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Effective Strategies for Crafting Compelling Medical Research Papers

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Sir Shaukat Jawaid, Editor-in-Chief of the Pakistan Journal of Medical Sciences, delivered a lecture at Central Park Medical College that left a lasting impression on me. This was during my tenure as a Professor of Anatomy there a few years ago. He humorously remarked that editors are loved only by their children and spouses, and it made everyone in the room laugh. Reflecting now, nearly five years later, I realize the truth in his words. As an editor, I've realized that while I may not be everyone's friend, my conscience remains my loyal companion, urging me to proceed with integrity and grace.

In these past five years, from enrolling in local certification courses to graduating from Harvard Medical School's "Effective Writing for Health Care" program, I've been on a continuous learning journey. Each day brings new lessons, shaping me not only as an editor but also as a mentor to those striving to improve their writing. Through this editorial, my goal is to offer my readers insights into crafting compelling medical research papers, from planning meticulously to increasing the visibility and impact of their work.

Writing a research paper is like telling story of your journey, your discoveries, and your contributions to medical science. It's not something you rush through; it requires careful planning and attention to detail. Each section, from the introduction that sets the stage to the discussion that interprets your results, plays a crucial role. And when it comes to increasing citations and quality, publishing in reputable journals, writing clear and concise abstracts, and adhering to guidelines for reporting research studies are key factors to consider. How many of us are familiar with the reporting guidelines for various research studies, such as CONSORT, STROBE, PRISMA, and COREQ?[1] These guidelines provide valuable frameworks for writing different types of studies, including randomized controlled trials, observational studies, systematic reviews, and qualitative research. As editors, we look for manuscripts that align with these principles, ensuring that each paper contributes meaningfully to the scientific community.

Crafting effective medical research papers goes beyond just writing skills; it requires a strategic approach to ensure the work achieves its full potential. A key aspect is boosting citations, which not only validates the research but also increases its influence. Publishing in open-access peer-reviewed journals indexed with WOS and Scopus establishes credibility and visibility. The most important part of your paper to increase visibility and citations is your title. It is important to include the study design and keywords in the title while avoiding unnecessary details like the study location unless essential. Highlighting the innovative aspect of the research in the title and indicating if it was multi-centered, ignites curiosity, especially in a competitive academic setting.

Editors play a crucial role in selecting articles that meet high scientific standards and align with the journal's goals. Factors like ensuring authors are from the same institution for single-centered studies, providing necessary documentation like IRB approval, and aligning the study design with objectives are vital.[2] Clear language, adherence to reporting guidelines, and referencing recent literature within the past five years are essential. Moreover, providing comprehensive inclusion and exclusion criteria of the population under study is also important. Often, when conducting clinical trials, observational studies, or systematic reviews, we overlook the importance of providing comprehensive details about the study population. This omission can lead to confusion among readers. It is crucial to include demographic information in the results section, following the parameters outlined in the methodology section, to ensure clarity and transparency in your research.

Manuscripts should avoid common pitfalls like being overly lengthy, containing spelling errors, or having excessive tables, figures, and references, as these can diminish the quality and impact of the research.[3] When responding to reviewer comments, authors should approach feedback constructively, addressing it with care and patience. The revise-and-resubmit process offers valuable opportunities for improvement, strengthening the research. Utilizing social media platforms for sharing work extends its reach and encourages meaningful discussions beyond traditional academic circles. We often wrap up our work by having it published in prestigious health journals. But, upon reflection, are we truly accomplishing our aims? Is this where our storytelling journey should end?

Unfortunately, we tend to overlook the vast audience active on social media platforms, who may not be reading and benefitting from health journals. To amplify the visibility of our work, it's crucial to engage with our audience across diverse social media channels like LinkedIn, Facebook, WhatsApp, Instagram, Twitter, and more. By embracing these strategies, researchers can enhance the impact of their findings, driving progress in medical science and ultimately benefiting healthcare outcomes for all.

In the end, let us remember the profound impact our writing can have on healthcare. Each paper we write, every insight we offer, and every collaboration we nurture holds the power to shape the future of medical science. Together, let us aim for excellence, challenge limits, and leave a lasting legacy. Our efforts today will shape tomorrow's health outcomes, inspiring generations and changing lives for the better.

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Original Article

Assessing Continuing Education Needs in Alveolar Dental Traumatology for Dental Interns

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Abstract

Objective: In the Emergency Department of the dental consultation and treatment center of the university hospital IBN ROCHD in Casablanca, the management of oral trauma is mainly carried out by dental interns. In view of the difficulties observed and reported by them concerning certain traumas, it seemed necessary to set up a training course in traumatology to optimize the management of patients consulting the emergency department. The objective of this study was to draw up a preliminary analysis of the dental trauma training needs of interns working at our university hospital.
Methodology: Two methods were utilized, individual interviews and a questionnaire, to gather information about training needs. The responses were then prioritized using the FGP (Frequency, Severity, Problem) grid.
Results: Following the initial meeting with dental interns, three key areas were identified: root fractures, complete dental dislocation, and alveolar fractures. Responses were collected from all 29 interns, who expressed a requirement for acquiring knowledge, expertise, and interpersonal skills regarding these three areas. For Knowledge Problems, interns indicated a necessity for theoretical understanding in handling alveolar fractures (1.45±1.183), with root fractures scoring lower (1.03±1.017), and total dislocation being the lowest priority (0.34±0.769). In terms of know-how problems, alveolar fractures had the highest score (2.34±1.317), followed by root fractures (1.72±1.032), and total dislocation ranked last with an average of (1.03±1.149). Regarding interpersonal skills problems, practitioners mainly experienced problems related to total tooth dislocation (1.17±1.365), followed by alveolar fractures (1.03±1.375), and lastly, root fractures (0.97±1.267).
Conclusion: The present study demonstrated a clear requirement for ongoing education in alveolo-dental traumatology among the interns at university hospital.

Keywords: Continuing Medical Education, Alveolar-Dental Traumatology, Dental Interns.

Introduction

Dental Traumatology refers to the field of dentistry that deals with the examination and management of dental and alveolar injuries, with a focus on prevention and treatment.[1] It represents a significant challenge in both clinical dentistry and public health. Accidents, falls, sports-related injuries, and interpersonal violence are common causes of dental trauma, affecting individuals across all age groups. The consequences of dental trauma extend beyond mere physical discomfort, often leading to aesthetic concerns, functional impairments, and psychological distress. Understanding the nature of dental trauma, its prevalence, risk factors, and potential consequences is essential for effective prevention, timely intervention, and optimal management.[2] Although not a standalone discipline, several scholarly and scientific associations addressed the subject and strived to standardize treatment methods. Among them is the International Association of Dental Traumatology (IADT), which unites multiple clinicians, educators, and researchers in the field and has published guidelines.[3] Numerous studies have evaluated the understanding of emergency teeth trauma management among diverse populations, including dentists, schoolteachers, and physicians. Many of these studies have highlighted the necessity for enhanced communication between dental professionals and the community to raise awareness.[2] The diagnostics and treatments within traumatology have grown significantly since the 1970s due to the work of Jens-Ove Andreasen and his team. Oral trauma has taken many forms and can vary greatly in severity, sometimes resulting in the loss of a tooth.

Optimizing treatment and preventing post-traumatic complications required urgent and prompt management of dental trauma. In the Emergency Department of the dental consultation and treatment center at UH IBN ROCHD in Casablanca, oral trauma management is primarily conducted by interns and residents from various specialties. It has observed diagnostic and decision-making challenges reported by interns in certain traumatic cases. Training dental interns in trauma management is essential for optimizing patient care in emergency departments. The hospital serves as a hub for training, assessment, and research, and has undergone significant development in recent years.[4] Nonetheless, it is imperative to meticulously supervise the continuing education of healthcare professionals, especially interns. The Pedagogy Units must persistently offer practitioners with support as they practice, facilitating exchanges between the diverse academic structures in a welcoming environment.[5] This analysis will aid in identifying the cognitive, psychomotor, and affective domains that must be developed in this dental consultation and treatment center.

Given the prevalence of dental trauma incidents and their potential long-term effects, training

dental interns in trauma management is paramount.[6] By equipping dental interns with trauma management skills, we can address a crucial aspect of public health. Timely and appropriate management of dental trauma not only improves individual patient outcomes but also reduces the burden on healthcare systems and society as a whole.[7]

Training dental interns in trauma management is essential for providing timely, comprehensive, and compassionate care to patients affected by dental trauma. By investing in such training, we empower future dental professionals to make a significant impact on the well-being of individuals and communities alike. The aim of the current work is to report on an exploratory approach aimed at identifying training needs in dental traumatology, adapted to intern doctors practicing at dental consultation and treatment center within the UH, with reference to the professional skills targeted.

Methodology

The present study is part of a pilot exploratory approach within the Emergency Department of UH IBN ROCHD in Casablanca. It is a cross-sectional study conducted between July 15, 2022, and July 30, 2022. This pilot study is a small-scale preliminary investigation conducted prior to the main research project. Its purpose is to test the feasibility, methods, and procedures of the larger study, as well as to identify and address any potential issues or limitations that may arise.

Participants

This cross-sectional study involved all 29 interns at the Casablanca dental consultation and treatment center, representing the entire intern population during the study period. The focus was on interns because they handle dental trauma cases in the Emergency Department. The study excluded subjective evaluations, maintaining formal, objective language with standard formatting and citation guidelines. Technical terms were clarified, and colloquialisms were avoided. The text was grammatically correct, with no spelling or punctuation errors. Interns rotated weekly through the emergency department and were on-call once a month.

Data collection

The method for identifying training needs relied on two means: individual interviews and an open-ended study. The prioritization of responses was based on the FGP grid (Frequency, Gravity, Problem).[8] Individual interviews were conducted to ascertain the interns' views on challenges faced while handling traumatic emergencies during their daily practice; and areas requiring additional training in dental traumatology. We conducted individual interviews aimed at gathering interns' perceptions regarding the difficulties encountered in managing traumatic emergencies during their daily practice, and perceived training needs in the field of dental trauma.

The training needed an assessment project, the purpose of the questionnaire and grid were presented and explained to all participants. The FGP grid is widely used in the context of continuing medical education in several countries around the world, and the present aim was to identify topics that could be the subject of a trauma training program. For each topic, each participant was asked to rate the frequency (F), gravity (G) and problems (P), according to his or her personal experience. Each item (F, G and P) was rated according to the participant's own assessment of it in terms of professional practice: Frequency (F): 0: rare; 1: moderately frequent; 2: very frequent. gravity (G): 0: 0: mild; 1: moderately severe; 2: very severe. Problems (P): 0: no problems, 2: average problems, 4: many problems. This last item is subdivided into 3 subgroups, depending on whether the problems concerned theoretical knowledge and reasoning [knowledge] technical or psychomotor skills [know-how] or psycho-affective and relational aptitudes [interpersonal skills]. The numbers assigned to the three FGP columns for each subject were then added together to the questionnaire.

Data analysis

Data were inserted into Excel and assessed utilizing SPSS software. Objective variables consisting of frequency (F), gravity (G), and problems (P) were reported as the average and standard deviation.

Frequency-Gravity-Problems (FGP) grid was used for this assessment needs analysis, where frequency (F) was graded as 0: rare; 1: moderately frequent; 2: very frequent; Gravity (S) was graded as 0: mild; 1: moderately severe; 2: very severe; Problems (P) was graded as Problems of knowledge (Knowledge), manual dexterity (Know-how), interpersonal skills, 0: no problems, 2: average problems, 4: many problems

Results

The individual interviews highlighted the training needs felt by all the doctors interviewed. As for the questionnaires, following our initial meeting with the intern doctors, three main topics were identified: root fractures, total dental luxation (Expulsion), and alveolar fractures. We were able to collect responses from all 29 participants. The results are detailed in Tables1,2,3.

The management of total dental luxation saw the highest average frequency (1.45±0.686), followed by root fractures (0.86±0.516), whereas alveolar fractures had the lowest frequency (0.72±0.751). In terms of gravity, alveolar fractures obtained the highest score (1.45±0.686), followed by total dental luxation (1.34±0.553) and root fractures (1.07±0.593). For Knowledge Problems, interns indicated a necessity for theoretical understanding in handling alveolar fractures (1.45±1.183), with root fractures scoring lower (1.03±1.017), and total dislocation being the lowest priority (0.34±0.769).

In terms of know-how problems, alveolar fractures had the highest score (2.34±1.317), followed by root fractures (1.72±1.032), and total dislocation ranked last with an average of (1.03±1.149). Regarding interpersonal skills problems, practitioners mainly experienced problems related to total tooth dislocation (1.17±1.365), followed by alveolar fractures (1.03±1.375), and

Table 1: Findings for Root Fracture Management

Values	Average	Standard Deviation	Minimum	Maximum
Frequency	0,86	0.516	0	2
Gravity	1,07	0.593	0	2
Problems	Knowledge 1,03	1.017	0	2
	Know-how 1,72	1.032	0	4
	interpersonal 0,97	1.267	0	4

Table 2: Findings for Total Dental Dislocation Management

Values	Average	Standard Deviation	Minimum	Maximum
Frequency	145	0.686	0	2
Gravity	134	0.553	0	2
Problems	Knowledge 034	0.769	0	2
	Know-how 103	1149	0	4
	Interpersonal 117	1365	0	4

Table 3: Findings for Alveolar Fractures Management

Values	Average	Standard Deviation	Minimum	Maximum
Frequency	072	0751	0	2
Gravity	145	0686	0	2
Problems	Knowledge 145	1183	0	2
	Know-how 234	1317	0	4
	interpersonal 103	1375	0	4

Discussion

In our study, we employed diverse assessment tools, including questionnaires, interviews, and scenario-based assessments.[9,10,11] Medical interns unanimously recognized the need for training, with dental interns expressing challenges in handling specific dental traumas. To prioritize educational goals, we used the FGP grid, effectively identifying predominant needs.[12] This assessment identifies training needs for university hospital dentists, emphasizing the necessity of trauma training for interns. Data show gaps in knowledge, skills, and interpersonal skills, crucial for on-call duty in the emergency department. Dental injuries are often underestimated due to patients not seeking consultation. These injuries are commonly overlooked among polytrauma patients unless they pose a risk to vital prognosis, such as inhaling teeth.[13,14,15] Tooth expulsion, a common emergency, requires immediate intervention for optimal prognosis, typically within an hour.[16,17] Familiarity with emergency procedures and transportation of expelled tooth is crucial.[14,18] Most expulsions affect central or lateral incisors, and management protocols are well-defined, including recommendations from dental associations covering patient evaluation, x-rays, preoperative instructions, reimplantation, postoperative care, and follow-up.[19] Scores for alveolar fractures were higher due to their complexity. Total tooth dislocation led to interpersonal skills problems, requiring interns to use psycho-affective skills to comfort patients and clarify treatment plans .[20] Dental interns faced challenges with root fractures in knowledge, know-how, and interpersonal skills.[21]

Limitations

Limited number of interns were present in our hospital that year, so we could not expand the sample size further.

Conclusion

The study emphasizes the need for continuous education in alveolar-dental traumatology for dental interns at the university hospital. A training plan was proposed to align with institutional goals and enhance skills for optimal trauma patient management. It underscores the importance of conducting a needs analysis before planning any training, covering cognitive, psychomotor, and affective domains.

Recommendations

This assessment identified key subjects for an ongoing education program aimed at improving dental interns' traumatology training. The objective is to enhance their ability to handle dental trauma cases effectively at the emergency department of IBN-ROCHD hospital in Casablanca.

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Original Article

Comparative Evaluation of Microleakage in High Copper Amalgam Restorations using various Adhesive Liners in Permanent Teeth

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Abstract

Objective: To evaluate the microleakage in four commonly used adhesives and high copper amalgam restorations and to determine the best adhesive and alloy combination with least microleakage for a long-lasting restoration.

Methodology: This study was conducted on a sample of 80 patients after obtaining the ethical approval. 320 standardized Class-I cavities were prepared in premolars indicated for extraction as part of orthodontic treatment. Various combinations of adhesive liners and high copper amalgam alloys were used to restore the cavities in vitro. Adhesive liner was applied in accordance with the manufacturer's instructions, and the cavities were subsequently filled with four different alloys. On the basis of adhesive liners used, four groups (n = 20) were formed randomly (Group A-Amalgam bond Plus, Group B-Scotch bond Multipurpose Plus, Group C-All bond 2 and Group D-Panavia EX). Four premolar teeth (one from each quadrant) were restored with one of four different amalgam alloys: Orosphere Plus, Indiloy, Oralloy or Galloy while the liner was kept same. Three months after their placement in vivo, ten patients were examined from each group, while the remaining ten were examined after six months for microleakage evaluation after extraction of the restored teeth. Quantitative microleakage was assessed as micrograms of dye per tooth through spectrophotometric analysis. Statistical analyses were performed with one way ANOVA and post-hoc Tukey tests at 5% level of significance.

Results: Among adhesives used, Amalgam bond Plus demonstrated least microleakage followed by Scotch bond Multipurpose Plus, No significant difference ($p>0.05$) was found in the degree of microleakage at three months and six months among all the 4 tested groups.

Conclusion: Indiloy and Amalgam bond Plus showed the best combination of alloy and adhesive in resisting microleakage. Bonded amalgam restorations have the ability to serve for the longer period of time successfully.

Keywords: Adhesive, Amalgam bond plus, bonded amalgam, dental amalgam, microleakage.

Introduction

Dental amalgam contains a mixture of metals, specifically liquid mercury and alloy primarily made up of silver, tin, and copper.[1] Amalgam has been widely used in dentistry for over 150 years, showing favorable clinical outcomes.[2,3] However, the last 25 years has seen notable progress in development of restorative materials, leading to a shift towards resin composite materials. This transition is attributed to apprehensions concerning the aesthetics and biocompatibility of dental amalgam.[1] Tooth preparation features to retain traditional amalgam restorations consists of parallel walls, undercuts, box forms, dove tails and grooves. These preparation features frequently require the healthy tooth structure removal and thus weakens the tooth. The idea of bonded amalgam emerged as an attempt to explore whether the merits of bonding resin composite could address certain inherent limitations linked with amalgam restorations.[4] The lack of ability to adhere to tooth structure results in an interfacial gap that permits the initial microleakage around the amalgam restorations. Cavity varnish have been used to control the initial microleakage, however, there is growing concern regarding its effectiveness to seal the amalgam restorations margin, particularly when using high copper amalgam alloys. Liners have also been recommended around freshly packed amalgam restorations to minimize marginal leakage.[3] In recent years, there has been a tendency among operative dentists to use the advantages of adhesive technology in the placement of amalgam restorations. These advantages include a reduction in microleakage between cavity wall and restorative material, which in turn causes a potential decrease in occurrence of recurrent caries, pulpal inflammation and post-operative sensitivity.[5] In research conducted in Pakistan by Hussain et al. (2020), it was found that high copper amalgam restorations demonstrated reduced microleakage in comparison to high-viscosity glass ionomer and resin-modified glass ionomer restorations.[6] However, no adhesive liner was used in this study and comparison was made with other restorative materials.

The literature search revealed that no local study has been carried out to assess the microleakage around amalgam restoration with various adhesive liners. Thus, the present study aimed to evaluate the microleakage in four commonly used adhesives and high copper amalgam restorations and to determine the best adhesive and alloy combination with least microleakage so that we can have a long-lasting restoration with clinical success.

Methodology

This in vitro and in vivo study was conducted in the Department of Operative Dentistry, de'Montmorency College of Dentistry, Lahore and Orthodontic Department of Punjab Den-

tal Hospital, Lahore. Ethical approval was obtained from the Ethical Review Committee of Post Graduate Medical Institute, Lahore (No.00/12519). Patients were selected from the Orthodontic Department of Punjab Dental Hospital, and each participant provided written informed consent. History of the patient was followed by clinical examination. Patients were chosen by non-probability purposive sampling technique based on specified inclusion and exclusion criteria. Patients aged 15 to 40 years with sound premolar teeth indicated for extraction as a part of orthodontic treatment were included. while the patients with poor oral hygiene, systemic diseases ,history of bruxism or any other para-functional habits and with any developmental anomaly, were excluded. 320 cavities were filled with different adhesive-alloy combinations in 80 patients (47 females and 33 males). Four types of high copper amalgam alloys on the basis of composition and shape of particle were used as restorative materials. Sound and healthy premolar teeth were selected for this study, indicated for extraction as a part of orthodontic treatment. On the basis of adhesive liners four groups were formed (Group A-Amalgambond Plus, Group B-Scotchbond Multipurpose Plus, Group C-All bond 2 and Group D-Panavia EX) i.e., each group was comprised of 20 patients and 4 teeth were investigated in each patient. Four teeth (one from each quadrant) were restored with one of four different amalgam alloys: Orosphere plus (admixed Ag 65%, Sn 18%, Cu 12%, Zn 1%), Indiloy (spherical Ag 60%, Sn 22%, Cu 13%, In 5%), Oralloy (spherical Ag 59%, Sn 28%, Cu 13%) or Galloy (powder - Ag 60%, Sn 28%, Cu 11%, Pt 0.05%; liquid – Gal 61%, In 24%, Sn 12%, Bi 0.05%) while the liner was kept same (adhesive from each group) in these teeth according to the symmetry as follows:Right upper premolar -Orosphere Plus ,Left Upper premolar -Indiloy ,Right Lower premolar Oralloy, Left Lower premolar -Galloy .

After detailed history and clinical examination, rubber dam was applied for isolation purpose and a standardized Class-I cavity (1.5 mm wide, 1.5 mm deep, and 3 mm long) was prepared in each tooth utilizing a handpiece (high-speed) with water coolant and a fissure carbide bur # 245. The dimensions of tooth preparation were gauged using a periodontal probe (QOW probe) to ensure uniformity. One of the adhesive liners was applied to the cavity walls following the manufacturer's instructions, and one of the alloys was utilized for the filling. After carving and polishing the restoration, patients were given the next appointment of three months and six months. Half of the teeth of each group were extracted after three months while the remaining half were extracted after six months. Following extraction, the teeth were kept in 2% formaldehyde (pH - 7) for 12 hours. Then, the teeth underwent a washing and cleaning with water and pumice using rubber cups at a slow speed, followed by storage for 24 hours in distilled water. Subsequently, the roots were sectioned using a double-faced diamond disc. The entire tooth surface leaving the restoration and 1 mm of tooth from its margins, was coated with two layers of fingernail varnish. Each tooth was immersed in a 2% methylene blue solution at 37 degrees Celsius for 12 hours. After washing, the nail varnish was removed from the tooth surface by scraping with a surgical blade. Using a double-faced diamond disc, the teeth were sectioned in dental blocks (5 mm wide, 6 mm high, 3 mm thick), with the restoration at the center. This procedure aimed to standardize the tooth volume for spectrophotometric analysis.

Before analyzing the samples in spectrophotometer (Techcomp UV-2300 spectrometer), methylene blue dye solutions at concentrations of 0, 1, 2, 3, 4, 5, and 6 micrograms per ml were prepared. These prepared standard solutions underwent centrifugation and were then read in the spectrophotometer to establish the maximum absorbance, determined to be 664 nanometers in this study. Next, a standard calibration curve was established after calibrating the spectrometer. Once calibrated, the samples were centrifuged, and readings were noted. The concentration of the dye in the samples was evaluated using the standard calibration curve. It was found that the higher the dye concentration, the greater the leakage through the tooth-restoration interface. Quantitative microleakage was measured as micrograms of dye per tooth.

Statistical Analysis

The data were entered and analyzed utilizing SPSS version 24.0. One-way ANOVA test was used to examine group mean differences among the four dental alloys. Post-Hoc Tukey tests were then applied to identify specific group mean differences. Additionally, independent t-tests were conducted to assess differences in leakage at three and six months. A p-value < 0.05 was deemed statistically significant.

Results

Out of total participants, 41.25% were males and 58.75% were females (Figure 1). The mean age was 33.25+11.2 year with minimum and maximum value of 15.0 and 40.0 respectively.

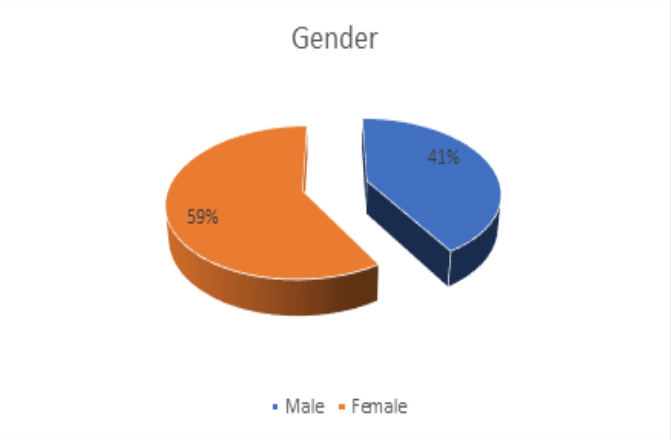

Figure 1: Showing Gender Distribution of Patients

The microleakage among different adhesive-alloy combinations at three months and six months are shown in Table 2 and Table 3 respectively. Adhesive dentin systems showed reduced microleakage in all the tested groups at three months and six months' duration.Among the adhesives, overall significant difference ($p<0.05$) was found when Amalgambond was compared with the other 3 types. ScotchbondMulti-purpose Plus also demonstrated significant difference ($p<0.05$) when compared with All bond 2 and Panavia EX at three and six months. No significant difference was found between All bond 2 and Panavia EX at

three months.However, significant differences ($p<0.05$) were found among all adhesives at six months.

Table 1: Microleakage among different adhesive-alloy combinations at three months

S. No.	Amalgambond Plus				$\bar{x}$	Scotchbond Multipurpose Plus				$\bar{x}$	All Bond 2				$\bar{x}$	Panavia EX				$\bar{x}$
	A1	A2	A3	A4		A1	A2	A3	A4		A1	A2	A3	A4		A1	A2	A3	A4	
1	1.1	1.2	1.5	1.2	1.2	2	2	2.6	2.7	2.3	3.1	3.1	3.4	3	3.1	3.2	3.1	3.9	3.1	3.3
2	0.5	0.5	2	0.5	0.8	2	2.2	2.3	2.1	2.1	3	3.1	3.2	3.4	3.2	3	3.2	4	2.9	3.2
3	2.1	1.5	1.5	2	1.7	2.9	2.1	2.5	2.4	2.4	3.5	2.9	3.6	3.5	3.4	3.7	2.9	3.6	3.2	3.3
4	1.2	0.9	1.7	1.8	1.4	3	2.4	2.6	2.7	2.6	3.5	3.2	3.7	2.9	3.3	3.2	3.1	4	3.3	3.4
5	2.5	1.5	2.5	1.5	2	3.2	2.2	2.9	2.1	2.6	3.9	3.4	3.9	3.7	3.7	3.5	3	4.5	3.1	3.5
6	2.2	1.2	2.2	1.6	1.8	3.2	2.1	3	2.2	2.6	4	2.9	4.1	3.5	3.6	4	3	4.5	3.4	3.7
7	1.5	2	2.6	0.7	1.7	2.1	2.5	2.6	2	2.3	4	3.8	4.2	3.2	3.8	4.2	3.5	4.6	3.5	3.9
8	1.9	1.5	2.7	1.8	1.9	2	2.4	2.7	2.1	2.3	3	2.9	3.7	3.1	3.2	3	3.4	4.9	3.7	3.7
9	2	1	2	2.1	1.7	3	2.3	3.5	2.2	2.7	3.1	3.5	3.9	3.2	3.4	3.6	3.6	5	3.2	3.8
10	2.5	0.5	1.5	2.2	1.6	2.5	2	3.4	2.1	2.5	3.9	3.6	4.2	3.6	3.8	4.2	3.7	5.1	3.4	4.1
$\bar{x}$	1.7	1.2	2.0	1.5		2.6	2.2	2.8	2.3		3.5	3.2	3.8	3.3		3.5	3.2	4.4	3.3	

Abbreviations: $\bar{x}$ = mean; A1 = Orosphere Plus; A2 = Indiloy; A3 = Oralloy; A4 = Galloy

Table 2: Microleakage among different adhesive-alloy combinations at six months

Sr. No	Amalgambond Plus				$\bar{x}$	Scotchbond Multipurposes Plus				$\bar{x}$	All Bond 2				$\bar{x}$	Panavia EX				$\bar{x}$
	A1	A2	A3	A4		A1	A2	A3	A4		A1	A2	A3	A4		A1	A2	A3	A4	
1	1.5	1.5	1.2	1.9	1.5	2.1	2	2.9	2.5	2.3	3	3	3.4	3.1	3.1	3.1	3	3.9	3.1	3.2
2	1.2	1.2	2.1	0.7	1.3	2.5	2	2.8	2.3	2.4	3.5	3.1	3.5	3.4	3.3	3.4	3.5	4	3.4	3.5
3	2	0.5	1.5	2	1.5	2.2	2.3	2.7	2	2.3	2.5	3.2	3.4	3	3.0	3.2	3	3.8	3.8	3.4
4	2.3	0.9	1.7	1.5	1.6	3	2.5	2.4	2.5	2.6	3.8	3	3.9	3.2	3.4	3.9	3.2	4.2	3.4	3.6
5	1.2	1.5	2.5	1.5	1.6	2.2	2.1	2.5	2.3	2.2	3	3.5	3.5	3.7	3.4	3.5	3.4	4.5	3.3	3.6
6	2.2	1.6	2.3	1.7	1.9	3	2	3.5	2.4	2.7	4	2.4	4.5	3	3.4	4.3	3.1	4.3	3	3.6
7	2.1	2	2.8	2.1	2.2	3.2	2.4	2.5	2	2.5	4.2	3.5	4.2	2.9	3.7	3.5	3.2	4.8	3.5	3.7
8	1.5	1.4	2.5	1.5	1.7	2.1	2.3	3	2	2.3	3	3.2	3	3.1	3.0	4.2	3	4.9	3.8	3.9
9	1.9	1.5	2.3	2.2	1.9	2.5	2.5	3.2	2.5	2.6	3.5	3	4	2.9	3.3	4.1	3.4	4.6	3.5	3.9
10	2	2	1.9	2	1.9	2.8	2.5	2.9	2.7	2.7	3.2	2.8	4.5	3.2	3.4	3.5	3.5	5	3.6	3.9
$\bar{x}$	1.7	1.4	2.0	1.7		2.5	2.2	2.8	2.3		3.3	3.0	3.7	3.1		3.6	3.2	4.4	3.44	

Indiloy showed the least leakage with no significant difference with the Orosphere Plus and Galloy, while significant difference ($p<0.05$) with Oralloy was found in all tested groups. Orosphere plus showed no significant difference in microleakage with Indiloy and Galloy in all groups except with Oralloy. Galloy showed significant difference with Orally in group B and D and in significant difference in group A and C at three months (Table 3). At six months, Orosphere Plus showed no significant differences when compared with Indiloy, Oralloy and Galloy in all groups. Indiloy showed significant difference with Oralloy in all groups but insignificant difference with Orosphere Plus and Galloy in all groups. Galloy demonstrated no significant difference with Oralloy in group A but significant difference with group B, C, D (Table 3).

Table 3: Microleakage among different adhesives at three and six months (n = 10 / group)

Variable	Amalgambond Plus	Scotchbond Multipurpose Plus	All Bond 2	Panavia EX	*p-value
Microleakage (At 3 months)	1.622 ± 0.096	2.470 ± 0.067	3.460 ± 0.062	3.625 ± 0.095	0.000^{*}
Microleakage (At 6 months)	1.747 ± 0.078	2.495 ± 0.060	3.345 ± 0.077	3.685 ± 0.087	0.000^{*}

Overall, both Amalgambond Plus and Indiloy demonstrated the least leakage at the three-month and six-month intervals. This indicates that these materials provided the most effective seal over time. Additionally, the study found no significant differences in leakage among all the tested groups at both the three-month and six-month intervals, suggesting that the performance of the materials was consistent over the different time periods.

*ANOVA; *p-value < 0.05 was considered statistically significant.
Abbreviations: $\bar{x}$ = mean; A1 = Orosphere Plus; A2 = Indiloy; A3 = Oralloy; A4 = Galloy

Discussion

This study was conducted both in vivo and in vitro at 3 and 6 months duration, to evaluate the microleakage in four commonly used adhesives and high copper amalgam restorations, and to determine the best adhesive and alloy combination with least microleakage for a long-lasting restoration. One of the goals of an ideal restoration is to prevent microleakage. According to Pashley7, one of the main clinical consequences of microleakage is the formation of secondary caries. This progression finally results in the failure of restorations, requiring their subsequent replacement.Various methods have been used to evaluate microleakage around restorations, with dye leakage being the most commonly used technique. This method gives the advantages of affordability and ease in application. Nevertheless, it comes with some drawbacks, including the subjective nature of result evaluation,a lack of standardization in the method and the dye having lower molecular weight.

The lack of universally accepted standards for experimental parameters makes it challenging to compare results across different studies.[7] To answer these limitations, volumetric leakage studies have been recommended as they demonstrate a more precise measurement of the actual leakage occurring around restorations.[8,9] Unlike most studies on microleakage that use dye penetration with qualitative analysis, which gives an incomplete assessment owing to its two-dimensional nature, volumetric studies provide a three-dimensional outlook on the leakage phenomenon.[9,10] The findings of the present study show that using Amalgambond Plus as a liner on cavity walls before placing amalgam restorations demonstrated superior sealing ability compared to the other tested treatments. This result is consistent with the previous studies.[11-15] It might be due to hybrid layer created by Amalgambond Plus with dental collagen which resulted in superior sealing of tubules and thus preventing dye from infiltrating dentinal tubules. The ability of Amalgambond Plus to seal the tubules early should also prevent the bacteria, which penetrates the cavity amalgam interface, from entering the dentinal tubules. High performance additive powder (HPA) in Amalgambond Plus contains polymethacrylate fibers responsible for mechanical interlocking, which also produces reinforced union between the two materials.

However, previous studies[16,17] found lower levels of microleakage when Scotchbond Multipurpose Plus was used as a liner than Amalgambond Plus, a finding contradictory to our study. This might be due to the high viscosity of the Scotchbond Multipurpose Plus making its mechanical bonding less efficient. Similarly, a study18 found no significant difference between All-Bond[2] and Amalgambond Plus adhesive systems in vitro at any intervals tested. This is in contrast to our study as there is a difference in sealing abilities of adhesives used in our study. In spite of the recognized efficacy of Panavia EX resin cement in decreasing leakage around amalgam restorations with enamel margins in different studies, the current research found that it did not demonstrate the same microleakage reduction as the hydrophilic adhesive system.[19,20]

The utilization of various adhesive liners, such as All Bond[2], Amalgambond and Panavia EX, in bonding amalgam has been known.[21] Several previous studies investigating bonded amalgam restorations have shown noteworthy improvements in reducing microleakage.[22-25] Nevertheless, Mahler et al.[26] reported minimal to no benefits in bonding amalgam restorations regarding marginal fractures and post-operative sensitivity. It's critical to highlight that these results were derived from the data collected within 1-2 weeks after placement.

In the present study, Indiloy showed least microleakage among the various alloys used. Greater microleakage was observed in Oralloy than Galloy and Orosphere Plus. Different factors are responsible for microleakage around amalgam restorations i.e., type of alloy, condensation, burnishing, use of liners/varnishes, bonded amalgam restorations etc. Condensation and burnishing, a variable factor, are under the control of operator. Use of liners and varnishes are not in use due to their nature of solubility and now have been replaced with adhesive liners. As for as type of alloy is concerned, lathe cut and admixed alloys display less leakage than spherical alloy.

Among the alloys, Indiloy, Oralloy and Galloy belong to spherical blend and Orosphere Plus belong to admixed blend. Admixed alloys display less microleakage than spherical alloys. But in this study spherical blend (Indiloy) showed least leakage, though no significant difference was found between spherical (Indiloy) and admixed alloy (Orosphere Plus). This is in consistent with the findings of Meiers et al.[25] However, Mahler et al.[27] and Chang et al.[28] in their studies, concluded that spherical alloys as a group had an increased tendency towards microleakage than lathe cut or admixed alloys. It means that factors other than the particle shape are important in microleakage like oral environment and the composition of alloys.

The assessment of oral health continues to be a vital factor for the successful performance of any restorative material. As far as oral environment is concerned, it is a variable from patient to patient and is not under operator control. Among the alloys used, the major difference in composition is the percentage of tin. The detected differences could be attributed to the higher tin content (18% in Orosphere Plus, 22% in Indiloy and 28% in Oralloy), potentially influencing the dimensional stability at the time of setting of dental amalgam. Although Galloy having a tin content of 28.05%, the formation of distinct phases during setting, mainly Ga-Cu and Ag-In, might contribute to some dimensional change.

Limitations

However, the study has the limitations as well.All the fillings in this study were done in Class-I cavity design. It must be noted that in the majority of cases, microleakage does not occur at the occlusal margins of the restorations (thick enamel) but rather initiates from the gingival margin (thin enamel) and extends toward the axial wall. Thus, using the other cavity designs may

show different results. We used the fourth-generation adhesive system; any new generation adhesives may show different behaviors. The amalgam alloys used were high copper, other alloys with different composition may show different behavior. The evaluation of amalgam retention based on adhesive liner versus retentive features was not included in the study. Time period for study was limited. Prolonged period of time may change the result. Additional long-term clinical evaluations are essential to clarify the full potential of bonded amalgam restorations.

Amalgam is still in use and bonded amalgam further ensures the success and longevity of the restoration which is directly related to its marginal seal. So ,it is recommended to use the bonded amalgam especially in third world countries like Pakistan, where poverty is prevailing and spending money on restorations that have to be replaced continuously is a financial burden.

Conclusion

Within the limitations of this study, Indiloy and Amalgambond Plus showed the best combination of alloy and adhesive in resisting microleakage. Bonded amalgam restorations have the ability to overcome the problem of microleakage successfully.

Authors' Contribution:

SN contributed in the conceptualization, design, procurement, analysis, and interpretation of data, MAH in creating the initial draft of the article and meticulously revising it to ensure essential intellectual content. NB managed the literature search and helped in writing the draft.

Conflict of Interest: The authors declare that they have no competing interest.

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Original Article

Assessing Undergraduate Medical Students' Awareness Regarding the Use of ChatGPT as an Educational Tool: A Cross-Sectional Survey

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Abstract

Objective: To examine the level of knowledge, present utilization, and opinions of undergraduate students on the application of ChatGPT for educational objectives.

Methodology: This cross-sectional study was carried out at a private medical institution in Pakistan and included 219 participants from various academic years. The data was gathered by employing a pre-tested, structured survey form generated through Google Forms after obtaining informed consent. The gathered data underwent descriptive and inferential analyses using SPSS software version 26.0.

Results: Out of the 219 students who were invited, 198 students completed the survey, resulting in a response rate of 90.41%. The average age of the participants was 22.48 ± 0.56 years. Out of the total student population, 92.4% were acquainted with ChatGPT, but 25.9% had never utilized it for educational endeavours. Merely 1% of individuals reported using it frequently, whereas 44.2% used it on occasion. The students exhibited favourable perceptions: 61.6% expressed an improved comprehension, 85.9% placed importance on immediate availability, and 81.3% acknowledged the significance of individualized instruction. The concerns mentioned encompassed information accuracy (65.5%), privacy issues (48.7%), and potential overreliance (42.1%). Proposed enhancements encompassed instantaneous updates, heightened precision, and seamless connectivity with educational systems. An overwhelming majority of participants (78.7%) expressed a strong intention to continue using ChatGPT in the future.

Conclusion: The findings provide new light on how ChatGPT might be used in medical education. It reveals positive views, major problems, and suggestions for its use. Even though there were some problems, most people still wanted to use ChatGPT in the classroom. It draws attention to the probable influence on medical education's trajectory in the future.

Keywords: Artificial Intelligence, ChatGPT, Medical Students, Medical Education.

Introduction

Technological innovations have significantly affected the field of medical education. An increasing development in this context is the integration of artificial intelligence, namely Chat Generative Pre-Trained Transformers (ChatGPT), into medical education.[1]

This indicates a sudden alteration in how medical students get information, interact with learning resources and acquire essential clinical skills. Medical students can partake of AI enabled virtual assistants, chatbots and modules through ChatGPT which uses natural language processing to enable dialogue. It allows personalized learning experiences, immediate access to medical knowledge and develops problem-solving skills.[2] The introduction of ChatGPT into the teaching of medicine mirrors the current worldwide shift as universities implement AI for traditional pedagogies.[3] Medical students' responsibilities are growing with changes in healthcare delivery. Today's doctors need not only a deep understanding of the basics of medicine but also competence in technology, adaptability, and knowledge on how to effectively use artificial intelligence tools in clinics.[4] The learning of these abilities begins in medical schools.[5] Hence, it is mandatory to apprehend the current trends and the implications of ChatGPT in Abwa Medical College towards medical education.

This study aims to establish how much our youth understand about the educational use of ChatGPT. It will consider such issues as what drives AI-powered educational tools and evaluate possible advantages, obstacles and readiness of students for collaboration with such systems based on artificial intelligence.

Methodology

To assess the undergraduate medical students' awareness, a cross-sectional survey was administered at Pakistan's ABWA Medical College. A one-year ethical clearance was granted by ABWA Medical College's Institutional Ethical Committee (No. 834/2023). The study took around seven months to complete, beginning in June 2023 and ending in January 2024. The 219 participants in this poll represent a range of academic years at the institution. After receiving a thorough description of the study's features, the students gave their consent.

Following standard procedures for calculating survey sample sizes allowed us to arrive at an appropriate number of participants for this investigation. The sample size for this research was 500 ABWA Medical College medical students. With a 5% margin of error, we assumed that the outcome factor would occur 50% of the time in the population. For this investigation, a 95% confidence level was used. This sample size ensures that the study has adequate statistical power to detect significant differences or associations among variables of interest with a con-

fidence level of 95%. The data was gathered using a pre-tested, standardized questionnaire that was conducted through Google Forms. The purpose of the questionnaire was to gather data regarding the usage patterns of ChatGPT, the perspectives of students, the benefits and limitations, and their future intentions to use ChatGPT in an educational context. The data analysis was conducted using the SPSS version 26.0 program. The descriptive statistics provided an analysis of usage trends and student perceptions regarding the application of ChatGPT.

Results:

Out of 219 medical students, 198 completed an online survey questionnaire, resulting in an impressive overall response rate of 90.41% (refer to Table 1). The study participants were on average 22.48 + 0.56 years old. The survey included representation from every academic year of the Medical Bachelor's Degree program. The 4th and 5th-year medical students comprised the largest groups, contributing 24.4% and 24.2%, respectively. In contrast, the 1st-year medical students made up the smallest cohort, comprising only 11.6% of the respondents. Table 1 shows the demographic characteristics of the study participants. The gender distribution was relatively balanced, with 52.5% of respondents identifying as male and 47.9% as female. The majority of participants were between the ages of 21-23 years, comprising 55.5% of the sample. The distribution across different age groups included 16.6% aged 19-20 years, 26.2% aged 24-26 years, and only 1.01% aged above 26 years. These demographic details provide a comprehensive overview of the study participants, setting the stage for further exploration of their perceptions and experiences with Chat Generative Pre-Trained Transformers (ChatGPT) in the subsequent sections of the research findings.

Table 1: Demographic characteristics of study participants in the cross-sectional survey

Demographic Characteristics	Study Participants (n=198)	Percentage (%)
Gender		
Male	104	52.5
Female	95	47.9
Age		
19- 20 years	33	16.6
21-23 years	110	55.5
24- 26 years	52	26.2
>26years	2	1.01
MBBS Year		
1st Year	23	11.6
2nd Year	35	17.6
3rd Year	43	21.7
4th Year	48	24.4
5th Year	48	24.2

As part of the survey, we analysed the participants' familiarity with ChatGPT. Of all the participants, 182 accounting for 92.4% were familiar with ChatGPT, while 15 participants making up 7.6% had not heard of or did not know about it. Participants were also asked to rate their frequency of ChatGPT usage. Only 2 participants accounting for 1% reported using ChatGPT very frequently, 87 participants comprising 44.2% reported occasional usage, 57 participants accounting for 28.9% reported frequent usage, while 51 participants making up 25.9% reported rarely or never using ChatGPT. Participants were asked to rate their perception of the usage of ChatGPT. The participants can choose multiple options for the question. Out of the total participants,122 participants (61.6%) agreed that ChatGPT enhances understanding of medical concepts and improves problem-solving skills while 170 participants (85.9%) agreed that ChatGPT provides instant access to medical knowledge and 161 participants (81.3%) agreed that ChatGPT personalizes the learning experience (Figure 1).

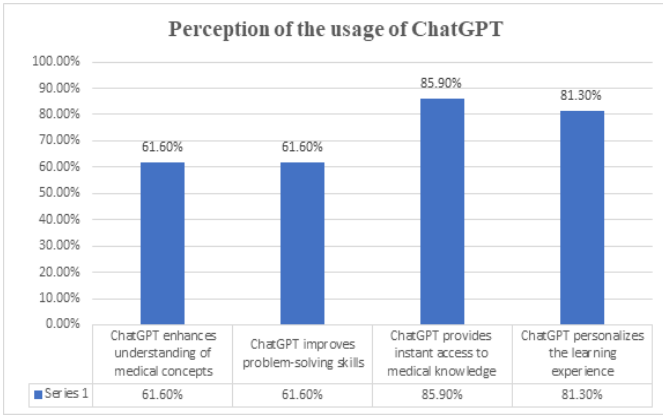

Figure 1: Bar chart of responses about the perception of usage of ChatGPT

During a survey, 198 ChatGPT users were asked to share their concerns or challenges they faced while using the platform. The participants can choose multiple options for the question. Out of these participants, 129 individuals (65.5%) expressed concerns about the accuracy of information provided by ChatGPT. Additionally, 96 participants (48.7%) were worried about privacy and data security issues while using the platform, while 83 participants (42.1%) felt that overreliance on ChatGPT was a challenge (Figure 2)

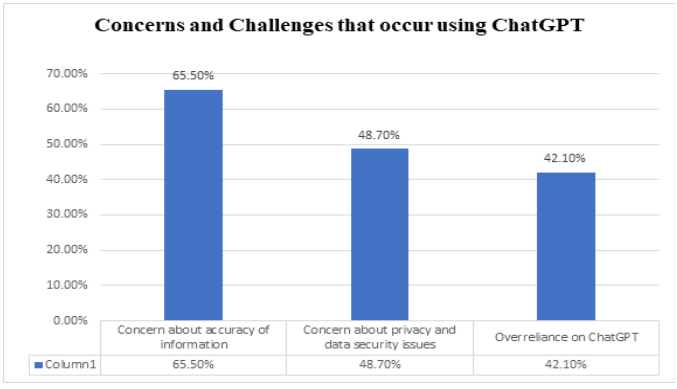

Figure 2: Bar chart of concerns and challenges that occur using ChatGPT

Despite the concerns and challenges that occur when using

ChatGPT Participants recommend improvements and features that would be more likely to use ChatGPT for medical education purposes. A total of 155 participants (78.7%) recommended Real-time updates on medical research in ChatGPT. Further,150 participants (76.1%) recommended improved accuracy of responses in ChatGPT while 129 participants (65.5%) recommended integration of ChatGPT with other educational tools. Participants were also asked if given the choice, would continue to use ChatGPT for medical education in their future academic years,155 participants (78.7%) agreed to use ChatGPT for medical education in their future academic years (Figure 3).

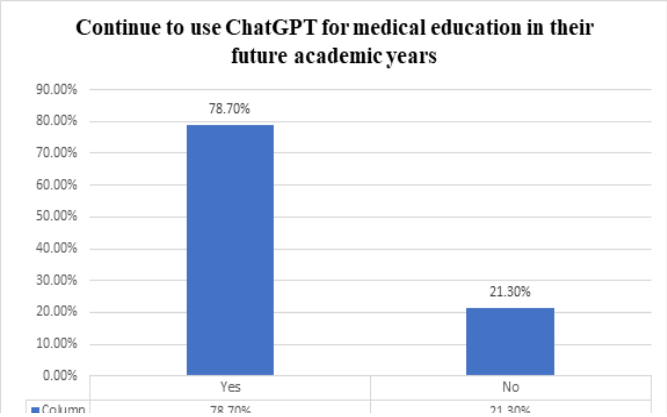

Figure 3: Bar chart illustrating students' intention to continue utilizing ChatGPT for medical education in their subsequent academic years

Discussion

The study examines the level of knowledge, usage habits, and opinions of undergraduate medical students considering Chat Generative Pre-Trained Transformers (ChatGPT) as a tool for education. This research provides a detailed picture of the changing trends in medical education. The study's findings offer useful insights within the existing literature, contributing to the broader discussion on the incorporation of AI technologies in medical curricula.

The participants from Abwa Medical College in the current study had an impressive awareness level of AI technologies, more specifically ChatGPT in the medical student community at a rate of 92.4%. This is in line with other studies that have shown that current medical education has increasingly acknowledged AI tools due to its emphasis on technical competence.[6] The acknowledgment of AI's probable impact on medicine and learning is constructive since this means that these students are being exposed to emergent technologies, which could redefine their future roles as healthcare providers.[7]

While some students use ChatGPT frequently (1%), others use it intermittently (44.2%) in out study. This finding is congruent to the previous research findings where acceptance rates for AI tools used in medical education were different.[8] Previous studies have recognized that the frequency of using ChatGPT could be influenced by a number of things such as institutional support, training and perceived benefits.[9]

In this paper, respondents expressed positive views on improved comprehension (61.6%), instant access (85.9%), and individualized instruction (81.3%). These observations are congruent with studies affirming that AI can enhance education and academic performance. Different research articles[8,10] have pointed out the positive effect of AI-based instructional technology on medical knowledge learning as well as problem-solving abilities. The adoption of ChatGPT in medical teaching, which has led to a high rating by the participants, reflects a worldwide trend in which institutions want to take advantage of AI's capabilities for modernizing traditional teaching methods.[11]

Despite the above, participants' concerns call for careful consideration while using ChatGPT for learning. For ChatGPT to succeed in being integrated into medical education, it must address critical issues such as information accuracy (65.5%), concerns over privacy (48.7%), and potential overdependence (42.1%). These findings are consistent with many earlier studies indicating the need for improvement of information accuracy, and data privacy assurance as well as reducing excessive dependence on AI.[11,12]

The participants' suggestions for faster updates (78.7%), more accurate results (76.1%), and integration with other educational resources (65.5%) offer practical guidance for developers and educators. Applying these recommendations could make ChatGPT more efficient and user-friendly, especially for medical education. These suggestions are in keeping with the continuous improvement and integration of AI technology to meet the evolving needs of medical students.[13]

It is encouraging to see that a large majority of participants (78.7%) are prepared to keep utilizing ChatGPT as they go through their academic careers (figure 3). There will soon be a change in educational frameworks to reflect the increasing demands on physicians to be technologically savvy and adaptable, and medical students' eagerness to incorporate AI technology into their learning process is a sign of that transition.[6,14]

Our study results support the use of AI technology in medical curricula, and our work contributes to the current discussion on the topic. Results are in line with previous research, but the study nevertheless shows that medical schools shouldn't use ChatGPT in a cookie-cutter way. The concerns and suggestions voiced by respondents must be addressed. The integration of AI technology into medical education is a complex topic, and future studies should investigate the contextual aspects that play a role in this. It is critical to approach the use of artificial intelligence tools like ChatGPT with caution and moderation as medical education develops.

Limitations

This research only included ABWA Medical College, therefore its findings may not be generalizable to other medical schools. Furthermore, since the results are based on self-reported data, which may be affected by response bias, the exactness of the conclusions may be compromised. The next research should use objective measures to evaluate the use of AI tools and include

multi-site studies to better understand the impact of these technologies on medical education.

Conclusion

The research throws light on the positive approval of ChatGPT among undergraduate students in the field of medical education. The study demonstrates a notable degree of awareness and favourable perception of the tool among students. Despite a few issues, pupils offered suggestions for enhancement, and a substantial majority indicated their goal to persist in utilizing ChatGPT throughout their academic endeavours. ChatGPT's potential impact on the future of medical education is emphasized.

Authors' contributions

HMAA and NKN conceived the idea. AA did data collection and analysis and did initial manuscript writing. NKN did the final manuscript review after editing. Both authors approved the final manuscript for submission.

Conflict of Interest: The authors have no conflict of interest.

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Origional Article

Incidence of Anomalous Coronary Arteries in Pakistani Population

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Abstract

Objective: To identify the origin of coronary arteries and detect its abnormalities.
Methodology: This was a retrospective analysis comprising 1200 patients during the course of 2 years from May 2021 to a May 2023 who underwent for coronary CT angiogram to determine the coronary artery anomalies at the Islamabad Diagnostician center, with the collaboration of South East Hospital and research center, Islamabad. All the patients who were included in this study had a base line heart rate>65 bpm, and suffered from coronary artery disease and chest pain. They were advised to avoid smoking and coffee 12 hours before the procedure and also avoided eating solid food 4 hours prior to the procedure.
Results: The patients' mean age was 49 years, mean heart rate 61.39±5.356 and mean creatinine level was 1.029±1.383. It also showed that 85.7% male and only 2% females were in records. Medical history showed that 64.3% patients were hypertensive, 50% diabetic, 92% patients had presented with shortness of breath, 85% with chest pain, 35.7% were smokers and 42.9% had positive family history of heart diseases. Angina grading score also known as the Canadian cardiovascular society (CCS) showed 50% patients with CCS I, 28.6% CCS II and 21.4% CCS III.
Conclusion: Coronary CT angiography is a highly effective diagnostic technique for the diagnosis and origin of coronary arteries as well as its course and termination. We can observe easily all the presentation which cannot be detected through other diagnostic tools.

Keywords: Coronary artery disease, Computed Tomography, Angiography, Anomalous Coronaries.

Introduction

The aortic sinuses of Valsalva are the origin of coronary arteries, which converge closer to the top of the coronaries.[1] There are commonly two primary coronary arteries: the Right Coronary Artery (RCA) and the Left Coronary Artery (LCA). The left circumflex artery, and the left anterior descending artery split out from the left main coronary artery.[2] The RCA normally originates in the ascending aorta's right sinus of Valsalva.[3] The RCA pivots and moves posteriorly via the sulcus onto the diaphragmatic surface and the heart's base at the intense line of the heart.[3] Throughout the RCA, various branches appear: the posterior interventricular branch, the conus branch, the atrial branch, the sinus node,right marginal, and the atrio-ventricular nodal branch.[4] One of the most dangerous coronary artery anomalies is abnormal origin of left coronary artery from the pulmonary artery.[5,6] The LCA, RCA, right coronary sinus and non-coronary sinus are patterns of an anomalous origin of the coronary artery from the opposing non-coronary sinus.[7] A disorder known as a coronary artery fistula occurs when one or more coronary arteries communicate with the superior vena cava, pulmonary artery, cardiac chamber, and coronary sinus.[8,9] As opposed to the Left Marginal Artery (LMA) arising from the LCA, the RCA is more frequently involved.[10] Coronary arcade is an uncommon instance of connection when coronary artery stenosis is not present between the RCA and the LMA that is large enough to be seen angiographically.[11] The extra-cardiac vessels that the coronary arteries are connected to include the bronchial, internal mammary, pericardial, anterior mediastinal, superior and inferior, intercostal, and esophageal branches of the aorta.[12] Only when there is a pressure gradient between two artery systems do these channels become functionally important. Although coronary anomalies are benign, the intra-arterial anomalous right coronary artery and the inter-arterial anomalous left coronary artery are the two most common subtypes that predispose young people to sudden cardiac death. Anomalous origin of coronary arteries occurs when either artery (right or left) arises from different site instead of its actual origin site. Most of the anomalous origin occurs when both coronary arteries arise from the same aortic sinus from the single ostium or two separate ostia. The aim of this study was to examine the origin of coronary arteries retrospectively of 1200 patients over a period of 2 years from May 2021 to May 2023 who underwent coronary CT angiogram to determine the common patterns of coronary arteries anomalies in the local population.

Methodology

It was a retrospective study of 1200 patients conducted over a two-year period, from May 2021 to May 2023 who had undergone CT coronary angiography to determine the coronary arteries anomalies at the Islamabad Diagnostic center with collaboration of South East Hospital and Research Center. Ethical approval was taken from hospital Institutional Review Board committee (Re: 008-ERC-SEH). From the records, all the

patients of both genders included in this study had a base line of heart rate>65 bpm, and suffered from coronary artery disease and chest pain. The patients had been advised to avoid smoking and caffeine twelve hours before the procedure, and also avoided eating solid food 4 hours prior to the process. From the instruction list, it was also observed that patients who were allergic from contrast agent and also who received beta-blockers and had renal insufficiency were excluded from this procedure. Using double-syringe injector, weight based iodinated contrast agents followed by using the right cubital vein, 30 milliliters of saline was injected. The injection was applied using the CT devices' corresponding threshold levels; the regions of interest were located in the ascending aorta. The scan parameters were as follows: slice thickness of 0.5 mm and tube voltage of 100 kv with automated tube current modulation. Heart rate acquisition phase for heart rates less than 65 beats per minute. Iterative reconstruction was used for the picture reconstruction. This approach was employed retrospectively to the patients. Data was entered in SPSS (version 23.00, Chicago, IL, USA). Data were expressed as mean ±SD for quantitative parameters, such as age, heart rate, weight and creatinine level. The frequency and percentage of qualitative factors was determined, such as gender, medical history, anomalous coronaries and risk factors.

Results

All 1200 patients underwent coronary CT angiography, out of which 14 patients were detected with anomalous coronaries. Aand overall quality of this systematic review on the role of Vitamin B12 in the mental health of children and adolescents.

Table 1: Demographic Profile and Medical History of the Patients (n=14)

Characteristics	**Mean**	**±SD**
Age (years)	49.79	11.074
Heart Rate (minutes)	61.93	5.356
Creatinine (mg/dl)	1.029	.1383
Gender		
Characteristics	Frequency (n)	Percentage (%)
Male	12	85.7
Female	2	14.3
Medical History	**Frequency**	**Percentage**
Hypertension	9	64.3
Diabetic Mellitus	7	50.0
Chest pain	12	85.7
Shortness of breath	13	92.9
Smoking	5	35.7
Family history	6	42.9
Dyspnea Classifications	**Frequency**	**Percentage**
Class I	7	50.0
Class II	4	28.6
Class III	3	21.4

Table 1 illustrate the mean age of the patients (49.79±11.074), mean heart rate (61.39±5.356) and mean creatinine levels (1.029±.1383). It also shows that 85.7% males and only 2% females underwent this procedure. Medical history shows that 64.3% patients were hypertensive, 50% diabetic, 92% patients presented with shortness of breath, 85% with chest pain, 35.7% were smokers and 42.9% had positive family history of heart diseases. Dyspnea classifications shows 50% patients with CCS I, 28.6% CCS II and 21.4% CCS III.

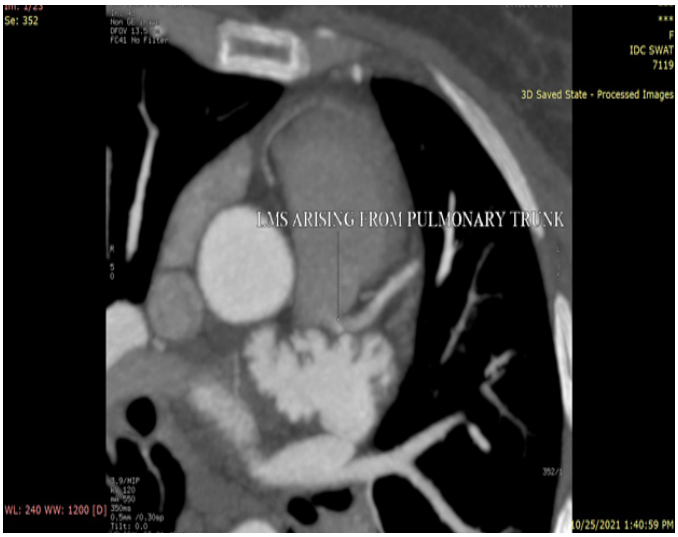

Figure 1a. Axial CT coronary angiogram showing left main stem arising from pulmonary trunk, suggestive of pulmonary artery-derived anomalous left coronary artery (ALCAPA)

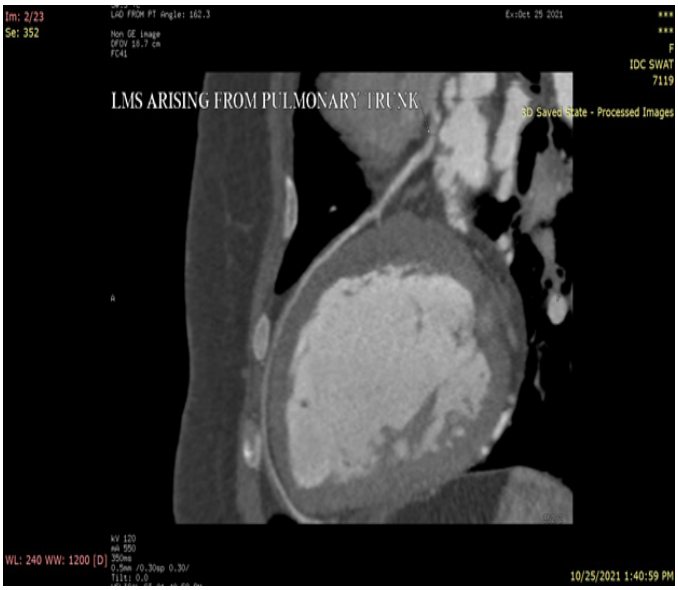

Figure 1b: Curved MPR CT coronary angiogram reconstructed image, showing left main stem arising from pulmonary trunk, suggestive of pulmonary artery-derived anomalous left coronary artery (ALCAPA)

During image reconstruction on the AW workstation, four distinct images were generated: (a) Maximum Intensity Projection (MIP), which allows the observation of the stenosis in a single vessel; (b) Curved Planar Reformations (CPR), which provide a detailed view of the vessel; (c) Volume Rendering Technique

(VRT), and (d) Multi-Planar Reformations (MPR), both of which facilitate the examination of the interaction between the myometrium and coronary arteries.

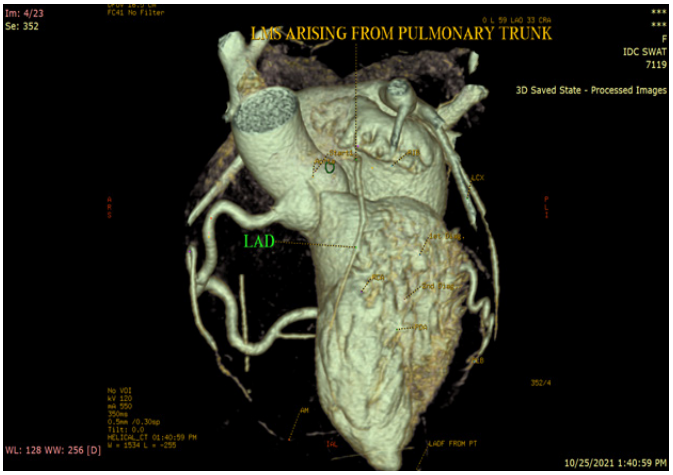

Figure 1c: 3 D Volume rendered CT coronary angiogram reconstructed image, showing left main stem arising from pulmonary trunk, suggestive of pulmonary artery-derived anomalous left coronary artery (ALCAPA)

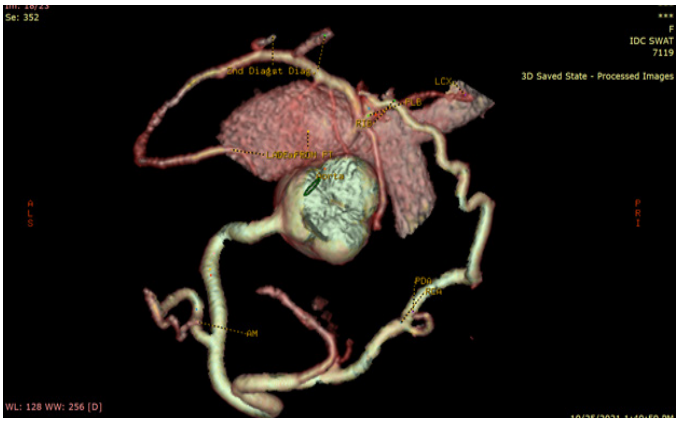

Figure 1d: 3 D Volume rendered CT coronary angiogram reconstructed image, showing left main stem arising from pulmonary trunk, suggestive of pulmonary artery anomalous left coronary artery.

Discussion

In our retrospective observational study, 1200 patients underwent CT angiography in the different branches of Islamabad Diagnostic Center, for a period of two years from May 2021 to May 2023. The findings showed that out of 1200 patients, coronary anomalies were present in 14 (2%) patients. Out of 14 total cases of anomalies of origin, 6 were observed with right coronary artery, 3 with diagonal, 2 with Posterior descending artery, 1 with obtuse marginal, and 1 with Ramus. We only observed the origin of anomalous coronaries and did not observe the anomaly of course and anomaly of termination. In contrast, a study by Fuad Zuki *et al.* in the clinical university of Sarajevo examined 919 patients and observed that 130 (14.1%) of them had coronary anomalous arteries, of which 14 (1.52%) had anomalies of origin, 115 (12.5%) had anomalues of course and 1 (0.1%) had anomalies of termination.[13] Anomaly of course and origin of both coronary arteries were also found in a study conducted by Smettei *et al* (2017) in the population of Saudi Arabia.[14] Referring to the symptoms and clinical presentation, we observed that 64.3% patients were hypertensive, 50% were diabetic, 92% patients had shortness of breath, 85% had chest pain, 35.7% were smokers and 42.9% had positive family history of anomalous coronary arteries.

Dyspnea classifications showed 50% patients with angina grading score, also known as the Canadian Cardiovascular Society (CCS) CCS I, 28.6% CCS II and 21.4% CCS III. Patient with coronary anomaly with malignant course of RCA often present with palpitation or chest pain resulting in ordering of tests like coronary CT angiography or conventional angiography. These tests help in diagnosing the patients whose coronary arteries have an abnormal origin. Unfortunately, many patients with malignant course of RCA especially when the artery traverses between aorta and pulmonary trunk may present with sudden cardiac death or cardiac arrest. According to another research, out of 115 patients with anomalies, 12.7% involved bridging, 37 involved the LAD, 25 involve D1 and D2, and 49 involved the ramus intermedius. It also showed that 0.43% involved the intra-atrial course of the RCA. The prevalence of bridging the LAD reportedly ranges from 0.5% to 2.5%, which is less than what our analysis found in the literature.[15] Only one incidence (0.1%) with a termination anomaly with a fistula between the coronary sinus was noted.[16] In comparison to other research statistics, 0.33% of individuals had coronary artery fistulas.[17,18]

Limitations of the study

Although it was a multicentered study and included all those patients who underwent coronary computed tomography, yet the small sample size was not representative of the whole population of Islamabad. Another limitation of our research is that a catheter angiography comparison was not made. Additionally, the population that presented to the hospital owing to a particular ailment was the focus of our study; healthy population was not included.

Conclusion

Coronary angiography is a highly effective method for identifying coronary artery arteries as well as course and termination. This non-invasive method accurately illustrates coronary abnormalities, giving crucial information for precise diagnosis and patient care planning. We can observe easily all the presentation which cannot be detected through other diagnostic tools.

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Authors' contributions: AM conceptualized the study design. RU and HM helped in data. AHK wrote the first draft of manuscript and analysis of the data. The final text draft was read and approved by all authors.

Conflict of interest: The authors affirm that there was no conflict of interest.

Funding: None

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Original Article

Expert Prediction Versus Difficulty Index Measured by Psychometric Analysis; A Mixed Method Study Interpreted through Diagnostic Judgment by Cognitive Modeling Framework

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Abstract

Objective: The item difficulty is determined in two ways; one relies on expert judgments, and the other on psychometric analysis. This study compared item developers' perceptions of item difficulty with psychometric analysis results and explored their thought processes in categorizing items.
Methodology: This explanatory sequential mixed method study was conducted from October to December in 2022 in three phases (quantitative, qualitative, and mixed method strand). Difficulty ranking of items by 20 subject experts, for all the preclinical years' end-of-module exams was compared with that obtained by psychometric analysis from the OMR (Optical Mark Reader). Cohen's Kappa was used to check the agreement and Pearson's correlation was used to infer the correlation between the two measures (item writers' perception of item difficulty and Rightmark analysis). All the item developers (20) were interviewed through an open-ended two-item questionnaire. Interviews were recorded and transcribed. Themes and subthemes were identified from interview data through manual coding. The anonymity of the participants was maintained.
Results: A total of 1150 items from Anatomy, Physiology, Biochemistry, Pharmacology, Pathology & Forensic Medicine were compared. These items were developed by 20 content experts. There was a weak positive (r=0.11) but significant correlation (p=0.00) between faculty perception and Right mark analysis of the item difficulty. However, there was no agreement between the two measurements (Cohen's Kappa k=0.042, p=0.027). The interviews of item developers identified four major themes: Academic performance, learning habits, the content targeted, and the item's construction.
Conclusion: Experts consider contextual factors which cover content and student background, when ranking items, while psychometric analysis is based on item performance data. Thus, contextual nuances may lead to differences in judgment.

Keywords: Assessment, Expert Prediction, Dia Com Framework, Item Difficulty, Test Psychometrics

Introduction

An ideal MCQ paper requires a balance of easy, moderate, and difficult questions. Item difficulty is a psychometric concept that measures how easy or difficult a test item is to answer correctly. It is determined in two ways. One common approach to predicting item difficulty is to rely on expert judgments, where subject matter experts rate the expected difficulty of each item based on their experience and intuition. The item developers may have different reasoning for ranking the items on a scale of difficulty (easy, moderate, and difficult) and other characteristics (cognitive level). This method has no set criteria for categorizing items on the difficulty scale. Another approach is to use empirical data from test administrations, where item difficulty is estimated using psychometric analysis (statistical analysis).[1] Both methods have advantages and limitations. The literature on the comparison of the two methods reveals variable findings but emphasizes the complexities of assessing item difficulty in educational contexts. It showed a correct estimate by the faculty of less than 50% on the one hand, an underestimation of difficulty by the faculty, and an overestimation by the students on the other hand.[2,3]

In Pakistan, there is a drive to adopt MCQs as the primary assessment tool for theoretical knowledge in undergraduate healthcare education. Departments of Medical Education in almost every institute are training the faculty to develop quality MCQs and interpret the statistical analysis of difficulty and discrimination indices. The pre-testing of newly added items is not only administratively and financially costly, but can also compromise item security which increases the reliance on expert judgment of item difficulty.[4,5] However, the prediction of item difficulty is an important task for test developers and researchers, as it can inform the selection and calibration of items for different purposes and populations for example for the standard setting of pass scores. In addition to that, this skill is a part of the teachers' assessment competence which is differentiable from other teacher competencies.[6]

Loibl and colleagues termed this skill as "Diagnostic judgment" by the teachers; they proposed a framework to understand the cognitive processes causal to such decisions by the faculty, the Diagnostic Judgment by Cognitive Modeling (The DiaCom Framework).[7]

Although post-hoc report generation and interpretation are routine in institutes where MCQs are the desired assessment tool, our local literature is not only lacking in data about the comparison of item developers' judgment and the post-hoc analysis but also in explaining the cognitive processes in this regard. Therefore, comparing the faculty judgment with the values obtained from the post-test scores and understanding the experts' reasoning for this seems

pertinent. In this study, we aim to compare the item developers' perception of item difficulty with the one obtained from psychometric analysis and discover the thought process behind the ranking given by them. We believe this will inform our future decisions while designing question papers. It will be a stimulus to the developers for critical thinking allowing them to revisit their judgments while ranking the items for future implementation of standard setting for determining passing scores.

Methodology

This was an explanatory sequential mixed-method study, which was conducted after the approval of IRB-IMDC (94/IMDC/IRB-2022) at Islamabad Medical and Dental College from October to December 2022.

Phase 1 Quantitative strand

The ranking of items on difficulty and cognitive basis by test developers was done while submitting the items to the MCQ bank; all item writers submitted their items individually to the bank. The two parameters were recorded from there, of all the end-of-module papers of 1st, 2nd, and 3rd year MBBS (20 modules) in the year 2021. These were compared with the difficulty index measured through psychometric analysis (condensed report) obtained from the OMR (Optical Mark Reader) or Rightmark. The item categorization of difficulty index (DI) on psychometric analysis was easy items <0.76 DI, moderate 0.45-0.75 DI, and difficult <0.44 DI.[8]

SPSS Version 20 was used for all statistical analyses. Cohen's Kappa was used to check the agreement between item writers' perception of the item's difficulty and the Rightmark analysis of the difficulty of items (difficulty Index). Pearson's correlation was used to find out the correlation between item writers' perception of item difficulty and assigned cognitive level as well as item writers' perception of item difficulty and Rightmark analysis of the difficulty level of items.

The data from the question bank and the condensed reports were used with the permission of the Head of the Examination Department after approval from IRB.

Phase 2 Qualitative strand

All the faculty members (twenty) of the first three years of MBBS whose items (MCQ) were used in the quantitative strand were interviewed (criterion/purposive sampling) through a two-item open-ended questionnaire.

1.What criterion do you use for ranking the item as easy moderate and hard?

2.What is the basis for applying this criterion (factors influencing this reasoning)?

Cognitive pre-testing of the interview questions was done for comprehensibility and respondent difficulties. It was done through think aloud technique, probing, and debriefing. Items were replaced and modified on that basis. The participants were Assistant professors, Associate Professors, and Professors in their disciplines. All the participants had prior training for item construction and identification of item writing flaws. Written informed consent was obtained and all interviews were face-to-face by the first two authors. A concurrent probing technique was used during the interviews.

All the interviews were audio recorded and transcribed manually by the authors. No repeat interviews were done, and the average time of the interviews was 10 minutes. The transcribed files were reviewed by all the researchers individually and matched with the audio. Modifications were done through consensus. Two strategies were used for generating meaning from transcribed data:

1. Open coding of the words/phrases, counting frequencies of the repeated words/phrases, followed by axial coding by combining the codes with the constant comparative method. Clustering was done by creating categories of words/phrases with similar meanings or connotations. The themes were further divided into subthemes.

2. Plausibility was checked with the help of analytic memos created while going through the transcribed data in the form of short phrases.

The findings were then interpreted based on Diagnostic judgment by Cognitive Modeling Framework by Katharina Loibl and colleagues.[7]

The anonymity of the participants was maintained. There were no potential risks for the participants and no monetary benefit was given to them.

Phase 3 Mixed method strand

The qualitative data was interrogated again by the first two authors, to gain additional insight into the quantitative results.

Results

Quantitative strand

A total of 1150 items of the twenty item writers (from Anatomy, Physiology, Biochemistry, Pathology, Forensic Medicine, and Pharmacology) who taught in a system-based integrated curriculum in first three years of MBBS were used in the study. All items were single best MCQs.

The item writers assigned a difficulty level to the items based on their experience and perception. Rightmark (Avison Scanner AD 240) calculated the statistical difficulty index for each of the items.

The total number of items submitted by each writer and the comparison of item writer perception to the Rightmark statistical analysis is shown in Table 1. The item writers also categorized the questions according to their cognitive level (Recall or Application). Of the 1150 questions, 763 (66.30%) were labeled as "recall", while 387 (33.70%) were "application" by the item writers.

Table 1: Number of items submitted by each item writer and the comparison of item writers' perception & and Rightmark analysis of difficulty

ITEM SUBMITTER	SUBJECT	ITEM WRITER PERCEPTION (LEFT) & RIGHTMARK ANALYSIS OF DIFFICULTY (RIGHT)						
		EASY		MODERATE		DIFFICULT		TOTAL
1	Physiology	50	47	22	23	11	13	83
2	Anatomy	3	20	58	24	2	19	63
3	Biochemistry	4	20	30	11	2	5	36
4	Anatomy	38	46	66	38	6	26	110
5	Biochemistry	37	16	15	25	0	11	52
6	Physiology	14	21	32	19	3	9	49
7	Anatomy	19	31	49	28	2	11	70
8	Physiology	26	29	53	30	5	25	84
9	Anatomy	14	17	31	18	1	11	46
10	Biochemistry	12	25	54	29	0	12	66
11	Biochemistry	0	19	61	30	1	13	62
12	Physiology	17	36	51	29	11	14	79
13	Pathology	6	9	30	14	4	17	40
14	Pharmacology	3	8	17	7	0	5	20
15	Forensic Medicine	49	36	59	28	0	44	108
16	Pharmacology	2	18	37	8	0	13	39
17	Pathology	15	15	29	21	6	14	50
18	Pathology	1	11	16	5	3	4	20
19	Pharmacology	1	5	42	15	0	23	43
20	Pathology	6	9	21	18	3	3	30
TOTAL		**307**	**438**	**771**	**420**	**56**	**292**	**1150**

There was a weak positive (r=0.26) but statistically significant correlation (p = 0.000) between faculty perception of the difficulty of items and their assigned cognitive levels implying that more difficult questions were labeled as Application cognitive level.

In table 2, all of the comparisons show no agreement between the two measurements, and of all the writers, writer 12 and 17 showed the highest level of agreement.However, there was seen a weak positive but statistically significant correlation between faculty perception of difficulty of items and Rightmark analysis (r = 0.11).

Qualitative strand

Of the twenty item developers, eighteen agreed to participate in the study. There were 2 (20%) male and 16 (80%) female participants with an age range of 30-68 years. We explored the thought process of the item developers for the categorization of the items on a scale of difficulty. In response to the first question, four themes and eight subthsemes were identified. The themes were categorized under two heads; related to students and related to items (Table 3)

Two factors emerged in response to the second question: 1; the interactions of the test developers with the students in class and 2; their teaching experience. When we asked them why their item ranking did not match the post-test analysis, some attributed the students (for not studying well or being stressed during the exam); some acknowledged their errors and some claimed that they usually ranked the items correctly.

We interpreted the qualitative findings in light of the DiaCoM framework (Figure 1), which stands for Diagnostic Judgements-by Cognitive Modeling Framework, designed by Loibl and colleagues.[7]

Mixed method strand

A review of the qualitative data in the perspective of quantitative results led to the following insights:

1. The experts were too focused on didactic teaching, they thought that students learn only through lectures and student-centered learning methods are of little use.

2. Almost all experts thought that the recall questions were easy, yet they tagged the majority of the recall items as moderate.

Table 2: Agreement between Item writers' perception and Rightmark difficulty analysis

ITEM SUBMITTER	Agreement (Cohen's Kappa, k)	p
1	0.125	0.120
2	0.009	0.846
3	0.027	0.721
4	-0.030	0.642
5	0.042	0.622
6	0.035	0.728
7	-0.104	0.215
8	-0.007	0.918
9	0.108	0.870
10	0.152	0.43
11	-0.022	0.352
12	0.189	0.010
13	-0.21	0.809
14	0.066	0.538
15	0.070	0.176
16	-0.50	0.157
17	0.178	0.068
18	-0.145	0.103
19	-0.027	0.226
20	0.085	0.543

Table 3: Themes and subthemes for assigning an item easy, moderate, or difficult by the experts

Themes and subthemes	Illustrative Quotes
Theme "Academic performance"	
Subtheme "Average student "	"A moderate question is the one that an average student will be able to solve" "An easy question is the one that a below-average student can answer correctly"
Theme "Learning habits"	
Subtheme "Superficial learners"	"Most of the students study superficially to answer the MCQs"
Theme "Construction of the Item"	
Subtheme "Cognitive level" (Application or recall)	"The recall questions are easy because there is not so much mental work". "We categorize recall questions under the easy category and usually, application-based questions are categorized as moderate and difficult"
Subtheme "The phrasing of the items"	"When something is asked indirectly they are categorized as difficult"
Theme "Content"	
Subtheme "Repetition"	"Easy questions are the ones that target content repeated many times "
Subtheme "Teaching Strategy"	"Difficult ones are the ones targeting content that is left to the students for self-study. For example, some learning objectives are covered through small group discussions with students knowing that they are not that important"
Subtheme "Difficult concepts"	The difficult items have difficult concepts that are difficult to retain

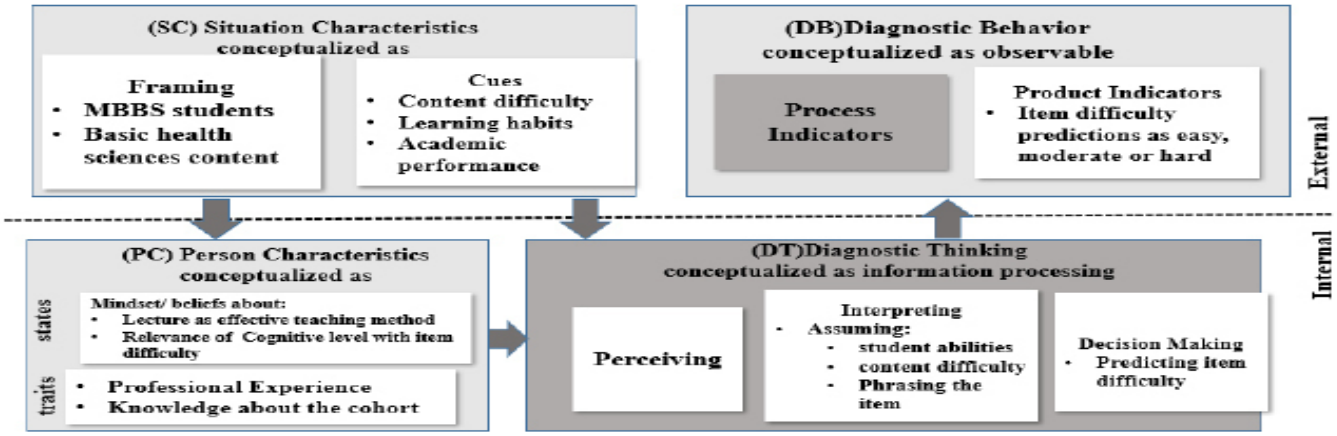

Figure 1: The DiaCom Framework

Discussion

In this explanatory sequential mixed method study, the expert prediction of item difficulty was compared with the one obtained from psychometric analysis for agreement between the two (the quantitative analysis). Later the experts were interviewed to explain the quantitative findings, which led to the unveiling of four themes (the qualitative analysis); Academic performance, learning habits, the content targeted, and the item's construction. The quantitative analysis revealed no agreement between the item writers' perceptions and the actual item difficulty. This is contrary to the expectation as the item writers are not only experts with postgraduate qualifications but with teaching experience ranging from three to thirty years. Our observation conflicted with the findings of Witat Fakcharoenphol and colleagues who had observed accurate predictions of test item difficulty by the content expert test-makers[9] and attributed this to their experience. The qualitative strand showed that they have varied reasons for their classification. It is reasonable to state that assigning the item difficulty is very subjective and it is not unusual that the two measurements do not match.[5] Urhahne and Wijnia in their meta-analysis on the accuracy of school teachers' judgment concluded that teachers' experience is only weakly associated with judgment accuracy.[10] We can also attribute these findings to the "Experts' blind spot" that leads teachers to inaccurately judge student abilities especially while assessing the difficulty of the task.[11] Interesting facts were revealed while exploring the reasoning behind their perception of an item's difficulty. It was influenced by two main factors; the characteristics of the students and the item suggesting that it is not a fixed attribute, but a relative and situational one.

Our experts compared the difficulty of an item to the expected level of performance of the students and adjusted their judgment accordingly. For example, they characterize a student as an "average performer" if his or her assessment scores are close to the mean. They would classify the questions expected to be answered correctly by such students of moderate difficulty. This assumption about the competence of the examinees while designing test items aligns with the guidelines by Gerard and Janine who argue that it is important to consider the "level of student population" while composing the assessment for a given performance standard so that it can be associated with the difficulty of the assessment. This is a usual practice in standard-setting procedures to think about an average or below-average student while assigning difficulty to test items.[3] The second theme refers to the faculty members' perception of the learning habits of their students. They generally had the view that most of the students were superficial learners. Thus while ranking they classify the items that require deeper thinking as difficult compared to the ones targeting lower thinking levels like recall and comprehension. This notion is linked to the other subtheme "cognitive level" identified under the theme "construction of the item" where the same reasoning is repeated that an item targeting a higher cognitive level like application is ranked as moderate or difficult as compared to the one targeting testing of rote memory. This was in line with the findings of the quantitative strand where a weak positive but statistically significant correlation was found between the cognitive level and difficulty of items. However, there is conflicting evidence in the comparable literature. The findings of Rush and colleagues are closer to our observations that increasing the cognitive complexity directly increased the difficulty of the items.[12] The percentage of recall (60% vs 66%) and application (30% vs 34%) items in both studies is also similar. However, the works of Pedro et al and Kibble and Johnson did not find any correlation between the cognitive level of the item and the difficulty of the item on psychometric analysis.[13,14] The difference might be due to the difference in sample size and characteristics of the cohort or the delivery of content; whatever the case maybe our quantitative results are validating the perceptions of the experts in this case. The experts also shared that phrasing of the item is important because indirectly asked questions were termed as difficult and directly asked questions as easy, by them. This premise aligns directly with the theory of affordances which implies that the way information is presented influences the way the human mind processes it.[15] Different ways of presenting the same problem lead to distinct problem-solving approaches.[15] Thus indirectly asked questions require additional cognitive processing as compared to direct ones. Analogously, they lack clear affordances, making them more challenging. Consequently, the directly asked questions are perceived as easier because the affordances guide the respondents. The most repeated word in the transcribed text was content and it emerged as a separate theme. It influenced the item writer in different ways; they thought of content in terms of its difficulty, its repetition in class, and the teaching strategy used. They based their judgment of the difficulty of items on the concepts the students struggled with[16] which they identified during formal or informal student interaction.[17] Similarly, they deemed that content or information easy that was repeated or reiterated in various academic sessions. Another interesting subtheme was the teaching strategy. Some of the experts thought that the content learned through learner-centered strategies like small group discussions and problem-based learning were difficult and the ones taught by the experts in the lectures were relatively easy. Hence, they ranked the item based on the teaching method used as well. This perception is contrary to the empirical evidence where learner-centered strategies are proven to improve students' critical thinking and application of content.[18]The researchers endorse the teachers' ability to identify learners' level of understanding and predict their performance is crucial for effective teaching. Although the research struggles to precisely measure or link it directly to better learning outcomes.[19] Application of DiaCom framework to our qualitative findings (Figure 1) depicted how Situational Characteristics (SC), such as basic health sciences context and framing biases, influence Perceptual Characteristics (PC), including mindset and professional experience. These characteristics impact Diagnostic Thinking (DT), which involves assessing situations and decision-making processes. The framework suggests that these elements collectively contribute to Diagnostic Behavior (DB), observable through various product and process indicators. This model highlights the complexity of diagnostic decision-making and the interplay between different factors affecting it.

Limitation

The limitation of our study is that it focused only on the preclin-

ical years in a single institute. Valuable insights would have been gathered by including clinical teachers in the study and analyzing the item statistics from clerkship exams.

Conclusion

The expert prediction is influenced by many factors which are usually contextual and lead to discrepancies and errors in judgments. In contrast to that the psychometric analysis is solely based on statistical properties like response patterns. Despite the soundness of reasoning, these findings raised questions about the quality of expert judgments because of the stark disagreement between the two rankings. While experts' insights are valuable and educationists suggest a combination of both perspectives (experts' opinion and psychometric history) of items for predictability, we advise otherwise and propose reliance on item history.

Implications of the study

Many variables have been suggested to explain item difficulty, but predicting item difficulty is still a difficult problem in educational assessment. This study has the potential to affect different areas; it can inform how we weigh expert predictions versus data-driven approaches (psychometric analysis) in decision-making, it can contribute to the development of AI systems combining expert knowledge with data analysis leading to more accurate predictions, information can be used to develop training programs for experts for improved judgment.

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Authors' contribution: MM is the principal investigator who conceived the idea and collected the data (psychometric analysis and interviews), transcription and thematic analysis, and manuscript writing. SI collected the data (psychometric analysis and interviews), transcription and thematic analysis, and intellectual input to the manuscript. AT developed the Interview script, statistical analysis and interpretation, transcription and thematic analysis, and intellectual input to the manuscript. RS supervised the project, transcription and thematic analysis, and gave intellectual input to the manuscript

Consent form for the study

https://docs.google.com/document/d/10GD2OQc6GAo0WsUZ4VwF-HKD4Kq0Q9NYo/edit

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Original Article

Variations in Optic Cup to Disc Ratio Due to Refractive Errors and Smoking

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Abstract

Objective: To evaluate the deviation of Optic Cup to Disc Ratio with refractive errors and smoking status.
Methodology: This was a cross-sectional observational study carried out from January to October, 2016 at Dr Akil bin Abdul Kadir Institute of Ophthalmology, Karachi, Pakistan. A total of 300 eyes of 300 patients were included in the study and divided according to the error of refraction into emmetropic (n=135), hypermetropic (n=77) and myopic (n=88) eyes for Cup to Disc Ratio measurements. To assess the effect of smoking, emmetropic eyes were further divided into smokers (n=23) and nonsmokers (n=112). Independent T test and ANOVA was used to analyze the differences in the mentioned groups. P value <0.05 was taken as significant.
Results: The optic Cup to Disc Ratio in emmetropic eyes was found to be 0.27 ± 0.03. It was found to be significantly decreased in myopic eyes (0.24 ± 0.05) and significantly increased in hypermetropic eyes (0.31 ± 0.07) with p value = 0.01. CDR was significantly increased in smokers (0.31 ± 0.07) than nonsmokers (0.26 ± 0.01) with p value of 0.01. These findings will aid the clinicians in diagnosing and treating different ophthalmic diseases involving the optic cup.
Conclusion: Cup to Disc Ratio was significantly increased in myopic eyes and significantly decreased in hypermetropic eyes compared to emmetropic eyes. Smokers and nonsmokers also showed significant variations in CDR. This study concludes that the cup to disc ratio is significantly affected by the refractive errors and smoking status.

Keywords: Optic Disc, Refractive Errors, Smokers, Cup to Disc Ratio.

Introduction

The optic Cup-to-Disc Ratio (CDR) is a fundamental, ophthalmologic, parametric test used in the clinical setting for evaluation of various eye conditions and progression of ocular diseases. It shows the proportion of the optic cup's diameter to that of the optic disc and is crucial in assessing the health and integrity of the optic nerve head. The optic cup and disc are located at the posterior pole of the eye globe, appearing as a pale, circular structure, visible through fundoscopy.[1]

The optic disc is a slightly vertical oval area which marks the region from where retinal nerve fibers exit the eyeball to form the optic nerve. The optic cup is a central depression within the optic disc. The vertical dimensions of both are critical for assessing the anatomical and physiological conditions of the optic nerve head. The CDR is expressed as a ratio, quantifying the relative sizes of the cup and disc. The size of the optic disc effects the measurements of CDR. Eyes having larger optic discs tend to have larger cups, ensuing relatively smaller CDR, while smaller discs have higher CDR values because of proportionately larger cup size.[2]

Examination and measurement of CDR helps clinicians to get valuable insights into underlying ocular conditions.[3] Any deviation in CDR from the normal may suggest optic nerve damage due to various ophthalmic or systemic pathologies, especially glaucoma and also indicate the progression of the disease.[4,5] Understanding the link between CDR and different eye conditions is important for accurate diagnosis, timely intervention and planning of effective management strategies. The CDR is commonly influenced by factors that include anatomical features and physiological deviations besides pathological conditions. Studies have shown that the CDR increased with increase in age,[6,7] as changes in connective tissues and vascular supply contribute to alterations in optic disc morphology with advancement in age.[8] The CDR measurements have also shown to be impacted by gender, with males exhibiting increased CDR compared to females.[6] Ethnicity is also known to influence retinal thickness and optic disc morphology, showing variations in disc size, shape, and CDR among different racial groups.[9] Axial length has proven to alter CDR because the changes in the eye globe tend to change the size and shape of the optic disc.[10] In myopia, eyes with longer axial lengths, are likely to have larger optic discs and cups, leading to a potentially higher CDR. In hypermetropia, CDR tends to decrease.[11-13] Elevated intraocular pressure is also known to have mechanical stress on the retinal layers, resulting in retinal thinning leading to cupping and raised CDR. Glaucoma is commonly related with raised (IOP) resulting in progressive enlargement of the cup and hence, the increased CDR.[14] Smoking has been attributed with several ocular pathologies, including retinopathies, ischemic optic neuropathy and macular degeneration.[15] It has also been implemented in early cataract formation secondary to accumulation of toxins in the lens. Retinal scans obtained by Optical Coherence Tomography (OCT) has also shown to cause thinning in the retinal nerve fiber layer in smokers.[16] This study was formulat-

ed to investigate the relationship between CDR, refractive errors and smoking in our population. Understanding this relationship will aid ophthalmologists in diagnosis, evaluation and management of existing and prevention of potential ocular diseases.

Methodology

This cross-sectional research included 300 eyes from 300 individuals from an eye clinic of Karachi, Pakistan. Convenient sampling method was used. Sample size was calculated to be 300, using WHO sample size calculator. Ethical approval was taken from Ziauddin University, Karachi, Pakistan. (Ref. # 0271214SMANA) and samples were obtained from the ophthalmology OPD at Akil bin Abdul Qadir Institute because the facility of Optical Coherence Tomography was not available at Ziauddin Hospital. Participants of both sexes, more than 40 years of age and having apparently normal eyes were selected for the study. To rule out glaucoma, eyes with controlled intraocular pressure (IOP) were included only. Those eyes with any other retinal pathologies, diabetic and hypertensive retinopathies, history of laser therapy or intraocular surgery, diseases such as parkinsonism or multiple sclerosis, high refractive errors were also not included. After getting the informed consent, participants underwent a detailed ophthalmic examination which included slit-lamp bio-microscopy, refractive error testing and visual acuity. As the internal environment is the same for both the eyes, a single eye was randomly selected from each participant. The selected participants' eyes were first grouped according to the error of refraction into emmetropic (n=135), hypermetropic (n=77) and myopic (n=88) eyes. Then these participants were sent for further examination and CDR and IOP measurement. The emmetropic eyes were further evaluated to see the effects of smoking on CDR measurements. Two groups were made: Smokers (n=23) & Nonsmokers (n=112) and their CDR measurements were compared.Statistical analysis was done by SPSS, version 20. Mean and standard deviation were used for the quantitative variables. For the qualitative variables, percentages and frequencies were used. Independent T test and ANOVA was used to analyze the differences in the mentioned groups. P= <0.05 was taken as significant.

Results

A set of 300 eyes from 300 individuals were involved in this study. The mean age of the participants was 57.67 ± 11.42 years. The distribution of study participants according to gender and error of refraction is shown in Table 1.

Table 1: Basic distribution of Study Participants According to Gender & Error of Refraction.

Error of Refraction	Gender (N)		Total (N)
	Males	Females	
Emmetropia (N)	67	68	135
Hypermetropia (N)	35	42	77
Myopia (N)	48	40	88
Total (N)	150	150	300

N = number of eyes

Table 2 shows the CDR measurements in each group of refractive errors that include Emmetropic eyes, Hypermetropic eyes & Myopic eyes. Hypermetropic eyes show significant decrease in CDR whereas Myopic eyes show significant increase in CDR as compared to Emmetropic eyes Table 2, Figure 2.

Table 2: CDR Measurements in Eyes with Refractive Errors

Error of Refraction	N=300	CDR Mean ± S.D	P Value
Emmetropia	135	0.27 ± 0.03	0.01*
Hypermetropia	77	0.24 ± 0.05	
Myopia	88	0.31 ± 0.07	

N = number of eyes, S.D.= standard deviation *highly significant

It was observed that smoking affected the retina, involving its layers specially the retinal nerve fiber layer leading to visual disturbances. Keeping this in mind, we assessed the emmetropic eyes using the history of smoking as a variable. Out of 135 emmetropic eyes, we found that 23 eyes were of smokers and 112 eyes belonged to nonsmokers. The CDR was measured and it was found to be significantly different in between the two groups Table 3, Figure 3.

Table 3: CDR Measurements in Smokers and Non-Smokers

Smoking Status	N=135	CDR Mean ± S.D.	P Value
Smokers	23	0.31 ± 0.07	0.01*
Nonsmokers	112	0.26 ± 0.01	

N=number of eyes, S.D.= standard deviation, *highly significant

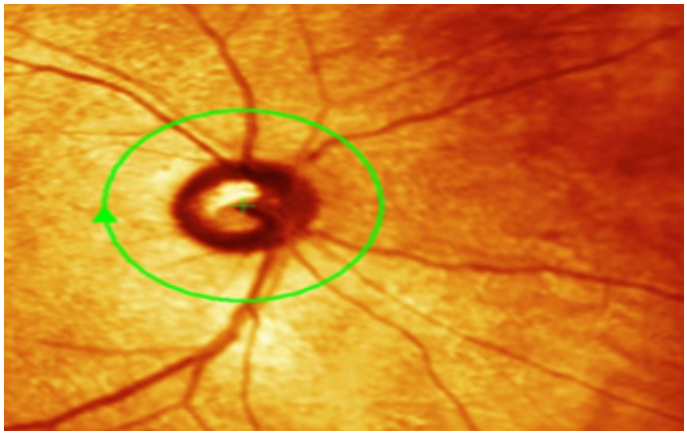

Figure 1: Optic Nerve Head in a 55 year old emmetropic male eye when observed through Optical Coherence Tomography.

Figure 1 shows the appearance of Optic Nerve Head for measurements of CDR when observed through Optical Coherence Tomography.

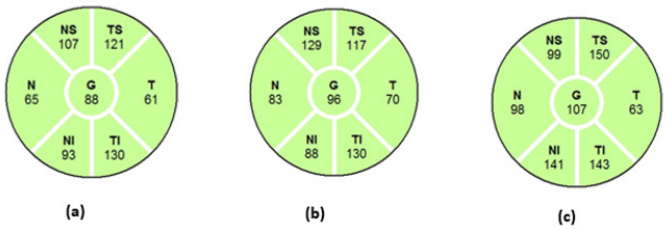

Figure 2: Retinal Nerve Fiber Layer (RNFL) thickness in each quadrant of Optic Nerve Head (ONH) in 58 years old males having (a) emmetropic eye (b) myopic eye & (c) hypermetropic eye by using OCT where G= mean global thickness at ONH, NS= Nasal Superior, TS=Temporal Superior, T=Temporal, NI= Nasal Inferior, TI=Temporal Inferior, N= Nasal

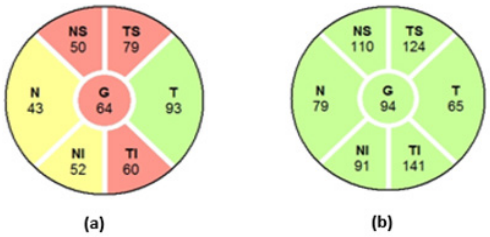

Figure 3: Retinal Nerve Fiber Layer (RNFL) thickness in each quadrant of Optic Nerve Head (ONH) in 55 years old males with (a) smoking & (b) non-smoking status by using OCT where G= mean global thickness at ONH, NS= Nasal Superior, TS=Temporal Superior, T=Temporal, NI= Nasal Inferior, TI=Temporal Inferior, N= Nasal

Discussion

A total of 300 eyes from 300 patients were examined in this study. The eyes were initially divided according to refractive errors. After examination, the division was: 135 eyes in the emmetropic group, 77 eyes in the hypermetropic group and 88 eyes in the myopic group. Based on the fact that retinal thickness ultimately effects the CDR,[2] CDR was measured of each group. The process of aging precedes ophthalmological complications, so only those subjects who were 40 years and above were selected, and the mean age of the participants that were included in our study was 57.67 ± 11. 42 years. CDR measurements in myopic group were significantly increased while in hypermetropic group CDR was significantly decreased in comparison to emmetropic group. [Table 2, Figure 2] These observed alterations could be related to difference in axial lengths which influences optic disc size. Significant increase in CDR of myopic eyes supports the fact that retinal thickness is reduced by short sightedness. When retina gets thinner the CDR increases.[12] It is postulated that the degree of elongation of the globe is related to the extent of retinal thinning, leading to reflex stretching and increased CDR.[17,18] This theory is also supported by Ganekal et al.(2021) in their study done in 2020.[19] Other studies done by Tai et al. (2018) Hamed et al. (2019) Ibrahim et al.(2020) and Oishi et al.(2020) also found the same effect of myopia and axial length on Retinal nerve fiber layer (RNFL) thickness and subsequently on CDR.[20-23] Previous research was conducted which showed smoking to cause a significant decrease in retinal nerve fiber and ganglionic cell layers.[23] To avoid any confounding effects of refractive errors, we analyzed the difference in the CDR of smokers and non-smokers in emmetropic group only. The smokers showed significant increased CDR compared to non-smokers which could be due to decrease in retinal thickness (Figure 3). A study conducted by Dervişoğulları et al.(2015) confirmed the results of our study and proposed that smoking history of a patient should be considered when inferring the results of ophthalmic examinations.[24] Liu et al.(2015) has suggested that smoking caused decreased optic disc perfusion, leading to disruption in retinal thickness and CDR.[15] The harmful effects of cigarette smoking on deep retinal vascular density were also seen by Dogan et al.(2020)[25] In another study, Abdelshafy observed functional and structural changes in the RNF and ganglionic cell layers in heavy smokers.[26] Kaymaz et al.(2020) demonstrated that even after smoking a single cigarette, the vessel density parameters were markedly decreased.[27] The onset of age-related macular degeneration is also augmented with smoking exposure as shown in mice by Feng et al.(2020)[28] Using the results of our study as a forerunner, further studies using a larger sample size should be designed to achieve a normative data base for our population, which would help in screening of high-risk people with diseases involving ONH.

Limitations

Our study was conducted in Karachi, which is a multicultural metropolis; hence, ethnicity may pose to be a significant limitation as a confounding factor.

Conclusion

This study concludes that CDR was significantly affected by refractive errors and smoking. CDR significantly increased in myopic eyes while decreased in hypermetropic eyes compared to eyes with no refractive errors. The CDR measured in smokers was significantly raised compared to non-smokers' eyes. These parameters are important to consider while assessing ophthalmic diseases involving the retina.

Authors' Contribution: SM idea conception, data collection and analysis, literature search & manuscript writing; ABA literature search; NY data analysis; MS Data collection & literature search; AA data collection; NH supervision of the whole process.

Conflict of Interest: Authors have declared that no competing interests exist.

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Original Article

Diagnostic Accuracy of Modified Kenneth Jones Scoring Criteria as Screening Tool to Diagnose New Cases of Pulmonary Tuberculosis in Children

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Abstract

Objective: To evaluate the effectiveness of the Modified Kenneth Jones Scoring System as a screening tool for diagnosing pulmonary tuberculosis in children.
Methodology: A cross sectional study was conducted to assess the symptoms of tuberculosis among 100 pediatric patients with male to female ratio was 67:33. through Modified Kenneth Jones Scoring System (MKJSC) at Gulab Devi Tertiary Care Hospital, Lahore from June-December, 2022. The study included symptoms based on gender, drug usage and microbial load. Patients diagnosed with TB were included in this study to assess the system's effectiveness in identifying specific symptoms and clinical manifestations of TB. This inclusion allowed for a comprehensive evaluation of the MKJSC's diagnostic accuracy and its potential utility in early detection and intervention in pediatric TB cases. The Data was analyzed using SPSS to identify specific symptoms.
Results: The Modified Kenneth Jones Criteria diagnosed 65 patients out of 100 with one false positive. The sensitivity for TB detection was 84.2% (95% CI: 73.6% - 91.2%), specificity was 95.8% (95% CI: 76.8% - 99.7%), positive predictive value was 98.4% (95% CI: 90.5% - 99.9%), and negative predictive value was 65.7% (95% CI: 47.7% - 80.3%). Statistical analysis with 5% confidence interval revealed a medium of age of 73 months and a mode of 120 months among patients. While cough prevalence varied, all patients had a history of prolonged fever. Meningeal irritation was observed in 52% of participants and 77% had contact with TB patients. Other findings included malnutrition 50%, pneumonia 48% and BCG screening 24%.
Conclusion: The Modified Kenneth Jones Scoring System demonstrated high sensitivity and specificity in detecting tuberculosis, outperforming previous methods. It proves to be an effective tool in resource-limited healthcare settings for diagnosing TB in children.

Keywords: Tuberculosis, Bacterial load, Modified Kenneth Jones Scoring System.

Introduction

Tuberculosis (TB) remains a major global health concern, causing significant morbidity and mortality worldwide.[1] To effectively combat this infectious disease, it is essential to comprehend the clinical and diagnostic manifestations of tuberculosis patients, particularly with respect to their physical aspects and related signs and symptoms. Early detection and precise diagnosis are critical for ensuring prompt treatment initiation and decreasing the spread of TB in the community.[1]

The majority of pediatric populations who are infected with Mycobacterium tuberculosis exhibit a lack of clinical symptoms.[1,2] On the other hand, the likelihood of disease progression and extrapulmonary manifestations is greater within the first two years of life, with a progression risk of 40-50%.[3] Of all cases of TB disease in children, pulmonary TB accounts for approximately 60-80%, with most cases developing within 2-12 months of initial infection.[4] The most prevalent extrapulmonary manifestation is lymphadenopathy, followed by central nervous system involvement.[4] The classification system utilized here distinguishes between thoracic and extra thoracic disease, recognizing that hilar or mediastinal adenopathy, often viewed as extrapulmonary disease, is a defining characteristic of pulmonary disease in children. Separating pulmonary foci from regional adenopathy is not biologically significant.[5]

The primary source of infection for most children who have contracted the disease share close living quarters, often within the same household. This course of action facilitates the identification of children who are at risk of developing TB disease because of recent infection within the household and enables the early detection of eligible children who can benefit from isoniazid preventive therapy (IPT).[6] By implementing contact screening, vulnerable children can be recognized, and appropriate measures may be taken to prevent the progression of the disease.[7] In the Kenneth Jones scoring system, various clinical and radiological factors are assessed to determine the likelihood of TB in a child. These factors include symptoms like persistent cough, fever, weight loss, and radiological abnormalities like chest X-ray findings.[8] However, the presence and severity of these symptoms and abnormalities may vary depending on the type of TB manifestation in the child.

In this study, Kenneth Jones scoring system was used as screening tool for TB diagnosis in children, where sputum contained a high bacterial load.[9] Despite recent advancement and improvements in bacteriological test, their performance in diagnosing childhood TB does not meet the expectations outline in the world health organization, endorsed target products profile for TB diagnoseis.[10] The study aimed to assess the diagnostic accuracy of MKJSC as screening tool

for diagnosing pulmonary tuberculosis in children. In involved evaluating TB symptoms among pediatric patients and analyzing data to determine the sensitivity, specificity and predictive values of the MKJSC in detecting TB cases. The objective was to provide insights into the performance of the MKJSC and its potential utility in resources limited healthcare setting for early TB diagnosis in children. By examine the diverse physical aspects such as specific sign and symptoms, we aimed to acquire insights into the presentations of TB in this population.

Methodology

The present research employed a cross-sectional study design to investigate TB patients' clinical and diagnostically manifested symptoms with implementation of MKJSC. A study was conducted at Gulab Devi Tertiary Care Hospital in Lahore, Pakistan, serving as a representative sample of the region. A detailed methodology was employed to compile and analyze the data. The data was collected and underwent analysis utilizing the SPSS statistical tools to ensure the statistical validity of the finding. The research study focused on evaluating the diagnostic accuracy of the modified Kenneth Jones scoring system as a screening tool for the identification of new cases of tuberculosis. The ethical letter was obtained from ERB with tracing ID: AAMC/IRB/EA-28.2022.

The study sample comprised of 100 children of both gender, who were diagnosed with TB based on clinical and laboratory criteria. A convenience sampling approach was implemented, wherein qualified participants who satisfied the inclusion criteria were consecutively enrolled until the desired sample size was attained. The patients were recruited from outpatient department of the participating hospital after obtaining consent from the legal guardians of the children. Sputum culture was used as a scoring standard to determine the diagnostic accuracy of MKJSC, and the scoring system was determined by calculating measures such as sensitivity, specificity, positive predictive values, negative predictive values and the area under the receiver operating characteristic curve. These measures offer an assessment of the system's ability to accurately identify individuals with and without tuberculosis. The trained personnel involved in the research project employed standardized data collection forms, which included clinical symptoms, medical history, and participant demographics such as age and gender. Diagnostic procedures and bacterial detection techniques were performed to ascertain the level of microbial burden and establish the presence of TB infection. SPSS version 21 was used to analyze the data. Descriptive statistics, such as frequencies and percentages, were utilized to compile the research participants' demographic details and clinical symptoms. In instances where it was appropriate, as per the collected data and information, the chi-square test or Fisher's exact test was employed to examine the relationship between variables. The statistical significance was defined as a p-value of 0.05.

Results

The system exhibited a high degree of sensitivity, specificity, and an overall accuracy in differentiating between individuals with tuberculosis and those without the disease. Table 1 shows the distribution of ages within the study population. The median age was 73 months (average 67.01 months), while the mode was 120 months. Although only 69% of participants reported having a cough that lasted longer than two weeks, all patients had a history of fever that lasted longer than two weeks. In the oldest and youngest age groups, coughing was more prevalent.

The 52% of the patients surveyed showed signs of meningeal irritation, including symptoms of fits; 77% of respondents said they interacted with somebody who had previously been diagnosed with tuberculosis; 4% of interviewees said they had never had whooping cough, whereas 15% confessed they had measles in the past. Only 24% of the patients showed evidence of the BCG vaccine scarring, and 52% of the patients showed signs of malnutrition. Physical tests of the patients indicated pleural effusion in 8%, gibbus deformity of the thoracic spine in 2%, and pneumonia in 48% of the patients. In 49% of the research sample, radiological data showed significant opacity and different bronchovesicular patterns. Additionally, 14% of the people showed signs of miliary mottling. In 57% of the individuals, a BCG response higher than 10mm indicated a satisfactory diagnostic result. 52% of those polled had CSF fluid that may have been connected to tuberculous meningitis. Compared to 29% of the patients who had positive results for acid-fast bacilli, only 11% had cultures that tested positive for Mycobacterium tuberculosis.

The Modified Kenneth Jones criteria were found to be satisfied by 65 patients, and there was only one incidence of a false positive diagnosis. It's important to note that, according to the Kenneth Jones criteria, only 12 out of the total study participants received a negative score (below 7). However, the results of subsequent tests revealed that these patients did in fact have tuberculosis. The computed sensitivity for tuberculosis detection using the Kenneth Jones criteria was 84.2%, with a 95% confidence interval (CI) ranging from 73.6% to 91.2%. A specificity of 95.8% (95% CI: 76.8% to 99.7%) was found. Additionally, it was found that the positive predictive value was 98.4% (95% CI: 90.5% to 99.9%) and the negative predictive value was 65.7% (95% CI: 47.7% to 80.3%).

The quantification of the bacterial load, which represents the concentration of Mycobacterium tuberculosis in a patient's system, was assessed and categorized into three levels: low, medium, and high. By quantifying the bacterial load, medical practitioners can employ the most optimal means MKJSC of infection control to curb the spread of tuberculosis and make informed decisions about the selection and duration of antibiotic therapy.

The outcomes of the study propose that the modified Kenneth Jones scoring system can be a valuable tool in the primary screening and diagnosis of tuberculosis cases. Its high diagnostic accuracy makes it a potentially useful approach in resource-limited settings where access to advanced diagnostic techniques may be limited. The sign and symptoms with bacterial load over age are mentioned in Table 2 within gender base.

Table 1: Data of some patients from this cross sectional study

Age (months)	Gender	Symptoms	Bacteria Load Detection	Other Evidence	MKJSC
14-15	Male	Cough, Weight Loss	Low	Mantoux Positive, Hemoptysis	3-4
13-14	Female	Fever, Cough	Low	Mantoux Positive, Sputum ATB Positive,	≥5
12-13	Male	Fever, Cough, Weight Loss	Medium	Sputum ATB	3-4
11-12	Female	Fever, Cough, Weight Loss	Medium	Sputum ATB	3-4
8-10	Male	Fever, Cough	High	Mantoux Positive, Sputum ATB Positive,	≥5
5-8	Female	Fever, Cough, Weight Loss	High	Mantoux Positive, Sputum ATB, Sputum	≥5
3-5	Male	Fever, Cough, Weight Loss	High	Sputum ATB	3-4
1-2	Female	Fever, Cough, Weight Loss	High	Sputum ATB	3-4
<1	Male	Fever, Cough, Weight Loss	High	Sputum ATB	3-4

Table 2: KJ Scoring and Gene Expert Comparison

KJ Score	Inference	Gene Expert*	KJ score Efficiency (Total)	Std. Dev.
3-4	Negative	Negative	100%	3.808
≥5	Positive	Negative	MTB Detected	
3-4	Negative	Negative	100%	
3-4	Negative	Negative	100%	
≥5	Positive	Positive	100%	
≥5	Positive	Positive	100%	
3-4	Negative	Negative	100%	
3-4	Negative	Positive	MTB Not Detected	
3-4	Negative	Negative	100%	

*Gene Expert is a rapid molecular diagnostic test for tuberculosis and rifampicin resistance. It detects Mycobacterium tuberculosis DNA and rifampicin resistance mutations using PCR technology, providing results within two hours.

Discussion

A comprehensive research investigation was carried out on patients with TB based on the provided data, which focused on both male and female individuals across different age groups and examined clinical manifestation, symptoms and detection of bacterial load in order to gain insights into the progression and transmission of the disease.[11] The study reveals that TB patients exhibit similar signs and symptoms across age groups, but the severity of bacterial burden varies, suggesting different stages of the disease. Bacterial load was categorized into low, medium, and high levels, providing insights into microorganism proliferation and potential implications.[12] Some patients show early-stage disease with lower bacterial loads, indicating early infection or less active disease, while a considerable proportion display medium or high bacterial loads, signifying advanced disease stages and increased transmission risk.[14]

Screening new cases of pulmonary tuberculosis in children is a critical task that requires an accurate diagnostic tool. The modified Kenneth Jones scoring system has been evaluated for its efficacy as a screening tool.[13] It integrates multiple clinical and laboratory parameters to assign a scoring the indicate the like hood of tuberculosis. These parameters may encompass symptoms, radiographic findings and laboratory test results.[5] Understanding the bacterial burden in TB patients is essential for disease management including treatment decision infection control and assessing transmission risk.[15] Quantifying bacterial load helps healthcare provides choose antibiotics, monitor treatment response and implement infections control measure to contain TB spread. Early detection and intervention are emphasized to prevent transmission and reduce diagnostics and treatment options, considering the challenges posed by varying bacterial loads and clinical manifestations in TB.[16,17]

Further analysis of symptoms presentation between male and female TB patients reveals both similarities and differences. Both genders commonly experience symptoms such as fever and cough while females may also present with chest pain, weight loss vomiting abdominal pain.[18] The findings underscore the importance of early detection, tailored treatment approaches and effectives infections control measure to mitigate the impact of TB on individuals and communities. The data also highlights the ongoing need for further research and advancement in diagnostic and treatment options to address the challenges associated with varying bacterial loads and the divers' clinical manifestations of TB.[19] This study describes a cross sectional study that aims to evaluate the clinical and diagnostically manifestation symptoms of TB patients in relations to their physical response. The following sections offers compressive description of the study methods data analysis and results followed by discussion other implications and potential applications of the findings. The study extensively highlights its methodology, including aspects such as age, distribution, symptoms, bacterial load detection, and the MKJSC utilization. For instance, the findings reveal a median age of 73 months and a mode of 120 months among the participants. Furthermore, all patients exhibited a

history of prolonged fever, with the prevalence of cough varying across different age groups. The sample size is determined using sample size determination for estimation of a single population proportion formula and the following assumptions are considered 95% confidence interval The determination of the sample size was conducted through the utilization of appropriate statistical methods to guarantee ample representation of the intended population.

The total number of cases detected through specific testing strategies defines the diagnostic yield. In the case of intrathoracic tuberculosis in children by following Kenneth Jones scoring system as a screening tool, various factors affected the diagnostic yield, which included Persistent cough (>2-3 weeks), persistent fever (>1 week), unexplained weight loss, close contact with a TB case, presence of night sweats, enlarged lymph nodes, BCG vaccination status, chest X-ray abnormalities (hilar lymphadenopathy, lung infiltrates, cavitations), and detailed CT scan findings. The factors mentioned, including the inherent diagnostic accuracy of laboratory tests, specimen quality and quantity, transport efficiency, and laboratory system quality, directly influence the diagnostic yield of the Kenneth Jones scoring system. For example, if laboratory tests used to confirm TB are not accurate or if specimen collection is inadequate, the diagnostic yield may be compromised.[5,8]

Moreover, the drivers' manifestations of intrathoracic TB in children such as cavity disease or primary lymph node disease, affected bacilli recovery from secretions. Cavity disease often yield higher concentrations of bacilli compared to primary lymph node disease where bacilli level might be lowered. This variations in bacilli recovery can impact the sensitivity of diagnostic test and consequently the diagnostic yield of the Kenneth jones scoring system.

Therefore, these factors collectively influence the sensitivity and specificity of the Kenneth Jones Scoring Criteria, impacting its ability to accurately diagnose intrathoracic TB in children. These include the inherent diagnostic accuracy of laboratory tests, the quality and quantity of collected specimens, the efficacy and promptness of specimen's transport and the availability of high-quality laboratory system which rely on skilled personnel. It is noteworthy that intrathoracic TB in children has a broad secretion,8 for example, cavitary disease such as Ghon focus lesion, the most common form of intrathoracic TB in children, may exhibit very low levels of bacilli, MKJSC might be utilized as a screening tool for its diagnosis. By illuminating the diverse manifestations of tuberculosis, this study aims to contribute to the ongoing efforts in tuberculosis research and enhance the understanding of this global health challenge.[20] This study's primary goal was to evaluate the diagnostic accuracy of the modified Kenneth Jones scoring system, which was used as a screening tool to find new cases of pediatric pulmonary TB. The study identified diverse symptoms and bacterial burden levels in tuberculosis patients. Accurate quantification of bacterial load is vital for disease management and control. Early detection and intervention are crucial to reduce transmission and disease burden. Further research is needed for improved diagnostics and treatments for varying bacterial loads in tuberculosis patients.[21]

The findings exhibited a moderate degree of diagnostic accuracy, characterized by excellent sensitivity and positive predictive value (Table-2). The results of study identified the ability to identify the specific physical characteristic linked to tuberculosis, as well as their correlation with patients' attributes, providing healthcare professional with valuable insights for timely identification and intervention.[22,23] These discoveries bear substantial consequences for the management, treatment, and formulation of preventive approaches for tuberculosis globally. The study places its findings within the wider framework of tuberculosis research, addressing the challenges posed by diverse bacterial loads and clinical presentations. It also delves into the potential utility of the Modified Kenneth Jones scoring system in settings with limited resources, emphasizing its effectiveness as a screening tool for diagnosing tuberculosis in children.

Limitations

The relatively small sample size may affect the generalizability of the results. Secondly, the research was conducted at a single hospital in Lahore, which may limit the applicability of findings to other regions. Thirdly, the study relied on the Modified Kenneth Jones Scoring System without comparing it to other advanced diagnostic tools, potentially limiting its comprehensiveness. Additionally, there may be selection bias as patients were recruited from outpatient departments, possibly excluding more severe cases not attending the clinic. Lastly, the cross-sectional design captures data at a single point in time, which may not reflect long-term outcomes or variations in symptoms over time. however, these tests have limited sensitivity in detecting paucibacillary TB in diagnosing testing, which refers to cases with low levels of bacilli, due to inherent technologies limitations.

Future Perspective

By examining TB clinical manifestations and laboratory parameters, we assessed the system's sensitivity, specificity and predictive values in detecting TB cases. Understanding the performance of the MKJSC in diverse patients' populations in different areas under disease conditions is essential for its effective implementations in clinical practice. Moreover, insights gained from this study may inform strategies for early detection and intervention, particularly in resource limited setting where access to advanced diagnostic techniques may be limited. To minimize cost in implementing the modified Kenneth jones scoring system for pediatric TB screening, leverage existing infrastructure train healthcare staff prioritize cost effective diagnostic test, and integrate screening into community health program.

The manuscript puts forward the need for additional investigation and advancement in area of diagnostic and therapeutic options to address the challenges associate with fluctuating bacterial and diverse clinical manifestation of TB. The modified scoring system created by Kenneth Jones holds promise as a valuable tool in the initial screening and identified of TB cases, particularly in setting with limited availability of state of art diagnostic techniques.

Conclusion

The finding of our research pertaining to the scoring chart de-

veloped by Kenneth jones have demonstrated higher level of sensitivity and specificity in comparison to previous investigation conducted in the field.

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Original Article

Effects of Exogenous Neurokinin B Administration on Hematological and Coagulation Parameters in Adult Male New Zealand White Rabbits

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Abstract

Objective: To explore the effects of varying doses of Neurokinin B (NKB) on hematological and coagulation parameters in adult male rabbits.

Methodology: This experimental study was conducted at Gomal University, Dera Ismail Khan, Pakistan from June-2019 to June-2020. Eighteen adult male New Zealand white rabbits, weighing 1.5–2 kgs each, were divided randomly in to three groups (n=6 animals/group). Group-I rabbits (control) received injections of distilled water subcutaneously. Group-II rabbits received 1 µg NKB, Group-III rabbits received 1ηg NKB subcutaneously twice daily (12 hourly), consecutively for 12 days. Animals from each group were sacrificed after 12 days of continuous treatment and blood collected for analysis of hematological [complete blood count (CBC)] and coagulation parameters [Bleeding time (BT), clotting time (CT), prothrombin time (PT) and activated partial thromboplastin time (APTT)]; CBC was performed by automated hematology analyzer, while CT and BT by Duke's and capillary tube methods respectively; PT and APTT were analyzed using commercially available kits as per manufacturer's instructions.

Results: BT was significantly prolonged in NKB-treated rabbits compared to control (group-II: 367.5±28.06sec, group-III: 302.5±39.59sec, control: 102.5±22.08sec). CT was also increased (group-II: 317.50±25.84sec, group-III: 280±32.40sec, control: 157.50±28.06sec), as did PT (group-II: 37.0±3.69sec, group-III: 23.67±1.21sec, control: 22.0±1.41sec) and APTT (group-II: 39.0±2.89sec, group-III: 25.50±1.87sec, control: 20.83±2.32sec). Additionally, mean platelet volume [group-II: 6.57±0.30fl, group-III: 6.55±0.36fl, control: 6.05±0.27fl] and leukocyte count (×103/µl) [group-II: 15.73±1.38, group-III: 14.88±1.56, control: 8.22±1.16] were significantly increased in NKB-treated animals. International normalized ratio was significantly increased at group-II (2.0±0.1) compared to control (1.1±0.07). Conversely, platelet count (×103/µl) was decreased significantly in all NKB-treated animals (group-II =143.50±13.60, group-III=179.67±28.09) compared to control (246.34±28.73).

Conclusion: Neurokinin B administration led to leukocytosis, thrombocytopenia, with prolonged BT, CT, PT and APTT dose-dependently.

Keywords: Tachykinins, Neurokinin B, Platelets, Blood Coagulation, Activated Partial Thromboplastin Time, Prothrombin Time, Blood Coagulation Tests.

Introduction

Neurokinin B is a fascinating decapeptide and belongs to a family of peptide hormones known as tachykinins.1 They play vital roles in the body, affecting various tissues and organs. The mammalian tachykinin family includes six key peptides: Neurokinin A, Neurokinin B, Neuropeptide K, Neuropeptide γ, Substance P (SP), and Hemokinin-1.[1] It is interesting to observe that inspite of such diversity in their functions, all of them share a common structural sequence of five amino acids (Phe-X-Gly-Leu-Met-NH2), which makes them unique and researchable.[1] Tachykinins exert their biological effects through three specific G-protein coupled receptors: NK1, NK2, and NK3.[1] Each tachykinin has a preferred receptor—Substance P, which primarily binds to NK1, Neurokinin A to NK2, and Neurokinin B to NK3.[1] However, these peptides can also interact with the other receptors with lower affinity, enabling them to influence a wide range of physiological processes.[1]

Neurokinin B is synthesized from a larger precursor protein encoded by the pre-protachykinin-B gene.[1] This precursor undergoes enzymatic cleavage to form pro-neurokinin B, which is then converted to Neurokinin B.[2] The primary actions of Neurokinin B are mediated through the NK3 receptor, present in both the central nervous system and peripheral tissues.[1]

Evidence for the critical role of Neurokinin B originates from its prominent involvement in reproductive health. Research indicates that mutations in the TAC3 gene, which encodes Neurokinin B, can result in hypogonadotropic hypogonadism, characterized by inadequate production of sex hormones.[3-5] Beyond its role in reproduction, Neurokinin B is involved in a spectrum of biological processes. Its activity has been observed in immune responses, inflammation, and even in conditions such as pre-eclampsia, menopause, and cancer.[2,6-8] Substance P, another tachykinin, can activate immune cells and promote the production of inflammatory molecules.[9] Both Neurokinin B and Substance P are linked to the development of certain cancers, including breast and gastric cancer.[6, 10]

Bleeding disorders, inherited in an autosomal recessive manner, are common worldwide. Pakistan's high rate of consanguineous marriages likely increases the prevalence of conditions like thalassemia, hemophilia, and other coagulation disorders, posing significant public health challenges.[11] However, these disorders often remain undiagnosed due to a lack of specialized diagnostic facilities, low public awareness, and low

clinical suspicion.[11] Insights into how Neurokinin B influences blood cell counts and clotting mechanisms could lead to new therapeutic approaches for managing these conditions.

However, keeping into account its important and diverse involvement in various physiological processes, the effects of Neurokinin B on blood and clotting parameters remain largely unexplored. Blocking NK1 receptors has been shown to reduce platelet aggregation and thrombus size, highlighting the important role of tachykinins in coagulation.[12] This study aims to bridge this gap by investigating how different doses of Neurokinin B affect blood cell counts and clotting factors in adult male rabbits following subcutaneous injection. By exploring these effects, we hope to provide deeper insights into the hematological and coagulation dynamics influenced by tachykinins. The objectives are to quantify changes in white blood cells, red blood cells, platelets, and coagulation parameters, providing new insights into the hematological and coagulation dynamics influenced by Neurokinin B.

Methadology

Animal Handling and Housing

This experimental study was carried out over the course of a year, from June 2019 to June 2020. Eighteen healthy adult male New Zealand white rabbits, each weighing between 1.5 and 2 kg, were acquired from the National Institute of Health, Islamabad. The animals were housed in the animal facility at Gomal Centre of Biochemistry and Biotechnology, Gomal University, Dera Ismail Khan, Pakistan for the duration of the trial. Before the experiment commenced, the animals underwent a 10-day acclimatization period. They were kept under a 12-hour light/dark cycle at a constant temperature of 25±2°C, with free access to food and water. European Union regulations for the use of animals in research were followed for handling the animals during the trial period. The study was approved by the Ethics Review Board of Gomal University vide letter # 118/QEC/GU dated 29–01–2019.

Peptide Dosage and Treatments

Neurokinin B was sourced in lyophilized form from Sigma Aldrich (USA) having catalogue # of N4143-1MG. A stock solution was created by dissolving the peptide in 1ml of dimethyl sulfoxide (VWR, USA). This stock solution was then diluted with distilled to obtain desired concentrations of the peptide for subcutaneous injections. Animals were randomly allocated to different groups (n=6 per group). Group-I served as a control and received subcutaneous injections of distilled water. Group II was administered 1 µg of Neurokinin B subcutaneously, while Group III received 1 ηg of Neurokinin B subcutaneously, both dosages given twice daily at 12-hour intervals for a period of 12 consecutive days. After the 12-day treatment period, the animals were anesthetized with sodium pentobarbital (60 mg/kg body weight, subcutaneously) three hours after the final dose of Neurokinin B, and then sacrificed for further analysis.

Collection of Blood samples

To determine the effect of Neurokinin B treatment on coagulation parameters, the blood was collected directly from left ventricle. The collected blood samples were then transferred into two types of vacutainers; blue top vacutainers – containing 3.2% trisodium citrate (IMPROVE, China) and purple top vacutainers – EDTA.K3 (IMPROVE, China). The blood sample from the blue top vacutainer was used to analyze prothrombin time (PT) and activated partial thromboplastin time (APTT). Plasma was obtained through centrifugation and assayed for PT and APTT using commercially available kits according to manufacturer's instructions. While the blood sample from the purple top vacutainer was used for the analysis of complete blood counts.

Hematological Analysis

The blood sample collected in vacutaner having purple top was promptly utilized for complete blood count analysis. This analysis was performed using an automated hematology analyzer (RT-7600, China). Blood counts provided the estimation of total leukocyte count (103/µl) and differential leukocyte count, red blood cell counts (106/µl), hemoglobin [Hb] (g/dl), mean corpuscular volume [MCV] (fl), mean corpuscular hemoglobin [MCH] (ρg), mean corpuscular hemoglobin concentration [MCHC] (g/dl), hematocrit (%), red blood cell distribution width (RDW), platelet count (103/µl) and mean platelet volume [MPV] (fl).

Analysis of Coagulation Parameters

The bleeding time (BT) in the rabbits was estimated using the Duke's method as per modifications given by Wenche Jy, et al.,.[14] Briefly, a 6mm wide incision was made on the rabbit's ear in the area having no visible vessels with scalpel blade. Timing of the test started with the incision. A filter paper was gently applied to the incision every 30seconds. BT was measured as the duration until bleeding stopped and the disappearance of the blood stains on the filter paper. BT was recoded in seconds.Capillary tube method was used for the estimation of the clotting time (CT). Marginal (lateral) ear vein was used for the collection of blood in capillary tubes. At regular intervals of 30 seconds the capillary tube was broken. Clotting time was measured as the duration until the clot start forming and is measured in second. Estimation of the PT was performed using commercially available Soluplastin kit obtained from the Wiener Lab, Rosario – Argentina. The reagent contains lyophilized rabbit brain thromboplastin with calcium chloride in concentration of 10mM. Reagent was reconstituted by adding 2ml of deionized water in the vial and left for 30 minutes at room temperature with occasional gentle swirling. The kit works on the principle of assessing the time taken for the fibrin clot to form via the extrinsic coagulation pathway upon the addition of calcium thromboplastin to citrated plasma. Citrated plasma and the constituted thromboplastin reagent was preheated at 37°C for 15 minutes in a water bath. Plasma (100 µl) was mixed with thromboplastin reagent (200 µl) in a glass tube. Time till the clot formation was recorded as PT in seconds. Estimation of the APTT was performed using commercially available APTT test kit obtained from the Wiener Lab, Rosario – Argentina. The reagent contains lyophilized rabbit brain

cephalin with ellagic acid and calcium chloride solution (0.025 mol/l). APTT evaluates intrinsic coagulation pathway. The kit works on the principle of assessing the time taken for the coagulation of acitrated plasma via the intrinsic coagulation pathway in the presence of calcium chloride solution and cephalin. As per manufacturer's instructions the citrated plasma, the reagent and the calcium chloride solution was preheated at 37°C for 15 minutes in a water bath. Reagent (100 µl) was mixed with the citrated plasma (100 µl) in a glass tube, swirled gently and incubated at 37°C. Then calcium chloride solution (100 µl) was mixed. Time till the clot formation was recorded as APTT in seconds.

International Normalized Ratio (INR)

Below mentioned formula was used for the calculation of INR in the present study: $INR = (PT/(MNPT))^{ISI}$

Where; PT is prothrombin time of the peptide-treated animals, MNPT is the mean prothrombin time of the distilled water treated control animals and ISI (international-sensitivity-index) for the reagents used, which was 1.1.

Statistical Analysis Data were presented in form of tables and figures as Mean±SEM. SPSS version 26 was used for the analysis of results. Statistical significance was assessed using one way ANOVA which was followed by the post-hoc Tukey's test, with $P<0.05$ was considered statistically significant.

Results

General Observations

Throughout the experiment, all peptide-treated rabbits remained healthy as assessed by their vital signs, overall condition of the body, eating habits, drinking habits, and activity inside the cage. However, a notable exception was observed in the rabbits treated with Neurokinin B that their incised wounds continued to bleed for a much longer duration post-treatment. In contrast, rabbits that served as control and received distilled water treatment showed no excessive bleeding tendency.

Hematological Parameters

The study found a significant increase in the total leukocyte count in the Neurokinin B-treated groups compared to the control group (Table I).

The red blood cell count (RBC) did not show significant differences among the treated and control groups. Parameters such as RDW, hemoglobin levels, MCH, MCHC, MCV and hematocrit did not exhibit significant variations among the groups (Table I).

The platelet count showed a significant decrease in the Neurokinin B-treated groups compared to the control group. While MPV exhibited a significant increase in both Neurokinin B-treated groups compared to the control group (Table I).

Coagulation Parameters

PT and APTT showed significant prolongation in the Neurokinin B-treated groups compared to the control group (Figure 1).PT and APTT showed significant prolongation in the Neurokinin B-treated groups compared to the control group (Figure 2).

International Normalized Ratio (INR)

INR exhibited significant ($P<0.001$) elevation in the Neurokinin B µg group (2.0±0.13) compared to the control group (1.1±0.07), while there is no significant increase in Neurokinin B ηg group (1.32±0.04).

Table 1: Hematological Parameters of the Control and Neurokinin B-Treated Groups

Variables	Control	NeuroKininB ηg µg	NeuroKininB µg
Total Leukocyte Count (10^3/µl)	8.22±1.16	14.88±1.56***	15.73±1.38***
Hemoglobin (g/dl)	10.75±1.76	9.77±0.61	10.15±0.73
Mean Corpuscular Hemoglobin [MCH] (pg)	20.35±0.67	22.20±0.88*	22.27±1.42*
Mean Corpuscular Hemoglobin Concentration [MCHC] (g/dl)	33.84±0.51	35.15±1.09	35.31±2.19
RBC Count	5.29±0.93	4.39±0.22	4.58±.43
Mean Corpuscular Volume [MCV] (fl)	60.10±2.43	63.22±2.15	63.05±2.32
Hematocrit (%)	31.80±5.34	27.78±1.20	28.82±1.98
Red Blood Cell Distribution Width [RDW] (%)	12.10±0.45	12.0±1.16	11.98±0.66
Platelet Count (103/µl)	246.34±28.73	179.67±28.09***	143.50±13.60***
Mean Platelet Volume [MPV] (fl)	6.05±0.27	6.55±0.36*	6.57±0.30*

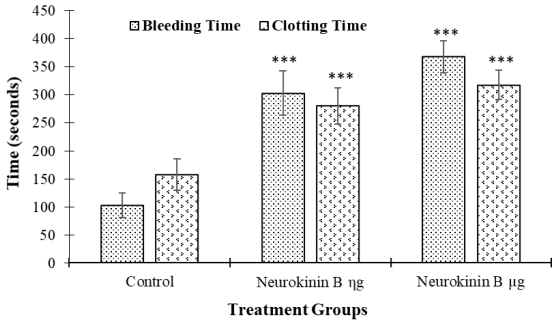

Figure 1: Bleeding time (in seconds) and clotting time (in seconds) of the control and Neurokinin B treated groups (***$P<0.001$ compared to control).

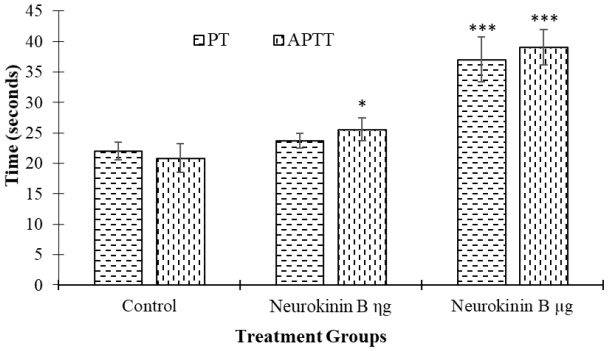

Figure 2: Prothrombin time (in seconds) and activated partial thromboplastin time (in seconds) of the control and Neurokinin B treated groups (***$P<0.001$ and *$P<0.05$ compared to control).

Discussion

The present study investigates the anticoagulation effects of subcutaneously administrated Neurokinin B in adult male rabbits. We observed a dose-dependent impact on the hematological and coagulation parameters following the administration of variable doses of Neurokinin B. We observed a significantly increased bleeding and clotting time with increased PT, APTT, INR and TLC and decreased platelet count in Neurokinin B treated rabbits as compared to control. This effect was dose dependent which potentiated as the dose of Neurokinin B increases (Table I and Figure 2).

Prolonged bleeding time is linked with the thrombocytopenia, impaired platelet ability to adhere with vascular endothelium, von Willebrand disease and disseminated intravascular coagulation. Increased clotting time is associated with hemophilia, deficiencies of the factors involved in clotting pathways (II, V, XI, XII) and congenital coagulation disorders. Elevated PT reflects the activity of the extrinsic coagulation pathway, and is associated with the deficiency of vitamin K or the acute/chronic liver disease. Conversely, APTT evaluates intrinsic coagulation pathway and it is typically performed when there is unexplained bleeding or clotting.[15, 16]

In present study, we observed significantly increased clotting and bleeding times, along with prolonged PT and APTT, suggesting an impact on both intrinsic and extrinsic coagulation pathways. We also noted a marked decrease in platelet count, indicating a disruption in the normal coagulation process. It's worth mentioning that thrombocytopenia is often associated with prolongedBT.13,15In spite of the prolonged BT, PT and APTT, coupled with reduced platelet count, the occurrence of disseminated intravascular coagulation (DIC) as a reason for increased bleeding propensity is highly unlikely.[15] This is supported by the fact that the Neurokinin B treated rabbits remained active, healthy and survived throughout the study period without displaying any signs of internal hemorrhage, sepsis, infection, or liver damage (data not shown). Therefore, our study suggests that Neurokinin B likely blocks the coagulation pathway at its initial stages. Prolongation of the PT and APTT was observed in Neurokinin B treated rabbits which suggests interference with the availability of the vitamin K, however it's important to note that vitamin K deficiency typically does not affect bleeding time or platelet count.[15, 16] Therefore, while it is speculative at this stage to conclude that Neurokinin B directly impedes the availability of vitamin K to stimulate its anticoagulation effects. However, the possible role Neurokinin B in down-regulating the vitamin K dependent pathways, cannot be entirely overruled.[14,15] Neurokinin B has a short plasma half-life and blood samples were collected at least three hours after the last dose of the peptide and anticoagulation profile was assayed. This suggests that the primary anticoagulation effects might occur shortly after peptide administration. This rapid onset of action is similar to anticoagulants like Argatroban and Heparin, which also induce anticoagulation effects in a short time frame.[17] Despite using citrated blood for the conduction of PT and APTT tests—standard for all coagulation tests—the observed anticoagulation effect is more likely attributable to Neurokinin B treatment rather than sodium-citrate.[18] The results of the present study demonstrated a negative association between the thrombocytes and MPV. Presence of bleeding disorders or iron deficiency or anticoagulants may present with a similar scenario.[19] Patients having heterozygous thalassemia may have increased MPV. Conversely a decreased MPV has been observed in subjects undergoing chemotherapy. This converse relationship between thrombocyte size and count is valuable in assessing abnormal thrombocyte production.[17,19] In present study, marked thrombocytopenia was evident with Neurokinin B treatment and a dose dependent effect was noticed with the higher dose accounting for the more severe Neurokinin B-induced thrombocytopenia.[13] Heparin-induced thrombocytopenia is a serious and often underestimated adverse effect of heparin treatment which occurs in about 2% of individuals when they are exposed to heparin for more than four days.[20] Heparin is commonly prescribed for the treatment of deep vein thrombosis and pulmonary embolism. It is a powerful anticoagulant and it significantly increases the formation of thrombin-antithrombin.[15] Although Neurokinin B appears to act similarly to heparin, it is a small peptide, and its mechanisms may differ. The exact mechanism behind Neurokinin B-induced thrombocytopenia remains unknown, however the present data suggested a direct action of the peptide on platelets. Discerning reduction in thrombocytes with increased WBC counts, supports the notion of Neurokinin B-induced thrombocytopenia. Additionally, there was no significant change in hemoglobin content and hematocrit, while mean corpuscular hemoglobin (MCH) increased with Neurokinin B treatment (Table I).

In vivo, Neurokinin B-induced thrombocytopenia might result from modulation of megakaryocyte production. Thrombocyte count can be used as a prognostic index as the production of the thrombocytes was stimulated by many neoplasms through initiation of megakaryocyte production.[21] Although platelet aggregation tests were not conducted in this study, Neurokinin B-induced disaggregation of thrombocytes might be accountable for the observed anticoagulation effects. With Neurokinin B treatment, we observed a significant reduced thrombocyte count with prolonged anticoagulation profiles. These conditions are typically associated with end-stage liver disease, disseminated intravascular coagulation or massive transfusion reactions.[15,16] Although liver function tests were not performed, necropsy of the Neurokinin B-treated rabbits showed no signs of liver damage. Additionally, the animals enrolled in the present study were healthy throughout the experiments and did not show any signs of sepsis as mentioned earlier.

Given that Neurokinin B is a non-toxic peptide, it is likely that the observed anticoagulation effect was attributable to Neurokinin B.

Neurokinin B may exert its effects by down-regulating thromboplastin, thereby deactivating the factors especially VII, X and IX. Another probability is that Neurokinin B directly inhibits thrombin, which can subsequently suppress the subsequent events in the coagulation pathways.[15] Anticoagulatory activity of the Neurokinin B may be activated directly by inhibiting the formation or actions of the thrombin or tissue plasminogen activator. Our results suggests that Neurokinin B can be used as an effective thrombolytic therapy. This potential effect or Neurokinin B warrants additional investigation. It could be highly beneficial for treating venous thromboembolism. Current treatment options for thromboembolism include unfractionated and low molecular weight heparins (LMWHs), warfarin and inferior vena cava filters.[22]

Limited data is available on the effect of tachykinins on the hematological and coagulation profile. It has been demonstrated that SP induces platelet aggregation and degranulation. This effect of SP has been supposed to be mediated through tachykinin receptors, specifically NK1 (the receptor for SP) and NK3 (the receptor for neurokinin B).[8] Another study highlighted the role of tachykinins (SP and Endokinins A and B) in the activation of platelet function and the formation of thrombi.[23] Furthermore, additional research indicated that the pro-thrombotic effects of tachykinins on platelets are mediated via the neurokinin 1 receptor.[12] In another study, it was found that Substance P and Neurokinin A are crucial for neutrophil priming and the release of superoxide anions from neutrophils.[24]

Anticoagulants often use GPCR to mediate their anticoagulant effects and aggregation of platelets. [15,16] Notably, Neurokinin B also exerts its actions through a GPCR.1 Therefore, it is plausible that Neurokinin B promotes its anticoagulation effects by using intracellular second messenger pathways.

To our knowledge, this study is the first to explore the effects of continuous subcutaneous administration of varying doses of Neurokinin B on hematological and coagulation parameters. As a result, there are currently no other studies available for direct comparison.

Limitations

The study observed significant changes in platelet count but did not analyzed platelet aggregation for understanding the mechanisms behind Neurokinin B-induced thrombocytopenia. Additionally, liver function tests were not performed, though necropsy showed no signs of liver damage. The focus was limited to specific hematological and coagulation parameters, and including additional parameters like fibrinogen levels and D-dimer could provide a more comprehensive understanding. The present study is preliminary and warrants detailed biochemical investigation into the anticoagulation effects of Neurokinin B, as the exact mechanisms behind the observed effects remain unclear and require further exploration of the molecular pathways involved for its potential use as a therapeutic agent.

Conclusion

Neurokinin B administration led to remarkable results, with increase in leukocyte count, however at the same time it altered the platelet dynamics with decreased count and increased volume, and also prolonged BT, CT, PT and APTT. Further research is needed to understand these effects and their clinical significance.

To conclude, Neurokinin B significantly impacts blood and coagulation parameters, and understanding these effects may provide new therapeutic insights for managing prevalent blood disorders.

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Original Article

The Outcome of Endoscopic Sinus Surgery in terms of Olfaction in Patients of Chronic Rhinosinusitis with Polyps

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Abstract

Objective: To assess the effectiveness of functional endoscopies sinus surgery in improving olfaction in patients diagnosed with chronic rhinosinusitis with nasal polyps, as measured by changes in Sniffin's Stick scores and olfaction scores pre and post operatively.

Methodology: The clinical observational study was conducted at the ENT department, Services Hospital, Lahore for 6 months from 01-03-2022 to 31-08-2022. Sixty-six patients (66) diagnosed with chronic rhinosinusitis with nasal polyps were enrolled, and evaluated by using Sniffin's Stick score and olfaction baseline score. The inclusion criteria were patients aged 10-60 years of age diagnosed with this condition and willing to undergo surgery. Operative time was noted. After surgery, patients were discharged and were followed-up in OPD for 3 months. After 3 months, patients were re-evaluated for Sniffin's Stick score and olfaction score.

Results: The mean age of the patients was 36.18±13.87 years, 49(74.24%) patients were male. On pre-op evaluation the mean Sniffin's Stick score of the patients was 6.14±0.41 which improved to 7.34±0.41 on post-op evaluation. Similarly on pre-op evaluation the mean olfaction score of the patients was 8.30±5.84 which improved to 21.12±5.95 on post-op evaluation.

Conclusion: There is significant improved outcome observed in terms snuffiness and olfaction score for functional endoscopic sinus surgery in patents of chronic rhino-sinusitis with nasal polyps

Keywords: Chronic Rhinosinusitis, Nasal polyps, Functional Endoscopic Sinus Surgery, American Society of Anesthesiologists (ASA).

Introduction

Chronic rhinosinusitis with or without polyps, is common in ENT practice affecting the nose and sinuses. The therapeutic approach is prolonged administration of medication (oral and topical steroids) and if ineffective, endoscopic sinus surgery is done. The chronic rhinosinusitis may present as a condition with or without nasal polyps. The prevalence of both forms of chronic rhinosinusitis is around 11% globally.[1]Chronic rhinosinusitis with nasal polys is considered the more severe form and is linked with prevalence ranging from 1% to 4%.[1] The olfactory dysfunction is highlighted and prominent symptoms reported by individuals with this condition. The pathophysiology of olfactory dysfunction in chronic rhinosinusitis is multifactorial, often involving substantial obstructive pathophysiology.[2] Endoscopic sinus surgery has proven to be an effective treatment for the chronic rhinosinusitis with nasal polyps when medical intervention has not succeeded.[3]

The improvement in smell after sinus surgery for chronic rhinosinusitis nasal plops are significant but research in this area is limited. Local data is scarce, highlighting the need for evidence specific to our population to support the use of sinus surgery for nasal polyps. These factors impede the binding of odorants to the olfactory receptor sites and can result in alterations to the nasal epithelium.[4] The amelioration of chronic rhinosinusitis can yield a favorable success rate for improving olfactory loss associated with the condition, although complete restoration to normal olfaction levels is not always attainable.[5] Chronic rhinosinusitis with nasal polyps (CRSwNP) is a common inflammatory condition that impacts a significant portion, estimated to be around 12%-14% particularly in European countries.[6] This ailment is characterized by the presence of bilateral nasal polyps and persistent symptoms, including nasal congestion, runny nose, loss of smell, and headache. These symptoms have a profound effect on quality of life and contribute to a substantial economic burden.

Medical intervention such as nasal corticosteroids nasal irrigation antibiotics and short course of oral corticosteroids are used initially. Functional Endoscopic Sinus Surgery (FESS), along with medical treatment, has been shown in numerous studies to significantly alleviate symptoms.[7]However, despite the benefits of ESS, many patients experience a high rate of disease recurrence in the long term, even after surgery. This highlights a pressing need for innovative therapies that can offer better long-term control of CRSwNP. Further research and the development of new treatment approaches are essential to address this challenge and improve the long-term outcomes for individuals with CSRwNP. Therefore, out study aims to fill this gap by investigating the effectiveness of ESS specifically in our local populations, with goal of identifying ways to achieve more sustainable control of CRwNP. [8]

Methodology

This clinical observational study was executed on

66 patients at the Department of Otolaryngology of Services Hospital located in Lahore for a duration of six months, commencing from March 1st, 2022, until August 31st, 2022. The ethical approval was taken from committee with ref. number 14/09/23/l189. The subjects included were those diagnosed with CRSwNP, excluding patients possessing a history of previous sinus sugery, severe comorbidities, or contraindications pertaining to FESS. Baseline assessment was performed on the patients, which involved evaluating their Sniffin's Stick score and olfaction score. The Sniffin' Stick test evaluates olfactory function through three subtests: Threshold (T), Discrimination (D), and Identification (I). The T test determines the lowest concentration of an odorant a person can detect, scored by the mean of the last four out of seven reversal points.

The D test assesses the ability to distinguish different smells using 16 triplets of pens, with each correct identification scoring 1 point (max score 16). The I test involves identifying 16 different odors from four choices, with each correct answer scoring 1 point (max score 16). The composite TDI score, summing T, D, and I, ranges from 0 to 48, indicating the overall olfactory function. Higher scores reflect better olfactory performance, with specific cutoffs used to classify normosmia, hyposmia, and anosmia.[9] It comprises three tests of olfactory function, namely, test for odor threshold, odor discrimination, and odor identification. FESS was executed by a single surgical team, with the aid of a researcher, under general anesthesia.

The duration of surgery for each patient was noted. Post-surgery patients were discharged and monitored in the outpatient department (OPD) for a span of three months. At the conclusion of the three-month follow-up period, patients were reevaluated for their Sniffin's Stick score and olfaction score.[10] Descriptive statistics were utilized to analyze the baseline characteristics of the patients. Paired t-tests or non-parametric tests were employed to compare the pre- and post-operative Sniffin's Stick scores and olfaction scores. The collected data were analyzed and interpreted to offer insights into the effectiveness of FESS in ameliorating olfaction in this specific patient population. The statistical analysis was done by applying the statistical tools of SPSS version 21.

Results

A total of 66 patients were included, falling between the age range of 13.87 – 36.18 years. Among the cohort, 49 individuals (74.24%) were male and 17 individuals (25.76) were females, establishing a male to female ratio of 2.8:1. An additional 30 patients were enrolled in a control group, which received standard medical treatment without surgery. The control group served to provide a baseline comparison, ensuring the observed improvements in the FESS group were attributable to the surgery. The results of the study have been given in detail in Table 1 below.

Table 1: Summary statistics of Pre and Post-op Sniffin's Stick Store

Sniffin's Stick score	n	Mean	SD	Minimum	Minimum
Pre-op	66	6.14	0.41	5.50	7.00
Pre-op	66	7.34	0.41	6.70	8.20

On pre-op evaluation the mean olfaction score of the patients was 8.30±5.84, having range of 0.00 to 20.0. On post-op evaluation, the mean olfaction score of the patients was 21.12±5.95 having range of 8 to 30.

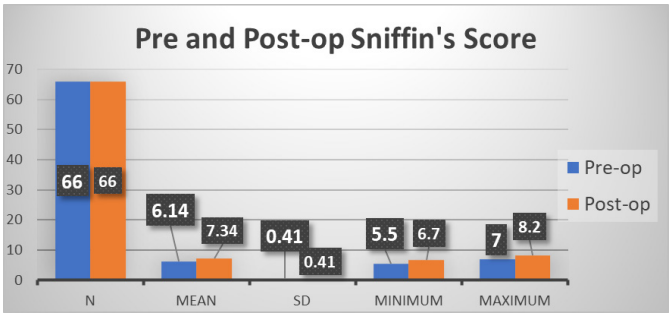

Figure 1: These summary statistics demonstrate a noticeable improvement in both the Sniffin's Stick score and olfaction score following the functional endoscopic sinus surgery. The higher post-operative scores indicate an enhancement in olfactory function among the patients with chronic rhinosinusitis and nasal polyps.

Table 2: Summary statistics of Pre and Post-op olfaction score

Olfaction score	n	Mean	SD	Minimum	Minimum
Pre-op	66	8.30	5.84	0.00	20.00
Post-op	66	21.12	5.95	8.00	30.00

Table 2 compares the pre operative and post operative Sniffin's Stick scores across different variables such as age, gender, duration of symptoms, American Society of Anesthesiologists (ASA) classification and operative time. The p-value indicate the statistically significant difference between pre-op and post-op scores of each variable.

Table 3: Mean and SD Values

Parameter	Mean ± SD	Range (Min - Max)
Duration of Symptoms (months)	3.91± 2.72	0.50 - 10
ASA I	53(80.30%)	
ASA II	13(19.70%)	
Operative Time (minutes)	38.48 ± 15.56	10 - 90
Pre-op Sniffin' Stick Store	6.14 ± 0.41	5.57 - 7
Post-op Sniffin' Stick Store	7.34 ± 0.41	6.70 - 8.20

Discussion

In this study we sought to evaluate the effectiveness of functional endoscopic sinus surgery (FESS) in improving olfaction in patients diagnosed with chronic rhinosinusitis with nasal polyps. Out methodology involved conduction a descriptive cases series at the ENT department of Services Hospitals, Lahore, over six-month period. Sixty patients were enrolled and performed baselines evaluations using Sniffin's Stick score and olfaction score pre-operative. We conducted 3 month post operative evaluation. Our results demonstrated significant improvements in both Sniffin's Stick scores and olfaction scores post operativly. The purpose of study was to investigate whether FEES could serve as an effective treatment modality for olfactory dysfunction in patients with chronic rhinosinusitis and nasal polyps.

The timing and indications for functional endoscopic sinus surgery (FESS) in the management of chronic rhinosinusitis with or without polyps (CRSwNP/CRSsNP) are primarily based on the knowledge of practitioners.[11]

The determination of when and why functional endoscopic sinus surgery is recommended in the treatment of chronicrhinosinusitis with or without polyps relies mainly on the clinical expertise and judgment of healthcare professionals. Medical protocols both the national and international levels recommend initiating pharmacological intervention for at least one-month prior to contemplating surgical intervention.[12] Following clinical evaluations, patients are typically prescribed a pharmacological intervention regimen that includes nasal corticosteroids, with the possibility of a short course of systemic corticosteroids or more prolonged antibiotic regimen.[13-15] In this study on pre-operative evaluation, the mean score on the Sniffin' Stick test for patients was 6.14±0.41, which improved to 7.34±0.41 on post-operative evaluation. Similarly, the mean olfaction score for patients on pre-operative evaluation was 8.30±5.84, which improved to 21.12±5.95 on post-operative evaluation. While our results demonstrate significant improvements in both Sniffin's Stick scores and olfaction scores post-operatively, it is essential to consider potential confouning variables that could have influenced these outcomes.[16,17] Patients with additional health conditions, such as diabetes or asthma, may experience different outcomes due to their overall health status, and the use of medications like systemic corticosteroids or antibiotics before and after surgery could also affect the results. Additionally, the baseline severity of CRSwNP might influence post-operative outcomes, with patients having more severe disease potentially responding differently to surgery compared to those with milder forms. Variations in surgical technique and the experience level of the surgeon performing the FESS are other confounding factors.[18,19,20]

Lourijsen et al. (2022) conducted a study that demonstrated a significant improvement in the sense of smell of patients with CRSwNP following sinus surgery, which is the most responsive CRS subgroup to surgical intervention. [21] Moreover, improving olfaction in the CRSwNP subgroup is likely to enhance the patient's overall quality of life. Endoscopic sinus surgery also significantly improved the NOSE scale in both CRS subgroups six months following the surgery. In a study by Zhang et al. (2019) post-endoscopic sinus surgery olfactory improvements were noted in 70% of patients with CRS, while olfaction declined in 8%.[22] In another study, the mean change in olfaction score improved from 2.05±3.93 to 10.43±4.13 after three months.8 Additionally, it was reported that the mean Sniffin's Stick score in cases with nasal polyps improved from 6.4±3.6 to 7.5±3.0, with the difference between the groups being significant and indicating that the outcome (olfactory function) was better without polyps than with polyps.[23] Qureshi et al. (2022) conducted a five-year prospective study, of whom 75% had CRSwNP, and noted a significant improvement in measured olfaction at two years post-surgery, which became nonsignificant at five years. Interestingly, Mullol et al. (2023) also demonstrated a significant improvement in olfaction following ESS that remained significant long-term.[24] Mohanty et al. (2016) conducted a study examine the impact of nasal surgery encompassing both sinusand septal procedure, on olfaction suing the 16- item order identification sniff in stick test. [25] The conclusion at 3.5 month postoperatively revealed a notable enhancement in the sinus surgery groups, in contact to less significant improvement in the septal surgery groups. Interestingly both groups showed non-significant changes at the 12-month marks. The study also indicates thar the presence of polyps and eosinophiles served as positive prognostic factors for improved olfactory outcomes. Yang et al. (2021) investigated the effects of nasal surgery, including both sinus surgery and septal surgery, on olfaction using the 16-item odour identification 'Sniffin' stick test. [26] At 3.5 months postoperatively, there was a significant improvement in the sinus surgery arm, as opposed to a nonsignificant improvement in the septal surgery arm. Notably, both became non-significant at 12 months. They also found that polyps and eosinophilia were good prognostic factors for improvement in olfactory outcome.

Kamath et al. (2024) illustrated in their study that individuals with profound olfactory impairment demonstrated noteworthy enhancement subsequent to endoscopic sinus surgery, whereas individuals with moderate impairment did not encounter such marked modifications. [27] Therefore, an authentic assessment of the influence of ESS on smell could be established. The rationale of this study is to determine the outcome of functional endoscopic sinus surgery in improvement of olfaction in patents of chronic rhino-sinusitis with nasal polyps. The mean change in Olfaction score was improved from 2.05±3.93 to 10.43±4.13 after 3 months. It has been reported in a study that the mean Sniffin's Stick score was improved from 6.4±3.6.0 to 7.5±3.0 in cases with nasal polyp. The difference in both groups was significant and showed that without nasal polyps, the outcome (olfactory function) was better than with polyps.The postoperative medical treatment of individual with Chronic rhinosinusitis with nasal polyposis remains a subject of controversy. Furthermore, extensive epidemiological and olfactometric studies within the population are necessary to better understand olfactory disorder in this context. This study innovates by providing he data on the effectiveness of functional endoscopic sinus surgery in improving olfaction in chronic rhinosinusitis with nasal polyps' patients. Through rigorous statistical analysis and comprehensive assessments, it quantified the notable improvement in olfactory function post-surgery. By comparing its findings with previous research, the study adds to the existing knowledge on FESS outcomes, particularly in the context.

The localized approach is an analytical approach to medical worker for better understanding the diagnostic criteria of patients.[27] Future studies can enhance the evaluation of FESS for chronic rhinosinusitis with nasal polyps (CRSwNP) by using advanced techniques. Objective olfactory tests, like olfactory event-related potential (OERP) tests, can provide more accurate assessments. High-resolution imaging techniques, such as diffusion tensor imaging (DTI), can reveal structural changes in the olfactory bulb and tract. Wearable technology can monitor patients' daily olfactory experiences and nasal airflow, offering real-world data. Machine learning algorithms can analyze large datasets to identify patterns and predictors of surgical success. Integrating patient-reported outcome measures (PROMs)

through mobile health (mHealth) applications can facilitate continuous monitoring of olfactory function and quality of life. These techniques can lead to improved treatment strategies and better patient care.

Limitations

Limitation of study is the sample size which is narrow line to significant but not cover the major domains. Further the control group is not adding an effective role over to study by hindering the comparison. Additionally subjective measure for absence of a control group function and short-term focus limits the study robustness.

Conclusion

This study concluded that there is improved outcome observed in terms of snuffiness and olfaction score following functional endoscopic sinus surgery in individuals of chronic rhino-sinusitis with nasal polyps.

Recommendations

To enhance the internal validity of future studies, we recommend conducting thorough assessments of all relevant comorbidities and ongoing treatments at baseline, implementing standardized protocols for pre- and post-operative medications, stratifying patients based on key variables such as disease severity, comorbidities, and medication use, and ensuring that all surgeries are performed using a standardized technique by surgeons with comparable levels of experience. By acknowledging and addressing these potential confounding factors, future research can more accurately assess the effectiveness of FESS in improving olfaction in patients with CRSwNP, enhancing the generalizability and reliability of the findings, and providing clearer guidance for clinical practice.

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Original Article

Assessing the Curriculum Viability Inhibitors in an Undergraduate Medical Curriculum from the Perspective of Teaching Faculty

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Abstract

Objective: Curriculum viability refers to the sustainability and effectiveness of an educational curriculum. This study was done to assess curriculum viability inhibitors in an undergraduate medical curriculum at the University College of Medicine and Dentistry, Lahore, Pakistan.

Methodology: This qualitative exploratory study was conducted from November 2023 till March 2024, including 8 faculty members with more than 5 years of experience from both the clinical and basic sciences of undergraduate MBBS program at UCMD. The questionnaire filled in before conducting FGD contained 6 viability inhibitors, which included Educational Program Inhibitors; Disciplinary Cultural Inhibitors; Social Interaction Inhibitors; Institutional Policies Inhibitors; Communication Practices inhibitors; and Faculty Involvement Inhibitors. There were total of 25 items collectively under these six inhibitors. The FGD that followed was conducted for two hours, involving two main interviewers, two observers and one interpreter for recording the data.

Results: All of the 8 participants of the cohort unanimously agreed that there were no issues in the educational program and the curriculum was designed according to the major outcomes of the institute and was being followed in letter and in spirit. However, they highlighted 3 out of 25 items which according to them were not effective. First two items belonged to institutional policies inhibitors (item 12, and 15), and one belonged to faculty involvement inhibitors (item 25). The data underwent rigorous thematic analysis, involving the meticulous manual examination of transcribed data.

Conclusion: While the faculty was generally satisfied with the curriculum, minor challenges exist that can be addressed through collaborative SWOT analysis meetings with stakeholders. The report emphasized the importance of continuous improvement and stakeholder engagement for a sustainable and responsive curriculum.

Keywords: Curriculum viability inhibitors, undergraduate, medical curriculum, Focus group discussion.

Introduction

A curriculum is a standards-based sequence of planned experiences where students practice and achieve proficiency in content and applied learning skills. It acts as the central guide for all educators as to what is essential for teaching and learning, so that every student has access to rigorous academic experiences.[1] University College of Medicine and Dentistry has implemented Integrated Modular Curriculum since 2015. Although regular program evaluations and faculty feedback have been conducted since its implementation nine years ago, the curriculum's viability had not been assessed until this research was undertaken.[1] Curriculum viability refers to the sustainability and effectiveness of an educational curriculum.

It means that the distinctly articulated content and skills can be taught and learned without rushing through the timeframes available during the academic year.[2,3] Usually major components of curriculum viability include: the alignment of knowledge and skills a student is acquiring with educational objectives and goals; flexibility and adaptivity of curriculum to new innovations; ideas, and pedagogical advancements; relevance to need of time; cultural and social sensitivity; engagement and motivation of students and faculty members; assessment and evaluation; professional development of faculty, and Integration of feedback mechanism.[2,4] Curriculum viability plays a crucial role in ensuring that educational programs remain effective, relevant, and responsive to the evolving needs of students, educators, and society.

Curriculum viability is determined by assessing alignment with educational goals, relevance to learners, effectiveness in achieving desired learning outcomes, adaptability to different contexts, appropriateness of assessment methods, resource requirements, feedback mechanisms for improvement, long-term sustainability, standard compliance, and consideration of cultural and ethical factors. Educators can establish whether a curriculum effectively serves the requirements of learners, complies with educational standards, and is long-term sustainable by assessing these elements. This thorough evaluation assures that the curriculum is effective, interesting, and conducive to significant learning opportunities. This study was a small part of evaluating the curriculum's viability by conducting a qualitative analysis that gathered the perspectives and viewpoints of faculty members to gain insights for further improving the curriculum's effectiveness. The aim of this study was to assess the undergraduate medical curriculum at University College of Medicine and Dentistry, determining its alignment with the evolving demands of medical education and healthcare practice. Additionally, the

study sought to identify any factors impeding its viability from the faculty's perspective, using six specific viability measuring parameters.Hematological Analysis.

Methodology

A qualitative exploratory study was conducted (mme02230001/ammarb12c2a2f), utilizing Focus Group Discussions to examine the factors inhibiting the viability of the curriculum. The structured questionnaire contained the following six inhibitors: i. Educational Program Inhibitor ii. Disciplinary Cultural Inhibitor iii. Social Interaction Inhibitor iv. Institutional Policies Inhibitors v. Communication Practices inhibitors vi. Faculty Involvement Inhibitors. There were a total of 25 items collectively under these six inhibitors.

Eight faculty members were selected via purposive sampling and invited for a focus group discussion. These faculty members encompassed both basic and clinical sciences, and had already an experience of 5 years and hence were well familiar with the questionnaire. Their names were coded to conceal their identity (Table: 1)

Table 1: Coding of Participants

CV 1	Professor	CV 2	Professor
CV 3	Associate Professor	CV 4	Associate Professor
CV 5	Assistant Professor	CV 6	Assistant Professor
CV 7	Assistant Professor	CV 8	Senior Demonstrator

The session commenced with participant introductions, fostering a sense of inclusivity, and ensuring that everyone had a clear understanding of the topic under discussion. A comprehensive grasp of the subject matter was vital for productive engagement. The questions posed during the discussion were thoughtfully designed to delve into the underlying reasons for the inhibitors with suboptimal scores, identified through phase one of the study. This exploratory approach aimed to uncover the root causes of curriculum challenges and pave the way for potential solutions and improvements.

Participants were requested for formal consent of their participation. They were asked to introduce themselves and the moderator started with an opening statement on the importance of the focus group discussion and curriculum viability. The questions asked were divided into two sets. The first set was regarding the whole questionnaire and all six inhibitors. The second set related to the three items which according to participants were below par in University College of Medicine and Dentistry's Curriculum. The first set was semi structured questions just to identify which of the above-mentioned factors were below par and second set was open ended to identify the reasons why these factors were significant according to faculty members and how can these factors could be improved.The primary recording app was Otter.ai which was transcribing the group's discussion as well. The FGD that followed was conducted for two hours, involving two main interviewers, two observers and one interpreter for recording the data. Transcribed data was sent to participant to reduce observer bias. Throughout the FGDs, co-moderators played an active role in facilitating the conversation, observing participant contributions, and meticulously taking notes. These notes were a secondary source of information for transcription, which later proved invaluable in synthesizing the insights gathered and formulating a course of action. Thematic analysis was performed on transcribed data, themes were carved out of it which were sent to two renowned medical educationists in order to ensure dependability.

Results

The questionnaire filled in before conducting FGD contained 6 viability inhibitors, as shown in Table-1 below;

Table-2: Showing Six Viability Inhibitors and 25 Items in Total

1-Educational Program (EP) Inhibitor	
1	The contents I teach are relevant to the intended learning outcomes of the curriculum (e.g., doctor as a professional, leader, communicator, researcher, etc.).
2	In my institution, the content taught in one course/module helps the students to understand the related concepts in other courses/modules.
3	The curricular content taught in my institution contributes to making students good doctors.
4	I use different assessment tools to assess knowledge, skills, and attitude in a course.
5	I construct assessment items according to the blueprinting for an exam.
6	The contents I teach are relevant to the intended learning outcomes of the curriculum (e.g., doctor as a professional, leader, communicator, researcher, etc.).
2-Disciplinary culture (DC) Inhibitor	
7	The attendance of faculty on campus is strictly monitored through biometric thumb impressions.
8	Students are fined if they do not adhere to institution policies.
3-Social interaction (SI) Inhibitor	
9	My institution offers formal opportunities for enhancing social interaction on educational issues among students.
10	My institution provides interactive online discussion forums.
11	My institution has meeting places for students and teachers for interaction.
4-Institutional policies (IP) Inhibitor	
12	Faculty can appeal against institutional decisions without any fear.
13	My institution's decisions are based on defined policies and procedures.
14	I have been provided with a clear job description.
15	My institution gives awards for educational innovation (e.g., development of a new assessment tool, teaching method etc.)
16	My teaching and research activities are considered equally important for my promotion.
5-Communication Practices (CP) Inhibitor	
17	In my institution, there are no restrictions on the use of social media such as YouTube, WhatsApp etc. for educational purposes.
18	In my institution, regular faculty meetings are held at the departmental level where everyone has the right to voice their concerns.
19	In my institution, the curriculum managers clearly communicate educational changes to the faculty.
20	In my institution, the faculty share strategies for effective classroom management among themselves.
21	In my institution, the faculty share their experiences of various instructional designs (e.g., 4C ID, Gagne 9 events) amongst them.
22	My institutional management shares the educational courses/modules in the curriculum with the faculty.
6-Faculty involvement (FI) Inhibitor	
23	I am invited to the meetings in which curricular issues are discussed and decisions are made.
24	My suggestions to update a course/module are given due consideration by committees that make curricular changes.
25	I have the authority to update the content of course/module in the curriculum based on students' feedback.

The items for each viability inhibitor were graded on a scale from 1 to 5, with the following meanings: Strongly Agree (5), Somewhat Agree (4), Neither Agree nor Disagree (3), Somewhat Disagree (2), and Strongly Disagree (1).

All of the 8 participants of the cohort unanimously agreed that there were no issues in the educational program and the curriculum was designed according to the major outcomes of the institute and was being followed in letter and in spirit. However, they highlighted 3 out of 25 items which according to them were not effective. These three items along with themes are mentioned below in table 3. First two items belonged to institutional policies inhibitors (item 12, and 15), and one belonged to faculty involvement inhibitors (item 25). The data underwent rigorous thematic analysis, involving the meticulous manual examination of transcribed data. Raw data was systematically coded, a process that entailed categorizing information to unveil underlying patterns and relationships. This analytical method provided a structured framework for generating meaningful interpretations, allowing for the exploration of connections among diverse data elements. As the coding process unfolded, distinctive themes and sub-themes began to emerge, encapsulating the core findings and insights derived from the FGD. This in-depth analysis served as a powerful tool for gaining a deeper understanding of the curriculum viability challenges and potential solutions identified during the discussion.

Figure 1: Overview of the Methodology for the Entire Process

Table 3: Showing items which were not effective.

Items	Themes	Representative Quotes
Faculty can appeal against institutional decisions without any fear (item number 12)	No proper protocol	"There is no method by which we can apply against any decision or issue. Even our Head of departments are not aware of any system of appeal"
	Repercussions	"I am honestly scared that since there is no system of confidentiality in place, so my complains are not anonymous and I will have to face the consequences of all these complaints. This stops me from even registering any of our departmental issues in any meetings"
	Not transparent	"I have my doubts on transparency of how conflict matters are dealt with because of biasness towards certain individuals."
My institution gives awards for educational innovation (item number 15)	No rewards	"There used to be a proper certificate and award for best module coordinator on annual dinner but now we are just expected to work without any reward or even appraisal."
	No awareness about changes	"I was among the team which created these modules but even I am unaware of which module is running right now because it has changed drastically."
	No positive discrimination	"We were even not appreciated for the efforts we put in for the development of modules. After all our hard-work other members of the committee were given the credit."
	No incentive	"All module coordinators used to get monetary rewards at the start of implementation of integrated curriculum. But it has stopped now. It used to be a major motivation to do extra task of designing a module and its time table"
	No faculty discounts	"We are forced to pay registration fees of different conferences arranged by institute but are not given any kind of discount."
I have the authority to update the content of course/ module in the curriculum (item number 25)	No Authority	"I feel like I have no authority to make any change in my own module. There is no flexibility. I am from clinical faculty and there are so many time when I have rare patients in OPD but I can't show my students because they have fixed learning objectives."
	No Flexibility	"It is said repeatedly to us that we have a student-centered curriculum but neither students nor faculty members are given any kind of flexibility in how they want to learn or teach"

Table 4: Showing Recommendations which can be Adopted to Remove these Deficiencies.

Themes	Sub Themes	Representative quotes
Transparent System	Written Protocol	"There should be proper written protocols for appeal and the system should be made public and displayed as well so that everyone is aware of it."
	Time limit for answering the appeal.	"I personally think most of our requests are not catered when required so I suggest setting a deadline to respond requests and appeals by concerned department and administration."
	Anonymous appeal	"Please make sure there is an anonymous system of appeal so that the method is transparent."
Voting System	Regular Faculty Meeting	"There should be regular faculty meetings which include all faculty members. Faculty members involved in meeting are mostly AP and above and that too in Board of Studies, where usually no change in decisions are made."
	Representation of Complete Faculty	"Committees usually formed are not complete representative of faculty members and often, similar faces are represented in all committees."
	Monetary Incentive	"High performer students and faculty members should be given monetary incentives. There are no bonuses and very less increments."

	Faculty Discounts	"Faculty should be given discounts on conferences, certificates and post-graduate courses. If faculty members are giving so much time to the institute, institute should also sponsor their CPD events."
		"Annual dinner should restart a section of best module coordinator, like before."
Public Appreciation	Highlighted on big occasions and public platforms.	"Module coordinators and academic teams should be given enough autonomy to make changes in the curriculum how they deem fit, with approval of curriculum committee."
Provision of proper Guidelines	Autonomy	"FDP is arranged for faculty but the workshops are same and usually during the times when faculty can't attend."
Trainings	Training of Module Teams	

Discussion

This qualitative exploratory study was undertaken at the University College of Medicine and Dentistry to assess the undergraduate medical curriculum, determining its alignment with the evolving demands of medical education and healthcare practice. The study sought to identify any factors impeding its viability from the faculty's perspective, using six specific viability measuring parameters. Calculating curriculum viability involves assessing its alignment with educational goals, relevance to student and societal needs, feasibility within available resources, and effectiveness in achieving learning outcomes. Additionally, it aims to evaluate adaptability to evolving trends and sustainability over the long term. By incorporating stakeholder input, ensuring accessibility, and maintaining compliance with regulatory standards, institutions can enhance the quality and relevance of their curriculum. Continuous quality assurance and improvement mechanisms are essential for maintaining viability and meeting the needs of students and society effectively.

The questionnaire utilized identified six major inhibitors that an institution might encounter, which could obstruct the smooth implementation of the curriculum(Tabel 2). Educational program inhibitors relate to issues within the educational program itself. It may encompass problems with curriculum design, content, or delivery. Issues such as outdated materials, inadequate teaching methods, or a lack of alignment with educational goals can fall under this category.[5] The participants of the cohort agreed that there were no issues in the educational program and the curriculum was designed according to the major outcomes of the institute and was being followed in letter and in spirit. The disciplinary culture inhibitor was concerned with the overall culture and attitudes within a specific academic discipline. It referred to resistance to change, traditional practices that hinder innovation, or a lack of interdisciplinary collaboration.[6] All of the participants agreed that the attendance of faculty was correctly being monitored through biometric thumb impression and that the students were fined for disciplinary actions and practices. In literature it also shows that student's attendance is directly related to leadership and discipline.[7] Social interaction inhibitors pertained to the extent and quality of social interaction among students, faculty, and other stakeholders. In studies, it shows that problems with social interaction can negatively impact the learning environment, as collaboration and peer support are essential in education.[8, 9] Institutional policies inhibitor encompassed the rules, regulations, and guidelines set by the educational institution. This inhibitor included issues such as rigid policies that hinder curriculum adaptation, inadequate support for faculty, or unclear evaluation procedures.[10] Most of the disagreement was shown in this inhibitor, as the faculty members were either unaware of or disagreed regarding the freedom of appeal against institute policy and if there were awards for educational innovation at their institute.[1] A study conducted in Pakistan by Wajid et al. (2019) shows that they have clear cut institutional policies to work upon that enhance students' learning environment.[11]

Effective communication is essential for the smooth functioning of educational programs. Communication practices inhibitors encompassed problems with information flow, transparency, or the exchange of ideas among faculty, students, and administrators. As per study done in 2023, effective communication has positive impact in digital world and educational systems.[12] The majority of faculty members agreed that there was no issue in communication of content or policy with faculty or students and there is proper mechanism for management and dissemination of information.[13] Faculty inhibitor relates to the level of engagement and participation of faculty members in curriculum development and delivery. Insufficient faculty involvement can lead to a lack of commitment, innovation, and responsiveness to student needs.[14,15] The cohort agreed that they were invited to meetings to discuss issues in curriculum and their suggestions were welcomed but when it came to making changes in the curriculum and being autonomous in decision making, the participants showed resentment.

Limitations

The major limitation of this study was that curriculum viability was assessed using feedback from only a small cohort of faculty. A comprehensive evaluation should have included alignment with educational goals, learner relevance, effectiveness in achieving outcomes, adaptability, assessment methods, resource requirements, feedback mechanisms, long-term sustainability, standard compliance, and cultural and ethical considerations. We plan to conduct a case study to assess the curriculum's viability from multiple perspectives.

Conclusion

Overall, faculty was very satisfied with the curriculum. No inhibitor as a whole was identified to be present in University College of Medicine and Dentistry. Only three items were deficient. The reasons were identified and recommendation were made to improve these 3 items as well.

Conflict of Interest: The authors declare no conflict of interest.

Authors' Contributions: AQ and QL wrote the manuscript and conducted the FGDs; GA and MM were the observers, took notes, and helped with the thematic analysis and literature search;

KM did the interpretation, transcription and thematic analysis, and gave intellectual input to the manuscript; RAK supervised the project, transcription and thematic analysis and gave final approval to the manuscript.

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Original Article

Predicting Intrauterine Growth Restriction in Hypertensive Pregnancy: Cerebroplacental Ratio & Umbilical Artery Waveform

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Abstract

Objective: To evaluate the diagnostic accuracy of the cerebroplacental ratio compared to the umbilical artery waveform in predicting adverse fetal outcomes, specifically intrauterine growth restriction (IUGR), in hypertensive pregnancies.

Methodology: This descriptive cross-sectional study of six months' duration from August 2018 to February 2019 was carried out at the Department of Obstetrics & Gynecology, Lady Aitchison Hospital, Lahore on 160 females, who underwent ultrasonography by experienced radiologists. Cerebroplacental ratio and umbilical artery waveform was noted in form of resistive index (RI). Patients were categorized as positive or negative for respective methods. Females then underwent clinical evaluation for IUGR by experienced gynaecologists, and all the data was collected through proforma, entered and analyzed through SPSS 21. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy of cerebroplacental ratio and umbilical artery waveform was measured.

Results: The patients had mean age of 29.16 ± 6.92 years. The mean gestational age at enrollment was 35.58 ± 1.08 weeks. At recruitment, the mean systolic blood pressure of females was 168.97 ± 13.71 mmHg and diastolic blood pressure was 108.32 ± 8.56 mmHg. There were 142 (68.75%) patients with pregnancy induced hypertension while 18 (11.25%) had eclampsia. The mean BMI of patient was 24.14 ± 3.39kg/m2. The specificity, sensitivity, NPV, PPV and diagnostic accuracy of cerebroplacental ratio were 95.1%, 96.97%, 95.1%, 96.97% and 96.25% respectively whereas of umbilical artery waveform were 49.2%, 71.7%, 51.7%, 96.6% and 63.1%.

Conclusion: The cerebroplacental ratio was more accurate than umbilical artery waveform for prediction of IUGR in hypertensive pregnancy.

Keywords: Cerebroplacental ratio, umbilical artery waveform, intrauterine growth retardation, hypertensive pregnancy, eclampsia, pregnancy induced hypertension, preeclampsia

Introduction

Placental malfunction during pregnancy is intimately linked to pre-eclampsia and pregnancy-induced hypertension, which can lead to intrauterine growth restriction.[1] When the ultrasound-estimated fetal weight is less than the 10th percentile for the gestational age, intrauterine growth restriction (IUGR) is detected. Around the world, IUGR affects 23.8% of newborns, with 75% of affected babies being born in Asia.[2] About 25% of pregnant ladies in Pakistan, especially in Karachi, were discovered to have IUGR.[3] Doppler ultrasonography velocimetry of the umbilical, fetal, and uteroplacental arteries is now a recognized technique for prenatal surveillance and is crucial for the detection of defective placentation. Adverse perinatal outcomes are predicted by alterations in circulation, which are evident in specific fetal Doppler waveforms.[1] Diagnosis of new hypertension is confirmed after 20 weeks of gestation if the patient's blood pressure exceeds 140/90 mmHg four hours apart, and if there is absence of protein in the urine.[4] Preeclampsia is defined as gestational hypertension and proteinuria (>300 mg of protein in a 24-hour urine sample).[1] The most frequent cause of hypertension in expectant mothers, accounting for 5–10% of cases, is gestational hypertension.[5] It is a leading factor in the morbidity and death of both mother and fetus.[6] Pre-eclampsia, however, is more common in nulliparas (3%–7%) than multiparas (1%–3%).[7]

For the evaluation of umbilical and uterine arteries, Doppler ultrasound examination has emerged as a useful technique in uteroplacental circulation detection, starting at an early stage of pregnancy. It has also been suggested as a possible screening tool for the onset of fetal growth restriction and pre-eclampsia.[8,9] For prenatal prediction, the cerebroplacental ratio (the ratio of the middle cerebral artery's pulsatility index to the umbilical artery) has superior sensitivities and specificities than the umbilical artery alone.[9,10] Obesity, age 35 or older, a history of diabetes, hypertension, and renal diseases, teenage pregnancy, new paternity, thrombophilias, multiple gestations (twins, triplets, etc.), placental abnormalities, a family history of pre-eclampsia, and African American race are the main risk factors for gestational hypertension.[11] In routine practice, the umbilical artery waveform is commonly used to predict whether IUGR is present or if the fetus has normal growth. However, literature suggests that the cerebroplacental ratio is more valuable than the umbilical artery waveform, though no local evidence has been found in the literature. Typically, studies have combined the umbilical artery and cerebroplacental ratio for predicting IUGR, but to find a more

accurate and reliable method, we aim to conduct this study to enhance our understanding and application. In the future, we intend to use the study's findings in a local context. Therefore, the purpose of this study was to assess the diagnostic accuracy of the cerebroplacental ratio versus the umbilical artery waveform for predicting IUGR in hypertensive pregnancies. The goal was to compare the diagnostic accuracy of the umbilical artery waveform against the cerebroplacental ratio for predicting IUGR in hypertensive pregnancies undergoing clinical examination.

Methodology

This cross-sectional study was carried out from August 2018 to February 2019 at Lady Aitchison Hospital, Lahore (OBG-2015-066-6880). Using actual fetal weight for the given gestational age assessed at term via ultrasound, a sample size of 160 cases was determined through non-probability sampling. The statistical analysis was based on a 95% confidence level, an expected IUGR proportion of 25%, the sensitivity and specificity of the umbilical artery waveform (67% and 90%, respectively), and a margin of error of 5.5%. Among the inclusion criteria were women between the ages of 18 and 40, with a parity of less than 5, who presented with hypertension (blood pressure ≥140/90 mmHg 4 hours apart) at gestational age >32 weeks (on LMP).

Exclusion criteria included females with chronic or gestational diabetes (BSR>186mg/dl), anemia (HB<10mg/dl), those suffering from cardiac problems and taking medication during pregnancy (on medical record) and females with placental abnormalities (previa, accrete, increta or placental abruption) on USG, and very lean females (BMI<19kg/m2). Data collection involved the use of a self-structured questionnaire after obtaining ethical approval and informed consent.

Cerebroplacental ratio and umbilical artery waveform were assessed on ultrasonography by senior consultant radiologist. IUGR was confirmed if fetal weight was less than 10th percentile on ultrasound for particular gestational age near term or before delivery. All collected data was analyzed through SPSS 21. By assessing IUGR using fetal weight for a specific gestational age, 2x2 tables were created to evaluate the sensitivity, specificity, PPV, NPV, and diagnostic accuracy of both the umbilical artery waveform and the cerebroplacental ratio.

Results

The mean age of patients was 29.16 ± 6.92 years. In this study, 40 (25%) females were primigravida (nulliparous), 77 (48.2%) had parity of 1-2, and 43 (26.8%) had parity of 3-4. For each patient's parity, the data was stratified.

The mean gestational age at presentation was 35.58 ± 1.08 weeks. At presentation, the mean blood pressure of females was 168.97 ± 13.71 mmHg while diastolic blood pressure was 108.32 ± 8.56 mmHg. There were 142 (68.75%) patients with pregnancy induced hypertension while 18 (11.25%) had eclampsia (Figure- 1). The mean BMI of patient was 24.14 ± 3.39 kg/m2 (Table-1).

During clinical evaluation, the cerebroplacental ratio demonstrated a specificity of 95.1%, sensitivity of 96.97%, NPV of 95.1%, PPV of 96.97%, and overall diagnostic accuracy of 96.25%. In contrast, the umbilical artery waveform showed a specificity of 49.2%, sensitivity of 71.7%, NPV of 51.7%, PPV of 96.6%, and diagnostic accuracy of 63.1% (Table-2).

Table 1: Basic Demographics of Females

Number of Patients	160
Age (in years)	29.16 ± 6.92
Gestational age (weeks)	35.58 ± 1.08
Parity	
Primigravida	40 (25%)
Parity 1-2	77 (48.2%)
Parity 3-4	43 (26.8%)
Systolic Blood pressure (mmHg)	168.97 ± 13.71
Diastolic blood pressure (mmHg)	108.32 ± 8.56
Pregnancy induced hypertension	142 (68.75%)
Eclampsia	18 (11.25%)
BMI (kg/m2)	24.14 ± 3.39

Table 2: Accuracy of Cerebroplacental Ratio and Umbilical Artery Waveform Based on Clinical Evaluation

		Clinical Examination		Total
		Positive	Negetive	
Cerebroplacental ratio	Positive	96	3	99
	Negetive	3	58	61
Total		99	61	160
Umbilical artery waveform	Positive	71	31	102
	Negetive	28	30	58
Total		99	61	160

There were 142 (68.75%) patients with pregnancy induced hypertension while 18 (11.25%) had eclampsia.

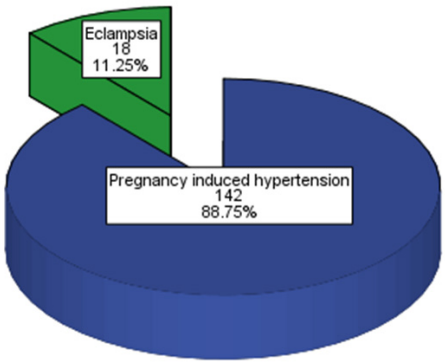

Figure -1: Distribution of severity of blood pressure among the 160 patients

Discussion

This study was undertaken to assess the diagnostic accuracy of the cerebroplacental ratio versus the umbilical artery waveform for predicting IUGR in hypertensive pregnancies. We wanted to compare the diagnostic accuracy of the umbilical artery waveform against the cerebroplacental ratio for predicting IUGR in hypertensive pregnancies undergoing clinical examination. In our study, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of cerebroplacental ratio were 96.97%, 95.1%, 96.97%, 95.1% and 96.25% whereas of umbilical artery waveform were

71.7%, 49.2%, 96.6%, 51.7% and 63.1% on clinical evaluation. Similar study has showed that the sensitivity, specificity, PPV and NPV of umbilical artery waveform were 67%, 90%, 42% and 96% respectively, while for cerebroplacental ratio were 90%, 95%, 6% and 98%.[10] Doppler indices are a crucial part of the noninvasive assessment of the health of the fetus. Normal obstetric Doppler indices are not well documented, especially in the Indian subcontinent.[12] When evaluating different prenatal and perinatal problems, the cerebroplacental ratio is a stronger indication of fetoplacental circulation than umbilical artery waveform examination alone.[5,13] According to one study conducted by Ropacka-Lesiak et al. (2015), the cerebroplacental ratio's sensitivity, specificity, PPV, and NPV were 87.8%, 68.5%, 51.4%, and 93.7%, respectively, in predicting an unfavorable neonatal outcome.[14] Munikumari et al. (2017) reported that the umbilical artery waveform has a sensitivity of 91% and a specificity of 84.6% for IUGR prediction.[15] A study conducted in 2004 examined the relationships between umbilical artery (UA) Doppler, ductus venosus (DV) Doppler, fetal heart rate variation, and perinatal outcomes in preterm, intrauterine growth-restricted (IUGR) fetuses.[16] Majadla et al. (2024) found the umbilical artery waveform to have a sensitivity of 64% and a specificity of 90.7%.[17]

However, Fong et al. (1999) observed the sensitivity and specificity of the umbilical artery waveform to be 44.7% and 86.6%, respectively.[18] In contrast, Dhand et al. (2011) reported that in a comparable setup, IUGR could be predicted with a sensitivity of 44% and a specificity of 61.5%.[19] In a related study, Lakhkar et al. (2006) found that the umbilical artery waveform has a 44.4% sensitivity, 81.8% specificity, 80% positive predictive value, and a 47.3% negative predictive value for predicting any major adverse outcome, such as neonatal IUGR, in pregnancies that are complicated by severe preeclampsia, IUGR, or both, and that are beyond 30 weeks of gestation.[20] According to Ibrahim et al. (2014) the umbilical artery waveform may predict newborn IUGR in hypertensive pregnancies with a high sensitivity of 94.8% and a poor specificity of 36.8%.[21] Placental insufficiency, which happens when the trophoblast is unable to pierce sufficiently deeply into the uterine lining, is the most common cause of IUGR.[22] When the trophoblast of the fetus fails to penetrate the uterine wall, the spiral arteries do not undergo a complete transformation into low-resistance channels.[23] This insufficient conversion of spiral arteries increases the barrier to uterine blood flow during pregnancy and has been associated with gestational hypertension.[24] An erroneous immunological reaction by the mother's tissue to the alien foetal tissue may be one cause of this partial rupture of the spiral arteries, which causes gestational hypertension.[25] As a result, the fetus modifies its circulation to protect the brain's supply of oxygen and nutrients (a process known as "brain-sparing"). Currently, not much is understood regarding the postnatal progression and implications of this antenatal cerebral circulation adaptation. A different approach to cerebral monitoring and clinical management of IUGR preterm newborns than their correctly developed counterparts would be necessary if the abnormal cerebral haemodynamics were to remain after birth. There aren't many research articles on this subject, and little that is known is also disputed.[26]

Cerebroplacental ratio reflects the status of redistribution of the cardiac output to the cerebral circulation, which improves accuracy in predicating adverse outcome compared to middle cerebral artery and umbilical artery Doppler alone.[27] The cerebroplacental ratio is also considered to be more physiological in the measurement of centralization of fetal blood flow. Srikumar et al. (2017) found that cerebroplacental ratio showed a strong positive correlation with gestation age till 30 weeks of gestation followed by strong negative correlation thereafter till 40 weeks of gestation. This is probably due to different amount of blood volume required by brain in different gestation. There is paucity of information in the literature on this account.[12] There are few studies, which have tried to formulate reference ranges for cerebroplacental ratio over the gestation period in normal pregnancies.[28] Umbilical cord plays a crucial role in fetal health and development. Several complications like IUGR, cord accidents, and stillbirths are attributed to an abnormal fetoplacental circulation. In conclusion, understanding and monitoring fetoplacental circulation, particularly through measures like the cerebroplacental ratio and umbilical artery waveform, are crucial for identifying potential complications such as IUGR, cord accidents, and stillbirths. Continued research and the development of precise reference ranges for these measures throughout gestation can significantly enhance prenatal care and improve fetal outcomes.

Limitations

Firstly, the study's sample size is somewhat limited, with only 160 patients from a single hospital, which may not represent the broader demographic of our hypertensive patients. Secondly, the cost-effectiveness of implementing the cerebroplacental ratio (CPR) over Doppler waveform was not addressed. Lastly, the study uses clinical evaluation of IUGR, which can sometimes be subjective.

Authors' Contributions

SIS conceived and designed the study, participated in data collection, and contributed to draft-ing and revising the article. IN supervised and critically revised and analysed the work, and gave intellectual input.

Conclusion

Cerebroplacental ratio was more accurate than umbilical artery waveform for prediction of IUGR in hypertensive pregnancy. Now we can implement the use of cerebroplacental ratio instead of umbilical artery waveform for prediction of IUGR in our setting, as it found to be more accurate than umbilical artery waveform. This would help to improve our knowledge and practice.

Conflict of Interest: The authors have no conflict of interest.

Source of Funding: None.

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Original Article

Examining Clinical Outcomes and Management Strategies in Wheat Pill Poisoning

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Abstract

Objective: To retrospectively analyze the clinical presentation and management strategies of patients who died from wheat pill poisoning.

Methodology: A retrospective study was conducted in the Department of Medicine in Divisional Headquarters teaching Hospital, Azad Kahmir, in which 12 deaths caused by wheat pill poisoning were analyzed. All patients who died from wheat pill poisoning from October 2019 to October 2022 were included in study. The presenting symptoms, clinical findings, initial resuscitation, management and mode of death was recorded for all cases.

Results: A total of 12 cases were included, with a mean age of 27 ± 12.2 years. There were 2 males (16.6%) and 10 females (83.3%). The main presenting symptoms were vomiting (11 cases, 92%) and irritability (7 cases, 58%). Pre-existing psychiatric illness was present in 4 of the 12 cases (33%). The majority of the patients (92%) died within 48 hours of pill ingestion. In most cases, the mode of death was cardiac arrhythmias, with other modes including recalcitrant shock, metabolic acidosis, and myocardial infarction. Management strategies included initial assessment of airway, breathing, and circulation, system management to stabilize symptoms and maintain cardiovascular function, and advanced treatments such as magnesium sulfate administration and considering hemodialysis in severe cases.

Conclusion: The study found that among the 12 cases of wheat pill poisoning, the majority were young females, with high mortality rates primarily due to cardiac arrhythmias. Prompt hospital arrival and medical management are crucial, as most deaths occurred within 48 hours of ingestion.

Keywords: Wheat pill poisoning, Aluminium phosphide, Ionotropic support, Management strategies, Epidemiology

Introduction

Aluminum phosphide is a readily accessible rodenticide used in agricultural regions like Pakistan to safeguard crops, notably wheat and occasionally rice.[1] Wheat pill" or less commonly known as rice pill mainly consists of Aluminium phosphide (AlP) and is used in agricultural countries like Pakistan to preserve wheat grains and rice. [2] Wheat pill is a fumigant rodenticide and pesticide and is extremely toxic. Due to its low price and ease of availability, it is a commonly used agent with suicidal intent.[3,4] Deliberate self-harm is a major health problem worldwide but is especially prevalent in developingcountries.9 Wheat pill intoxication is a growing public health concern in Pakistan and has escalated over the past few years predominantly among young adults.[5] Although very less literature is available on aluminum phosphide poisoning in Pakistan, according to a national health survey done in 2022 in South Punjab areas, it was concluded that among unintentional injuries aluminum phosphide poisoning is the second commonest cause.[6] AlP is available in tablet form or powdered sachets and the lethal dose for an average-built adult is 150-500 mg.[7] When the AlP in a wheat pill comes in contact with moisture or in the case of ingestion – with acid in the stomach, a gas called phosphine is released. This is lethal to rodents as well as to humans as phosphine binds to cytochrome oxidase and causes cellular hypoxia leading to unrestricted organ damage and acute cardiac toxicity leading to focal myocardial necrosis.[8,9] Despite early diagnosis and efficient resuscitative measures, a poor prognosis and high mortality rate has always been observed among wheat pill poisoning cases.

The study's primary objective was to conduct a retrospective analysis, providing a comprehensive depiction of the clinical characteristics exhibited by patients admitted to intensive care units due to wheat pill poisoning. Additionally, it aimed to clarify the management strategies employed in these cases and document the progression of the disease until the unfortunate occurrence of the patients' demise. This study's findings hold significance not only for medical practitioners but also for policymakers and public health officials involved in agricultural safety and pesticide regulation in regions where Aluminum phosphide usage is prevalent. The purpose of this study was to retrospectively analyses the deaths caused by wheat pill poisoning and describe the clinical characteristics and management of cases presenting to the intensive medical care unit and the course of disease till death.

Patients and Methods

A retrospective study was conducted in the department of Medicine in Divisional Headquarters Teaching Mir-Pur Azad Kashmir, Pakistan, on patients who died of wheat pill poisoning from October 2019 to October 2022. The ethi-

cal permission was taken from IRB with reference number ERC 5284/1523. All 12.0 patients who died with a diagnosis of AlP poisoning based on history were included. Patients were included based on a confirmed diagnosis of Aluminium phosphate poisoning derived from their medical history. The analysis encompassed all demographic information, including age, gender and marital status, ensuring a comprehensive representation of affected individuals. Pre- existing psychiatric illness status did not exclude patients from the study. Over a period of 3 years there were 12 deaths caused by wheat pill poisoning and the patients were included irrespective of their age, gender and marital status.

From the records, all patients with AlP poisoning were initially resuscitated by gastric lavage if not done at a primary health care facility. Ionotropic supports (dopamine, dobutamine) and fluid therapy was initiated in those patients who had a blood pressure of less than 90/60 mmHg. Thorough examination of all systems was carried out and documented. All baseline blood investigations were sent, and ECG and arterial blood gases (ABGs) were checked. All patients were given IV MgSO4 and calcium gluconate, Symptomatic treatment for individual symptoms was done such as IV amiodarone in cases of arrhythmias, sodium bicarbonate for metabolic acidosis and anti-emetics in cases of vomiting. Data was entered and analyzed in SPSS V25.0. Age was presented as mean and standard deviation. Gender, Marital status, time for pill ingestion to hospital, pre-existing psychiatric illness etc. were presented as frequency and percentage. Chi square test was applied to compare the general parameters with age group gender. P value less than 0.05 was considered as significant.

Results

Total 12 cases were included. The mean age was 27+ 12.2 year. There was 2(16.6%) male and 10(83.3%) female. Fig: 1There were 5(41.6%) respondents in 11 to 20 years of age group, 6(50%) in 21 to 30 years of age group and only 1(8.30%) in greater than 30 years of age group. Table: 1 Out of 10(83%) of female, 50% of them were unmarried. There were 1(50%) male and 4(40%) female in 11 to 20 years of age group, 6 (60%) females in 21 to 30n years of age group and only 1(50%) male in greater than 30 years of age group. there was a significant difference of age and gender. (P<0.05). Distribution of general parameters among marital status and time from pill ingestion to hospital arrival, pre-existing psychiatric illness etc. were shown in Table: 2 Pre-existing psychiatric illness was found to be present in 4 of the 12 cases (33%). 11(92%) of the patients of wheat pill poisoning died within 48 hours (about 2 days) of pill ingestion. In most of the cases, the mode of death was cardiac arrhythmias. Other modes included recalcitrant shock, metabolic acidosis, myocardial infarction (table 2). Most of the patients took one to two pills only and all of them ingested the pills with the intention of deliberate self- harm or suicide. There were 67% of the patients from the records, who were brought into the hospital within 4 hours of pill ingestion. Most cases (83%) presented in the summer from March to August. The main presenting symptoms were vomiting 11(92%) and irritability 7(53.8%). There was 6 (50%) of the cases which presented with hypotension, but along the course of illness, eventually all the patients developed hypotension and thence required fluid (figure 3).Particularly, these symptoms of the disease, we can confirm it after diagnostic criteria and ionotropic support. Particularly these are symptoms of this disease, we can confirm it after diagnostic test. Arterial Blood Gases (ABGs) revealed metabolic acidosis in 4(33%) of the cases, however in the remaining cases ,no record of ABGs was available.

Wheat pill poisoning, specifically referring to aluminum phosphide, is a serious condition that requires immediate and comprehensive medical management. Below are the tables showing management of wheat pill poisoning in all 12 cases.

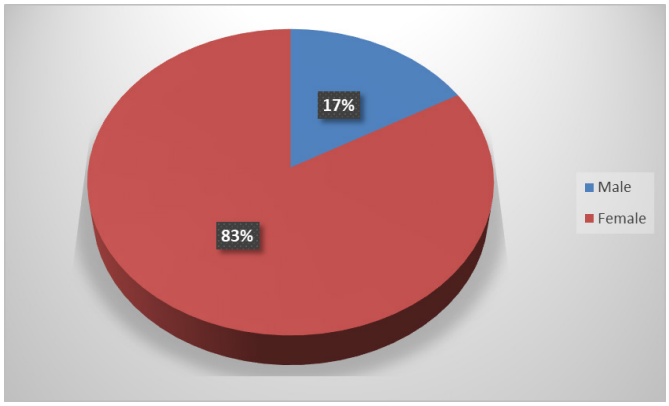

Fig 1: Gender Distribution Among Wheat Pill Poisoning Cases

Table: 1: Age Distribution Among Wheat Pill Poisoning Cases

Age	Percentage
11---20	41.6
21-30	50.0
>30	8.30

Table: 2: Demographic and Clinical Characteristics of Wheat Pill Poisoning Cases

Martal Status	Unmarried	50%
	Married	50%
Time from pill ingestion to hospital arrival	<4 hours	67%
	<4 hours	33%
Pre-existing psychiatric illness	Yes	33%
	No	67%
Time from pill ingestion to death	<48 hours	92%
	<48 hours	8%

Table: 3: Clinical Presentation and Frequency Distribution

Clinical Presentation	Frequency	Percentage
Vomiting	11	92%
Irritability	7	53.8
Hypotension	6	50%
Metabolic acidosis	4	33.3%
Hypoxia	2	16.6%
Nausea	4	33.3%

Table 4: Management Protocol for Poisoning: Steps, Descriptions, and Outcomes

Management Step	Description	Outcome
Initial Assessment	Evaluation of airway, breathing, circulation	Patient is stabilized with ensured breathing and a stable heart rate
	Obtaining patient history	Better-informed treatment plan based on a thorough understanding of poisoning extent
System Management	Monitoring, and management of symptoms such as vomiting, hypotension and metabolic acidosis	Symptoms are stabilized, and severe complications like shock or organ failure are prevented
	Cardiovascular function monitoring, and electrolyte imbalances especially hypokalemia and metabolic acidosis	Blood pressure is maintained, and electrolyte levels and acid-base balance are normalized
Laboratory Treatment	Obtaining blood tests including Glucose, renal and liver functions	Organ function and metabolic status are assessed, guiding further treatment
	Monitoring ECG	Cardiac abnormalities are detected early and managed appropriately
Advance Treatment	Administering magnesium sulfate to minimize toxic effects on the heart	Cardiac toxicity is potentially reduced, improving patient prognosis
	Considering hemodialysis if severe poisoning	Toxins are removed more effectively from the bloodstream, reducing systemic effects

Discussion

The study retrospectively analyzed 12 cases of wheat pill poisoning at a single hospital from October 2019 to October 2022. The majority of patients were young females presenting with symptoms such as vomiting and irritability. Most patients died within 48 hours of ingestion, with cardiac arrhythmias being the primary cause of death. Management strategies included initial stabilization, symptom management, and advanced treatments like magnesium sulfate administration and hemodialysis in severe cases. The findings emphasize the importance of immediate medical intervention to improve patient outcomes.Attempting suicide with poisonous agents is a worldwide public health concern. According to the WHO about 2 million people are globally affected by deliberate self-intoxication.[10] Wheat pill poisoning is a growing medicolegal concern in Pakistan and many other agricultural countries.[11] In European countries the availability of AlP is restricted to qualified users hence its misuse is rare.[12] This retrospective analysis of wheat pill poisoning cases delved into the multifaceted aspects surrounding this critical health issues. Firstly the study highlights the global significance of deliberate self-intoxication, with wheat pill poisoning emerging as a significant public health concern, particularly in agricultural countries like Pakistan. The study's findings reveal a disturbing trend of escalating cases, predominantly among young adults, highlighting the complex interplay of socio-economic pressures, mental health challenges and agricultural factors driving suicidal behaviors.

In this study, there were more females 10(83.3%) affected by wheat pill poisoning compared to males 2(16.6%). This finding was consistent with many previous studies and owes to the fact that it is in this age group that the transition from teenagers to young adults occurs and the responsibilities and difficulties along with it come up. Individuals in this age group are affected the most by the economic de-stability and inflation occurring worldwide as pursuing a means of income becomes more profound and difficult at the same time. In one study, 30 patients were admitted. Females outnumbered males in all age groups with a sex ratio of 2.75:1. The mean age of patients was 22.77 ± 12.79 years and 96.6% of patients came from rural areas. There were 93.3% of the cases exposed to poisoning at home, where suicidal poisoning accounted for (86.7%) of cases. Elghany et al. (2018) reported that 43.3% of patients died from wheat pill poisoning.[13] Peer pressure, the upkeep of positive social bonds, and coping with challenges stemming from fractured family dynamics and job dissatisfaction are issues that affect individuals across all age brackets.[14] These elements collectively contribute to declining mental well-being, potentially resulting in conditions such as depression and even suicidal behavior. In areas where access is unrestricted, the ingestion of wheat pills becomes a viable option for addressing such issues. Pre-existing psychiatric illness was found to be present in 4 of the 12 cases (33%). 92% of the patients of wheat pill poisoning died within 48 hours (about 2 days) of pill ingestion. In one study, it was reported that ALP poisoning is most often lethal. However, there is an emerging evidence of successful use of various drugs such as magnesium sulfate, trimetazidine, and other interventions such as intra-aortic balloon pump and extra corporeal membrane oxygenation in case of ALP poisoning.[15,16]

Numerous management factors are linked to the outcomes of wheat pill poisoning cases, yet death remains an unavoidable outcome, prompting ongoing exploration and experimentation of new modalities. Initially, bioinformatics facilitated the progression from virtual assistance to animal trials and ultimately to human trials. While the effectiveness of these methods remains a subject of debate, continued research is imperative to advance the body of knowledge regarding the early detection, treatment, and prognosis of wheat pill poisoning.[17] Wheat pill poisoning represents a complex and challenging public health issue with far reaching implications. Effective prevention and management demand a multifaceted approach encompassing awareness campaigns, policy interventions and enhanced clinical practices.[18] By addressing the underlying social, economic and psychological determinants contributing to suicidal behaviors, stakeholders can work towards reducing the burden of wheat pill poisoning and improving patient outcomes.

Limitations

The study's limitations include a small sample size of 12 cases, limiting generalizability. Reliance on medical records may introduce inconsistencies or missing data. Lack of a control group hampers the ability to establish causality. The focus on fatal outcomes neglects potential long-term effects or variations in presentation. Being a single-center study may limit applicability to

diverse settings.

Authors' Contributions

QAA conceived and designed the study, participated in data collection, and contributed to drafting the article. SMS and critically revised and analysed the work, and gave intellectual input..

Conclusion

The study concludes that wheat pill poisoning, primarily affecting young females, exhibits high mortality rates, often due to cardiac arrhythmias. Urgent hospitalization and timely medical intervention within 48 hours post-ingestion are crucial, emphasizing the importance of restricting access, raising awareness, enhancing healthcare professional training, and furthering research for improved prevention and treatment strategies.

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Review Article

A Systematic Review of Artificial Intelligence in Healthcare: Opportunities, Advancements, and Challenges

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Abstract

Objective: To analyze opportunities, advancements, and challenges in the role of artificial intelligence in healthcare services.
Methodology: Studies published between 2020 and 2023 were systematically searched following PRISMA guidelines, and selected from major databases including PubMed, Scopus, and Google Scholar, by using specific Medical Subject Headings (MeSH) and key words related to AI and healthcare services. Selected studies included data on AI's contributions in addressing challenges and opportunities in healthcare. The systematic search and screening process identified a total of 200 records, from which 40 full-text articles were assessed for eligibility. Among these, 15 of them were selected for further review and analysis. The selected studies explored AI applications in clinical decision-making, diagnostics, telemedicine, vaccine research, robotics in neurorehabilitation, and ethical challenges.
Results: Out of the 15 studies included, 12 of them highlighted the advancements and opportunities, whereas 6 of them highlighted the challenges, as 3 out these 15 studies had overlapping results, and included data on both opportunities and challenges. AI's potential in enhancing diagnostics, treatment, patient care, vaccine research, and neurorehabilitation are the main opportunities and advancements observed, alongside challenges such as data security, bias, ethical concerns, and the need for regulatory standards.
Conclusion: From improving diagnostic accuracy and patient care to addressing challenges in healthcare delivery, AI technologies offer promising solutions. However, challenges such as data security, bias, ethical concerns, and regulatory standards remain critical areas requiring further attention and research.

Keywords: Opportunities, Advancements, Challenges, Artificial Intelligence, Healthcare Services.

Introduction

Artificial intelligence (AI) has become synonymous with computational technologies mimicking human intelligence, including cognitive processes such as learning, adaptation, engagement, and sensory comprehension. These technologies have transcended traditional boundaries, finding applications in diverse fields like medicine and healthcare. As early as the middle of 20th century, medical practitioners progressively took steps to integrate AI into diagnostic processes, marking the inception of AI's journey in healthcare.[1] Recent years have witnessed an exponential surge in AI's role in medicine, fueled by the exponential growth in computing capabilities and the abundance of digital data ripe for analysis and utilization.[2,3]

AI's impact on healthcare is multifaceted, influencing various aspects such as clinical practices, diagnostics, rehabilitation, surgery, clinical pharmacology, psychiatric medical services and predictive analytics. Particularly noteworthy is AI's contribution to clinical decision-making and disease diagnosis, actively utilizing vast datasets across modalities to enhance accuracy and efficiency.[4] Moreover, AI's role extends beyond data analysis; it further explores into drug invention, healthcare management, and personalized patient care, revolutionizing a new era of precision medicine.[5,6]

Therefore, despite the AI's potential in healthcare, challenges persist, necessitating rigorous studies to validate efficacy and optimize applications.[7] This paper adopts a structured literature review methodology to investigate opportunities, advancements, and challenges in the role of artificial intelligence in healthcare services.[8] Additionally, this research encompasses advancements in health care by AI specifically in the developed countries within recent time frame, where advancements in AI has changed the way people live. The objective of this systematic literature review was to analyze the opportunities and challenges in healthcare services in recent technological development.

Methodology

Protocol and Registration

This review was conducted in accordance to the standard Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines 2020.[9]

Eligibility Criteria

The published research studies selected for this literature review were analyzed for their study design, publishing year, regional background of publication, core variable of interest i.e. discipline of healthcare affected by AI. The freely available studies in PDF form in English language were included in this review. The studies published in 2020 to 2023 including all types of studies, both qualitative and quantitative, were incorporated into review, as there was no significant literature on AI and its application in health

care before 2020. This led to a notable decrease in the number of relevant articles, as AI is still evolving. The electronic data base was created by searching the research articles with specific MeSH terms and key words in PubMed, Scopus, and Google Scholar. The used MeSH terms included artificial intelligence and healthcare services. Two authors (AMK and SF) performed study selection by evaluating the research studies through research title, abstract and full text studies, whereas the remaining two authors (AYK and RT) counterchecked the articles to identify the role of AI in specific health care domain. Both quantitative and qualitative studies were selected which included data on AI's contributions in addressing challenges and opportunities in healthcare. To reduce subjectivity, all four reviewers independently assessed the risk of bias for each study.[11] Discrepancies were resolved through discussion or by involving a third reviewer, ensuring a consensus was reached. The included research studies were firstly evaluated based on title and abstract. The in-depth reading of full text article done to collect the data. Three authors independently studied and extracted the data from selected studies in 15 days from 17th March to 2nd April 2023.

Study Selection

The study selected parameters such as role of AI in different disciplines of healthcare, ethical concern with AI based healthcare services, accuracy and precision of AI based healthcare services, and challenges to healthcare services due to incorporation of AI. The study selection procedure for the review followed the PRISMA guidelines, ensuring a transparent and systematic approach to data collection and analysis. Initially, a total of 200 records were identified through screening processes by using the search engines i.e. PubMed, Scopus, and Google Scholar.

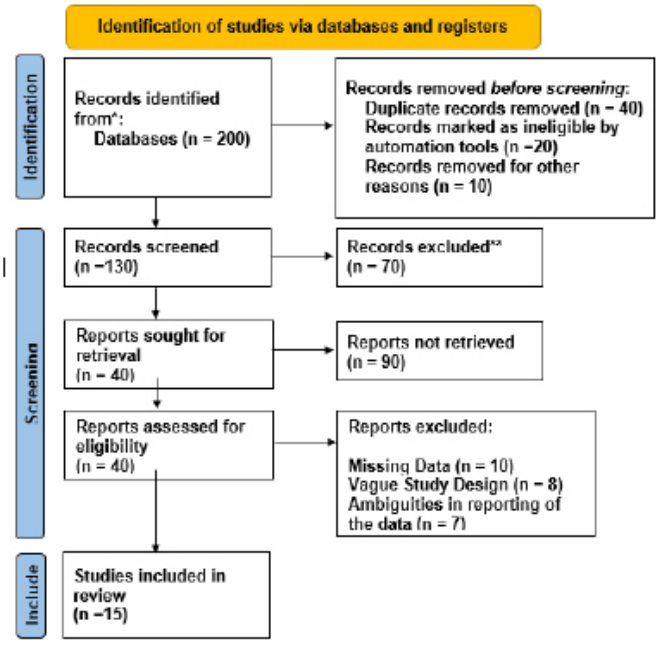

Figure 1: PRISMA Diagram Showing the Study Selection Procedure for investigating the role of Artificial Intelligence in healthcare services

During the initial screening phase, records were assessed for relevance to the research topic based on the research titles and publication years. After this stage, 130 records were deemed potentially relevant for further evaluation. The screening process involved a detailed assessment of the 130 records based on predefined inclusion and exclusion criteria. This step resulted in the exclusion of 90 records, leaving 40 full-text articles for eligibility assessment. The full-text articles were thoroughly reviewed to determine their eligibility for inclusion in the study. Criteria such as relevance to AI in healthcare services and availability of quantitative and qualitative data were considered. Among the full-text articles assessed, 25 were excluded due to reasons such as lack of relevant data or not meeting inclusion criteria. As a result, 15 studies were considered suitable for this review. The PRISMA diagram visually represents each stage of the study selection procedure in Figure 1.

Results

The results of this study are presented and briefly explained in Table 1. Whereas 6 of them highlighted the challenges, as 3 out these 15 studies had overlapping results, and included data on both opportunities and challenges. AI's potential in enhancing diagnostics, treatment, patient care, vaccine research, and neurorehabilitation are the main opportunities and advancements observed, alongside challenges such as data security, bias, ethical concerns, and the need for regulatory standards.

Discussion

This systematic literature review investigates the recent advancements, trends, opportunities, and challenges of AI in healthcare, focusing on its impact on healthcare outcomes, patient care, diagnosis, treatment, and system optimization. Following PRISMA guidelines, the review analyzed studies from 2020 to 2023, highlighting AI's significant contributions to clinical decision-making, diagnostics, telemedicine, vaccine research, and neurorehabilitation robotics. Despite AI's transformative potential in improving diagnostic accuracy and patient care, the review identifies critical challenges, including data security, bias, ethical concerns, and regulatory standards, underscoring the need for ongoing research and ethical implementation to maximize AI's benefits in healthcare services.

The selected studies provide a diverse range of insights into the intersection of healthcare and technology, particularly in the context of opportunities and challenges posed by the COVID-19 pandemic. A comprehensive retrospective study involved patients to identify undiagnosed HCV cases using advanced predictive algorithms, surpassing traditional screening rates.[11] Jnr[12] and Bagabir et al.[16] highlighted the importance of telemedicine and virtual care during pandemics, emphasizing their role in reducing exposure risks and improving healthcare delivery remotely. The potential of AI-driven tools cannot be underestimated in managing pandemics like COVID-19, focusing on data-driven insights and its impact on vaccine research and development.[13] Hussaini et al.[17] provided a survey-based overview of AI applications in clinical services during the pandemic, showcasing advancements in medical data analysis accuracy us-

Table 1: Characteristics of Included Studies

s	Author(s)	Research Design	Research Population	Analysis Method	Outcomes
1	Doyle et al.[11]	Retrospective Study	Approximately 10 million patients in the US (2010-2016)	Logistic regression, random forests, gradient boosted trees, stacked ensemble	Using longitudinal medical claims and prescription data, predictive algorithms identified undiagnosed HCV patients with high precision (>95%) at low recall levels (10%). The stacked ensemble method achieved the best performance with 97% precision at over 50% recall, surpassing CDC screening rates.
2	Jnr[12]	Rapid Literature Review	Not specified	Not specified	Advocated for telemedicine during COVID-19 to enable remote diagnosis, treatment, monitoring, and follow-ups, highlighting its importance in reducing exposure risks and enhancing healthcare delivery during pandemics.
3	Santosh[13]	Conceptual Paper	Not specified	Not specified	Emphasized the need for AI-driven tools with active learning models using diverse data to detect and forecast COVID-19 outbreaks globally, highlighting AI's potential in managing big data during pandemics.
4	Hussain et al.[14]	Survey Study	Not specified	Neural networks, SVM, edge significant learning	Summarized AI applications in clinical services during COVID-19, emphasizing Big Data use, classifying AI techniques for pandemic data analysis, and highlighting AI-driven cloud computing benefits and advances in medical data accuracy (up to 90%).
5	Bajwa et al.[15]	Review Article	Not specified	Not specified	Outlined recent AI healthcare breakthroughs, focusing on building reliable AI systems, and proposed future directions to enhance population health, patient care, caregiver experience, and cost reduction.
6	Bagabir et al.[16]	Rapid Literature Review	Not specified	Not specified	Advocated telemedicine for remote COVID-19 care to reduce exposure, emphasizing its importance in pandemic healthcare.
7	Hassani & Silva[17]	Perspective Article	Not specified	Not specified	Discussed ChatGPT's potential in data science for workflow automation and improved decision-making, while addressing concerns about bias and plagiarism, emphasizing its ability to enhance productivity and accuracy.
8	Xu et al.[18]	Systematic Review	Not specified	Not specified	Reviewed recent advances in medical chatbot technology for cancer therapy, discussing diagnosis, treatment, patient support, workflow efficiency, and health promotion, while highlighting implementation limitations and concerns regarding ethical, security, technical, and regulatory standards.
9	Li et al.[19]	Deep Learning Model	Multimodal Longitudinal Electronic Health Records	Hierarchical Transformer-based Model (Hi-BEHRT)	Created Hi-BEHRT, a Transformer-based model, for precise clinical event prediction using multimodal EHR, outperforming existing deep learning methods in forecasting risks like heart failure, diabetes, chronic kidney disease, and stroke, particularly for patients with extensive medical records.
10	Wang et al.[20]	Perspective Article	Not specified	Not specified	Identified metaverse opportunities in healthcare, focusing on Me-TAI for better quality, accessibility, cost-effectiveness, and patient satisfaction. Discussed virtual scanning, data sharing, regulatory science, and medical interventions, addressing privacy, security, and disparity.
11	Yu et al.[21]	Not specified	Clinicians, Healthcare Institutions	Not specified	AI challenges at point-of-care in pandemics: optimization, resource allocation, and addressing flaws in tech, ethics, institutions.
12	Javaid et al.[22]	Not specified	Healthcare	Not specified	ChatGPT's healthcare potential: data reliability, privacy, ethics.
13	Sharma et al.[23]	Not specified	Pharmaceutical, Healthcare	Machine learning, AI	AI/ML accelerates COVID-19 vaccine R&D by identifying candidates and optimizing processes, expediting SARS-COV-2 drug discovery.
14	Lambercy et al.[24]	Not specified	Neurological Patients	Robotics, AI	COVID-19 challenges in neurorehabilitation, driving decentralized, AI-enhanced therapy with robotics.
15	Connelly et al.[25]	Not specified	Healthcare	Not specified	AI drawbacks in healthcare: data security, privacy, ethics, lacking universal guidelines.

ing AI techniques. Similarly, Bajwa et al.[15] and Hassani & Silva[17] discussed recent AI breakthroughs and opportunities, proposing future directions for AI-augmented healthcare systems and addressing challenges such as bias and plagiarism in AI workflows. Xu et al.[18] and Li et al.[19] delved into specific technologies like chatbots and deep learning models for improved clinical predictions and patient support, albeit with considerations for ethical and regulatory standards. Other studies explored innovative approaches such as robotics in healthcare delivery and neurorehabilitation, respectively. They emphasized personalized adaptation and safe use of AI in patient care and therapy settings.[20-24] Connelly et al. highlighted potential drawbacks of AI in healthcare, focusing on data security, privacy, and ethical concerns, urging the establishment of universal guidelines for AI's ethical use in healthcare contexts.[25] These outcomes collectively shed light on the evolving landscape of healthcare technology, emphasizing the promising potential of AI, telemedicine, chatbots, and deep learning models in improving patient care, diagnosis, treatment, and overall healthcare delivery while also addressing critical concerns regarding data security, privacy, ethics, and regulatory standards.

Strengths and Limitations

While there are numerous studies on AI applications in healthcare, the research is often fragmented, focusing on specific aspects or technologies without providing a holistic view. This fragmentation creates a gap in understanding the comprehensive impact of AI across different domains of healthcare. Rapid advancements in AI technologies over the past few years necessitate an updated review. Previous reviews might not capture the latest innovations, ethical concerns, and regulatory changes that have emerged between 2020 and 2023. By identifying current opportunities and challenges, the review provides valuable insights that can guide future research directions, inform policymakers, and help healthcare providers make informed decisions about adopting AI technologies. However, this study also has certain noteworthy limitations. The quantitative analysis in the review is based on only five studies, which may restrict the generalizability and robustness of the numerical findings. This small sample size might not fully capture the range of quantitative impacts of AI in healthcare. Moreover, AI in healthcare is a rapidly evolving field, with new developments and technologies emerging continuously. The findings of this review might quickly become outdated, necessitating continuous updates to maintain relevance.

Conclusion

This systematic literature review emphasizes the transformative potential of AI in revolutionizing healthcare services. The reviewed studies collectively highlight AI's impact across various healthcare domains, including diagnostics, clinical decision-making, telemedicine, neurorehabilitation, and vaccine research. The integration of AI technologies showed promising outcomes in enhancing accuracy, efficiency, and patient care experiences within healthcare ecosystems. However, alongside these opportunities, significant challenges such as data security, ethical considerations, bias mitigation, and regulatory standards emerge as crucial areas of concern.

Future Implications

The review emphasizes the importance of establishing universal guidelines and ethical frameworks for AI's responsible deployment in healthcare settings. Addressing these challenges is paramount to ensure patient privacy, data integrity, and fair AI-driven decision-making processes. Furthermore, the review points out the need for continued research and validation of AI-driven innovations to optimize healthcare outcomes effectively. Future research endeavors should focus on refining AI algorithms, improving interoperability among healthcare systems, enhancing data quality, and addressing societal and ethical implications comprehensively. In conclusion, AI holds immense promise in transforming healthcare delivery, improving patient outcomes, and optimizing resource utilization. However, realizing this potential requires a collaborative effort among researchers, healthcare professionals, policymakers, and technology developers to navigate challenges effectively and harness AI's capabilities for the betterment of global healthcare systems.

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Review Article

Private Sector Engagement in Healthcare Delivery in Developing Countries: A Review

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Abstract

Objective: Private sector engagement is crucial for the success of health programs, as it brings in additional resources, expertise, and innovation. The main objective of this review is to understand private sector engagement in healthcare delivery

Methodology: A descriptive case study design using an analytical framework was used. Literature from well-researched articles was reviewed. Only articles written in English language between 2012-2022 were considered if they talked about private sector engagement in health delivery. The strategy and procedure involved searching for articles using scholarly search engines, namely Google Scholar, Scopus, and Semantic Scholar.

Results: Findings demonstrated an in-depth understanding of the challenges faced by healthcare delivery in developing countries, which included 58.2% of private sector involvement by the government, 34.29% inadequate human resources, 30% inadequate budgetary allocation, and 8.45% bordering on meagre leadership and management. Employing various private sector engagement could provide resources required for strengthened health systems. During COVID-19 pandemic, it was established that four contextual factors were very critical in dealing with the pandemic. Individual features, economic crises, a weak health system, and a multi-sectoral response to COVID-19, were the main important factors established. Other contextual factors that impact the success of private sector involvement included human resource management, financial capacity, and multi-sectoral response to the pandemic

Conclusion: The private sector plays a critical role in supporting provision of healthcare but is mostly recognized only during health disasters like COVID-19 Pandemic. Challenges faced by healthcare can be addressed when steps to involve the private sector are deliberately made to garner support for provision of healthcare through Private Sector Engagement initiatives for the sustainability of health programs.

Keywords: Private Sector Engagement, Public-Private Partnership, Healthcare Delivery, COVID-19, Developing Countries.

Introduction

Private sector engagement can enhance the effectiveness and sustainability of health programs. With the many challenges faced by healthcare delivery in developing countries, private sector involvement can result in positive effect if this engagement with the health sector is harnessed properly. The aim of this review was to examine articles on private sector engagement in healthcare delivery in developing countries. In this review, the focus was to bring out information on the challenges faced by healthcare delivery, types, contextual factors, and challenges and solutions related to private sector engagement in the delivery of healthcare services. During the coronavirus disease (COVID-19) pandemic, respective governments in developing countries were seen to collaborate with the private sector in combating the pandemic. The COVID-19 pandemic has put an enormous strain on public health resources and overwhelmed health systems in countries worldwide.1 This was an ongoing global health crisis caused by the severe acute respiratory syndrome coronavirus[2] (SARS-CoV-2) and was first identified in December 2019 in Wuhan, Hubei Province, China.[2] As a result of this pandemic, the health systems were in distress, and support from the private sector was inevitable. Therefore, lessons can be drawn from how nations managed to deal with the pandemic with involvement of the private sector.

The "private sector" refers to the part of the economy that is owned, managed, and operated by private individuals, companies, or organizations rather than being controlled by the government.[3] Health equity framework is based on three core principles: prioritizing equity in health outcomes, acknowledging the diverse and interconnected factors that affect health, and adopting a historical and lifelong perspective. Health equity framework further states that health outcomes are shaped by the complex interactions between individuals and their environments.[4] Therefore, the private sector could be one important support for health programmes through effective engagement.

Private sector engagement in health programmes refers to the involvement of private businesses, organizations, multinational corporations, private firms, and individuals in activities related to the improvement and delivery of healthcare services.[5] It also involves public-private partnerships. A public-private partnership is a venture that involves collaboration between at least two partners from the public and private sectors.[6] Developing countries encounter challenges related to low budgetary allocation to the health sector, thereby negatively affecting the provision of health services. Inadequate workforce and budget, and poor leadership and management remain the main challenges faced by the health sector,[7] which has contributed to

weak health systems. Therefore, the health sector needs to find alternative funding through private sector engagement. This was demonstrated during the public-private collaboration in tackling the COVID-19 pandemic. Most governments partnered with different organizations, including the private sector, to deal with the pandemic. It is critical to understand how these governments manage to engage the private sector to effectively combat COVID-19. Few studies have been conducted to understand the role played by the private sector in tackling this pandemic. However, there is still a knowledge gap on lessons learnt and how this can be endured for sustainability of healthcare service delivery.

Healthcare has been mainly provided by the public sector; however, private sector continues to play a significant role of supplementing government efforts in ensuring quality health services are provided. To ensure quality and sustainability of healthcare provision, private sector's involvement remains critical. In developing countries, health systems remain extremely weak due to over dependence on donor funding which keeps reducing annually. Additionally, inadequate health budget allocation by respective governments has worsened the situation, resulting in weak and challenged health systems. Therefore, private sector involvement is very critical as it has been seen to bring in critical resources which can strengthen healthcare systems. To what extent has private sector played this role of bringing in additional resources for improving quality healthcare? Studies have shown that private sector played a significant role during COVID-19 pandemic but there is still inadequate information concerning aspects of private sector engagement.

The objective of this research was to review literature on private sector engagement in health service delivery during COVID-19 pandemic and draw lessons for policy and future research. What types of private sector engagement, contextual factors, challenges, and potential solutions could affect healthcare delivery in developing countries? This review aimed to provide a comprehensive understanding of how the private sector engages in healthcare delivery. This study is significant as it brings important information on the various types of private sector engagement, contextual factors, challenges, and potential solutions, particularly in the context of the COVID-19 pandemic. The findings from this review will contribute to the body of knowledge and will further interest scholars, policy makers, decision makers and researchers on ways in which health systems could be strengthened through private sector engagement. In addition, the review will establish areas that require further research to enhance private sector engagement for sustainability of healthcare service delivery.

Methodology

A comprehensive method following PRISMA guidelines was utilized to gather data from articles on private sector engagement-related health programmes. The study employed a descriptive case study approach with an analytical framework that enabled the analysis of data. The study only included articles written between 2012 and 2022. Only articles written in English language and having full text were considered if they talked about private sector engagement in health delivery. Any articles written before 2012 and after 2022 and were not written in English language, or did not contain the whole text and only abstract were excluded from this review.

The strategy and procedure involved searching for articles using scholarly search engines, namely Google Scholar, Scopus, and Semantic Scholar. Search terms were first created by employing open search methods to ascertain the possible range of literature and to experiment with different keywords. Key words included 'Private Sector Engagement', 'Public-Private Partnership', 'Healthcare Delivery', 'COVID-19', and 'Developing Countries'. Out of 60 peer reviewed articles found eligible through search engines, only 20 were included, which focused on key challenges faced by the health sector, types of private sector engagement, contextual factors, challenges, and solutions pertaining to the response to COVID-19.

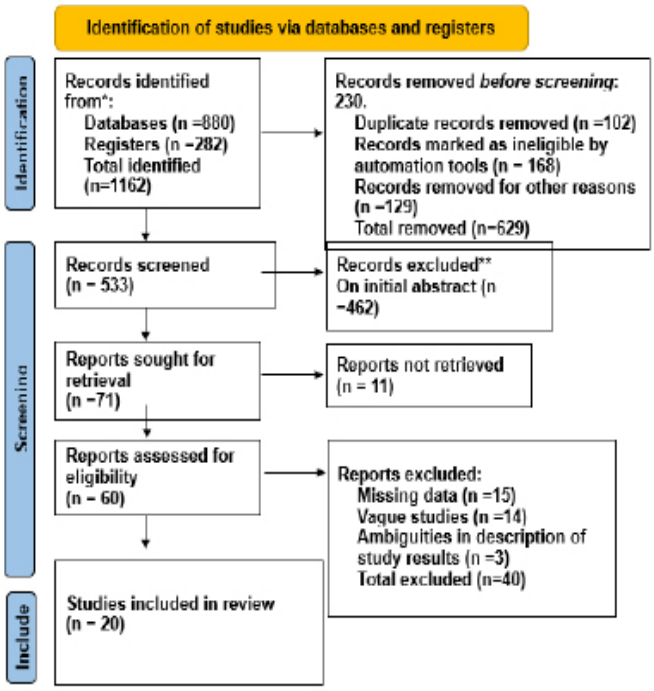

Figure 1: PRISMA Diagram Showing the Study Selection Procedure for investigating the role of Private Sector in healthcare delivery.

Data collection involved review of articles written on private sector engagement in health delivery with a focus on types, contextual factors, challenges, and solutions. This involved a review of studies conducted with the goal of reconciling conflicting research findings and identifying gaps and areas that require future studies.8 Most of the articles reviewed highlighted private sector involvement during COVID-19 and had personal biases based on the researcher's area of interest.

Data analysis involved the process of organizing the codes into themes during thematic analysis. Data collation entailed gathering the data and sorting it into appropriate subgroups. The support arising from private sector engagement from different countries were analyzed and changes based on different factors were discussed. Also, other studies relating to private sector en-

gagement contextual factors, models, challenges and solutions of private sector engagement and their effect on healthcare were analyzed and discussed.

Results

Table 1 showing Summary of Results from different articles reviewed.

Types of Public Contextual Factors	Challenges Facing the Health Sector	Engagement of Private Sector	Solutions of Private Sector Engagement
Private	1. 34.29% inadequate human resources	1. Public-private partnership	1. Features
	2. 30% inadequate budgetary allocation	2. Budgetary allocation	2. Budgetary allocation
	3. 27.26% others-budget allocation	3. Weak health system	3. Sector-wide approach
Individual			
	1. Education	2. Marketing	4. Management
	2. 8.45% bordering on meagre leadership	3. Human resources	5. Vouchers
	and management	4. Financial resources	6. Contracting out
Social			
	1. Economic crises	4. Multi-sectoral response	7. Dual practice regulation
	2. Weak health system	5. Public-private mix	8. Financial government support
		6. Capacity building and training	9. Technology systems
		7. Advocacy to ensure political	
		will and commitment	
	4. 58.2% of private sector involvement		

Key Challenges and Solutions Facing the Health Sector

The health sector faces several key challenges that have significant implications for healthcare delivery, public health, and overall well-being. From the literature reviewed, the main challenges faced by the health sector were (34.29%) inadequate human resources, (30%) inadequate budgetary allocation, and (8.45%) bordering on meagre leadership and management while the remaining (27.26%) covered others and solutions included increasing budget allocation, capacity building and training, and advocacy to ensure political will and commitment.[7] These results mirror the six building blocks for a strong and effective healthcare system by WHO.

Other studies pointed out the similar challenges faced by health sector and the need for private sector engagement as a way forward. The challenges included poor expenditure, inadequate budgetary allocation, and a lack of health financing policy as the main challenges, and the solution required private sector participation.[9] Private sector involvement by the government was inadequate and went on to suggest that the private sector should be involved in policy formulation so that they could leverage their financial resources to provide free or subsidised treatment to patients.[10] Other studies revealed that the private sector remains an important partner in providing resources that enhance healthcare. The private sector was not only the provider of financial resources but could contribute positively to development by bringing on board leadership skills necessary for sustainable development.[11] The use of PSEs can provide financial support as the private sector remains a key stakeholder in the provision of health care services.[12]

Types of Public-Private Engagement

The reviewed pointed out eight types of private sector engagement utilised in southern Africa, which included public-private partnership, social marketing, a sector-wide approach, the public-private mix, vouchers, contracting out, dual practise regulation, and financial support.[13] These approaches are commonly employed in various sectors to improve service delivery, public health, and development outcomes. Social marketing was the most popular PPEs used in southern African countries.[13]

Studies demonstrate that stakeholder engagement has positive effects on scale-up in HIV/AIDS service delivery.14 However, it is worth noting that organisational characteristics and capacities, strong interpersonal relationships built on trust, mutual respect, and effective communication, and the chosen PPP model that should align with the specific needs and challenges of the context in which it operates remain crucial factors.13 Addressing these factors thoughtfully and proactively can significantly improve the chances of success for public-private partnership initiatives in various contexts, including those in southern Africa.

Contextual Factors of Private Sector Engagement

One of the reports outlined four contextual factors, which are individual features, economic crisis, a weak health system, and a multi-sectoral response to COVID-19; these were the four main important factors established.[15] Other contextual factors that impact the success of private sector involvement include human resource management, financial capacity, and sanctions imposed by the state.[16] The study mentioned some of the wealthiest individuals in Africa, like Aliko Dangote, as having contributed huge sums of money, about $5 million US dollars, in the fight against COVID-19, motivated by selflessness and a desire to help others without any expectation of personal gain or bene-

fit.[15] Another prominent factor observed is weak health systems. Nigeria has been ranked by the WHO as number 163 out of 191 countries according to their health system report of November 2021 because the country has weak health.[17]

Studies reviewed showed that most projects had challenges providing primary health care through PPPs when they started and during the implementation stages. To overcome these challenges, the study recommended solutions related to education, management, human resources, financial resources, information, and technology systems.[12] The private sector played a critical role in increasing awareness of health education and promotion, which subsequently led to an increase in prevention and treatment services.

Challenges and Solutions of PSE

Education, management, human resources, financial resources, information, and technology systems remain the main challenges during the start-up and implementation periods of health care programs and digital tools remain the main solution.[12] The study conducted across the [4] nations (Nigeria, Democratic Republic of Congo, Senegal, and Uganda) between November 2020 and March 2021 established that private sector involvement strengthened laboratory and surveillance systems, COVID-19 case identification and management, sensitization, and health service delivery continuously.[18] Implementation of PSE increased access to and provision of treatment and prevention services in India and several African countries though studies on PPP was not included.[12]

Discussion

An analysis of the key challenges faced by the health sector in developing countries is mainly bordering on lack of financial resources and the private sector can be the solution through private sector engagement platform. This is because private sector engagement could provide the much-needed financial resources to support the health sector. Studies have shown that private sector involvement has been critical in the provision of health care, directly or indirectly through the manufacturing of materials and the supply of technology important in enhancing health programmes.[4] Moreover, the private sector plays a significant role in various aspects of education, including health education and promotion.

The private sector should be regarded as a key partner in the provision of health services because articles on the COVID-19 fight have demonstrated that they can provide the needed financial resources for combating health challenges. It was established that implementation of PSE increased access and provision of treatment and prevention services in India and several African countries.[12] Businesses and other private entities provided financial resources which increased uptake of healthcare. This is a clear demonstration that private sector engagement can provide not only resources but also increase uptake of services. Private sector engagement can take various forms, depending on the nature of the collaboration and the specific objectives of the involved parties. Each of these types of private sector engagement brings unique advantages and challenges. Governments and organizations in southern Africa and other developing countries may use a combination of these approaches to address various developmental issues and improve the well-being of their populations.

Public Private Partnerships (PPPs) have emerged as a prominent model for private sector engagement, where collaborations between public and private entities combine resources, expertise, and accountability to deliver public services and infrastructure projects.[19] The need for improved health systems including infrastructure is critical for the health sector. Furthermore, financial support from the private sector can come in various forms, such as donations, grants, or investments in development projects. Social marketing, which was reported to be most popular involves using marketing techniques to promote social and behavioral change.[13] In the context of southern Africa, this approach may be used to encourage positive health behaviors. PPP allows the government to leverage private sector expertise and resources to improve service delivery.[20]

Each of these types of private sector engagement brings unique advantages and challenges. Governments and organizations in southern Africa may use a combination of these approaches to address various developmental issues and improve the well-being of their populations. Therefore, there is a need to create a platform where the private sector can be engaged on a regular basis for the sustainability of healthcare delivery.

Contextual factors play a significant role in private sector engagement, especially when it comes to facilitating the mobilization of resources for various initiatives. These factors create an enabling environment that encourages private sector entities to invest, participate, and contribute to projects and programs. It is worth noting that philanthropic efforts from individuals and companies, as observed during the fight against COVID-19 in Nigeria, provided additional resources for healthcare facilities, research institutions, and humanitarian organisations responding to the crisis.[15] Furthermore, most developing countries have weak health systems. The weaknesses in healthcare systems highlighted the importance of private sector engagement in filling resource gaps, expanding healthcare provision.

From the studies reviewed, it can be argued that private sector engagement can be beneficial to supporting the health systems in majority of countries globally. The private sector contributed to the COVID-19 response through engagement in surveillance and testing, management of cases, and health promotion to maintain health access.[17] Collaborations between the private and public sectors can bring together their respective strengths and resources, leading to more effective and sustainable solutions to address pressing national challenges. Having a streamlined pathway to facilitate private sector engagement with the public sector for national causes is critical.[10] From various research articles, it emerged that private sector engagement is very critical for improving health outcomes and sustaining business production. The financial support provided to the fight against COVID-19 in Nigeria resulted in the halting of tragic deaths of employees and businesses.[15] It also prevented loss of productivity by ensuring

the preclusion of the spread of COVID-19 infections through adherence to the golden rules set up and implemented by both the private and public sectors through this partnership.

Overall, the public-private collaborations during the COVID-19 pandemic demonstrated the importance of a coordinated and inclusive approach to tackling global health challenges. By leveraging the strengths of each sector and working together, governments, private entities, and civil society organizations were better equipped to respond effectively to the pandemic's impact on health, the economy, and society.

Conclusion

The private sector plays a critical role in supporting provision of healthcare but is mostly recognized during health disasters like COVID-19 Pandemic. Challenges faced by healthcare can be addressed when deliberate steps to involve the private sector are made deliberately to garner support for provision of healthcare through PSE initiatives for the sustainability of health programs. Through active and enhanced private sector engagement, healthcare delivery and systems would be strengthened as established by various articles written on the response of private sector during COVID-19.

Limitations

This review was constrained by time. The three months allocated was not enough to conduct an extensive review of articles. In addition, this study relied on desk review of articles on PSE in the healthcare delivery conducted between 2012- 2023 from developing countries of Africa and Asia and did not include other studies done under other disciplines or sectors. The study only utilized articles written in English language. Examining a wide range of written articles and consulting key opinion leaders on the subject matter would have provided a broader understanding into this topic under review.

Recommendations

There is a need for further studies on what factors could motivate effective private sector engagement for the sustainability of health programs. Further, there is a need for further studies to look at the effects of private sector engagement on healthcare delivery in developing countries, considering factors such as access to services, quality of care, cost-effectiveness, and patient outcomes.

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Review Article

Role of Vitamin B12 in Mental Health Outcomes of Children and Adolescents: A Systematic Review

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Abstract

Objective: To investigate the role of Vitamin B12 in mental health outcomes among children and adolescents.
Methodology: From January-April, 2023, following PRISMA guidelines, a comprehensive search strategy was employed across databases, including PubMed, PsycINFO, Cochrane Library, and Google Scholar to identify relevant studies linking Vitamin B12 levels with mental health outcomes in children and adolescents. The initial search yielded 150 records, leading to the inclusion of 10 quantitative studies, including one cross-sectional, seven case-controls, and two systematic reviews. Parameters recorded included study design, population sample size, age of the participants, place of study, biochemical investigations conducted and mental health disorders as outcomes. The biochemical markers examined across all 10 studies included vitamin B12, folate, homocysteine, ferritin, fatty acids, inorganic phosphorus, and 25-OH vitamin D. These markers were assessed to understand their associations with various mental health disorders such as depression, anxiety, attention deficit hyperactivity disorder (ADHD), and autism spectrum disorders (ASD).
Results: Out of the 10 studies included, 6 studies reported significant improvements in symptoms of depression and anxiety with vitamin B12 supplementation. However, 4 studies found no significant association between B12 supplementation and the studied disorders. Three studies out of 6 observed lower levels of vitamin B12 in patients with ADHD and ASD compared to healthy controls, suggesting a potential role for B12 supplementation in these conditions.From the biomarkers identified, lower levels of vitamin B12 were associated with depression among children, while increased intake of certain nutrients such as fiber, omega-3 fatty acids, and vitamin B12 were marginally associated with reduced odds of aggressive behavior. Furthermore, there was a significant decrease in symptoms of depression and anxiety following supplementation with B vitamins and/or vitamin D.
Conclusion: Supplementation of B12, could help improve mental health issues like depression, anxiety, aggression, and ADHD.

Keywords: Adolescents, Children, Vitamin B12, Mental Health,Dietary Patterns.

Introduction

The developmental stages of childhood and adolescence are vital periods for mental health, shaping lifelong well-being and resilience. The World Health Organization's findings in 2021 emphasized the global significance of mental health issues among adolescents, with a substantial burden on their overall health and future prospects.[1] Unaddressed mental health challenges during these formative years can persist into adulthood, impacting various aspects of life, including academic performance and social interactions.Among the multifaceted factors influencing mental health, dietary patterns have emerged as pivotal contributors.[2] Studies highlighting the benefits of diets like the Mediterranean diet on mental and physical well-being signifies the importance of nutrition in mental health maintenance.[3] While numerous nutrients play essential roles, such as vitamin B12, obtained primarily from animal products like meat, fish, and eggs, stand out for its vital biochemical functions.Vitamin B12 operates as an important coenzyme in biochemical pathways vital for neurological and hematological health.[4] Therefore, deficiency in this nutrient can disrupt critical processes, leading to neurological symptoms and potential mental health implications.

Evidence in adults has pointed to correlations between vitamin B12 levels, dietary patterns, and mental health outcomes like depression, anxiety, and schizophrenia.[5] However, there remains a notable gap in understanding these associations in children and adolescents.The prevalence and impact of mental health disorders in this demographic, particularly concerning conditions like autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), anxiety, and depression, it becomes imperative to explore the role of vitamin B12 comprehensively.[6,7]

Thus, this systematic review investigates the existing observational studies to elucidate the relationship between vitamin B12 levels/intake and mental health outcomes in children and adolescents. By synthesizing available data, the study aims to contribute to a deeper understanding of nutritional influences on mental well-being during crucial developmental stages.

Methodology

The review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[7]

Search Strategy and Literature Review

For this systematic review, authors employed a comprehensive search strategy following the PRISMA guidelines. Electronic databases in-

cluding PubMed, PsycINFO, Cochrane Library,and Google Scholar, were systematically searched from January to May, 2023 by three authors independently.The search strategy utilized a combination of keywords including Vitamin B12, cobalamin, mental health, children, adolescents, and dietary patterns. Additionally, hand-searching of reference lists from relevant articles and reviews was conducted to identify any additional studies that met the inclusion criteria of study.

Study Selection

Three independent reviewers screened the titles and abstracts of retrieved articles identified potentially relevant studies for inclusion in this review. Full-text articles written in English were then obtained and assessed for eligibility based on predefined inclusion criteria. The review included studies that examined the association between Vitamin B12 status or supplementation and mental health outcomes in children and adolescents. Clinical trials and interventional studies were excluded from review.

The initial search yielded a total of 150 records.After removing duplicates, authors screened 100 records based on titles and abstracts, leading to the identification of 35 full-text articles for eligibility assessment. Among these, 25 articles were excluded during full-text assessment due to reasons such as inadequate data reporting, inappropriate study designs, or failure to meet inclusion criteria.Upon thorough assessment, 10 studies were deemed suitable for inclusion.

Data Extraction

Data extraction was conducted using a standardized form to capture key information from the selected studies. Information extracted included study characteristics such as author(s), publication year, study design, participant demographics (e.g., age, sample size), methods used to assess Vitamin B12 status, mental health outcomes measured, main findings, and conclusions. Where available, effect sizes, confidence intervals, and statistical significance were also recorded to facilitate data synthesis and analysis.

Data Synthesis and Analysis

Given the anticipated heterogeneity in study designs and outcomes, a narrative synthesis approach was planned for data synthesis. Findings from individual studies were summarized and synthesized to identify common themes, trends, and areas of consensus or divergence regarding the role of Vitamin B12 in the mental health of children and adolescents.

Reporting

The systematic review adhered to the PRISMA guidelines to ensure transparent reporting and methodological rigor. A PRISMA flow diagram was used to illustrate the study selection process, detailing the number of records identified, screened, assessed for eligibility, and included in the final synthesis. This comprehensive reporting approach enhances the clarity, reproducibility, and overall quality of this systematic review on the role of Vitamin B12 in the mental health of children and adolescents.

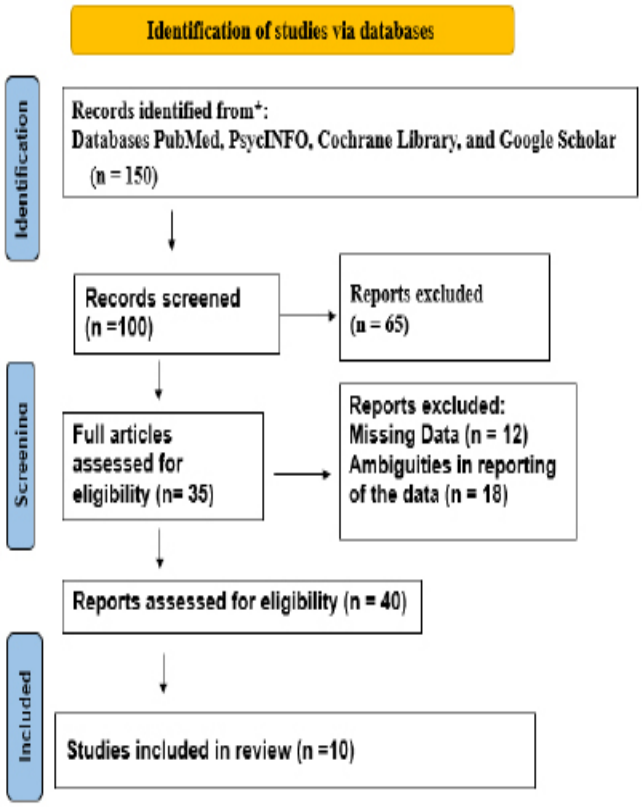

Figure 1: PRISMA Diagram Showing the Study Selection Procedure for investigating the role of Mental Health Outcomes of Children and Adolescents

Results

Out of the 10 studies included, 6 studies reported significant improvements in symptoms of depression and anxiety with vitamin B12 supplementation. However, 4 studies found no significant association between B12 supplementation and the studied disorders. Three studies out of 6 observed lower levels of vitamin B12 in patients with ADHD and ASD compared to healthy controls, suggesting a potential role for B12 supplementation in these conditions.

From the biomarkers identified, lower levels of vitamin B12 were associated with depression among children, while increased intake of certain nutrients such as fiber, omega-3 fatty acids, and vitamin B12 were marginally associated with reduced odds of aggressive behavior. Furthermore, there was a significant decrease in symptoms of depression and anxiety following supplementation with B vitamins and/or vitamin D. Moreover, the studies highlighted the potential of vitamin B12 in modulating behavioral issues, particularly aggressive behavior, when included as part of a broader dietary regimen. The impact of combined nutrient supplementation appeared more pronounced in some studies, indicating a need for further exploration into synergistic effects. Moreover, the studies highlighted the potential of vitamin B12 in modulating behavioral issues, particularly aggressive behavior, when included as part of a broader dietary regimen.

Table 10: Showing Comprehensive description of all the 10 inchluded studies

First Author	Saras-wathy[8]	Wang[9]	Esnafoglu[5]	Jamshid-nia[10]	Mohseni[11]	Sourande[12]	Erden[13]	Topal[14]	Borges[15]	Prades[16]
P-value	≤0.05	≤0.05	≤0.05	≤0.05	≤0.05	≤0.05	≤0.05	≤0.05	≤0.05	≤0.05
Out-comes	Vitamin B-12 and Folate deficiency was not significantly directly associat-ed with Depression and GAD, however indirectly significantly influenc-es the depression and anxiety through mediation of hyperho-mocysteine	Unhealthy dietary pat-terns linked to poor nutritional biochemis-try profiles and ADHD	Vitamin B12 defi-ciency or insuffi-ciency and elevated homocys-teine con-tributes to depression etiopatho-genesis	Lower level of vitamin B-12 is associat-ed with depression among children	Increased intake of simple car-bohydrates, total fat, SFAs, TFAs, and caffeine linked to increased occurrence of AB. Intake of fiber, W3, and vitamin B-12 marginally associated with reduced odds of AB	No associ-ation be-tween lower maternal Vitamin B12 levels and offspring ADHD	Lower vita-min B12 and homocys-teine levels in ASD group, no significant difference in APCA levels	Higher neutrophil levels and neutrophil/ lymphocyte ratio in ASD and ADHD groups. Neutrophil/ lymphocyte ratio correlat-ed with social interaction problems in ASD	Supple-mentation with B vitamins and/or vitamin D signifi-cantly decreased depres-sion score scales and improved symptoms of depres-sion and anxiety	Signifi-cantly lower vi-tamin B12 levels in ASD and ADHD patients vs. healthy controls; higher fo-late levels in ADHD patients post-sup-plementa-tion
Statistical Analysis	Multiple Regres-sion and Correlation Analysis	Structural Equation Model (SEM)	Descrip-tive Analy-sis and T-test	RevMen Analysis for (SMD), Odds Ratio (OR)	Indepen-dent t-test, Mann-Whit-ney test, Chi-square test, Logistic regression models	Logistic regression (adjust-ed odds ratio, 95% confidence interval)	Comparison of means	Comparison of means (neutrophil levels, neutro-phil/lympho-cyte ratio), Correlation analysis (neu-trophil/lym-phocyte ratio and social interaction problems in ASD)	Results aggregated from 20 RCTs	Meta-anal-ysis
Mental Health Disorders Studied	GAD	ADHD	Depres-sion	ASD, ADHD, Depression, Behavioral problems	Aggressive Behavior	ADHD	ASD	ASD, ADHD	Major depressive disorder (MDD), generalized anxiety disorder (GAD)	Various psychiatric disorders including ASD, ADHD
Data Col-lection Tool for Mental Disorders	Patient Health Question-naire and Generalized Anxiety Disorder scale	Clinical Ob-servation	Childhood Depres-sion Inventory, State-Trait Anxiety Inventory	Data Ex-tracted in Excel Sheet	Busse-Perry questionnaire (aggression score)	ADHD di-agnosis (cas-es), matched controls	Childhood Autism Rating Scale (CARS)	Affective Disorders and Schizophrenia for School-Age Children K-SADS-PL, Gilliam Autism Rating Scale-2 (ADHD screening)	Standard-ized rating scales (i.e. depres-sion score scales)	Clinical scales (i.e. symptom rating scales)

Biochemical Tests for Deficiency Analysis/ Interventional Supplementation	DNA extraction and MTHFR C677T gene polymorphism Analysis	Serum levels of nutritional markers (vitamin B12, folate, vitamin B6, ferritin, fatty acids, inorganic phosphorus)	Serum levels of folate, vitamin B12, homocysteine, and 25-OH vitamin D	Vitamin B12 Levels	Fiber, W3 (omega-3), vitamin B-12	Chemiluminescence microparticle immunoassay (maternal serum)	Enzyme-linked immunosorbent assay (ELISA)	Serum Levels	Blood level measurements	Serum levels of water-soluble vitamins specifically folate and vitamin B12
Micronutrient Deficiencies	Vitamin B-12 and Folate	Vitamin B12, folate, vitamin B6, ferritin, monounsaturated fatty acids (MUFA)	Vitamin B-12 and Folate & Vitamin D	Vitamin B12	Vitamin B12	Vitamin B12	Vitamin B12	Vitamin B12, Folate, Ferritin	B vitamins (folic acid, L-methylfolate, B1, B12, methylcobalamin), vitamin D	Water-soluble vitamins specifically folate and vitamin B12
Country	India	Taiwan	Turkey	China	Iran	Finland	UK	Turkey	Multiple countries	Multiple countries
Age of Participants	up to 25 Years	Elementary school children	Mean age: 15.08 (SD 1.46) for depression group, 14.41 (SD 2.32) for control group	Less than 25 Years	9-13 years old	Singleton children born in Finland (1998-1999)	Patient Group's Age (month) mean(±SD) 51.67 (23.63), Control Group's Age (month) mean(±SD) 57.94 (19.26)	School-age children	≥ 18 years old	≤ 18 years old
Population & Sample Size	303 Both Male and Female	432 (216 ADHD, 216 controls)	Depression (n=89) and healthy controls (n=43) Children and adolescents	Children and adolescents (56 studies with 37,932 participants)	Adolescent girls (primary school students) 212 (106 with aggressive behavior, 106 healthy)	Singleton children born in Finland (1998-1999) with ADHD cases and matched controls (1026 cases, 1026 controls)	Children with ASD and controls (69 (36 ASD, 33 controls)	Children with ASD, ADHD, and Healthy Controls (203 ASD = 72, ADHD = 61, HC = 70)	Patients ≥ 18 years old with (MDD), (GAD), or depressive and anxiety symptoms (20 RCTs, 2,256 subjects)	(CAD) with psychiatric disorders [42 articles, 29 examining (ASD)
Research Design	Cross-sectional Study	Case-Control Study	Case-control Study	Systematic review and meta-analysis	Case-control study	Case-control study	Case-Control Study	Case-Control Study	Systematic review of (RCTs)	Systematic review and meta-analysis

Discussion

This systematic review involved 10 quantitative studies, including one cross-sectional, seven case-controls, and two systematic reviews(Table 1, figure 1).The primary findings highlighted that vitamin B-12 and folate deficiencies were not directly linked to depression and Generalized Anxiety Disorders.However, they did indirectly influence these conditions, particularly depression and anxiety, through the mediation of hyperhomocysteinemia. [8-13] This suggests a complex interplay between nutritional deficiencies and mental health markers. Some studies also highlighted the significant impact of unhealthy dietary patterns on poor nutritional biochemistry profiles, notably in relation to ADHD.[17,18] It also pointed out that vitamin B-12 deficiency coupled with elevated homocysteine levels might contribute to depression's etiopathogenesis, offering insights into potential mechanisms underlying mental health disorders.

The studies included in this review encompassed a diverse range of methodologies for data collection and analysis. Clinical observations using tools like the Childhood Depression Inventory and State-Trait Anxiety Inventory complemented biochemical tests such as DNA extraction and MTHFR C677T gene polymorphism analysis.[5,10,13,14] Additionally, serum levels of various nutritional markers including vitamin B12, folate, vitamin B6, ferritin, fatty acids, inorganic phosphorus, and 25-OH vitamin D were measured to assess micronutrient deficiencies and their implications.[8] The study's scope extended across different countries such as India, Taiwan, and Turkey, covering age groups ranging from elementary school children to adults aged upto 25 years of age. Sample sizes were diverse, reflecting populations with depression, ADHD, and controls. Various research designs including cross-sectional studies and case-control studies were employed, with different authors leading the investigations.[15] The reported p-values ≤0.05 across analyses suggest statistically sig-

nificant findings, reinforcing the robustness of the associations identified. Overall, the study's detailed approach sheds light on the multifaceted connections between nutritional status, dietary patterns, and mental health outcomes, contributing valuable insights to the field of psychiatric and nutritional research.

Through these studies, it was observed that lower levels of vitamin B-12 were associated with depression among children, highlighting the potential impact of nutritional deficiencies on mental health. Additionally, the study revealed that increased intake of simple carbohydrates, total fat, saturated fatty acids, trans fatty acids , and caffeine was linked to a higher occurrence of aggressive behavior.16Conversely, higher intake of fiber, omega-3 fatty acids (W3), and vitamin B-12 showed a marginal association with reduced odds of AB, emphasizing the importance of dietary patterns in behavioral outcomes.[10]

Moreover, lower vitamin B12 and homocysteine levels were observed in the ASD group, , indicating specific patterns of nutrient deficiencies in ASD individuals.[14] The statistical analyses of the studies investigated in this review included RevMen Analysis for Standardized Mean Difference and Odds Ratio , as well as independent t-tests, Mann-Whitney tests, Chi-square tests, and logistic regression models, highlighting a robust methodological approach to assess associations and differences across various variables.

The review focused on mental health disorders such as ASD and ADHD, depression, and behavioral problems, employing tools like the Busse-Perry questionnaire for aggression scores, ADHD diagnosis protocols, and the Childhood Autism Rating Scale for assessing autism symptoms. Biochemical tests for deficiency analysis and interventional supplementation included measuring vitamin B12 levels and utilizing assays such as chemiluminescence microparticle immunoassay and enzyme-linked immunosorbent assay. With a diverse participant demographic including populations from China, Iran, Finland, and the UK across different age groups and research designs such as systematic meta-analysis and case-control studies led by various authors, the study provides valuable insights into the complex relationships between nutrition, mental health, and behavioral outcomes. Furthermore, the higher neutrophil levels and a higher neutrophil to lymphocyte ratio were observed in groups with ASD and ADHD.[14] The study also found that the neutrophil to lymphocyte ratio correlated with social interaction problems specifically in the ASD group, indicating a potential biomarker for social difficulties in ASD. Moreover, supplementation with B vitamins and/or vitamin D led to a significant decrease in depression scores and improvements in symptoms of depression and anxiety, highlighting the therapeutic potential of these nutrients in mental health management.The analysis also revealed significantly lower levels of vitamin B12 in ASD and ADHD patients compared to healthy controls, alongside higher folate levels in ADHD patients post-supplementation, leading to a decrease in symptoms. These findingshighlights the importance of micronutrients like vitamin B12 and folate in mental health outcomes and the potential benefits of targeted supplementation strategies.[11] The study focused on a range of mental health disorders including ASD, ADHD, MDD, GAD, and depressive/anxiety symptoms, utilizing standardized rating scales and clinical assessments for data collection. Biochemical tests for deficiency analysis and interventional supplementation encompassed serum levels measurements, blood level measurements for micronutrients like vitamin B12, folate, and ferritin, as well as interventions with various B vitamins, vitamin D, and water-soluble vitamins.[12] Therefore, the study included participants across different age groups and regions, reflecting a diverse population and enhancing the generalizability of the findings. Various authors contributed to this research effort, bringing together a multidisciplinary approach to understanding and addressing mental health challenges through nutrition.

Strengths and Limitations

This review highlightsthe therapeutic potential of targeted nutrient supplementation in managing mental health conditions, particularly in cases where deficiencies or insufficiencies are identified.Furthermore, the research identified potential biomarkers such as neutrophil to lymphocyte ratios correlating with social interaction problems in conditions like ASD and ADHD. These biomarkers offer insights into underlying physiological mechanisms and potential avenues for targeted interventions or monitoring strategies. However, this review has certain limitations. With an inclusion of only 10 studies, and even those with three different study designs might have led to biases and inability to establish robust causation. The sample sizes with these 10 studies varied considerably, from very limited to enormous, and that too could have lack of ability to detect association between inadequate levels of B12 on mental health. The heterogeneity among the sample population, settings, and methodologies. Confounding factors, such as genetic, environmental, social, and other nutritional influences, were challenging to control. Publication bias might have favoured positive findings. Moreover, accurate assessment of dietary intake is difficult, potentially leading to misclassification of Vitamin B12 status. Additionally, the broad age range and different developmental stages of children and adolescents were not specifically addressed in this review. Also worth mentioning is the lack of contemplation of the long-term effects of Vitamin B12 status on mental health through this review. Further studies are advised to investigate these gaps, to further strengthen the impact of Vitamin B12 on mental well-being of children and adolescents.

Conclusion

Lower levels of Vitamin B12 were found to be associated with depression among children. Supplementation of B12, could help improve mental health issues like depression, anxiety, aggression, and ADHD. This highlights the potential impact of nutritional deficiencies, specifically in essential vitamins like B12, on mental health outcomes, particularly in younger populations. Dietary patterns and intake were also significant factors influencing mental health outcomes. Increased intake of certain nutrients such as fiber, omega-3 fatty acids (W3), and Vitamin B12 showed marginal associations with reduced odds of aggressive behavior (AB) and improved symptoms of depression and anxiety.

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Short Communication

The Yin and Yang of Artificial Intelligence

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Abstract

Artificial Intelligence holds the ability to transform medical education by improving the efficiency of training programs, enabling personalized learning, and providing new tools for evaluation and assessment. However, with any new technology, there are also potential risks and concerns that must be acknowledged. The use of AI in medical education raises concerns about privacy, ethical dilemmas, and the possibility of biased algorithms. It is vital to be aware of these potential threats and work to reduce them to ensure that AI is used in an ethical and responsible manner. By doing so, the potential benefits of AI in medical education can be enhanced while minimizing its drawbacks.

Keywords: Artificial Intelligence, Medical Education, Yin and Yang

Introduction

Artificial Intelligence (AI) is a rapidly growing field that involves the maturing of computer systems and algorithms that can perform tasks that generally require human intelligence. It has the capability to revolutionize many aspects of our lives, from healthcare and education to transportation and finance and many other fields. By using machine learning algorithms and large amounts of data, AI systems can learn from experiences and make predictions, decisions, and recommendations based on that knowledge. This has led to development of intelligent systems that can perform tasks such as image recognition, natural language processing and even autonomous driving. A recent study by Jungwirth D in 2023, explains how AI can be used to forsee student performance, identify knowledge gaps, and personalize learning experiences.[1] Literature shows that combining AI capabilities with IT strategy is important for digital transformation in recent times, when innovative and routine AI techniques are used together, they work better than when used independently. Despite the benefits of AI, there are also concerns about the potential negative impact of AI on society, including job displacement, privacy, and ethical considerations. As AI continues to evolve and become more widespread, it is very important to consider these issues and work to ensure that AI is used in a responsible and ethical manner.

AI can be used to revitalize education by offering personalized and individualized instructions, automated grading and feedback, improved student assessment, and increased engagement through interactive learning. Mentioned below are some of the potential benefits of AI.

Potential benefits of AI

AI has the ability to automate repetitive tasks, resulting in time and resource savings for various industries, including education, healthcare, finance and manufacturing. This can increase efficiency and productivity. For example, AI can simplify patient data management and minimize the workload of medical personnel in healthcare, allowing them to focus on providing better care. AI can also transform the healthcare industry for example in radiology, as it can improve disease diagnosis, develop personalized treatment plans, and advance drug discovery. In a study by Dileep and Gyani (2022),[2] the significance of AI was emphasized by highlighting a system that can detect breast cancer up to five years earlier than mammogram, potentially saving lives through early intervention.

Medical students learn more smartly and actively by analyzing their learning patterns and adapting to their individual needs. For example, AI-powered platform called Osmosis, uses algorithms to personalize learning content and assessments based on the individual's learning pace and preferences.[3] It can significantly help commitees to make informed decisions by analyzing large amounts of data in real time and to highlight insights and patterns that may not be apparent through traditional methods, leading to better decision-making.

AI can be used to provide personalized learning experiences, tailoring the curriculum to individual needs and abilities of each student which can definitely lead to improved student engagement and better learning outcomes. The implementation of AI can offer better accessibility in learning and identification, specifically for students with disabilities. For example, AI-led technologies can be used to provide real time captions or audio descriptions for students who are deaf or visually impaired. A study published in the Journal of Educational Computing Research in 2022, discussed the use of AI-powered speech recognition software for providing real-time captioning for deaf students in a classroom.[4] The study mentioned that use of AI-powered captioning software improved the students' participation

and engagement in class discussions.[3,4]

By implementing AI technology, grading and providing feedback to students can be automated. This can help teachers save time and effort, freeing them up to concentrate on other responsibilities. A study on "Automated Feedback in Online Courseware" explores the impact of automated feedback on student learning outcomes and provides examples of how AI algorithms can be used to provide one to one feedback to students, which help them identify areas for improvement and enhance their learning experience.[5] A study published in the Journal of Computing in Higher Education examined the use of an AI system called an e-rater for scoring essays. The study found that the e-rater system produced scores that were comparable to human scorers and provided more reliable and consistent feedback.[6]

Utilizing AI can facilitate the immersive and captivating learning opportunities that motivate, sustain students' attention and drive their enthusiasm. For example, virtual tutors can provide support and personalized feedback to students, making the learning experience more enjoyable and interactive.[7]

Moreover, AI can enable educators to gain data-based insights into students' learning, empowering them to make well-informed choices regarding their teaching approaches.8 This can help teachers improve their skills and provide better learning experiences for students.

Risks of AI

AI has the potential to greatly benefit society, but it also presents significant threats that need to be addressed. Some of the main threats include loss of jobs and privacy concerns. Automation through AI has the ability to displace many jobs, particularly in industries such as manufacturing and retail. This could lead to unemployment at a vast scale, and it is important for organizations and governments to consider and address this potential impact.[8]

AI systems can perpetuate and amplify existing biases in society, leading to unfair treatment of certain groups. AI systems are only as unbiased as the data they are trained on, and if that data reflects societal biases, AI systems can perpetuate and magnify those biases. This can result in unfair treatment of certain groups, such as racial or gender discrimination. A study by Gebru highlights how facial recognition algorithms can be biased and inaccurate, particularly when it comes to classifying people of different genders and races. It shows that these biases can have real-world implications, such as the potential for misidentification by law enforcement agencies.[9] It's important for industries and organizations to consider and address these potential assumptions in their AI systems to ensure they are not causing harm.

AI systems often use and collect large amounts of personal data, which raises privacy and security concerns. This data can be vulnerable to breaches, misuse, or exploitation, and individuals may not be fully aware of how their data is being used and in which setting. It's important for all organizations to ensure they are transparent in data collection practices and are protecting the privacy of individuals by issuing guidelines and policies.[9]

Darker side of AI

It can be difficult to determine who is responsible when AI systems cause harm, leading to a lack of obligation. In 2018, it was identified that data analytics firm Cambridge Analytica had harvested data from millions of Facebook without consent of users, using the data to influence political campaigns around the globe.[9] Despite the notable harm caused by the company's actions, no one has been held criminally responsible for the data breach or the misuse of personal data in this case. It's important for governing bodies to consider and address this possible lack of accountability as AI systems become vaster.

Overreliance on AI systems in medical education can reduce students' critical thinking, problem-solving, and creative skills. Students may also become passive learners and rely on AI systems to make decisions for them, which can lead to reduced self-reliance and decreased motivation to learn.[10]

AI systems used in medical education brings up some difficult ethical and legal questions, such as accountability for mistakes and malfunctions, ownership of information, and rights to intellectual property. Buja tackled the ethical issues that develop in the domain of medical education research, he talked about the potential risks to patient privacy and the need for transparency in the use of AI and other technologies in medical education.[11] There are also many ethical issues about the use of AI systems for delicate and important tasks, such as diagnosis, medical care, and surgery, which might have great impact on patients.[11]

The acceptance and adoption of AI in medical education may be met with resistance from educators, students, and healthcare professionals who are used to traditional teaching methods and may be unsure of the potential benefits of AI. To overcome, this resistance can be a significant challenge and may need effective training and communication of the advantages of AI.

Conclusion

It is essential to tackle these risks actively, through regulation, education, and the development of ethical AI practices. Addressing the threats posed by AI proactively is important to ensure that AI is developed and used in a way that benefits society and minimizes problems. This can be achieved through regulation, guidance, and the development of rigorous ethical AI practices. Regulations can help to ensure that AI systems are transparent, accountable, and secure.

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- All authors have seen and approved the manuscript as submitted.
- E-mail and postal addresses of all authors have been entered below in the form correctly.
- The manuscript has not been published and is not being submitted or considered for publication elsewhere.

Date								

Place of study	

Author Sequence	**Name**	**Email ID**	**Signature**	**Author's contribution**
1st				
2nd				
3rd				
4th				
5th				
6th				

Corresponding Author