI >25 Kg/m² ($p=0.575$). Foetal distress occurred in 33 (35.5%) and 10 (21.7%), respectively ($p=0.099$), while low Apgar score occurred in 4 (4.3%) and 6 (13.0%) respectively ($p=0.061$). None of these associations was statistically significant. **Conclusion:** Maternal BMI was not significantly associated with caesarean section, PPH, foetal distress or low Apgar score among primigravida women with an unengaged foetal head at term.

Keywords: Body mass index, Caesarean section, Foetal distress, Foetal head engagement, Maternal outcome, Neonatal outcome, Postpartum haemorrhage, PPH, Pregnancy, Primigravida

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INTRODUCTION

Foetal head engagement is an important event in the progress of labour, especially in primigravida women, in whom engagement is traditionally expected at term. At term an unengaged or high foetal head shows the altered foetopelvic adaptation and has been associated with prolonged labour. It then needs augmentation of labour and operative delivery.[1] However, unengaged foetal head alone is not an absolute indication for caesarean delivery. A careful intrapartum assessment is required to determine the appropriate mode of delivery. Previous studies have reported variable rates of deliveries by caesarean section (CS) with maternal and neonatal complications among primigravida women with an unengaged foetal head at term.[2]

The course and outcome of labour are influenced by maternal nutritional and anthropometric status. Body mass index (BMI) calculated from maternal weight and height, is a simple indicator of nutritional and metabolic status and is widely used to assess maternal adiposity. Increased maternal BMI has been associated with several physiological and obstetric changes, including altered labour progression, increased need for obstetric intervention and higher rates of caesarean delivery.[3] A multicentre cohort study reported a progressive increase in caesarean delivery with increasing maternal BMI, while higher BMI was also associated with increased neonatal complications. Therefore, maternal adiposity influences pregnancy and delivery through metabolic, endocrine and inflammatory mechanisms.[4] Increased adipose tissue is associated with altered insulin sensitivity, inflammatory signalling and changes in uterine contractility which can contribute to dysfunctional labour and operative delivery. Elevated BMI has also been associated with postpartum haemorrhage (PPH), particularly haemorrhage caused by uterine atony.[5]

The coexistence of an unengaged foetal head and altered maternal BMI can therefore have important clinical implications. Previous research has examined the obstetric consequences of an unengaged foetal head, and independently evaluated the relationship between maternal BMI and pregnancy outcomes.[6] Limited information is available regarding association of BMI with delivery and neonatal outcomes specifically among

primigravida women presenting with an unengaged foetal head at term. The existing evidence regarding this relationship is also inconsistent, particularly for foetal distress, PPH and low Apgar scores.

This study was conducted to determine the association of maternal BMI with obstetric and neonatal outcomes among primigravida women with an unengaged foetal head at term, with particular emphasis on caesarean delivery, PPH, foetal distress and low Apgar score.

METHODOLOGY

This analytical cross-sectional study was conducted in the Department of Anatomy, CMH Kharian Medical College, in collaboration with Department of Biochemistry, CMH Kharian Hospital, over a period of 6 months from Feb to Jul 2025 after obtaining approval from the Institutional Ethical Review Board Ref. No. CKMC/IERB/AC-00292 dated 3rd Jan 2025.

Written informed consent was obtained from all participants before enrolment. The sample size was calculated by a non-probability consecutive sampling technique, assuming an expected prevalence of 10%, a 5% margin of error and a 95% confidence level, yielding a minimum sample size of 139 participants. The expected prevalence was based on previously reported literature on primigravida women with an unengaged foetal head at term.[7] Women aged 18–40 years with a singleton pregnancy, vertex presentation and full-term gestation of 38–41 weeks were included. Women with a previous history of abortion, diabetes mellitus, hypertension, foetal growth restriction or malpresentation were excluded.

Maternal demographic characteristics, including age and gestational age, were recorded. Maternal body mass index (BMI) was calculated from weight and height and categorized as ≤25 Kg/m² and >25 Kg/m² for analysis.[6] Ultrasound examination was performed to confirm gestational age, singleton pregnancy, vertex presentation and the presence of an unengaged foetal head. An unengaged foetal head was defined as 5/5 of the foetal head remaining mobile above the pelvic brim, with the lowermost portion of the head remaining above the pelvic brim.[8]

Participants were followed until delivery. Women with inadequate uterine contractions were augmented with oxytocin when required and the final mode of delivery was determined by the consultant gynaecologist. Maternal and neonatal outcomes included CS, PPH, foetal distress and low Apgar score. Postpartum haemorrhage was defined as blood loss >1,000 mL following CS, or ≥500 mL following vaginal delivery within 24 hours.[9] Foetal distress was defined as an abnormal foetal heart-rate pattern identified by intermittent auscultation or continuous electronic foetal monitoring.[10] A low Apgar score was defined as an Apgar score <5 at 5 minutes after birth.[11]

Data were analysed on SPSS-24. Continuous variables, including age and gestational age, were expressed as Mean±SD, whereas categorical variables, including BMI category, mode of delivery, PPH, foetal distress and low Apgar score, were presented as frequencies and percentages. Chi-square test was used to assess associations between BMI categories and obstetric outcomes. Multivariable binary logistic regression analysis was subsequently performed to assess the independent association of BMI category with each obstetric outcome while adjusting for potential confounding variables, including maternal age and gestational age. Adjusted odds ratios (aORs) with 95% confidence intervals (CIs) were reported. Stratification was performed according to maternal age and gestational age where appropriate. A *p*-value of ≤0.05 was considered statistically significant.

RESULTS

A total of 139 primigravida women with unengaged foetal head at term were included. There were 93 (66.9%) women having BMI≤25 Kg/m^2, and 46 (33.1%) had BMI>25 Kg/m^2. The anthropometric and demographic and characteristics of the patients are presented in Table-1.

The mode of delivery (vaginal or caesarean) was not statistically different (p>0.05) (Table-2). Association of maternal BMI with PPH or foetal distress was also not significant (p>0.05) (Table-3).

Overall, adverse maternal and neonatal outcomes were observed in the study population. Maternal BMI was not significantly associated with CS, PPH, foetal distress, or low Apgar score.

Table-1: Demographic and anthropometric characteristics of the study population (n=139)

Variables	Values
Age (Years, Mean±SD)	28.45±2.32
Gestational age (Weeks, Mean±SD)	38.82±0.85
BMI (Kg/m², Mean±SD)	24.9±3.6
BMI≤25 Kg/m²	93 (66.9%)
BMI>25 Kg/m²	46 (33.1%)
Age 18–30 Years	120 (86.3%)
Age 31–40 Years	19 (13.7%)

Table-2: Association of maternal BMI with mode of delivery [n (%)]

BMI category	Vaginal delivery	Caesarean section	*p*
≤25 Kg/m²	49 (52.7)	44 (47.3)	0.161
>25 Kg/m²	30 (65.2)	16 (34.8)	
Total	79 (56.8)	60 (43.2)	

Statistical test: Chi-square test

Table-3: Association of maternal BMI with maternal and intrapartum outcomes (n=139) [n (%)]

BMI Kg/m²	Postpartum haemorrhage n (%)			Foetal distress n (%)		
	Present	No	*p*	Present	No	*p*
≤25	11 (11.8)	82 (88.2)	0.575	33 (35.5)	60 (64.5)	0.099
>25	4 (8.7)	42 (91.3)		10 (21.7)	36 (78.3)	
Total	15 (10.8)	124 (89.2)		43 (30.9)	96 (69.1)	

Statistical test: Chi-square test.

Table-4: Stratification of caesarean section, foetal distress and low Apgar score according to maternal age and BMI [n (%)]

Category	Caesarean section	*p*	Foetal distress	*p*	Low Apgar score	*p*
Age (Years)						
18–30	51 (42.5)	0.691	36 (30.0)	0.549	8 (6.7)	0.545
31–40	9 (47.4)		7 (36.8)		2 (10.5)	
BMI (Kg/m²)						
≤25	44 (47.3)	0.161	33 (35.5)	0.099	4 (4.3)	0.061
>25	16 (34.8)		10 (21.7)		6 (13.0)	

Statistical test: Chi-square test.

Table-5: Multivariable logistic regression analysis of maternal BMI and obstetric and neonatal outcomes

Outcome	aOR	95% CI	*p*
Caesarean section	0.60	0.29–1.24	0.166
PPH	0.68	0.20–2.29	0.537
Foetal distress	0.50	0.22–1.15	0.102
Low Apgar score	3.36	0.90–12.60	0.073

Statistical test: Multivariable binary logistic regression

DISCUSSION

Foetal head engagement represents the descent of the bi-parietal diameter through the pelvic inlet and indicates that the foetal head has entered the maternal pelvis. In primigravida women, failure of engagement at term reflects the differences in relationship between foetal head size, foetal position and maternal pelvic dimensions.[12] An unengaged head therefore requires closer assessment during labour because continued failure of descent can affect the progress in labour and the eventual mode of delivery. However, an unengaged head at term does not necessarily indicate pelvic inadequacy or predict caesarean delivery in every woman. Its clinical significance should be considered together with labour progress, foetal position and maternal and foetal conditions.[2]

This study observed that BMI is not significantly associated with the studied obstetric and neonatal outcomes. The caesarean section rate was comparable with previous studies on primigravida women with an unengaged or high foetal head. Haroon *et al*[13] reported a similar occurrence of caesarean delivery among term primigravida women with an unengaged foetal head. The relationship between BMI and pregnancy outcome has been demonstrated in larger populations. Khalifa *et al*[14] found that caesarean delivery was more frequent in high maternal BMI. The present study focused specifically on primigravida women with an unengaged foetal head at term, which may explain differences between the findings. The predominance of younger women in the present study is also consistent with previous studies of primigravida women with an unengaged foetal head. Hussain *et al*[2] reported a relatively young maternal age in their study.

Maternal BMI was not significantly associated with mode of delivery in the present cohort. This finding differs from previous studies, which have generally reported increasing caesarean rates with increasing BMI. Dalbye *et al*[15] reported a significant increase in caesarean delivery across increasing BMI categories among nulliparous women. The difference between their findings and the present study may be related to the specific selection of women with an unengaged foetal head at term, differences in BMI categorization, sample size, or other clinical factors. The present study was restricted to primigravida women with an unengaged foetal head, which may have influenced the observed relationship between BMI and mode of delivery.

Maternal BMI was not significantly associated with postpartum haemorrhage in the present study. This finding is consistent with the WOMAN-2 study[16], which reported no significant association between maternal BMI and postpartum haemorrhage. Another observational study[17] has reported a higher risk of postpartum haemorrhage among women with higher BMI. These differences may be related to differences in study populations, BMI categories, and mode of delivery. Maternal BMI was not significantly associated with foetal distress in the present study. This finding is consistent with previous evidence showing no significant association between maternal BMI and foetal distress.[18] The findings suggest that maternal BMI was not a significant determinant of postpartum haemorrhage or foetal distress in this specific group of primigravida women with unengaged foetal head.

Low Apgar scores were more frequent among women with BMI >25 Kg/m². However, the differences were not statistically significant. This finding is consistent with previous work[19] showing a higher frequency of low Apgar scores among women with higher BMI. A large population-based study[20] of 9 million mother-infant pairs also reported that maternal overweight and obesity were associated with higher odds of a low 5-minute Apgar score. Maternal age was not significantly associated with caesarean section, foetal distress, or low Apgar score in the present study. This differs from a 2023 study[21] of primigravida women, which reported higher rates of foetal distress and other adverse outcomes among older primigravida women. These differences may be related to variations in study populations and clinical characteristics.

Neither maternal BMI nor age showed a significant association with the studied obstetric and neonatal outcomes in this study. In the multivariable analysis, after adjustment for maternal age and gestational age, maternal BMI was not significantly associated with caesarean section, postpartum haemorrhage, foetal distress, or low Apgar score. These findings are similar to results of Chi-square analysis. Although low Apgar score was more common in women with BMI >25 Kg/m², the difference was not statistically significant. Maternal BMI was not a significant predictor of studied outcomes in this group of primigravida women with unengaged foetal head.

LIMITATIONS & RECOMMENDATIONS

This single-centre study had a relatively small sample size of 139 participants which can limit the generalizability of the findings. Larger multicentre studies are recommended. The broad BMI categorization (≤25 and >25 Kg/m²) can also limit the detection of differences between specific BMI groups. Multivariable analyses are recommended to determine whether BMI independently predicts CS, PPH, foetal distress and low Apgar score. Potential confounding factors such as gestational weight gain and foetal birth weight were not assessed.

CONCLUSION

Among primigravida women with an unengaged foetal head at term, caesarean section, foetal distress and postpartum haemorrhage were relatively common obstetric outcomes. However, maternal BMI was not significantly associated with caesarean section, postpartum haemorrhage, foetal distress or low Apgar score. These findings suggest that, within primigravida women with an unengaged foetal head at term, maternal BMI alone may not be a significant determinant of adverse obstetric or neonatal outcomes.

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ORIGINAL ARTICLE

ASSOCIATION OF PROCRASTINATION WITH MOTOR AND COGNITIVE FATIGUE AMONG STUDENTS: A CROSS-SECTIONAL STUDY

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Background: Procrastination reflects delaying tasks, staying organized, and mentally alert. This can reduce productivity and add to emotional strain. Mental fatigue means difficulty concentrating, slower thinking, or forgetting things easily. Physical tiredness refers to reduced stamina, and sense of exhaustion. In medical profession where constant alertness are required, this affects both performance and well-being. The objective of this study was to assess the association of procrastination with motor and cognitive fatigue among students. **Methods:** This cross-sectional study was conducted at Ayub Medical College. A total of 206 students and graduates between 18 and 25 years of age were included after using convenience sampling. Incomplete proformas and other causes of fatigue like chronic medical conditions, mental illnesses and on medications were excluded. Duration of study was six months. Information was gathered through a self-administered questionnaire. Basic details, including age, level of education, and average sleep duration and 28 statements rated on a five-point scale, exploring patterns of procrastination with relation to mental and physical tiredness were recorded. The data was analysed using SPSS-25. To explore the relationship between procrastination and fatigue, Pearson's correlation and simple regression analysis were applied, and $p \leq 0.05$ was taken as significant. **Results:** There was a significant positive association between procrastination and motor-cognitive fatigue authenticated by Pearson's correlation analysis which revealed a significant relationship ($p<0.05$). **Conclusion:** Higher levels of procrastination corresponded to increased fatigue, highlighting its impact on students' performance and well-being.

Keywords: Cognition, Motor fatigue, Procrastination

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INTRODUCTION

Procrastination is usually described as putting off a task even when one knows that the delay may lead to unwanted consequences.[1] It is commonly seen among students and young professionals, particularly in settings where academic and professional expectations are high.[2] Earlier studies have linked procrastination with greater stress, constant time pressure, lower productivity, and weaker academic outcomes.[3] Although these effects have been widely discussed, much less attention has been given to how procrastination may relate to mental and physical tiredness.

Cognitive fatigue is a state of mental exhaustion featured by decreased concentration, impaired decision-making, and reduced memory efficiency following prolonged cognitive effort.[4] Physical, or motor, fatigue is different; it reflects a sense of bodily exhaustion and reduced physical efficiency after continued activity. Both types of fatigue can interfere with daily responsibilities and academic work. In demanding environments, where long hours of focus and effort are routine, their impact can be particularly noticeable.[5]

Procrastination may lead to fatigue through a repeating pattern of delay and pressure. When tasks are pushed close to deadlines, they often have to be completed in a short span of time, requiring intense focus and persistent effort. Working under such pressure can drain mental energy more quickly and leave a lingering sense of exhaustion.[6] If this cycle continues, it can gradually affect overall well-being. What begins as occasional delay may turn into a habit of last-minute effort, followed by exhaustion and reduced performance. Over time, this pattern can interfere with both daily functioning and long-term academic or professional growth.[7]

Although procrastination is increasingly seen as one form of failure of self-regulation shaped by personality, emotions, and environmental factors, like constant digital distractions.[8] In particular, how procrastination relates to both mental and physical tiredness has received little attention, especially in young adults. This link is important because students and early-career professionals often deal with ongoing academic and work pressures, which can make both mental and physical exhaustion worse.[9]

Building on this background, the current study was set out to explore how procrastination relates to fatigue, with a particular focus on mental and physical exhaustion among students and young professionals. Addressing procrastination effectively begins with

awareness recognizing one's own tendency to delay tasks. From there, simple strategies can make a difference: setting realistic, manageable goals, breaking larger tasks into smaller steps, reducing distractions, and limiting time spent on social media, which often consumes more time than intended.[9]

Using these approaches can help sustain motivation and interrupt the cycle of delay, with higher procrastination linked to greater mental and physical tiredness.[10] Understanding what drives procrastination is therefore important, not just theoretically but also in practice, because it can guide interventions aimed at improving academic outcomes, professional efficiency, and overall well-being in young adults which is the objective of our study to assess the association of procrastination with motor and cognitive fatigue among students and young professionals.

MATERIAL AND METHODS

This cross-sectional, questionnaire-based study was conducted at Ayub Medical College, Abbottabad over 6 months (Jan–Jun 2026). A total of 206 participants, aged 18–25 years, were recruited through convenience sampling. The study included both currently enrolled students and recent graduates who voluntarily agreed to participate and provided written informed consent. Individuals with diagnosed psychiatric or neurological disorders, chronic medical conditions known to cause fatigue, or incomplete questionnaire responses were excluded from this study.

The sample size was calculated using Open-Epi version 3.01 specific for cross-sectional studies with a 95% confidence level, a 5% margin of error, and prevalence of 50%. Ethical approval was obtained for this study from the Institutional Review Board (IRB) of Ayub Medical College (Ref. No. RC-EA-2026/07). Data was collected through a self-administered structured, questionnaire proforma divided into two sections. The first section captured basic demographic information regarding age, educational level, and average sleep duration. The second section focused on assessing levels of procrastination, and mental and physical fatigue.

Procrastination criteria was assessed using a improved version of General Procrastination Scale.[11] The questionnaire included 15 items, each utilizing on a five-point Likert scale (5=always, 4=often, 3=sometimes, 2=rarely, 1=never). Scores could range from 15 to 75, with higher total levels reflecting a higher level of procrastination.[2] Fatigue was measured using a 13-item scale covering both physical and mental exhaustion. Five items focused on motor fatigue, while eight items assessed cognitive fatigue. Each item was rated on a five-point scale from 1 (never) to 5 (always), resulting in total scores in ranges from 13 to 65. Higher scores indicating greater levels of fatigue.[2]

A pilot study with 20 participants was carried out to check the clarity, understandability, and practicality of the questionnaire. According to their feedback, minor word changes were made to improve precision. Data from the pilot study participants was not included in final analysis. The reliability of the procrastination scale was assessed by using Cronbach's alpha statistics, with the procrastination scale showing good consistency (α=0.90) and the fatigue scale demonstrating high internal consistency (α=0.92).

Data were analysed using SPSS 25. Descriptive statistics, like mean, standard deviations, frequency, and percentages were used to summarize the participants' demographic data and questionnaire scores. Bivariate linear regression was carried out to examine the relationship between procrastination (as the independent variable) and total fatigue score (as the dependent variable). Before running the analysis, key assumptions of linear regression, including normality, linearity and independence were checked. Results with $p \leq 0.05$ were considered statistically significant.

RESULTS

The study included 206 participants, mostly young adults. The largest groups were aged 21–25 years (107, 51.94%) and 15–20 years (95, 46.12%), with a very small number (4, 1.94%) aged 26–30 years, and no participants in the 31–35 age range. Most of the sample were graduates (175, 84.95%), reflecting a highly educated group. The remaining participants had higher secondary education (9, 4.37%), having post-graduate degrees (8, 3.88%), specialty education (8, 3.88%), or other educational backgrounds (6, 2.91%).

Regarding sleep, most participants (151, 73.30%) reported 5–8 hours per day, consistent with typical adult sleep recommendations. A smaller portion (43, 20.87%) slept more than 8 hours, while 11, 5.34% reported less than 5 hours daily. Sleep data for one participant (0.49%) was invalid. Overall, this sample represents young, well-educated adults with generally adequate sleep patterns. (Table-1).

Table-1: Summary of sample characteristics (n=206)

Characteristic/Category	Frequency (N)	Percentage
Age		
15–20 years	95	46.12%
21–25 years	107	51.94%
26–30 years	4	1.94%
31–35 years	0	0%
Education Level		
Higher Secondary	9	4.37%
Graduate	175	84.95%
Post-Graduate	8	3.88%
Specialty	8	3.88%
Other	6	2.91%
Sleep Hours/24 hours		
Less than 5 hours	11	5.34%
5–8 hours	151	73.30
More than 8 hours	43	20.87
Invalid data	1	0.49

The correlation Table-2 shows the association between procrastination (PR) and fatigue (FA) using Pearson correlation. The Pearson correlation coefficient between PR and FA was 0.477, indicating a moderate positive correlation. There was a clear and meaningful impact of procrastination on fatigue. (Table-2).

The regression model yielded Beta coefficient as 0.830, R-square as 0.228, and an F-statistic of 60.096, which was highly significant (p<0.001).

Table-2: Association between procrastination and fatigue

		PR	FA
PR	**Pearson Correlation**	1	0.477**
	***p* (2-tailed)**		0.000
	N	206	206
FA	**Pearson Correlation**	0.477**	1
	***p* (2-tailed)**	0.000	
	N	206	206

**Correlation is significant at 0.01 level

DISCUSSION

This study observed a clear positive relationship between procrastination and fatigue in students and young professionals. Procrastination accounted for 22.8% of the variation in fatigue scores, highlighting its role as a meaningful predictor. The moderate positive correlation (r=0.477) and the statistically significant regression results indicate that higher procrastination is linked to greater mental and physical fatigue. In this group of young, well-educated adults, those who reported higher levels of procrastination also experienced more mental fatigue, including reduced focus, slower decision-making, and a general sense of mental drain, along with lower physical energy.[11] Cognitive fatigue here appears to stem from the mental toll of delaying tasks, dealing with internal conflict, and facing repeated deadline pressure. Motor fatigue, meanwhile, may develop when postponed tasks are completed hastily under pressure, requiring extra physical effort in a short time.[1–10] This cycle of delay followed by urgent work seems to intensify both mental and physical exhaustion.

Procrastination has long been conceptualized as a failure of self-regulation.[12] Students who manage their tasks well usually show stronger executive control, higher academic performance, and greater self-confidence.[13] In contrast, chronic procrastination is linked to delayed preparation, last-minute work, and increased emotional stress.[14] While much research has focused on its academic and psychological effects, less is known about how it relates to mental and physical fatigue. Our study adds to this understanding by showing that procrastination is not only tied to emotional strain but also to measurable symptoms of cognitive and motor fatigue as shown by high scores of responses in questionnaire.

From a psychological standpoint, procrastination often serves as a way to avoid tasks that trigger anxiety.[15] Comparable to this study our participants reported when academic demands feel overwhelming, putting off work can provide brief relief. Yet this temporary ease is usually followed by increased stress, self-criticism, and pressure to meet deadlines.[11,12] Prolonged stress sometimes involving heightened sympathetic nervous system activity can drain students mental energy and can lead to feeling of exhaustion as shown by findings of Khan *et al*.[14] Neuropsychological models point to reduced efficiency in prefrontal brain regions that govern executive control and decision-making.[16] When these cognitive processes are impaired, starting tasks become harder, errors become more taxing to monitor, and mental fatigue intensifies. Our results align with these models, highlighting how delaying tasks is closely linked to both behavioural and neurocognitive strain.[15]

The regression results in our study reinforce this interpretation. Procrastination accounted for almost a quarter of the variation in fatigue, showing that its influence is meaningful, even if not the sole factor. These findings are consistent with previous research linking procrastination to reduced cognitive efficiency, higher stress levels, and excessive engagement with digital devices.[17]

Interestingly, most participants reported getting 5–8 hours of sleep per night, which falls within the recommended range. This suggests that the fatigue observed in our sample was unlikely to be caused solely by lack of sleep. While previous studies have linked delaying bedtime and poor sleep quality to lower cognitive performance[18], our results indicate that procrastination itself even when sleep is adequate can contribute to fatigue as shown by Windred DP *et al*.[18] This distinction is important, as it points to procrastination as a direct behavioural factor rather than just a consequence of insufficient rest.

The academic environment plays a key role in this process. Students in challenging programs often face continuous mental demands and performance pressure. When tasks are postponed, these pressures can increase emotional exhaustion and reduce both mental and physical efficiency. Stress-avoidance models suggest that when individuals see a task as threatening or overwhelming, they may temporarily withdraw or delay engagement.[19] From a practical point of view, these findings emphasize the value of improving self-regulation skills. Various strategies such as breaking long tasks into smaller steps, setting clear objectives, and restructuring unhelpful thought patterns can help reduce procrastination and the fatigue that accompanies it. Behavioural approaches like 'if then' planning, structured to-do lists have been shown to support better task initiation and completion.[20] Cognitive-behavioural

techniques may be especially useful, as procrastination is often fuelled by irrational beliefs, fear of failure, and negative automatic thoughts.[21] Psychological support programs, mindfulness practices, and lifestyle adjustments can further enhance academic resilience and help reduce both mental and physical exhaustion.[22]

This study adds to the rising evidence that procrastination is more than a simple habit it has measurable effects on both mind and body. By showing its link to mental and physical fatigue in young adults, our findings expand the view of procrastination from being just an academic delay to a factor affecting overall well-being. Future research using longitudinal designs could help clarify cause-and-effect relationships and examine how factors like stress response, executive functioning, and emotional regulation might influence this connection. Gaining insight into these mechanisms could guide the development of specifically targeted strategies to reduce procrastination and the fatigue.

CONCLUSION

Procrastination is a strong predictor of both mental and physical fatigue, with higher levels linked to greater exhaustion. Tackling procrastination through practical strategies like setting clear objectives, breaking longer tasks into manageable small steps, and limiting digital distractions may help reduce fatigue, improve academic performance, and boost professional efficiency.

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ORIGINAL ARTICLE

DIAGNOSTIC PERFORMANCE OF SERUM C-REACTIVE PROTEIN, ASPARTATE AMINOTRANSFERASE, ALANINE AMINOTRANSFERASE, AND LACTATE DEHYDROGENASE AS ADJUNCTS TO RT-PCR IN DETECTION OF COVID-19

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Background: COVID-19 is a highly transmissible viral infection caused by SARS-CoV-2, with clinical manifestations ranging from asymptomatic disease to severe pneumonia and multi-organ involvement, necessitating timely and accurate diagnosis. Aim was to determine the diagnostic accuracy of serum C-reactive protein (CRP), Aspartate Aminotransferase (AST), Alanine aminotransferase (ALT), and Lactate dehydrogenase (LDH) levels as detecting COVID-19, using RT-PCR as gold standard. **Methods:** This Cross-sectional study was conducted in Department of Pathology, Bahawal Victoria Hospital/Civil Hospital Bahawalpur, from 10th Jan to 9th Jul 2023. After informed consent nasopharyngeal swab for RT-PCR and blood samples for CRP, AST, ALT, and LDH were collected from 165 symptomatic patients suspected of COVID-19. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated. **Results**: Sensitivity, specificity, PPV, NPV, and diagnostic accuracy of serum CRP in Detecting COVID-19 taking RT-PCR as a gold standard were 83.87, 69.44, 78.0, 76.92 and 77.58% respectively. Sensitivity, specificity, PPV, NPV and diagnostic accuracy of serum AST levels were 80.65, 68.06, 76.53, 73.13 and 75.15% respectively. Sensitivity, specificity, PPV, NPV and diagnostic accuracy of the serum ALT were 81.72, 68.06, 76.77, 74.24 and 75.76% respectively. Sensitivity, specificity, PPV, NPV and diagnostic accuracy of the serum LDH were 86.02, 72.22, 80.0, 80.0 and 80.0% respectively. **Conclusion:** CRP and LDH demonstrated relatively higher diagnostic performance than AST and ALT, therefore these serum markers may be used as an adjunct diagnostic tool in detecting COVID-19 in settings where RT-PCR is not available.

Keywords: COVID-19, CRP, LDH, RT-PCR, Sensitivity, Specificity

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INTRODUCTION

The coronavirus disease 2019 (COVID-19) is caused by the transmission of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). This virus was first detected in Wuhan China in 2019. It spread rapidly across the world leading to a global outbreak in 2020.[1] As of mid-2025 confirmed cases of COVID-19 have exceeded 767 million and the number of reported deaths due to COVID-19 ranging between 6.9–7.1 million.[2] COVID-19 spreads when people are in close proximity. The main mode of transmission is air bone transmission. The clinical presentation of this infection varies from asymptomatic infection to severe pneumonia and multiorgan failure.[3]

There is a variety of diagnostic tests used for the detection of COVID-19 including Polymerase Chain Reaction (PCR) and isothermal nucleic acid amplification assays. Serological tests, including ELISA and lateral flow immunoassay are also used to test patients who develop antibodies against the virus.[4]

The US Centers for Disease Control and Prevention (CDC) has declared Reverse Transcriptase Polymerase chain reaction (RT-PCR) test as a gold standard for the detection of COVID-19. RT-PCR detects viral genetic material from a sample taken from nose or throat swab. However, PCR is associated with several limitations including high false negatives, high turnaround time, requirement of trained staff and specialized equipment. The sensitivity of RT- PCR as reported by Woloshin S, and colleagues is only 70%.[5]

To address these limitations, researchers developed a machine learning (ML) model based upon routine blood tests which revealed that inflammatory markers such as C-reactive protein (CRP) and enzymes like lactate dehydrogenase (LDH), alanine aminotransferase (ALT), and aspartate aminotransferase (AST) are significantly altered in COVID-19.[6] COVID-19 triggers the release of inflammatory cytokines, particularly IL-6, resulting in increased hepatic production of CRP, while immune-mediated injury,

hypoxia, and direct viral effects contribute to elevated AST and ALT levels. Widespread cellular damage also increases LDH release, reflecting tissue injury and disease severity.[6] Therefore, these biochemical markers, can be utilized as one of the diagnostic tools for the detection of COVID-19.[7] A study published in Clinica Chemica Acta showed that raised serums CRP, serum LDH and lymphocytopenia are commonly observed abnormalities in COVID-19 infection. Levels of AST, ALT and Creatinine kinase are also elevated.[8] As serum level of ALT and LDH are highly sensitive to presence of COVID-19, therefore can be utilized as surveillance indicator for detection of COVID-19.[9] Many published articles have reported the epidemiological and clinical characteristics of COVID-19 disease, but data regarding the laboratory findings of infected individuals are limited.[10,11]

The rationale of this study was to evaluate the diagnostic potential of routine biochemical tests like CRP, ALT, AST and LDH for early detection of COVID-19. As biochemical tests are cost effective, less time consuming and more feasible in resource constrained setups. These tests require less skill and expertise to be performed. If these commonly available tests demonstrate high diagnostic value in detecting COVID-19, they could serve as alternatives/adjuncts in resource limited settings, particularly where RT-PCR is not available. These tests can be used to complement RT-PCR by increasing combined sensitivity or can also serve as initial screening tool to identify individual who should undergo RT-PCR especially when the capacity of testing is limited. Early detection via routine biochemical investigation can facilitate timely detection, isolation and management of cases by improving the patient outcome and reducing disease transmission.

METHODOLOGY

This cross-sectional study was conducted at the Department of Pathology, Bahawal Victoria Hospital/ Civil Hospital Bahawalpur from 10th January to 9th July 2023, after obtaining ethical clearance from Institutional Review Board. A sample size of 165 was estimated using Buderer's formula through a Sensitivity and Specificity calculator, using 75% sensitivity, 70% specificity,[8] and 26.3% prevalence.[12] Ninety-five percent confidence level and 13% margin of error was used. After informed consent 165 patients with signs and symptoms consistent with COVID-19 were included.

Patients who had recovered from COVID-19, declined consent, or were diagnosed with other respiratory illnesses like asthma, chronic bronchitis, emphysema, lung cancer, cystic fibrosis, bronchiectasis, pneumonia, pleural effusion, liver disease, metabolic syndrome, or on medication were excluded.

Nasopharyngeal swab samples (for RT-PCR) and venous blood samples for CRP, AST, ALT, LDH were collected at the time of initial presentation, before initiation of treatment and analysed on respective automated analyzers. Demographic data and results of tests were recorded on a predesigned proforma. The predefined cut-off values for the index tests were CRP >5 mg/dL, AST >35 U/L, ALT >45 U/L, and LDH >360 U/L; values above these thresholds were considered positive (abnormal) for COVID-19.[13]

Data were analysed using SPSS-23. Numerical Data (Age, AST, ALT, LDH, CRP levels) were expressed as Mean±SD. Categorical variables like gender, RT-PCR result, CRP, LDH, AST, ALT (positive/negative) were reported as frequencies and percentages. A 2×2 table was constructed and diagnostic indices (sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy) were calculated for CRP, AST, ALT and LDH by taking RT-PCR as gold standard.

Effect modifiers like age and gender were controlled through stratification. Post-stratification diagnostic accuracy was also calculated.

RESULTS

Out of 165 patients, 111 (67.27%) were male and 54 (32.73%) were female. Age of the participants was between 10–90 years with majority of the patients 125 (75.76%), within the 10–50 years age group Table-1. Mean age of the patients was 43.90±8.14 years.

Table-1: Age-wise distribution of patients

Age (years)	No. of Patients	Percentage
10–50	125	75.76
51–90	40	24.24
Total	165	100.0

Mean ALT levels were 93.85±14.28 U/L. Mean AST levels were 42.33±12.39 U/L. Mean CRP levels was 8.45±4.33 mg/dL. Mean LDH levels were 423.12±22.73 U/L. Among the patient with positive serum CRP, 78 were True Positive and 22 were False Positive. Among 65 CRP negative patients, 15 (False Negative) had SAR-CoV-2 infection on PT-PCR whereas 50 (True Negative) had no SAR-CoV-2 infection on PT-PCR (p=0.0001). Overall sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of the serum CRP levels in detecting Covid-19 taking RT-PCR as a gold standard was 83.87, 69.44, 78.0, 76.92 and 77.58% respectively. The diagnostic accuracy of the serum LDH, serum ALT and serum AST in detecting COVID-19 taking RT-PCR as a gold standard was 80.0, 75.76, and 75.15% respectively. Comparison of diagnostic accuracy of various serum biomarkers with RT-PCR is given in Table-2.

Stratification of diagnostic accuracy with respect to age groups and gender is shown in Tables-3 and 4. Stratified analysis revealed higher sensitivity for CRP and LDH in the 51–90 years age group and among females.

Table-2: Comparison of diagnostic accuracy of serum biomarkers (CRP, AST, ALT, LDH)

Parameter	TP	FP	FN	TN	Sensitivity	Specificity	PPV	NPV	Accuracy	*p*
					Percentages					
CRP	78	22	15	50	83.87	69.44	78.00	76.92	77.58	0.0001
LDH	80	20	13	52	86.02	72.22	80.00	80.0	80.0	0.0001
AST	75	23	18	48	80.65	68.06	76.53	73.13	75.15	0.0001
ALT	76	23	17	49	81.72	68.06	76.77	74.24	75.76	0.0001

TP=True positive FP=False positive, FN=False negative, TN=True negative, PPV=Positive Predictive value, NPV=Negative Predictive value

Table-3: Stratified diagnostic accuracy of serum biomarkers (CRP, AST, ALT and LDH) with respect to age

Parameter	TP	FP	FN	TN	Sensitivity	Specificity	Accuracy	*p*
					Percentage			
Age: 10–50 Years (n=125)								
CRP	56	14	15	40	78.87	74.07	76.80	0.001
AST	53	15	18	39	74.65	72.22	73.60	0.001
ALT	55	15	16	39	77.46	72.22	75.20	0.001
LDH	58	12	13	42	81.69	77.78	80.0	0.001
Age: 51–90 Years (n=40)								
CRP	22	8	0	10	100	55.56	80.0	0.001
AST	22	8	0	10	100	55.56	80.0	0.001
ALT	21	8	1	10	95.45	55.56	77.50	0.001
LDH	21	8	1	10	95.45	55.56	77.50	0.001

TP=True positive, FP=False positive, FN=False negative, TN=True negative

Table-4: Stratified diagnostic accuracy of serum biomarkers (CRP, AST, ALT and LDH) with respect to gender

Parameter	TP	FP	FN	TN	Sensitivity	Specificity	Accuracy	*p*
					Percentage			
Male (n=111)								
CRP	55	14	12	30	82.09	68.18	76.58	0.001
AST	55	15	12	29	82.09	65.91	75.68	0.001
ALT	53	15	14	29	79.10	65.90	73.87	0.001
LDH	57	13	10	31	85.07	70.45	79.28	0.001
Female (n=54)								
CRP	23	8	3	20	88.46	71.43	79.63	0.001
AST	20	8	6	20	76.92	71.43	74.07	0.001
ALT	23	8	3	20	88.46	71.43	79.63	0.001
LDH	23	7	3	21	88.46	75.0	81.48	0.001

TP=True positive, FP =False positive, FN=False negative, TN=True negative

DISCUSSION

This study determined diagnostic accuracy of serum biomarkers in detecting COVID-19 using RT-PCR as gold Standard. The results revealed that the highest diagnostic accuracy was shown by LDH (80.0%), followed by CRP (77.58%), ALT (75.76%), and AST (75.15%). LDH also showed the highest sensitivity (86.02%) and specificity (72.22%), whereas CRP exhibited slightly lower sensitivity (83.87%) and specificity (69.44%). All findings were statistically significant (p=0.0001). These findings are consistent with international literature. A study by Poggiali *et al*[8], found that raised levels of LDH and CRP are strongly associated with respiratory failure in patients of COVID-19. It showed CRP at a cutoff of 11 mg/L had sensitivity and specificity of 72% and 71%, while LDH at cutoff of 450 U/L had sensitivity of 75% and specificity of 70%. These findings are comparable to our study.

Observation by Chen *et al*[14], revealed significantly elevated LDH in most COVID-19 patients, while elevated ALT and AST levels was more observed in severe cases. Similarly, a Pakistani study by Asghar *et al,* reported that elevated CRP and LDH were associated with disease severity, with CRP predicting ICU admission (AUC= 0.806) and LDH predicting mortality (AUC= 0.877), highlighting the prognostic value of these biomarkers in hospitalized COVID-19 patients.[15]

In another study Fan *et al,* compared the hematological indices of COVID-19 patients between the intensive care unit (ICU) and non-ICU patients. They showed lymphopenia and raised LDH levels were associated with higher rate of ICU admissions.[16]

Many patients with MERS-CoV had liver function abnormalities with increased alanine aminotransferase (ALT), aspartate aminotransferase (AST), and LDH.[17]

In a study, CRP was elevated in 60.7% of patients and lactate dehydrogenase (LDH) in 41% of COVID-19 patients.[18] A study by Wang *et al*, showed that a CRP level of 26 mg/L could serve as a cut-off to predict progression to severe disease.[19]

A systematic review by Fu *et al,* showed that increased CRP, increased LDH and reduced lymphocyte count were among the most consistent laboratory abnormalities in COVID-19. [20]

In the multicenter study by Gao *et al*, early-stage COVID-19 patients were examined, serum CRP and ALT levels as well as the presence of comorbidities were found to be predictors of disease progression.[21]

Similarly, Tan *et al*, reported a positive correlation between serum CRP levels and chest CT severity scores, suggesting that CRP reflects disease severity.[22] In another study, a significant correlation was found between chest CT scores, serum CRP and D-dimer levels, further supporting the role of inflammatory biomarkers in accessing COVID-19 severity.[23]

Mardani *et al*, reported that patients with RT-PCR-confirmed COVID-19 had significantly higher serum levels of CRP, LDH, AST, ALT, urea, and neutrophil counts than RT-PCR-negative patients. Furthermore, patients with positive RT-PCR had significantly higher neutrophil (NEU) count (p=0.0001), and C-reactive protein (CRP) (p=0.04), lactate dehydrogenase (LDH) (p=0.0001), aspartate amino-transferase (AST) (p=0.001), alanine aminotransferase (ALT) (p=0.0001), and Urea (p=0.001) levels in serum. ALT (AUC= 0.879), CRP (AUC= 0.870), NEU (AUC= 0.858), LDH (AUC= 0.835), and Urea (AUC= 0.835) had very good accuracy in predicting cases with positive RT-PCR for COVID-19, respectively.[24]

Our study is limited by its single center design and moderate sample size. Lack of disease severity classification, vaccination status, serial biomarker measurements may have affected the interpretation of the results. Future research should focus on multicenter studies with larger cohorts. Integration of these markers with clinical findings and imaging may further enhance diagnostic precision. It is recommended that serum CRP and LDH levels should be used routinely as an adjunctive biomarker to support early detection of COVID-19 infection, particularly in resource-limited settings where RT-PCR availability is limited.

CONCLUSION

Diagnostic accuracy of serum CRP and LDH levels is superior to Serum AST and ALT levels in detecting COVID-19. These serum markers may be used as an adjunct diagnostic tool in detecting COVID-19 in settings where RT-PCR is not available.

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Authors approved the draft and are accountable in ensuring that questions related to accuracy or integrity of the work are duly investigated and resolved.

MZ: Study design, Data acquisition and analysis, Manuscript drafting
MR: Data analysis, data interpretation manuscript drafting
RS: Critical review and final approval
MW: Critical review and final approval
AF: Data collection and formatting of manuscript
ABS: Critical review

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ORIGINAL ARTICLE

PREVALENCE AND SOURCES OF PSYCHOLOGICAL DISTRESS AMONG UNDERGRADUATE MEDICAL STUDENTS OF AYUB MEDICAL COLLEGE, ABBOTTABAD

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Background: Psychological distress can adversely affect both physical and emotional well-being and may arise when an individual's ability to cope with stress is exceeded. Medical students are exposed to multiple academic and personal stressors that may contribute to psychological distress. This study aimed to determine the prevalence of psychological distress and identify major sources of stress among undergraduate medical students. **Methods:** A cross-sectional study was conducted among 326 MBBS students from first to final year at Ayub Medical College, Abbottabad, of whom 202 responded to the questionnaire. Students were selected through convenience sampling. Psychological distress was assessed using the standardized Kessler Psychological Distress Scale (K10), while sources of stress were identified using the Medical Students Stressor Questionnaire (MSSQ). **Results:** The overall prevalence of psychological distress was 60.5%. Psychological distress was significantly higher among females than males (74.2% vs. 46.4%; $p<0.001$). It was also significantly higher among students in clinical years compared with those in non-clinical years ($p=0.032$) and among hostel residents compared with students living at home ($p=0.019$). Major sources of stress included poor academic scores, tests and examinations, lack of time for revision, heavy workload, poor motivation to learn, large amounts of content to be covered, and falling behind the reading schedule. **Conclusion:** Psychological distress was highly prevalent among undergraduate medical students at Ayub Medical College, affecting more than half of the participants.

Keywords: Kessler psychological distress (K10), Medical students, Psychological distress

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INTRODUCTION

Medical students have to manage difficulties unique to medical school in addition to the typical stresses of daily living. These include being overloaded with information and input, being indebted, not having enough free time, and facing pressures related to work, relationships at work, and professional decisions. It is well known that the prevalence of psychological distress including depression, anxiety and other related mental health problems among medical students is consistently higher than their non-medical peers.[1] According to L'hote *et al*. the prevalence of depression or depressive symptoms in medical students is higher than in the general population: 28.8% in 2014 vs. 3.8% according to the Institute of Health Metrics and Evaluation, based on 2019 data. The same holds true for anxiety (33.8% in 2019 vs 4.1% in 2016) according to the World Health Organization's data, the 12-month prevalence of suicidal ideation in medical students was 11.1% and 1.6% for suicide attempts.[2]

Due to the specific nature of the studies, medical students are exposed to particular risks. Several studies revealed that, in medical students', the volume of information to learn, forms of evaluation, competition, time constraints, fear of failure ethical challenges and exposure to human suffering were stressors that could be responsible for this distress. While a certain level of distress is a characteristic constituent of medical education and may function as a driving force for certain individuals, not every student may perceive distress as beneficial.[3] Many people experience feelings of worry, inadequacy, worthlessness, fury, and shame as a result of distress, which has been connected to both physical and psychological disorders as it can hinder students' ability to master academic material by affecting their ability to focus, solve problems, make decisions, finish tasks, and perform other skills that are essential for learning.[1]

Research on medical students' sources of stress typically identifies three areas: financial difficulties, social troubles, and academic pressure. Medical students report higher levels of stress, anxiety, and sadness than their age-matched counterparts who are not medical students, according to prior studies showing that mental health is especially affected.[4] Understanding medical students' psychological distress is crucial to explaining how it relates to their career goals and stability in the profession, given their prominent role in the healthcare system.

In order to bridge this gap, this study used a representative sample medical students to evaluate the

prevalence of psychological distress among medical students and investigate its causes. The results of this study will be crucial for improving medical students' well-being and for identifying those who need specialized mental health care, which will help address the shortage of healthcare workers in Pakistan.

METHODOLOGY

It was a cross sectional study. Convenience sampling was used to choose 326 MBBS students from first to final year out of which 202 filled the questionnaire (response rate=61.96%). Sampling was done by using WHO formula by keeping confidence level 95% , expected prevalence 50%, margin error 5% and z=1.96 and adding 10% non-response rate. The study was done at Ayub Medical College Abbottabad from June to July 2026. Ethical approval was taken from College Ethical Committee (Ref.No.RC-EA-2026/208).

The Kessler 10-item psychological distress scale (K10), which was created by Kessler *et al*. to measure psychological symptom severity and degree of distress, was used to gather data to know about respondents' current (1-month) discomfort.[4] The Kessler Psychological Distress Scales (K-10 and K-6) are reliable tools for measuring psychological distress in general and clinical populations (α= 0.93). The K10 consists of ten questions that ask, 'How often did you feel...?' and provides a list of particular symptoms. The five alternative answers, which span from 'none of the time' to 'all of the time,' are given a score between 1 and 5, which is then added up to produce a maximum possible score of up to 50. The cut-off scores recommended by the authors were used: <20 for no stress, 20–24 for mild stress, 25–29 for moderate stress, and 30–50 for severe stress.

A similar questionnaire, the Medical Students Stressor Questionnaire (MSSQ), was used to identify sources of stress. The items on MSSQ represent 40 events that have been reported to be possible sources of stress in medical students. Respondents were asked to rate each event in themselves during the last four weeks by choosing from five responses: 'causing no stress at all to mild stress (score: 0–1)', 'causing moderate stress (score: 1.01-2)', 'causing high stress (2.01–3)' and 'causing severe stress (3.01–4)'.[5] MSSQ was developed to identify sources of stress in medical students based on the literature, expert opinions, and several stress models. MSSQ identifies various sources of stress in medical students, which are categorized as follows: academic, interpersonal, teaching and learning, social, drive/desire, and group activity.

MSSQ has been validated in many countries, such as Malaysia, the Netherlands, Romania, Nepal, India, and Sri Lanka. The students received assurance about privacy and confidentiality of their answers and that their names would not be kept on file.

The results of categorical variables were tabulated as frequencies and percentages. The *p* was calculated by Mann-Whitney U-test and Kruskal Wallis test by SPSS-22, and $p \leq 0.05$ was considered significant.

RESULTS

A total of 202 students filled the questionnaires. Data were Non-normally distributed. Median age was 20.00 with interquartile range 16–25 years. Median Stress score was 22.00 with a wider interquartile range of 10–48. Students affected by psychological distress stress were 122 (60.5%). Both variables (Age and Stress Score) failed the Shapiro-Wilk and Kolmogorov-Smirnov tests ($p<0.05$), indicating non-normal distributions. Mann-Whitney U-test and Kruskal Wallis tests were applied to see significance level of results. The results are summarized in the following tables.

Table-1: Medical students' psychological distress levels on the Kessler 10-item psychological distress scale (K10) based on demographics

Variable	Number	%	Stress severity (n within group)				p value
			No stress	Mild stress	Moderate stress	Severe stress	
Gender							
Male	97	48.0	52 (53.6)	18 (18.6)	17 (17.5)	10 (10.3)	**0.000 (Mann Whitney U test)**
Female	105	52.0	27 (25.7)	31 (29.5)	20 (19)	27 (25.7)	
Year of study							
1st year MBBS	93	46.0	39 (41.9)	22 (23.7)	18 (19.4)	14 (15.1)	**0.001 (Kruskal Wallis test)**
2nd year MBBS	48	23.8	23 (47.9)	12 (25.0)	8 (16.7)	5 (10.4)	
3rd year MBBS	20	9.9	4 (20.0)	5 (25.0)	3 (15)	8 (40.0)	
4th year MBBS	19	9.4	2 (10.5)	6 (31.6)	3 (15.8)	8 (42.1)	
5th year MBBS	22	10.9	11 (50.0)	4 (18.2)	5 (22.7)	2 (9.1)	

Table-2: Kessler 10-item psychological distress scale (K10)

Classification	K-10 cut off scores	Number (n)	Percentage
No stress	**<20**	79	39.1
Mild stress	**20–24**	49	24.3
Moderate stress	**25–29**	37	18.3
Severe stress	**30–50**	37	18.3
Total		202	100

Table-3: Medical students distributed according to Kessler (K-10) scores.

Variable	Number	Percentage	Stress severity n (%age within group)				p value
			No stress	Mild stress	Moderate stress	Severe stress	
Academic group							
Pre-clinical	141	69.8	62 (44)	34 (24.1)	26 (18.4)	19 (13.5)	0.032 (mann whitney u test)
Clinical	61	30.2	17 (27.9)	15 (24.6)	11 (18)	18 (29.5)	
Living accommodation							
Home	123	60.9	56 (45.5)	31 (25.2)	22 (17.9)	14 (11.4)	0.019 (mann whitney u test)
Hostel	79	38.6	24 (29.5)	18 (23.1)	15 (19.2)	22 (28.2)	
Motivation to study medicine							
Self	155	76.7	64 (41.3)	41 (26.5)	24 (15.5)	26 (16.8)	0.090 (kruskal wallis test)
Family pressure	36	17.8	12 (33.3)	5 (13.9)	11 (30.6)	8 (22.2)	
No choice	11	5.4	3 (27.3)	3 (27.3)	2 (18.2)	3 (27.3)	

Table-4: Stressors (identified by the MSSQ) mean degree of psychological distress in medical students

Item	Mean±SD
Factors causing moderate to severe stress	
Getting poor marks	2.63±1.00
Tests / examinations	2.39±1.04
Lack of time for revision	2.27±1.08
Heavy workload	2.09±1.22
Poor motivation to learn	2.06±1.19
Large amount of contents to be learnt	2.03±1.16
Falling behind in reading schedule	2.02±1.13
Factors causing mild to moderate stress	
Unable to answer the teachers' questions	1.91±1.11
Not enough medical skill practice	1.88±1.11
Need to do well (imposed by others)	1.87±1.13
Unwillingness to study medicine	1.85±1.11
Learning context – full of competition	1.72±1.11
Having difficulty understanding the content	1.64±1.13
Parental wish for you to study medicine	1.55±1.15
Lack of time for family and friends	1.54±1.18
Feeling of incompetence	1.53±1.25
Uncertainty of what is expected of me	1.52±1.18
Participation in class discussion	1.52±1.26
Quota system in examinations	1.51±1.18
Talking to patients about personal problems	1.40±1.29
Inappropriate assignments	1.39±1.13
Teacher – lack of teaching skills	1.26±1.25
Frequent interruption of work by others	1.20±1.22
Unjustified grading process	1.18±1.18
Lack of recognition for work done	1.15±1.15
Participation in class presentation	1.05±1.10
Factors causing no stress to mild stress	
Not enough feedback from teacher(s)	0.99±1.15
Unable to answer questions from patients	0.95±1.11
Not enough study material	0.94±0.98
Facing illness or death of the patients	0.94±1.05
Conflicts with other students	0.92±0.93
Family responsibilities	0.87±0.90
Verbal or physical abuse by other student(s)	0.82±1.10
Lack of guidance from teacher(s)	0.77±1.11
Need to do well (self-expectation)	0.72±1.13
Conflict with personnel(s)	0.61±1.05
Verbal or physical abuse by teacher(s)	0.60±1.12
Working with computers	0.50±1.15
Verbal or physical abuse by personnel(s)	0.50±1.17
Conflict with teacher(s)	0.50±1.10

Degree of stress classification: 0–1.00 is 'causing nil to mild stress', 1.01 –2.00 is 'causing mild to moderate stress', 2.01–3.00 is 'causing moderate to high stress' and 3.01–4.00 is 'causing high to severe stress

DISCUSSION

This study assessed the prevalence of psychological distress and perceived sources of stress among undergraduate medical students at a medical college of Abbottabad. Psychological distress was identified in majority of participants, indicating a substantial burden among medical students. This finding is comparable with the prevalence reported among medical students in Iran.[1] The similarity may reflect common challenges of medical education, including heavy academic workload, frequent examinations, extensive curricular content, limited time, and pressure to achieve good academic performance.

A significant difference in psychological distress was observed between male and female students, with a higher prevalence among females. This finding is consistent with previous studies reporting greater anxiety and depressive symptoms among female medical students.[6] Possible explanations include differences in perceived academic pressure, coping strategies, social expectations, and willingness to report psychological symptoms. However, these factors were not directly assessed in the present study and therefore cannot be considered established explanations.

Clinical students demonstrated significantly greater psychological distress than pre-clinical students, with a higher proportion experiencing moderate and severe distress.[7] This may be related to the additional demands of clinical education, including patient interaction, clinical responsibilities, performance expectations, and exposure to illness and death. Previous studies have identified academic demands, evaluation, time constraints, fear of failure, and exposure to human suffering as important stressors during medical training. Nevertheless, these factors were not independently measured in this study.

Hostel residents also showed significantly greater psychological distress than students living at home which is in accordance with a study by Chauhdary *et al*.[8] Separation from family, adjustment to communal living, and reduced access to familiar social support may potentially contribute to this difference. However, social support, loneliness, financial circumstances, and adjustment to hostel life were not assessed and therefore causal explanations cannot be confirmed. Motivation for

studying medicine was not significantly associated with psychological distress (p=0.090), although differences were observed among students reporting family pressure or limited choice in selecting medicine. A similar finding was reported by Koochaki *et al* in their study on Iranian undergraduate students.[1] This finding suggests that motivation may warrant further investigation in larger studies.

MSSQ findings demonstrated that academic-related stressors were the most prominent perceived sources of stress. The highest-rated stressors were poor marks, tests/examinations, lack of time for revision, heavy workload, poor motivation to learn, large amounts of content to be learned and falling behind the reading schedule. These findings are consistent with previous MSSQ-based study by Rathi *et al* identifying examinations, workload, and extensive course content as major sources of stress.[9] Other stressors, including difficulty understanding content, parental expectations, competition, insufficient skills practice, and feelings of incompetence, were rated as mild to moderate, indicating that stress extended beyond academic workload to interpersonal, motivational, and performance-related domains.

LIMITATIONS

The cross-sectional design prevents determination of causal or temporal relationships. Convenience sampling from a single institution limits generalizability. Self-reported K-10 and MSSQ responses may be influenced by individual perceptions and response patterns. Important factors such as socioeconomic status, sleep, coping strategies, social support, and previous mental health history were not assessed. MSSQ findings represent perceived sources and intensity of stress and do not establish causation.

CONCLUSION

Psychological distress was common among undergraduate medical students, with 60.5% scoring above the K-10 cut-off for psychological distress, with predominance in females, clinical-year students, and hostel residents. Prospective multicenter studies should evaluate the effectiveness of targeted stress-reduction interventions. Targeted psychological support, academic guidance and stress-management strategies are recommended to improve students' well-being.

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ORIGINAL ARTICLE

A COMPARATIVE ANALYSIS OF DAYDREAMING, LONELINESS, AND PERCEIVED SOCIAL SUPPORT IN MEDICAL UNDERGRADUATES

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Background: Loneliness or maladaptive daydreaming (MD) is an emerging phenomenon and perceived social support is possibly protective in this regard. This study was undertaken to assess their relationship in medical students. **Methods:** A comparative cross-sectional study was conducted in Aziz Fatimah Medical and Dental College, Faisalabad, from Jun to Sep 2025. A total of 280 MBBS students were taken using non-probability quota sampling. Standardized tools used were: Maladaptive Daydreaming Scale-Short Form (MD-SF5), UCLA Loneliness Scale, and Perceived Social Support (PSS). Data were analysed using Mann-Whitney U and Kruskal-Wallis H tests on group comparisons; Spearman's correlation for associational studies and binary logistic regression to identify predictors. **Results:** The mean scores of scales observed were: loneliness -1.74±0.44, perceived social support (PSS) -2.24±0.66, and maladaptive daydreaming -1.44±0.49. Gender differences were non-significant for loneliness (p=0.497) and maladaptive daydreaming (p=0.718), but males reported significantly greater support from friends (p=0.001), family (p=0.005), and significant others (p=0.003). Logistic regression analysis showed that having support from a significant other marginally reduced loneliness (aOR=0.66, p=0.05), while friendship support reduced maladaptive daydreaming (aOR=0.39, p=0.030). All PSS subscales were negatively correlated with loneliness (p<0.01). **Conclusion:** Loneliness and maladaptive daydreaming were not correlated with either gender or year of study. Support from friends and significant others emerged as an important protective factor. However, findings are based on a single institution, limiting generalizability.

Keywords: Daydreaming, loneliness, social support, students

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INTRODUCTION

Maladaptive daydreaming (MD) describes imagination that interferes with the individual's life. It can be defined as 'vivid and immersive daydreaming that significantly disrupts daily life'.[1] Individuals with MD are tied up in fantasy which has pernicious influence on their overall well-being.[2] Some individuals strive to control daydreaming and some individuals deliberately engage themselves in daydreaming as an attempt to grapple emotional states. Individuals try to bridge the emotional gap through daydreaming. Some individuals visualize true companionship or harmonious family via daydreaming.[3]

Loneliness is an emotional experience or state which the individual feels when there is gap between social relationships, and wishes he had and what he actually has irrespective to be surrounded by people or not. It can be emotional and social loneliness. Emotional loneliness signifies the absence of emotional attachments and social loneliness considers as absence of social relations. Various mental health problems like anxiety and depression can occur which leads to physical health issues like hypertension, stroke and heart disease.[4] Loneliness for adults have become the maladaptive coping mechanism to establish their place in this world. It impairs inter-personals relations and reduces trust on other people.[5] Social support encompasses the concept of comfort, resilience and peace which a person gets from his family, friends, colleagues and community group. It is a subjective perception that he is cared for, valued and has reliable support within his social network.[6]

Interference of MD in daily life leads to feelings of guilt and can make someone emotionally unavailable. MD is often influenced by lack of social support, those with high level of perceive social support don't need an escape from reality. There are many evidences that have shown that lack of social support can lead to extreme usage of internet and other platforms that have serious consequences on a person's daily life.[7] Individuals with great parental support are more likely to develop emotional security, effective strategies, high self-regulation skills and rescued needs to escape to imaginary world, also helps to integrate the strategies to cope with the emotional resilience and they don't attract to the maladaptive coping mechanism.[8] Daydreaming is considered as coping mechanism against the reality especially among the university students who are new to the academic and social pressure being faced in professional studies and find it hard to form new social bond and interactions and

ultimately leads to feelings of loneliness and find their solace in day dreaming their imaginary world in which they are the centre of attention and have their meaningful social bonds.[9] Medical students, in particular, represent a high-risk group given their prolonged academic demands, competitive environment, and reduced time for social interaction, all of which may heighten vulnerability to loneliness and maladaptive coping strategies such as daydreaming. This study signifies the importance of the perceived social support that acts as buffer against loneliness and ultimately maladaptive day dreaming. It's not just the quantity of social support but the quality of perceive social support that matters the most. Most of the students are unmindful that it has detrimental effects on their academic performance and holistic health. Such a study has not been done in medical schools of Faisalabad. The purpose of this study was to see the prevalence of maladaptive daydreaming among local medical undergraduates.

METHODOLOGY

This comparative cross-sectional study was done in Aziz Fatimah Medical and Dental College, Faisalabad for 4 months from Jun to Sep 2025, utilizing non-probability quota sampling. Ethical clearance was granted vide Ref. No. IEC/366-25. Sample size was calculated for a single population proportion with 95% CI, 5% margin of error, and an estimated prevalence of daydreaming as 34.3%[10]. The initial sample size was calculated as 382. Since the total population was finite, the finite population correction (FPC) was applied:

$$n_{adj}=n_0/1+(n_0-1/N)=382/1+(381/700)=247$$

After adjusting for a 10% non-response rate, the final required sample size was estimated at approximately 280 students, so 56 from each class, 28 males and 28 females were recruited for the study. As the study involved a comparative analysis across subgroups, quota sampling allowed for non-random selection, but it still ensured that certain characteristics are proportionately represented in the final sample, and was more feasible given the absence of a complete sampling frame and time constraints.[11]

Informed consent was obtained from all participants. Students were selected based on voluntary participation until quotas were completed.[12] MBBS students, never diagnosed with any mental health illness were included, while those who were ever diagnosed with any mental health illness, allied health sciences students, and those who didn't give consent were excluded.

To assess MD, Maladaptive Daydreaming Scale (MD-SF5) was used having items with rating scale ranges from 0 to 100% (10 point increments), total score was calculated by taking average of 5 items with mean $\geq$33 indicated possible MD. Loneliness is a complex human emotion, describing a state of solitude or a lack of meaningful relationships and it was measured on University of California, Los Angeles (UCLA) Loneliness Scale, having 3 items with 3 options each on Likert scale having scoring from 1 to 3 and possible range of scores from 3 to 9 with people scoring 6–9 were classified as 'lonely'. Multidimensional Scale of Perceived Social Support (MSPSS) was used to assess perceived social support having 12 questions on Likert scale with scoring from 1 to 7 from strongly disagree to strongly agree. Three subscales were then made, i.e., significant other, family & friends' subscale and then as per their mean scale score ranges, they were considered as having low support (1–2.9), moderate support (3–5), and high support (5.1–7).

Data was analysed using SPSS-22, and $p\leq0.05$ was considered statistically significant. The normality of data distribution was assessed using the Shapiro-Wilk test, which showed that all scale scores deviated significantly from normality ($p<0.05$), therefore non-parametric tests were applied.

Descriptive statistics summarized the key variables as Mean±SD. To compare these variables across demographic groups Mann-Whitney U test or Kruskal-Wallis H test was used. To explore predictive relationships, binary logistic regression was used, adjusting for covariates (e.g., age, gender). Bivariate associations between daydreaming, loneliness, and social support were examined using Spearman's rank correlation for non-normal data.

RESULTS

A total of 280 participants were included in the study, with males and females equally represented. The class distribution was also the same, with an equal proportion of participants drawn from each MBBS class. Majority (218, 77.9%) of the students belonged to urban localities, and were day scholars (212, 75.7%). Mean of UCLA loneliness scale was 1.74±0.44. PSSS scale mean was 2.24±0.66, and its three dimensions, i.e., significant PSS had 1.61±0.8, friends PSS had 2.21±0.66, family PSS had 2.32±0.72, while MDS was 1.44±0.49.

Table-1 shows that, on the Mann-Whitney U test, males and females did not differ significantly in loneliness, whereas males reported significantly higher perceived social support than females from significant others ($p=0.003$), friends ($p=0.001$), and family ($p=0.005$).

On the Kruskal–Wallis H test, loneliness ($\chi^2=2.33$, $p=0.676$), perceived social support from significant others ($\chi^2=2.05$, $p=0.727$), friends ($\chi^2=2.44$, $p=0.656$), and family ($\chi^2=6.82$, $p=0.146$), and MDS scores ($\chi^2=7.74$, p=0.101) did not differ significantly across years of study. (Table-2).

In the binary logistic regression model, gender, year of study, and perceived support from friends, and family were not significantly associated with loneliness, whereas support from a significant other showed a borderline protective effect (aOR=0.66, 95% CI: 0.44–1.00, *p*=0.05). (Table-3).

In the binary logistic regression model, year of study, gender, and perceived support from significant others, and family were not significantly associated with maladaptive daydreaming, whereas support from friends was significantly protective (aOR=0.39, 95% CI: 0.17–0.92, *p*=0.030). (Table-4).

On Spearman's correlation, loneliness was significantly negatively correlated with perceived support from significant others (ρ= -0.178, *p*=0.003), friends (ρ= -0.172, *p*=0.004), and family (ρ= -0.158, *p*=0.008), whereas loneliness and any support subscale was not significantly correlated with MDS scores. (Table-5).

Table-1: Comparison of loneliness, PSS subscales, and MDS between male and female students [Median (IQR)]

Scale	Gender		Mann-Whitney U	Z	*p*
	Male	Female			
Loneliness	2 (1)	2 (0)	9450.0	-0.679	0.497
Significant others (PSS)	2 (1)	1 (1)	8042.0	-2.948	0.003
Friends (PSS)	2 (1)	2 (1)	7839.5	-3.207	0.001
Family (PSS)	3 (1)	2 (1)	8076.0	-2.781	0.005
MDS scoring	1 (1)	1 (1)	9590.0	-0.361	0.718

Table-2: Comparison of loneliness, PSS, and maladaptive daydreaming across year of study [Median (IQR)]

Scale	(Year of study)					χ^2 (df=4)	*p*
	1st	2nd	3rd	4th	5th		
Loneliness	2 (1)	2 (1)	2 (1)	2 (1)	2 (1)	2.33	0.676
PSS Significant Others	1 (1)	1 (1)	1 (2)	1 (1)	1 (1)	2.05	0.727
PSS Friends	2 (1)	2 (1)	2 (1)	2 (1)	2 (1)	2.44	0.656
PSS Family	3 (1)	2 (1)	2 (1)	2 (2)	3 (1)	6.82	0.146
MDS Scoring	1 (1)	1 (1)	1 (1)	1 (1)	2 (1)	7.74	0.101

Table-3: Binary logistic regression predicting loneliness among undergraduates

Predictor	B	SE	*p*	aOR	95% CI for aOR
Year of study	0.065	0.100	0.51	1.07	0.88–1.30
Gender	0.016	0.284	0.95	1.02	0.58–1.77
Significant Other PSS	-0.414	0.211	0.05	0.66	0.44–1.00
Friends PSS	0.021	0.493	0.96	1.02	0.39–2.69
Family PSS	-0.327	0.412	0.43	0.72	0.32–1.62

aOR=Adjusted Odds Ratio, CI=Confidence Interval

Table-4: Binary logistic regression predicting maladaptive daydreaming among undergraduates

Predictor	B	SE	*p*	aOR	95% CI for aOR
Year of study	0.129	0.088	0.141	1.14	0.96–1.35
Gender (F *vs* M)	0.029	0.248	0.906	1.03	0.63–1.68
Significant Other PSS	0.159	0.194	0.413	1.17	0.80–1.71
Friends PSS	-0.932	0.430	0.030	0.39	0.17–0.92
Family PSS	0.622	0.350	0.076	1.86	0.94–3.70

aOR=Adjusted Odds Ratio, CI=Confidence Interval

Table-5: Spearman's rank correlation among loneliness, perceived social support subscales, and maladaptive daydreaming

Variable	Loneliness	Significant Other PSS	Friends PSS	Family PSS	MDS Score
Loneliness	1	-0.178*	-0.172*	-0.158*	0.034
Significant Other PSS	-0.178*	1	0.667*	0.476*	-0.024
Friends PSS	-0.172*	0.667*	1	0.844*	-0.080
Family PSS	-0.158*	0.476*	0.844*	1	-0.023
MDS Score	0.034	-0.024	-0.080	-0.023	1

PSS=Perceived Social Support, MDS=Maladaptive Daydreaming Scale, ρ=Spearman's correlation coefficient, *p<0.01 (two-tailed)

DISCUSSION

The current research looked at how loneliness, perceived social support, and maladaptive daydreaming interrelate among undergraduate medical students. It showed that neither gender nor academic year significantly moderate loneliness or maladaptive daydreaming; rather, perceived social support (from friends and significant others) was significantly associated with lower loneliness and maladaptive daydreaming.

Consistent with other studies, we found that perceived social support from friends was associated with lower odds of maladaptive daydreaming. This finding is consistent with results in broader populations that consider supportive social networks as a buffer against escape behaviours like excessive daydreaming.[13] Our result showing that self-perceived support from friends independently lowers the probability of maladaptive daydreaming is consistent with the contemporary evidence placing MD alongside loneliness and other forms of psychological distress.[11] Recent longitudinal and large-scale studies have shown that maladaptive daydreaming commonly occurs with and prospectively contributes to loneliness and distress. Since peer support provides significant buffering against both constructs within student populations, increasing social networks could minimize escapist fantasies and disrupt maladaptive cycles involving the with problematic online behaviors.[14] The negative association between the support subscales and loneliness supports more generalized evidence that social bonding works against loneliness.[15]

The current findings obtained show that the perceived support from the friends protected against MD which accords with earlier literature on the close association MD has with loneliness and social distress. Daily elevations of MD according to Soffer-Dudek and Somer paralleled very closely the increase in negative affect and social dysfunction, suggesting the role of interpersonal connectedness in buffering the experience of MD.[16] More recent epidemiological evidence tends to indicate loneliness as a strong correlate of MD, thereby suggesting social support as enhancing that buffering against this detrimental effect.[7] At a more generic level,

the mental health literature supports the fact that peer and friendship support contribute to increased resilience and lowered distress which thus establishes a plausible mechanism by which seen friend support buffers against maladaptive escapist daydreaming.[17] It could be said that the small, protective effect of other people's support beyond that of a spouse against loneliness indicates the specific effect that recordings or other such types of close, emotionally yielding relations will have. Although it is statistically quite weak, it certainly reflects a wider psychological finding that strong emotional ties can reduce loneliness best when social broader networks fall short.[18]

There was no significant correlation between maladaptive daydreaming and loneliness or social support. Thus, it might be said that, while the constructs are related, maladaptive daydreaming is a product of different psychopathological or coping mechanisms, as well as loneliness. This actually aligns with Soffer-Dudek and Oh's brief MD screener development that predicts loneliness but sees MD as an independent construct.[19] On a similar note, Chirico *et al*[20] observed how MD relates with a bundle of psychopathology dimensions, emotional-regulation deficits, and digital dependencies that clearly define MD as more than mere loneliness.

The restricted cohort of our institution and the supportive environment may have offset such trends but fail to support the inability of our sample to find gender or year-of-study differences in loneliness or MD when compared to some stress-related literature which states that the psychological burden on medical students increases over academic years. PSS subscale showed quite a steep correlation particularly between family and friends which casts light that the social support systems are really interconnected and this nearest reinforces the idea that support received from multi domain may then be mutually reinforcing in protecting or in buffering loneliness.[21]

Staying much broader, digital and behavioural tools are becoming increasingly popular in studying loneliness. Qirtas *et al*[22] showed behavioural markers (like mobile phone using patterns) have strong correlations with different aspects of loneliness, leading to potential new avenues of data-informed intervention in student populations. On the clinical side, maladaptive daydreaming is phenomenologically described as an immersive fantasy that disturbs the course of daily functioning.[23] Our findings imply that social support, particularly that coming from friends, may serve as a potential non-medical buffering factor against functional implications of MD.

The present study is limited by its cross-sectional design, reliance on self-reporting measures, and sampling from one institution only. Future longitudinal or experimental studies could clarify causal pathways, such as whether enhancing friend-based support leads to decreased onset or severity of MD.

The research has added to the differentiation between psychosocial determinants of loneliness and maladaptive daydreaming during medical students. Importantly, gender and academic advancement were not predictive of the outcomes; instead, quality of social support emerged as the more salient factor, especially support coming from friends and significant others. These results call for the development of medical curricula to promote peer support networks and emotionally supportive relationships as protective factors for sustaining mental well-being.

CONCLUSION

Medical students showed comparable levels of maladaptive daydreaming and loneliness. There were notable gender variations in perceived social support, with males reporting higher levels of support on all subscales. Support from friends was associated with lower maladaptive daydreaming, and support from a significant other was associated with reduced loneliness. These results highlight the value of strong interpersonal ties in reducing students' feelings of isolation and maladaptive daydreaming.

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ORIGINAL ARTICLE

MEDICAL STUDENTS' EXPERIENCES OF ORGANIZATIONAL PRACTICES WITHIN THE HIDDEN CURRICULUM: A QUALITATIVE STUDY

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Background: The hidden curriculum comprises the implicit values, behaviours and organizational practices that influence learning beyond the formal curriculum. Students' interactions within the educational environment shape their understanding of professionalism, accountability and institutional culture. This study aimed to explore medical students' experiences of the hidden curriculum within the educational environment. **Methods:** A qualitative exploratory study was conducted at CMH Kharian Medical College from August to November 2025 after approval of the Institutional Ethical and Review Board. Twenty-two MBBS students from different academic years and genders were recruited through purposive sampling. Data were collected using semi-structured interviews conducted in English or Urdu. Interviews were audio-recorded, transcribed verbatim, anonymized using participant codes (P1–P22) and analysed with Braun and Clarke's thematic analysis framework with NVivo 12 Pro software. **Results:** Four themes emerged: Institutional accountability and responsiveness, Institutional communication and digital support, Institutional hierarchy and student participation, and Organizational constraints and staff support. Participants described variable experiences of complaint pathways and institutional responses. They also highlighted opportunities for improved communication, professional interactions, student participation, and organizational responsiveness. **Conclusion:** Organizational practices may contribute to the hidden curriculum by shaping students' perceptions of accountability, communication, hierarchy, and professional relationships. Strengthening transparent communication, student participation and organizational responsiveness may support a supportive educational environment and professional development.

Keywords: Educational Environment, Hidden Curriculum, Medical Education, Medical Students, Qualitative Research

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INTRODUCTION

The concept of the hidden curriculum was initially introduced by Philip Jackson in 1968, who described the implicit learning that occurs through the experiences of students within educational institutions.[1] In medical education, Frederic Hafferty played a pioneering role in establishing and developing the concept by distinguishing the formal, informal and hidden curricula and highlighting the influence of institutional policies, organizational practices, evaluation processes, and resource allocation on what medical students learn. Hafferty's work shifted attention from what medical schools formally teach to what students actually learn from their surrounding educational environment.[2]

Medical education extends beyond the formal curriculum of classroom teaching, clinical training and assessments. Students also learn through their everyday experiences within the educational environment, where institutional culture, organizational practices, interpersonal interactions and administrative processes collectively shape their professional attitudes and behaviours.[3] These unspoken lessons, commonly described as the hidden curriculum, have been widely recognized as an important component of medical education and professional socialization. The hidden curriculum refers to the implicit values, norms, behaviours, and expectations that students learn through their interactions with people, systems and organizational culture rather than through formal teaching alone. These experiences can contribute to professional identity formation by influencing values such as accountability, respect, communication, fairness, and ethical conduct.[4]

The educational environment includes not only faculty and learning activities but also the organizational systems that support students throughout their academic journey. This organizational framework operating behind all of these activities is equally very important.[5] Medical students frequently interact with institutional processes related to admissions, attendance, assessments, academic records, examination documentation, hostel services and official communication. These routine experiences influence on perceptions of students that how institutions value transparency, responsiveness and professionalism. Positive interactions may reinforce trust, collaboration

and organizational responsibility, whereas inefficient or inconsistent processes may convey unintended messages that become part of the hidden curriculum.[6]

Globally, medical schools are increasingly recognizing that the quality of the educational environment should extend beyond curriculum design to include institutional culture, student support, communication systems and organizational practices. Student-centred educational environments can promote not only academic achievement but also professionalism, ethical behaviour and professional identity formation.[7] Despite this growing awareness, research in medical education has predominantly focused on curriculum reform, teaching strategies, assessment methods and student wellbeing, while comparatively less attention has been given to how students experience the hidden curriculum through everyday institutional interactions.[2] Understanding experiences of students will provide valuable information regarding aspects of the educational environment that may not be identified through routine institutional evaluations. Exploring these experiences will help the educators to recognize and implicit the organizational messages that can influence on learning, professionalism and student's relationships with their institution. Limited qualitative evidence is available in Pakistan on how institution-specific organizational practices contribute to the hidden curriculum in medical education. Exploring these experiences can provide insight into the implicit lessons that students can receive about accountability, communication, hierarchy, participation and professional behaviour.

Therefore, this study was guided by the research question: How do medical students experience institution-specific organizational practices as part of the hidden curriculum, and how do these experiences influence their professional development? The study aimed to explore medical students' experiences of organizational practices as part of the hidden curriculum and their perceived influence on professional development.

METHODOLOGY

This qualitative exploratory study was carried out to explore medical students' experiences of the hidden curriculum within the educational environment at CMH Kharian Medical College. A semi-structured interview approach was used to obtain details students' everyday experiences focusing on organizational practices, communication, institutional responsiveness, student participation, and experiences relevant to professional development. The study was completed over four months, from Aug to Nov 2025, after approval from the Institutional Ethical Review Board of CMH Kharian Medical College (Ref: No. CKMC/IERB/AC-00269).

A purposive sample of 22 MBBS students from different academic years and both genders who had direct experience with institution-specific organizational practices was selected. Students were approached through the college, informed about the study and invited to participate voluntarily. Maximum variation was considered during recruitment to capture diverse student experiences. The sample size was determined by recruitment until no substantially new perspectives were emerging. Students on prolonged leave or those unwilling to participate were excluded. All participants were able to communicate either in English or in Urdu.

The interviews focused on students' views the hidden curriculum within the educational environment, including organizational practices, communication processes, institutional responsiveness, complaint mechanisms and other everyday interactions that influenced their learning and professional development. Participants were encouraged to share real experiences and explain how these interactions shaped their educational experiences and perceptions of the institution. To maintain confidentiality, each participant was assigned an identification code (P1–P22). Interviews were conducted in English or Urdu according to participant preference, audio-recorded with consent, and later transcribed verbatim. The interviews were conducted by a researcher with a background in medical education who was familiar with the institutional setting. Each interview lasted approximately 30–45 minutes and was conducted at suitable private locations within the institution to ensure confidentiality and minimize interruptions. The researcher had no direct role in evaluating the academic performance of the participating students. The interviewer maintained a neutral approach, used open-ended questions and avoided leading participants towards particular responses. Reflexive consideration of the researcher's position and potential influence was maintained throughout data collection and analysis. The study was reported in accordance with relevant COREQ recommendations.[8]

Data was analysed using Braun and Clarke's six-step thematic analysis framework. The process involved familiarization with the transcripts, generation of initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final report.[9] NVivo 12 Pro (QSR International) was used to organize transcripts, manage coding, and support theme development. Codes and themes were repeatedly reviewed and refined through comparison of participants' responses.[10]

RESULTS

Analysis of the interview data identified four major themes reflecting medical student's experiences of the hidden curriculum within the educational environment. These themes highlighted how organizational practices, communication, institutional processes and everyday interactions influenced students' educational experiences

and professional development. Participant codes are provided for each subtheme to show the range of students contributing to the finding. Direct quotations are included to support the themes and demonstrate that the findings were grounded in participants' experiences.

Theme-1: Institutional values and accountability

Sub theme-1.1: Perceptions of fairness and transparency (P2, P5, P8, P14, P19)

Students described uncertainty regarding how or where concerns should be reported. Sometimes the lack of clear complaint pathways influenced their perceptions of institutional fairness, transparency and accountability.

"*Sometimes I had an issue but I was not sure which office I should approach.*" (P5)

"*There should be a clear place where students can report their problems.*" (P14)

Sub theme-1.2: Institutional responsiveness to student concerns (P3, P7, P11, P16, P21)

Many participants reported that complaints were addressed sometimes immediately and sometimes only after considerable delay or did not result in visible action. These experiences shaped their confidence in the institution's responsiveness to student concerns.

"*Sometimes my concern was dealt with quickly, but at other times I had to wait for a response.*" (P7)

"*I raised the issue, but I was not sure what happened after that.*" (P16)

Theme-2: Professional communication and relationships

Sub theme-2.1: Digital communication and student support (P5, P8, P12, P17)

Participants believed that online services for notices, attendance and academic records could be further improved to facilitate timely communication.

"*It would be easier if all the important information was available on one online portal.*" (P12)

Sub theme-2.2: Reliance on manual administrative processes (P1, P6, P10, P15, P20)

Students shared that several routine institutional tasks still depended on paperwork and manual procedures.

"*For some simple things, we still have to fill out forms and visit the office.*" (P10)

Sub theme-2.3: Timeliness of institutional communication (P2, P7, P14, P22)

Some students reported occasional delays in receiving institutional updates during busy academic periods.

"*During examinations, sometimes information reaches us later than expected.*" (P22)

Theme-3: Hierarchy and student participation

Sub theme-3.1: Professional communication with institutional staff (P3, P9, P11, P16)

Students felt that communication with institutional staff was professional but sometimes limited opportunities for open discussion.

"*They are respectful, but sometimes you feel hesitant to discuss things openly.*" (P9)

Sub theme-3.2: Opportunities for student voice (P4, P10, P13, P18)

Participants believed that student feedback could be considered more frequently in decisions affecting them.

"*It would be helpful if students were asked for their opinion before some decisions are made.*" (P13)

Sub theme-3.3: Rule-oriented institutional practices (P6, P12, P15, P21)

Many students described the institutional system as structured and policy-driven in routine matters.

"*Most things are done according to the rules, so there is a proper procedure to follow.*" (P15)

Theme-4: Organizational culture and systems learning

Sub theme-4.1: Understanding institutional responsibilities (P3, P6, P10, P15, P22)

Students observed that staff members were generally helpful but had to work within institutional policies and procedures. Certain issues required senior approval, which sometimes delayed action.

"*The staffs usually try to help, but sometimes they have to wait for approval from seniors.*" (P3)

Sub theme-4.2: Learning from organizational constraints (P1, P7, P13, P21)

Some participants recognized that heavy workloads during examinations or admissions occasionally slowed institutional processes.

"*During admissions or examinations, the offices are very busy, so sometimes the process takes longer.*" (P21)

DISCUSSION

This study explored medical students' experiences of the hidden curriculum within the educational environment and identified four major themes related to institutional values and accountability, professional communication and relationships, hierarchy and student participation and organizational culture and systems learning. Rather than viewing these findings only as administrative concerns, they can be understood as examples of how institution-specific organizational practices transmit implicit expectations and values to students. The findings suggest that students learn about accountability, authority, communication, participation and organizational responsibility through everyday institutional experiences, even when these lessons are not formally included in the curriculum. This interpretation is consistent with the concept of the hidden curriculum, which recognizes that organizational structures and cultural practices influence what students learn beyond formal teaching.[1]

Institutional accountability was reflected in students' experiences of complaint pathways and responses to concerns. Some students reported that these processes were not always clear or equally timely. The

importance of these experiences lies not only in administrative resolution but in the messages, they may convey about whether speaking up is encouraged, concerns are valued, and organizations accept responsibility. From a hidden curriculum perspective, complaint handling mechanisms are important because they reflect transparency, accountability and institutional willingness to improve.[11] Javed *et al*[12] suggested that unclear or unresponsive complaint processes may discourage students from raising concerns and can influence their trust in institutional systems. This is particularly relevant to professionalism because future physicians are expected to recognize problems, communicate concerns appropriately and participate in systems that can promote the safety of patients and quality improvement. Thus, institutional responses to student concerns may serve as an indirect model of how professional organizations respond to problems and accountability.[13]

Professional communication also formed an important part of student's experiences. Participants generally described interactions with institutional staff as professional, although some perceived them as formal or less open to discussion. Everyday communication can therefore act as an informal model of professional relationships, teaching students through observation how respect, responsiveness and professional boundaries are practiced. Similarly, participant's comments about manual processes and digital services are relevant beyond efficiency. The way an institution communicates and organizes routine services can implicitly signal the value placed on accessibility, responsiveness and respect for learner's time.[14]

Participants noted that some routine tasks still relied on manual paperwork and that digital services such as portals for notices, attendance or records could be further improved. Universities across the world are increasingly using student portals, automated notices, digital attendance systems and online complaint mechanisms. Such systems improve convenience, reduce delays and allow better record management.[15,16] Timotheou *et al*[17] also described that in many countries some administrative functions are still on manual processes, there may be opportunities for further enhancement through digital solutions. Strengthening digital systems can reduce unnecessary office visits and save the time of students.[17] Beyond improving efficiency, timely communication and accessible digital services may also promote a supportive educational environment in which students experience professionalism through organizational responsiveness and respect for their academic needs.[18]

Institutional hierarchy requires particular consideration because medical education naturally involves differences in knowledge, experience, responsibility and authority. Although hierarchy is necessary for supervision and accountability, students' experiences of how authority is utilized may influence what they learn about professional relationships. Participants described communication as generally professional but sometimes formal and felt that student input could be considered more often. When students observe predominantly top-down decision-making, they may learn that organizational position determines whose voice is heard. Constructive communication and inclusion of student feedback can therefore play an important role in strengthening institutional relationships. These experiences implicitly teach students how organizations value communication, collaboration and shared decision-making, all of which contribute to professional identity formation. A balanced professional environment that remains approachable may improve trust and cooperation, as discussed by Gautam *et al*[19]. Their findings related to organizational constraints further demonstrate the role of organizational culture in the hidden curriculum. Students recognized that staff were generally helpful but worked within policies, approval processes, and periods of increased workload. Rather than representing only administrative limitations, these experiences exposed students to how professional organizations function within rules, competing demands, and shared responsibilities. Such exposure may contribute to systems.[20] Teamwork, and an understanding of organizational responsibility. This interpretation is consistent with research by Porlares and highlights organizational culture as an important influence on the hidden curriculum and professional development.[21]

LIMITATION & RECOMMENDATIONS

As it was conducted in a single medical college, student experiences may differ in other institutions with different educational environments and organizational cultures. The use of purposive sampling and self-reported responses may also have influenced the range and accuracy of views shared. Future studies should include multiple public and private medical colleges and use mixed-method approaches to gain a broader understanding of hidden curriculum within different educational environments. Further research should also explore the perspectives of faculty members, administrative staff, and institutional leaders to better understand how organizational practices contribute to the hidden curriculum and influence students' professional development.

CONCLUSION

The hidden curriculum within the educational environment plays an important role in shaping medical students' experiences and professional development. The findings identified areas such as institutional accountability, professional communication, student

participation, and organizational culture, which convey implicit messages about professionalism, collaboration, and institutional values. While many systems were viewed positively, there remains scope for further improvement. Strengthening transparency, student engagement, communication, and organizational responsiveness may foster a more supportive educational environment and positively influence the professional identity formation of future physicians. These findings do not establish a direct effect on professional identity formation but suggest areas that may influence students' professional development.

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